Alcoa

2017

Wagerup Alumina Refinery

Long Term Residue Management Strategy (LTRMS)

Revision	Date Issued	Reviewed By	Approved By	Date Approved	Revision Type
Draft	12 April 2019	A Wall	A Gilbert	31 March 2019	Draft for SRG and Alcoa Internal Review
Final Draft	17 December 2019	A Wall	A Gilbert	17 December 2019	Draft for RPLG Review
Final	9 April 2020	J Zimmerman	A Gilbert	9 April 2020	Final Document

Long Term Residue Management Strategy

Wagerup 2017

Alcoa

Contents

Executive Summary

The Wagerup Long Term Residue Management Strategy (LTRMS) was initially developed to meet Ministerial Conditions applied to the Wagerup Unit Two Expansion in 1990. As part of its commitment to sustainable operations, Alcoa has continued to develop long-term and closure management plans for bauxite residue deposits.

In order to keep the plan current it is reviewed and updated on a five yearly basis. This LTRMS represents the fifth published strategy for Alcoa's Wagerup Alumina Refinery.

A reference group of key stakeholders including community members, local and state government and Alcoa representatives, actively participated in the development of the strategy over a three month period from August-October 2017. The majority of the LTRMS content reflects presentations to, and outcomes from, the Stakeholder Reference Group (SRG) process.

The LTRMS is a reflection of current knowledge, technology and regulatory standards. It is not intended to provide detailed engineering information for future residue management.

Purpose of LTRMS

The LTRMS document is designed to inform local and state governments, as well as the wider community of Alcoa's long term management strategies and commitments for a sustainable future in residue management. In particular it outlines the current short term (5-7 years), mid-term (25 years) and life-of-mine (2045) management strategies for residue at Wagerup Refinery, including issues such as:

- where future residue infrastructure areas will be located,
- the proposed height requirements for the residue drying areas, and
- how environmental risks associated with residue storage will be managed.

The LTRMS also addresses closure of the residue storage area, future land use options for the residue storage area after closure and current research into residue management, re-use and revegetation. It is not intended to duplicate documents or processes already in place to address current operational management issues. These issues are managed via the Environmental Management System (EMS) and Environmental Improvement Plan (EIP) processes.

This report is designed to enable stakeholders to review both the longer-term strategy and those projects on the immediate planning horizon. The LTRMS is anticipated to address the key information requirements of the planning and approval mechanisms for the five to seven year period to which it relates, so that endorsement of this document by the Residue Planning and Liaison Group (RPLG) and Ministers for State Development and Environment ensures streamlined approvals processes. Similarly, endorsement of the 25-year and life-of-mine planning footprints is designed to provide a basis for approval applications required for the longer term. The outcomes of this LTRMS will also be incorporated into the ongoing planning processes for the Wagerup residue area.

Consultation and Key Issues

The contents of this document are based on issues and information discussed during consultation with the SRG. The purpose of consulting broadly with the community and government stakeholders in the development of the updated LTRMS was to:

- have stakeholders directly involved in the planning process,
- ensure that the concerns and queries of the local community, local governments and regulatory authorities were considered, and
- ensure Alcoa's responses to these issues were transparent and documented.

A summary of the SRG's deliberations was provided in the form of 30 Guiding Principles for Alcoa to consider in the development of the LTRMS. These were developed for environmental and social issues considered particularly significant by the group and include:

- residue reuse,
- dust management,
- odour,
- oxalate management,
- water use,
- groundwater management,
- alternative residue storage techniques,
- separation distance and height,
- visual amenity, and
- residue closure.

These Guiding Principles, together with Alcoa's responses, are documented in Section 10.

Residue Footprint Options

The ultimate land area used for residue storage will be affected by:

- the volume of residue requiring storage,
- the rate at which residue is produced,
- the residue drying treatment utilised, and
- the way the residue stack is constructed.

The most significant factor affecting the final volume of residue requiring storage is the availability of alternative uses for residue.

The other significant factor affecting the size of the final footprint of the residue area is the stack design. Specifically the height to which the stack can be created, while providing the required open area for drying or storage, defines the minimum residue footprint that can be achieved. Alcoa believes that many sustainability aspects of its residue operations (social, environmental and financial) are improved by seeking to minimise the final footprint of the residue area. Minimising the potential land area affected by residue can contribute to:

- a smaller residue area footprint from which groundwater contamination could potentially occur,
- a reduction in contaminated runoff water requiring treatment and discharge after refinery closure,
- less surface area requiring rehabilitation, and
- greater separation between residue and neighbouring properties.

If not properly managed, the following social and environmental aspects of minimising the final footprint have potential to be negatively impacted:

- structural stability of a higher residue stack,
- visual amenity of a higher residue stack, and
- dust emissions associated with higher wind speeds at increased stack heights.

A minimised footprint is being sought by alternative technologies and research and commercialisation efforts into residue reuse options, as well as opportunities to reduce the active drying area requirements for residue mud. In addition, the design of the residue stack is optimised wherever possible to ensure the most efficient use of land.

Alcoa is currently undertaking the comprehensive residue management planning processes for the short-term (5 year), medium term (25 years), and life of the current mining lease (life-of-mine, 2045). These planning processes give consideration to the guidance provided through the LTRMS SRG process.

For the purposes of this planning process, the life-of-mine is considered the life of the current lease (2045). However given the capacity of the mine and renewal options on the bauxite lease, at present the exact date of closure and volume of residue requiring storage remains uncertain.

Constraints on Forward Planning

Despite the level of effort which goes into forward planning, significant changes in direction are occasionally required as a result of a range of factors, including:

- changes in technology,
- changes at the refinery affecting the rate of production,
- changes in quality of bauxite and/or characteristics of residue material streams (the drying area required can be affected by small changes in the percentage of mud in the residue, with higher percentages of mud requiring a greater drying area),
- weather conditions along with long term weather and climate forecasts, in so far as they can affect mud drying rates and the construction schedules of new residue areas,
- diversion of the residue stream for other uses,
- input from the community and regulatory agencies while obtaining the necessary statutory approvals for new residue areas,
- internal funding availability, which is influenced by a number of factors including the global aluminium market, and
- the availability of key equipment and contractors.

The plans presented in this LTRMS are therefore subject to change. The five yearly review process is designed to allow these changes and their impact on long term planning for the residue area to be reviewed with key stakeholders. In the event that a significant change will impact the five to seven year plan presented in this document, additional consultation may be required.

The LTRMS will also be reviewed in accordance with Ministerial Statement No. 728 condition 13 requirements, if construction works to expand the refinery as outlined in the Ministerial Statement, are scheduled to commence. This includes consultation and an independent peer review.

Short-Term Construction Strategy

Key issues to be managed within the five year time frame are:

- maintaining the residue storage capacity to meet the requirements of the refinery,
- maintaining the water storage, surge capacity, cooling and process water supply functions for the refinery, ensuring they can service the RSAs, and
- relocation of infrastructure required to support the provision of adequate residue water storage capacity.

Life-of-Mine Strategy

The key issues to be managed during operations are:

- maintaining the residue storage and drying capacity to meet the requirements of the refinery, and
- maintaining the water storage, surge capacity, cooling and process water supply functions for the refinery, ensuring they can service the increased residue area.

Assuming current production rates, up to 250 hectares of additional drying area is required by 2045. It is currently envisaged that this additional drying area required will be met through development of greenfield drying areas.

Residue Filtration

Alcoa is proud to be leading the large-scale application of residue filtration in the alumina sector. The process forces bauxite residue through large filters that squeeze the water from the mud. The resulting filter cake has a moisture content low enough to allow for conveying and stacking.

Alcoa's first filtration facility is fully operational at Kwinana Alumina Refinery (see Figure A) and a second facility has just been commissioned at Pinjarra Alumina Refinery.

Filtration provides further environmental benefits including a significant reduction in water and energy use, as well as improved deposit stability, which reduces the long risks of storing residue. Critically, it also significantly reduces the amount of land required to store residue which is an important sustainability driver for Alcoa.

It is currently envisaged that feasibility studies for introducing residue filtration at Wagerup Refinery will be conducted during the coming five year period, however this is subject to change.

Figure A: Kwinana Refinery Residue Filtration Facility.

Closure Strategy

The process of defining the closure strategy will be ongoing, recognising that it will be many years before closure, and that available technology and community attitudes at the time may have changed.

The current closure strategy has three main objectives; that decommissioned residue areas should have the capability to be used for productive community benefit, be safe and self-sustaining in the long-term, and allow future access to bauxite residue for alternate uses. Key considerations at closure relate to the final form of the residue area, management of contaminated stormwater, management of leachate and final land use. The current closure strategy aims to rehabilitate the residue area to allow it to be used for a range of activities for future generations.

Ongoing Stakeholder and Community Engagement and Review Schedule

The LTRMS will be periodically reviewed. The frequency of these reviews is determined in conjunction with the Residue Planning Liaison Group and is currently five yearly. The process of future stakeholder consultation is anticipated to be similar to that undertaken in this review.

Concluding Remarks

The development of this LTRMS has been a constructive means of engaging the community. Alcoa is very appreciative of the SRG members who provided a considerable amount of personal time and commitment to help inform the LTRMS.


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Introduction 1

1.1 Background and Site Overview

In Western Australia, Alcoa owns and operates alumina refineries at Kwinana, Pinjarra and Wagerup, with a combined capacity of approximately nine million tonnes per annum (mtpa), equivalent to around 45% of Australian production and more than 10% of world demand.

The company also operates bauxite mines at Huntly and Willowdale in the Darling Range, south of Perth. A map of Alcoa's operations in Western Australia is provided in Figure 1-1.

Alcoa's Wagerup Alumina Refinery is situated 120 kilometres south of Perth, 2.5 kilometres north of Yarloop and approximately 7 kilometres south of Waroona. The refinery is positioned close to the foot of the Darling Scarp and is separated from the refinery's residue area by the South West Highway and the Perth-Bunbury railway line. The land surrounding the Wagerup Refinery and residue area is predominantly operated as a beef farming enterprise by Alcoa's Farmlands operations.

Wagerup Refinery commenced operations in 1984 producing 700,000 tonnes of alumina per year. Production capacity was increased to 1,750,000 tonnes of alumina per year in 1990 and further expanded to 3.3 million tonnes per annum in 1995. The proposed Unit Three Expansion has been approved by the Environmental Protection Authority (EPA) and State Government and has the potential to lift capacity to 4.7 million tonnes per annum. Although approval has been given, the expansion plans are currently on hold due to the challenging economic environment and the need to secure energy supplies.

Bauxite is supplied to the refinery by overland conveyor from Alcoa's Willowdale bauxite mine located 15 kilometres to the east. Alumina produced at Wagerup Refinery is transported by rail to Alcoa's Bunbury shipping terminal and then exported to overseas markets or to Alcoa's aluminium smelters in Victoria. The bauxite is low grade by world standards, requiring three tonnes of bauxite to produce one tonne of alumina. As a result, large volumes of bauxite residue are generated and stored in bauxite residue storage areas (RSAs) west of the refinery.

1.2 Purpose of the Long Term Residue Management Strategy

This Long Term Residue Management Strategy (LTRMS) document is designed to inform both the local and state government and the community of Wagerup Refinery's long term residue management strategy and associated commitments. The contents of this document provide information on the issues requiring consideration in the management of bauxite residue and Alcoa's strategies in relation to future residue facilities.

A reference group of key stakeholders including community members, local and state government and Alcoa representatives, actively participated in the development of this LTRMS during a three month period. The majority of the document's content reflects presentations to, and outcomes from, the Stakeholder Reference Group (SRG), with additional contextual information provided as required.

The LTRMS is a reflection of current knowledge, technology and regulatory standards. The document is not intended to provide detailed engineering information for future residue management.

1.3 Structure of Report

The contents of the key sections of this report are outlined below:

Section 2: Background and history to the development of the LTRMS and the evolution of the stakeholder engagement process to support its development.

Section 3: Overview of Wagerup Refinery's operations and the alumina refining process.

Section 4: Bauxite residue characteristics, design and construction of storage areas, and current residue research and development activities.

Section 5: Social and economic setting in which the Wagerup Refinery operates.

Section 6: Environmental, heritage and planning setting of the Wagerup Refinery site.

Section 7: Environmental management strategies for residue storage, changes in management since the last LTRMS review, impacts and management of an expanded footprint.

Section 8: Short, medium and life-of-mine residue development strategies, focusing on major infrastructure requirements and projects for each period.

Section 9: Alcoa's closure strategy and future land use options.

Section 10: Guiding Principles for residue management as developed through the 2017 Wagerup Refinery LTRMS Stakeholder Reference Group process.

Section 11: Glossary of terms, units and terms.

Section 12: References.

Figure 1-1: Location map.

2 Background and History of the LTRMS

Alcoa is committed to keeping the local community and other stakeholders informed about the progress of the LTRMS and the Guiding Principles.

2.1 Initial LTRMS Development

As part of the 1989 Consultative Environmental Review (CER) for the Wagerup Unit Two Expansion, Alcoa agreed to develop long-term and closure management plans for residue deposits in consultation with relevant state government agencies, as well as to submit design reports and monitoring results from the RSAs to the then Water Authority of Western Australia (WAWA). In March 1990 the Minister for the Environment authorised the proposed expansion, subject to certain conditions including the development of a satisfactory "walk away solution" for the residue deposits.

In response to these conditions the Residue Planning Liaison Group (RPLG) was formed in 1992. The role of the RPLG was to facilitate the planning activity and to review and endorse the plans developed by Alcoa for submission to the Minister for State Development and the Minister for the Environment. The RPLG initially had membership from the Department of Resources Development (chair), Department of Environmental Protection, Water and Rivers Commission, Department of Minerals and Energy, Ministry of Planning, Agriculture Western Australia, The Peel Development Commission, Department of Conservation and Land Management, and Alcoa.

The RPLG agreed to the following main elements of the LTRMS:

- identification of the major stakeholders in the planning process and a listing of the key issues of concern to them,
- discussion of the key issues, the environmental concerns stemming from them, and the current and recommended future management strategies to address them,
- conceptual plans for the expansion of drying facilities over the 50 year planning period,
- recommendation of a closure strategy for the deposits which satisfies, as far as possible, the concerns of the major stakeholders, and
- analysis of the gaps between the current situation and the desirable end condition and thereby identify improvement opportunities and research and development needs.

In addition, the RPLG agreed on a process and schedule (five yearly) for review of the LTRMS. Alcoa voluntarily agreed to extend this process to the Pinjarra and Kwinana Refineries. During the development of the draft LTRMS for Wagerup, Alcoa submitted another Consultative Environmental Review (CER) for a further expansion of the refinery's production capacity to 3.3 million tonnes per annum. This CER reinforced Alcoa's existing commitments to residue management with minor rephrasing of existing conditions to take into account the processes put in place since approval of the 1989 CER, such as the formation of the RPLG.

In August 1995 the expansion of the Wagerup Refinery was authorised by the Minister for the Environment. The Minister's statement (Number 390) replaced the earlier 1989 Ministerial conditions with expanded and clarified conditions related to long-term residue management. These required Alcoa to:

- develop a closure strategy and long-term management plan for the residue storage areas at Wagerup in consultation with the RPLG, to the satisfaction of the Minister for Environment,
- report annually on progress towards developing the closure strategy,
- implement the closure strategy to the satisfaction of the Minister for Environment (the timing of implementation shall be determined on advice from the Minister responsible for administering the Alumina Agreement Act), and
- periodically review the long-term management plans for the residue deposit in consultation with the RPLG.

The Wagerup Refinery LTRMS was developed in 1995 as a single document to meet the requirements of both the long-term management plan and closure strategy for the residue area. In order to complete the closure strategy, a detailed study was undertaken of the residue drying facility requirements to sustain 50 years of alumina production at the Refinery. The primary focus of the original Wagerup LTRMS (Alcoa, 1997) was on detailing the engineering elements of residue planning and closure, demonstrating sound environmental management of residue and compliance with legal and corporate requirements. A series of key technical recommendations arose through the development of the 1995 LTRMS.

The LTRMS was submitted to the RPLG in February 1996. The Minister for the Environment signed off in February 1997 that the Ministerial Condition on the closure strategy had been met.

2.2 2000 LTRMS Review

Alcoa initiated a review of the 1995 LTRMS in early 2000 as part of the commitment to the RPLG for five yearly reviews. During the review period Wagerup Refinery came under increased public focus and Alcoa recognised the need for improved community and local government involvement on bauxite residue planning. A protracted consultation process followed, which resulted in a much improved strategy with greater awareness and participation by stakeholders in Alcoa's residue planning programs. However it also caused the delays in its release, with the final report being endorsed by the RPLG in December 2003.

The following key changes to the LTRMS review process and content were endorsed by the RPLG as a result of the 2000 review:

- the Waroona Shire Council is now represented on the RPLG in recognition of the need to improve the linkage between the Council's planning approval process for individual RSAs and the LTRMS,
- the strategy's planning horizon was recommended to be reduced to 25 years, and
- the LTRMS was proposed to include more detailed facilities planning information for the 5 year review period to which it relates, to allow projects on the immediate planning horizon to be reviewed as part of the long-term strategy. This structure also aims to reduce duplication in the approvals processes by providing information necessary to support the planning and approval mechanisms for the 5 year period.

2.3 2005 LTRMS Review

Alcoa announced its intention to seek environmental approval to increase production capacity to 4.7 million tonnes per annum in 2004. A number of community working groups were established to consult on environmental and social issues associated with the expansion. A Water and Residue Working Group was consulted on the impacts resulting from expanded residue storage requirements. This group submitted a report containing their recommendations to Alcoa which was incorporated into the Environmental Review and Management Programme (ERMP).

The ERMP for the expansion, which was submitted to the EPA in May 2005, acknowledged the availability of the LTRMS review process to consult on the broader issues of residue management outside of the scope of the ERMP, such as possible alternative uses for residue. In addition, it recommended the LTRMS review process be used to consult specifically on the long-term stack height and footprint options for the expanded refinery. The increased residue storage requirements were also acknowledged in the ERMP.

This review of the LTRMS commenced in September 2005 and addressed the ERMP proposal to consult on footprint and stack height options for the expanded refinery. During the development of the LTRMS, new Ministerial Conditions were granted as part of the government's approval of the proposed expansion of the Wagerup Refinery to 4.7 million tonnes per annum. Initially, this LTRMS aimed to address the new conditions (13-1 to 13-4 of Ministerial Statement No.728), which require the LTRMS to be revised prior to commencement of construction of the expansion and for the LTRMS to be independently reviewed.

2.4 2012 LTRMS Review

The 2012 review of the LTRMS used an SRG to obtain advice and feedback on strategy options from local community, local government and regulatory authorities.

The 2012 LTRMS review addressed residue infrastructure requirements for the life of the mine (2045) as well as the 25 year footprint requirements and the 5-7 year development plan.

Key changes in environmental management and performance since the 2005 review were also presented; however the focus on routine operational environmental issues was reduced in recognition of the development of the Environmental Improvement Plan (EIP) process. The EIP process, implemented in 2006, is designed to address environmental improvement opportunities for the refinery and residue area. The EIPs for our WA operations are now reviewed triennially with local and government stakeholders.

2.5 2017 LTRMS Review

Like the 2012 review, the current 2017 review of the LTRMS used a SRG to obtain advice and feedback on strategy options from local community, local government and regulatory authorities.

However, this review addressed residue infrastructure requirements for the 5-7 year development plan and the life of the mine (2045) only, due to the similar timing of the 25 year and life-of-mine planning periods.

2.6 Sustainability

Throughout the world, sustainability drives us to minimize our impacts and maximize our value. Our current sustainability approach delivers value through the following three pillars:

- Creating sustainable value for the communities where we operate, with the aim to maintain our license to operate with opportunities to grow our businesses;
- Enhancing the value of our products through differentiation to improve our profitability; and
- Minimizing our environmental impacts and improving our health and safety performance to reduce our risk exposure.

Our long-term sustainability goals help guide our actions.

Alcoa's drive to apply these sustainability pillars is reflected in the emphasis of this document. The approach to residue management embraces stakeholder engagement, with local community and stakeholders directly involved in the planning process.

This ensures that the concerns and queries of the local community, local government and regulatory authorities, and Alcoa's response to these issues, are transparent and documented.

When making a business decision or developing a strategy, Alcoa aims to achieve simultaneous benefits across economic, social and environmental factors to achieve a net long-term benefit.

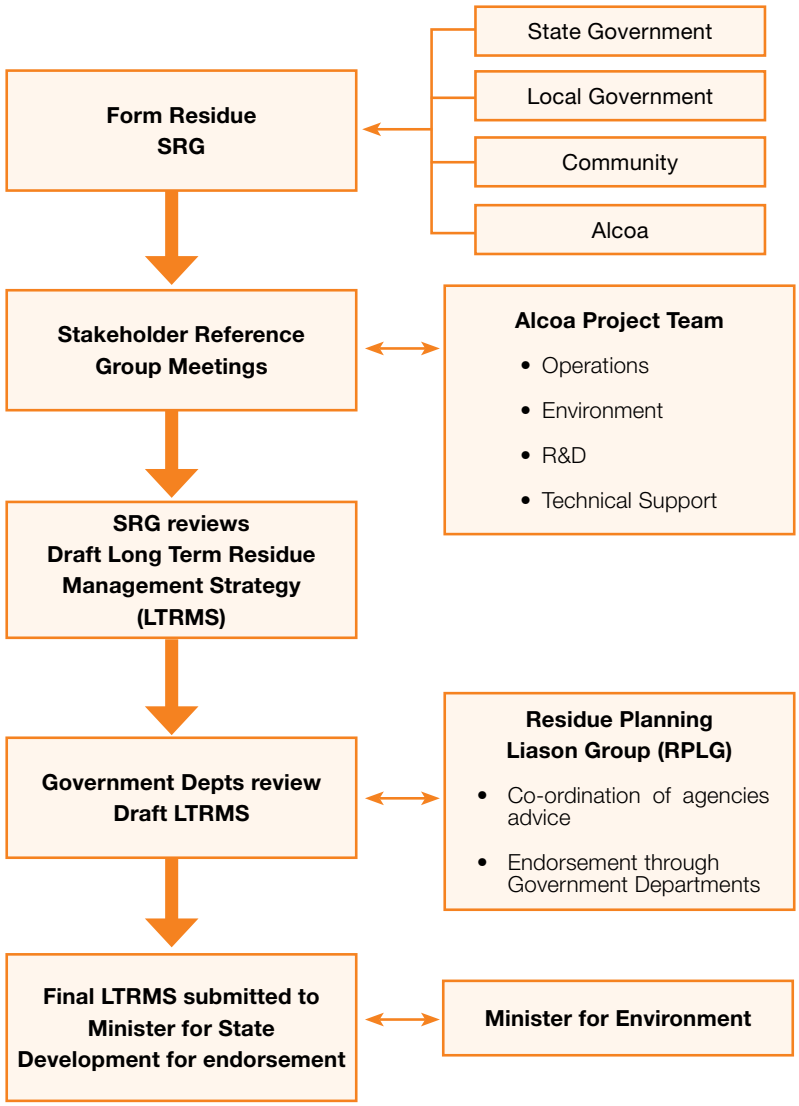

Figure 2-1: Framework for SRG participation in LTRMS development.

2.7 Alcoa's Stakeholder Engagement Process

Alcoa recognises that talking to communities, seeking input into plans, sharing environmental performance and understanding community needs is critical to maintaining its 'social licence to operate'. Consequently, a range of informal and formal consultation methods have been employed by Alcoa to involve and inform the community of the company's activities. The following section provides an overview of the current consultative groups in place at Wagerup and details of the process used to establish the 2017 Wagerup LTRMS Stakeholder Reference Group.

Figure 2-2: 2017 Wagerup Refinery LTRMS SRG Members.

2.7.1 Community Consultative Networks

Alcoa has established a Community Consultative Network (CCN) at Wagerup to provide an interactive and open forum that enables members of the community and Alcoa to freely discuss topics and issues relevant to Wagerup Refinery operations and the communities.

CCN is an open forum with all members of the community welcome to attend. Representatives from the towns of Yarloop and Waroona, and Local Government regularly attend these meetings. The CCN meets with Wagerup Refinery management and representatives on a bi-monthly basis with an expectation that information obtained through the CCN is then shared with their wider community networks. Minutes of meetings are published in the local newspaper.

2.7.2 Environmental Improvement Plan (EIP) Consultation Process

EIPs represent Alcoa's public commitment to continuously improve environmental performance, reduce environmental impacts and develop more sustainable operating practices. In WA, Alcoa has voluntarily committed to produce EIPs. In many cases, the commitments within the EIPs go beyond the environmental management requirements specified in Alcoa's formal licence conditions.

Wagerup Refinery released its first EIP in 2006. These plans are periodically updated to monitor progress against commitments and continuously improve our performance. The plans are currently updated triennially.

Alcoa recognises that input from stakeholders is vital, which is why several sectors of the community assist in the development of the EIPs. New environmental targets, aims and actions were established for the current EIP in consultation with the Wagerup EIP SRG which includes community members, Alcoa employees and local Government representatives. The EIP sets clear targets for improvement and outlines the actions and initiatives to be implemented to achieve those targets.

The EIPs cover areas such as:

- Air quality, including dust, noise and odour,
- Waste management,
- Water conservation, including groundwater management, and
- Land management, including visual amenity and rehabilitation.

2.8 Wagerup LTRMS Stakeholder Consultation Process

In the past, Alcoa's residue planning has largely been an internal process with feedback incorporated from government agencies included. The first review of the LTRMS in 2000 broadened the consultation process to seek input from the local community on the proposed LTRMS. Government feedback was sought separately through the RPLG process.

Alcoa has further developed its consultation process for major developments and strategic planning process to an SRG process. This process involves formation of an advisory group, with affected stakeholder groups represented, to work with the company in developing of the LTRMS. This transparent process ensures the local and state government departments and community members have access to the same information from the company, and better understand each other's issues and perspectives. The independently facilitated group works together to provide the company with

a series of 'Guiding Principles', or recommendations, for the company to consider in the development of the LTRMS.

The Wagerup LTRMS SRG is given an opportunity to review the draft LTRMS before it is presented to the RPLG for comment. Once the RPLG has endorsed the LTRMS, the document is submitted to the Minister for State Development. Input is then sought from the Minister for Environment before the Minister for State Development endorses the strategy.

The framework for stakeholder participation in the LTRMS review for Wagerup Refinery is presented schematically in Figure 2-1.

2.8.1 Formation of the Wagerup LTRMS Stakeholder Reference Group

The 2017 Wagerup Refinery LTRMS SRG was formed in August 2017 and met fortnightly from August 2017 until October 2017. The process used to establish the SRG is outlined below. Figure 2-2 shows 2017 LTRMS SRG members at one of the SRG meetings.

Community Representation

To ensure adequate representation by community members on the SRG, a letter was sent to all neighbouring landholders in Area A and existing CCN members in July 2017, inviting them to participate in the review of the LTRMS as a member of the SRG.

Advertisements were also placed in local papers inviting near neighbours, local business owners and those with a special interest in Alcoa's residue operations to nominate.

All six community members who nominated were appointed to the SRG.

Government Representation

Local government representation was sought from the Shire of Waroona and Shire of Harvey who both nominated two representatives for the SRG – one elected and one staff representative. Unfortunately the Shire of Harvey elected representative was unable to attend any of the SRG meetings.

State government representation was sought and received from the Department of Water and Environmental Regulation, Department of Jobs, Tourism, Science and Innovation, and Department of Planning, Lands and Heritage. A representative from the South West Development Commission was also appointed to the group.

A representative from the Department of Health and the Peel Development Commission were invited to participate in the SRG process however no nominations were received. The Department of Health offered to provide any required information to the SRG upon request.

Alcoa Representation

Alcoa was represented on the LTRMS by WA Residue Operations and Maintenance Manager, Matthew Cox, WA Operations Residue Senior Environmental Consultant, Anika Wall, Wagerup Refinery Community Relations Manager, Tom Busher and Wagerup Refinery Environmental Manager, Jocelyn Zimmerman.

Alcoa subject matter experts attended relevant meetings to present on the various topics.

Meeting reports were produced by the WA Operations Residue Senior Environmental Consultant, Anika Wall.

2.8.2 Stakeholder Reference Group Terms of Reference and Operating Procedures

The initial meeting of the SRG involved the clarification of the group's role and operation in the LTRMS planning process. The responsibilities of the SRG were to:

- consider the long-term planning and strategic issues in residue management in areas such as health, dust suppression, water usage, compatible land use, residue reuse, rehabilitation, and impacts on neighbouring land;
- provide advice to Alcoa on factors that influence long-term residue management;
- provide a summary of their deliberations to be included in the development of the LTRMS; and
- conform to the Terms of Reference (TOR) agreed to by the SRG.

Meetings were held fortnightly. Issues discussed at the SRG meetings were recorded in meeting reports. Between August and October 2017 five meetings were held in Waroona to address the issues raised by the SRG. Table 2-1 contains the actual meeting schedule and issues addressed by the group. Table 2-2 shows members of the SRG.

2.8.3 Key Outcomes of the Stakeholder Reference Group Process

As a result of the process undertaken 30 Guiding Principles were developed by the SRG over 14 topics. These Guiding Principles were considered by Alcoa and addressed, where possible, in the Wagerup LTRMS. The complete table of Guiding Principles, together with Alcoa's response to them, are detailed in Chapter 10. Guiding Principles on individual topics are also referenced throughout the body of the report, as appropriate.

2.8.4 Consultation Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed three Guiding Principles relating specifically to stakeholder engagement. These are presented below, together with Alcoa's response.

Several other Guiding Principles developed by the SRG requested community consultation in relation to specific activities. These consultation requests are noted in discussion on the areas to which they apply.

Guiding Principle: 1a) Reporting on Guiding Principle Progress

Alcoa to provide an annual report on progress against the Guiding Principles to the Wagerup CCN. The updates to be provided every 12 months from the date of Ministerial endorsement of the 2017 Wagerup LTRMS.

Alcoa's Response

Alcoa accepts and agrees with this principle. Alcoa will report annually to the CCN on progress against the Guiding Principles.

Guiding Principle: 1b) Feedback for Next LTRMS Review

Alcoa to document and share the feedback received from the annual reports for consideration in the development of the next Wagerup LTRMS.

Alcoa's Response

Alcoa accepts and agrees with this principle.

Guiding Principle: 1c) Social Media

Alcoa to use social media (where appropriate) and other communication methods easily accessible by the local community and other stakeholders to communicate progress on the LTRMS.

Alcoa's Response

Alcoa is committed to keeping the local community and other stakeholders informed about the progress of the LTRMS and the Guiding Principles. Alcoa considers the Alcoa website and CCN forums to be the most appropriate methods to ensure that this information is easily accessible.

Table 2-1: LTRMS Wagerup Stakeholder Reference Group Meeting Schedule.

Meeting Number	Date 2017	Topics Covered
1	24 August	Introduction to LTRMS process, purpose, expectations and reporting Overview of residue operations and tour of Kwinana Refinery's Filtration Facility Future Residue Area Development Plans
2	7 September	Environmental Management
3	21 September	Residue Reuse Residue and Health Residue Area Closure and Final Land Use
4	5 October	Approvals Required to Implement LTRMS Finalise Guiding Principles
5	26 October	Alcoa's Response to Guiding Principles

Table 2-2: Wagerup LTRMS SRG membership.

Affiliation	Name
Landholders	
Community	Mike LeRoy
Community	Helen Alexander
Community	Kath Camisa
Community	Barry Bowden
Community	Joanne Gunning
Community	Emma Garlick
Local Government	
Shire of Waroona	Cr John Salerian
Shire of Waroona	Leonard Long
Shire of Harvey	Cr John Sarbourne
Shire of Harvey	Simon Hall
State Government	
Department of Jobs, Tourism, Science and Innovation	Phil Knight
South West Development Commission	Alan Cross
Alcoa	
Senior Environmental Consultant – Residue, WA Operations	Anika Wall
Wagerup Community Relations Manager	Tom Busher
WA Residue Operations and Maintenance Manager	Matthew Cox

Aluminium Refinery Process

3

3.1 Overview

The Wagerup Refinery produces alumina from bauxite using the Bayer Process. The process involves four main steps: digestion, clarification, precipitation and calcination. In addition, two other important activities occur on site; the generation of power and steam for the Bayer Process and the storage of bauxite residue (the material left over after alumina is extracted) in impoundment areas known as the RSAs.

3.2 Digestion

Bauxite is milled to sand size particles and hot concentrated caustic soda solution is added making a bauxite slurry. The hot caustic dissolves the available alumina within the bauxite.

3.3 Clarification

Sand and clay (red mud) are settled out leaving an alumina rich "green" liquor. The settled out sand and mud are washed and then pumped out to the residue area.

3.4 Precipitation

The hot "green" liquor is cooled from approximately 100°C to 60-75°C and seed alumina hydrate crystals are added causing alumina hydrate to crystallise. The liquor and hydrate are separated. The hydrate crystals are sized, and crystals of a suitable size are removed. Undersized hydrate crystals are returned to the process as seed crystals.

3.5 Calcination

Sized hydrate is washed and dried, then heated to 1000°C to drive off chemically bonded water leaving aluminium oxide (alumina).

3.6 Power and Steam Generation

Power and steam requirements for the refinery are met by an onsite power station and a cogeneration facility. The primary fuel supply for the power station boilers is natural gas.

3.7 Residue and Waste

The material remaining after the alumina has been extracted from the bauxite ore is commonly termed "residue". Residue is produced at a rate of approximately two dry tonnes per tonne of alumina. This material is stored in RSAs adjacent to the refinery.

The residue consists of a coarse sand fraction (often termed "red sand") and a fine silt fraction (often termed "red mud"). Approximately 37% of the residue stream is sand and 63% is mud. The mud density is increased at the residue area by thickening prior to its final discharge into RSAs. The sand is stockpiled and subsequently used for internal construction activities at the residue storage area.

Oxalate, another process by-product, is also stored in approved areas on site. Included within the residue complex are a number of other facilities that support the refining operations.

These include ponds designed to cool the plant process waters (cooling ponds) and to store rainfall run-off water from the refinery site and residue area (run-off water storage (ROWS) ponds).
The ROWS pond is designed to contain the accumulated run-off from a 1:100 wet year so that no contaminated water is released to the environment. Water is recycled back to the refinery via the cooling pond.

3.8 Refinery Water Circuit

The refinery has been designed to operate an efficient closed water circuit, which is supplemented for water losses. Losses of water primarily occur as steam from the process, evaporation from water storage areas and residue surfaces, and water bound within the residue mud and sand.

Make-up water is primarily taken from licensed groundwater and surface water sources, along with Water Corporation supply. Onsite sources of makeup water include water contained in the caustic soda, rainfall runoff and the refinery sewerage system. Rainfall runoff from the refinery site and RSAs is captured, stored in lined ponds and recycled back into the refinery process.

Residue area water management is discussed in more detail in Section 7.8.

Bauxite Residue Management 4

4.1 Overview

Early bauxite residue management processes involved the deposition of residue mud as dilute slurry into storage areas – termed 'wet' disposal.

In 1991, Wagerup Refinery adopted an alternative storage technology termed 'dry stacking'. This process involves pre-thickening the residue mud and then depositing it in layers which are dried through solar evaporation. The process is assisted by physically turning over the mud, and produces a high-density, stable stack of residue upon which the next mud layer can be placed.

Dry stacking of residue is fully operational at all three of Alcoa's Western Australian refineries, and this type of storage is now adopted by other minerals industries. The advantages of this method include:

- a significantly reduced footprint;
- reduced environmental risks, such as groundwater impact; and
- a more stable landform that enables direct rehabilitation and a wider range of potential future land uses.

In 1990, a detailed report of the proposed residue drying operation for Wagerup was submitted to the Minister for Environment (Alcoa, 1990). This report formed the basis for government approval of the changes to residue management. Operating experience gained at Pinjarra, Kwinana and Wagerup, and continual improvements to the methods of RSA construction, have provided a sound basis on which the original residue management strategies can be updated. Alcoa is now able to project, with confidence, the facilities required to sustain the dry stacking operation well into the future.

In 2016, Alcoa introduced the first residue filtration facility at its Kwinana Alumina Refinery Residue operations. The filtration facility utilises large scale filter to force the moisture out of the residue, leaving behind a dry filter cake. This filtration process dramatically reduces the required drying time of the residue from approximately 100 days to 30 minutes. Residue filtration is expected to provide many potential benefits for residue management including:

- a reduction in water usage,
- a reduction in the future residue footprint,
- improved residue dam stability,
- reduced risk of alkaline material storage in future years,
- a reduction in dust potential from residue storage areas, and
- reduction of residue storage costs.

Alcoa's second residue filtration facility is currently being constructed at the Pinjarra Alumina Refinery. It is anticipated that commissioning of this facility at Pinjarra will commence in 2019. Additional information about residue filtration is presented in Section 8-6.

Alcoa believes the bauxite reserve Mineral Lease 1SA will sustain the company's operations for at least another 50 years. During this time, it is anticipated that alumina production will become more efficient and residue reuse options will assist in reducing the volumes of residue to be stored. For the purposes of this planning process, the life-of-mine is considered the life of the current lease (2045). However given the capacity of the mine and renewal options on the bauxite lease, at present the exact date of closure and volume of residue requiring storage remains uncertain.

As at December 2017, the total residue storage operation footprint at Wagerup, including water storage facilities, was 595 hectares and the maximum residue height was 36 meters above natural ground level (RL 50 m). The residue footprint expansion is planned to the west of the current footprint within the next five years. The rate of expansion of the residue footprint will depend on the actual production rates over time and the height of the stack. The height of the residue storage area will also influence the direction and timing of the footprint expansion; a higher stack height allows the footprint to be contained to a smaller overall footprint.

During the coming five year period, it is currently anticipated that investigations into the feasibility of introducing large scale filter presses to the Wagerup Refinery will take place. If future investigations prove residue filtration is a viable option for the Wagerup Refinery's residue area, and approval is granted for the construction of a filtration facility, it is anticipated that residue operations could be contained within a much smaller life-of-mine footprint. See Section 8.6 for more details.

4.2 Residue Characteristics

4.2.1 Chemical Condition

As described in Chapter 3, bauxite is crushed, ground and leached with a caustic soda solution during the alumina refining process. The remaining residue consists of both solids and entrained alkaline solution. During alumina extraction, raw caustic soda solution, lime and small quantities of chemical reagents are added. Side reactions occur which form small quantities of alkaline solids in the residue (Alcoa, 1997).

From an environmental viewpoint, the alkalinity of the bauxite residue imparted by the addition of caustic

soda and lime that is of most note. Typically, the solution entrained with the residue has a total alkalinity of between 20 and 30 grams per litre (g/L) expressed as sodium carbonate, and a pH of 13. Specifically, the alkalinity of the residue affects the mud drying rate and the dusting potential of the residue surface.

4.2.2 Physical Condition

Bauxite residue is composed primarily of iron and silica minerals. Residue from Darling Range bauxite is characterised by a high coarse fraction, due to silica in the bauxite. The coarse fraction can be considered as a fine to medium grained sand with a specific gravity of 2.9. This residue sand has proved to be an ideal material for embankment and road construction within the dry stacking operation, as a free draining material suitable for surface rehabilitation, and for the construction of drainage layers at the base of the RSAs (Alcoa, 1997).

The fine fraction of the residue, commonly termed 'red mud', is silt to clay sized material with a specific gravity of 3.2. The higher specific gravity of the fine fraction results from the relatively high iron content. This fine fraction settles very slowly and has little strength unless dewatered or dried. When in slurry form, the fine fraction must be contained within approved engineered embankments (Alcoa,1997).

4.3 Physical Structure of Storage Areas

A schematic diagram of the dry stacking process used at Alcoa's residue area is presented in Figure 4-1.

The fine tailings are pumped to a thickener vessel where they are settled using flocculent, producing a higher density underflow slurry of around 50% weight for weight (w/w) solids. This slurry is pumped to one of a number of RSAs where it is placed in layers and allowed to dry through solar evaporation.

To assist the natural drying process, the surface of the RSAs is mechanically turned over using bulldozers and amphirols. The final dry density of the tailings is around 70% solid material. This compares to the final density of 60 - 65% solids typically achieved using earlier wet disposal methods.

The coarse tailings (residue sand) are used for construction of embankment walls, drainage layers, rehabilitated surfaces and roads within the residue area.

4.3.1 Environmental Concerns

The main concern relating to the physical condition of the residue is the potential for embankment failure, which could result in the release of residue slurry or liquor into the surrounding environment. Also of possible concern are the more gradual processes of wind and water erosion, particularly on the sloped embankments of the residue deposits.

4.3.2 Current Management Strategies

From the commencement of Alcoa's operations in Western Australia, RSAs have been designed and constructed in accordance with accepted engineering standards. Prior to the introduction of dry stacking, residue embankments were designed as water retaining structures in recognition of the need to contain the residue leachate, which added conservatism to their design.

The introduction of dry stacking of the residue has reduced the likelihood of the release of residue slurry or liquor to the surrounding environment, as the red mud is contained initially by residue sand embankments and then dried to achieve a minimum strength which ensures the deposit is stable. The lack of any significant volume of free water either within or on the surface of the deposit, further decreases the risk of slope failure.

The overall stability of the residue storage area stacks has been designed in accordance with international standards to accommodate both static and earthquake loadings. The analysis has been taken further to demonstrate the mode of failure should it occur under extreme conditions. A finite element analysis showed the failure to be limited to small horizontal and vertical displacements, rather than a circular slip failure of the outer stack slope. While such a failure might cause short term operational problems (such as ruptured pipelines) it should not result in any flow of residue into the surrounding environment.

All major embankments are monitored regularly to check on their structural condition and visual inspections are carried out routinely. In addition, the structural integrity of water storage ponds and RSA embankments are inspected annually by a third party consultant.

4.4 Footprint Design

The two main factors affecting the design of the residue area are the volume of mud to be stored and the open area required to dry the mud.

The volume of mud required to be stored depends on the rate and timeframe over which residue is produced. The volume of a stack is a result of the footprint geometry and the height of the stack. The geometry of the stack (embankments and internal dyke slopes) is influenced by structural stability and visual amenity requirements. A lower stack height requires a larger area of land to store the same volume of mud.

Available drying area is a function of length and width of the open stack, less the internal areas taken up by dykes and infrastructure. As the mud elevation in RSAs increases over time, perimeter embankments progressively move inwards and the net available drying area reduces. As a consequence, to maintain the minimum drying area required to dry mud it is necessary to periodically construct new RSAs.

Figure 4-2 illustrates the process of developing the overall stack. Area A would need to be built and filled before you can start to build B, and similarly Area C would need to be built and filled before you can create a new area D.

4.5 Construction of New Residue Facilities

Prior to the design of a new residue facility, the area concerned is subject to a detailed site investigation that includes an evaluation of geotechnical and hydrogeological conditions. A preliminary design report is prepared for each new residue area 6 to 12 months prior to the commencement of construction and forms the basis for government agency review and environmental approval.

The RSAs are designed in accordance with the applicable edition of the 'Tailings Management' issued by the Australian Government Department of Industry, Tourism and Resources, and guidelines produced by the International Commission on Large Dams (ICOLD) and the Australian National Committee on Large Dams (ANCOLD). These guidelines include design criteria for earthquake risk, long term stability and management of storm events.

In addition, Alcoa has mandated standard internal design guidelines for all new RSAs in Western Australia to ensure the risk of ground and surface water contamination is minimised. These standards require all new residue areas to have:

- a constructed low permeability base and embankment seal that is at equivalent to approximately 0.45 metres depth of mechanically compacted clay with a hydraulic conductivity of less than 10-9 m/s, with a synthetic geomembrane (HDPE) placed directly on top of the clay seal,
- a base drainage system which reduces the hydrostatic pressure on the seal above the 'composite liner' referred to above,
- monitoring systems to indicate leakage or spillage outside of the containment system,
- a containment system to prevent uncontrolled and/or untreated discharge of contaminated runoff from the RSA (note: the existing system is designed to cater for run-off generated from the residue system as a whole during both a 1:100 wet year, and a 1:100 year storm event),
- design and layout to minimise the risk and impact of spillage from pipelines and pumping systems including primary and secondary spillage containment structures at high risk areas, and
- embankment design to ensure long term stability against slippage and erosion including thorough assessment of the risks and effects of dynamic loads such as earthquakes. Factors of safety are adopted in accordance with the guidelines.

Subsequent lifting of embankment walls is completed using an upstream embankment methodology and is subject to rigorous design criteria. This ensures stability both during construction and in the long term. The ultimate ability of the overall residue stack to be self- supporting is periodically verified through density analysis and computer generated stability models that consider a range of loadings.

Residue areas are subject to inspection by an independent consultant every year to ensure that they are being constructed and operated correctly. If the independent consultant recommends further stability investigations, stability assessments are carried out using a cone penetrometer (CPT) which gives a profile of material strength by measuring the resistance generated by forcing a probe through the residue stack. The results are then used as input into a stability software program which calculates a factor of safety for the stack configuration. If stability issues are suspected, detailed geotechnical studies are carried out and corrective actions are implemented to ensure ongoing adequate stability.

4.6 Bauxite Residue Research and Development Activities

4.6.1 Overview

Development of alternative uses for bauxite residue has been one of the major objectives of Alcoa's residue research program since 1978. By identifying and demonstrating a range of technically and economically feasible alternative uses, bauxite residue may become a resource rather than a waste. The company also recognises that if significant reuse can be achieved, the rate of expansion of the RSAs can be slowed, and the long term impacts of residue storage can be reduced.

4.6.2 Reuse Strategies

Bauxite residue is comprised of two main fractions that are treated to produce two distinct products. The coarse fraction (>150 µm) can be treated to produce a material known as Red Sand™ and the fine component (<150 µm) into a material known as Red Mud™ or Alkaloam®.

A number of opportunities for residue re-use continue to be investigated as part of Alcoa's research and development program based at Kwinana. Alcoa's primary focus is currently on commercialisation of Red Sand™.

Alkaloam®

Further opportunities for re-use of Alkaloam® have been put on hold until Red Sand™ has been formally commercialised for use in road construction, industrial land development and top dressing of turf for recreational uses.

Reuse of Red Sand™

Alcoa's residue sand is currently used for the construction of RSAs, with excess being stored within the RSAs. Alcoa has developed a process to wash and carbonate the sand so that it can be considered for use as a building and construction material. The resulting product is known as Red Sand™.

It is proposed that Red Sand™ be used in a number of applications which has been trialled and proven to perform equal to or better than virgin sand materials. These include top dressing of turf for recreational uses, road construction, and industrial land development. Red Sand™ is well structured and has improved retention properties compared to local sands. Red Sand™ has also been assessed as a growth medium for turf production, as a top dressing soil for golf courses, as a bunker sand for golf courses, for concrete production and as a general fill material for land reclamation.

The technology to produce Red Sand™ has been demonstrated through a pilot plant operated at Alcoa's Wagerup Refinery with the sand produced from this plant used by the Department of Main Roads in a road construction trial on Greenlands Road (Pinjarra, Western Australia), and by Fairbridge Village (Pinjarra, Western Australia) to topdress its main oval. The pilot plant has also been operated at Alcoa's Kwinana Refinery with the sand produced being used to top-dress the Alcoa Social Club oval, a series of trials with various golf clubs, and an industrial land development trial in conjunction with Landcorp.

Various health and risk assessments have been conducted on Red Sand™ to ensure its safe utilisation. These include:

1. A radiological assessment which has resulted in approval by the Radiological Council of Australia for road construction and top dressing.

2. A health risk assessment which has been reviewed by the Department of Health, resulting in their endorsement of Red Sand™ for top dressing, road construction, and industrial land development.

3. An independent technical assessment, conducted by the Energy Research Centre of the Netherlands (ECN), has been undertaken to assess Red Sand™ against the Dutch Building Material Decree, a well-established set of criteria that are well referenced and used widely. The review did not identify any issues with the use of Red Sand™ in construction works within their framework.

4. An independent peer review of the Red Sand™ project has been conducted by KMH Environmental. The peer review process was commissioned to identify any potential risk associated with use of Red Sand™, review these risks against the technical assessments and specialist investigations already conducted on Red Sand™, and identify any technical gaps and recommendations for further work. The review concluded that Alcoa has taken an expansive approach to evaluating and assessing the Red Sand™ material. No significant gaps were identified in the review.

One of the major hurdles for the use and commercialisation of Red Sand™ has been the lack of a clear regulatory approval process within Western Australia. In December 2014, the then Department of Environment Regulation (now DWER) released guidelines for the use of waste derived materials (WDM). These guidelines provided a pathway for the removal of the waste classification of WDM's to facilitate their reuse. Alcoa has conducted the necessary risk assessment required as part of the guidelines resulting in the development a set of material specifications based on soil and water quality limits endorsed by the DWER. Alcoa prepared an application for Red Sand™, which also required review by an independent DWER accredited contaminated sites auditor prior to submission, as per the WDM guideline.

The auditor report was supportive of Red Sand being used for the proposed applications (Road construction, industrial land development, and top dressing recreational ovals). The final submission was made in early June, 2016. Unfortunately, DWER have since removed the WDM administrative framework and responded to our application in July 2017 specifying that they would not make a formal determination on our application.

In October 2018 the DWER released a factsheet to provide guidance on determining whether material is "waste" within the meaning of the EP Act and WARR Act (https://www.der.wa.gov.au/images/documents/your-environment/waste/Factsheet-Assessing-waste.pdf). It remains the responsibility of the person in possession of the material to determine whether their material is a waste, but the factsheet outlines the process that DWER would follow to make a determination when performing their function. Alcoa is currently reviewing the content of this factsheet and interpreting what implications it may have on the future use and commercialisation of Red Sand.

Alcoa has also led the implementation of leaching test methods developed in the European Union by the ECN into Western Australia. Under a joint project with the Minerals Research Institute of Western Australia (MRIWA), the Chemistry Centre of WA and other industry sponsors, these leaching methods are currently being developed, applied and validated in WA.

4.6.3 Residue Reuse Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed three Guiding Principles related to alternate uses for residue. These are presented below, together with Alcoa's response.

Guiding Principle: 2a) Waste Materials Legislative Framework

Alcoa to actively lobby the Western Australian government to develop a waste materials legislative framework to facilitate the use and commercial production of Red Sand™ and red mud (Alkaloam®).

Alcoa's Response

Seeking approval for the use and commercial production of Red Sand™ is a key objective for Alcoa. The regulatory framework for seeking approval for the commercial production of Red Sand™ is currently uncertain and incomplete. Alcoa is currently considering how to progress the commercialisation of Red Sand™ and red mud (Alkaloam®) in the current regulatory environment, and ongoing engagement with government will be a key strategy.

Guiding Principle: 2b) Commercial Production Approvals

Alcoa to urgently pursue all necessary approvals for the use and commercial production of Red Sand™ and red mud (Alkaloam®).

Alcoa's Response

Alcoa accepts and agrees with this principle. Seeking approval for the use and commercial production of Red Sand™ and red mud (Alkaloam®) is a key objective for Alcoa, however various factors including the current regulatory uncertainty and economic, operational, and other regulatory impacts may impede progress of this action.
Alcoa's current focus is to initially seek approval and commercialization of Red Sand™ and to then pursue approval and commercialization of red mud (Alkaloam®).

Guiding Principle: 2c) Residue Reuse Product Markets

Alcoa to identify sustainable markets for the use of Red Sand™ and red mud (Alkaloam®), including business modelling to identify sources and location of demand.

Alcoa's Response

Alcoa accepts and agrees with this principle. Seeking approval for the use and commercial production of Red Sand™ and red mud (Alkaloam®) is a key objective for Alcoa, however various factors including the current regulatory uncertainty and economic, operational, and other regulatory impacts may impede progress of this action.
Alcoa's current focus is to initially seek approval and commercialization of Red Sand™ and to then pursue approval and commercialization of red mud (Alkaloam®).

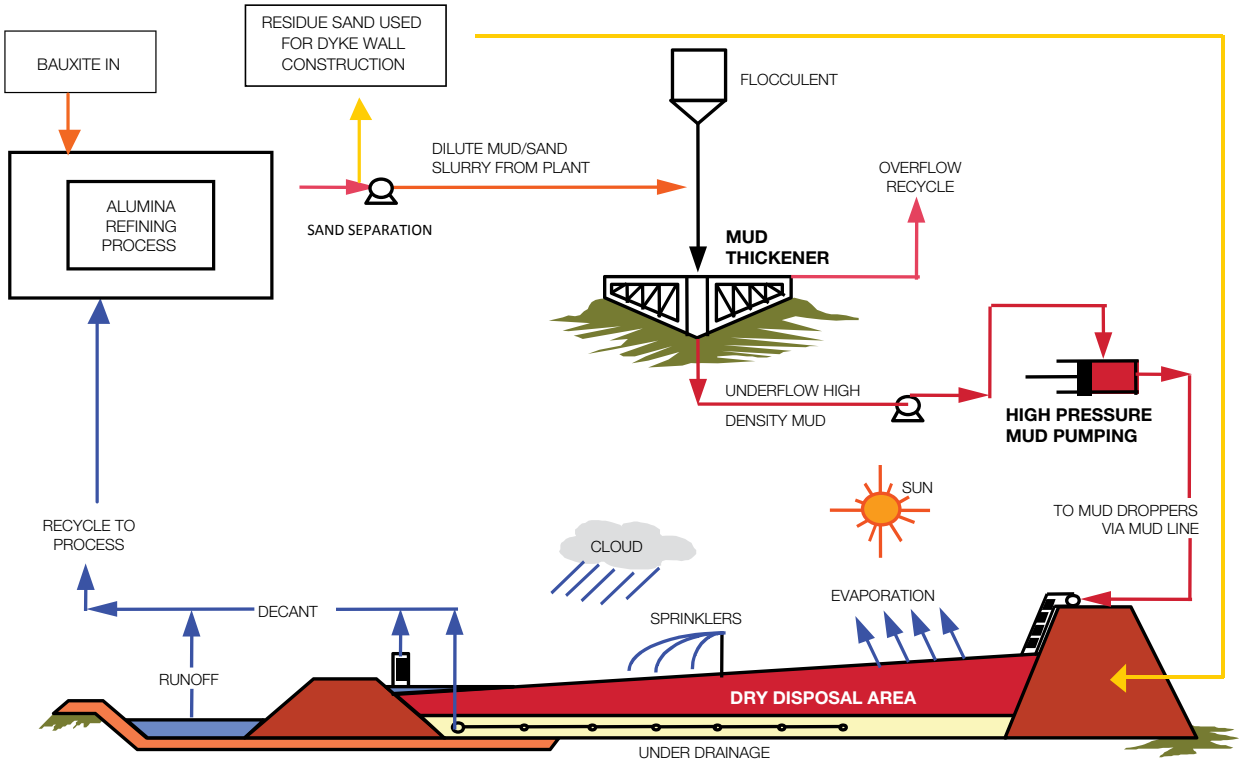

Figure 4-1: Dry stacking process used at Alcoa's residue area.

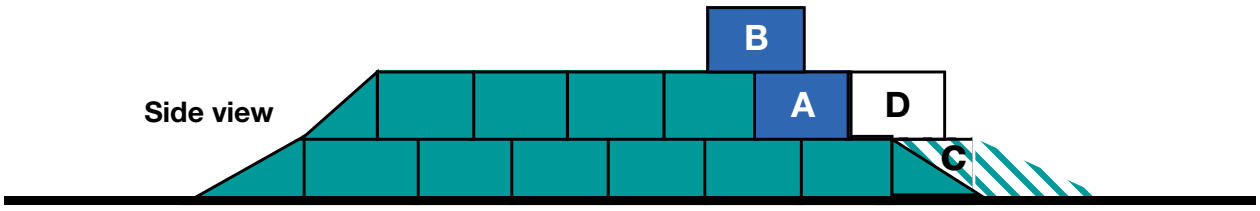

Figure 4-2: Residue stack development.

Economic and Social Setting

5

5.1 Description of the Local Community

The Wagerup Refinery is located 120 kilometres south of Perth and is located close to the southern boundary of the Shire of Waroona, bordering with the Shire of Harvey. The Shire of Waroona is part of the Peel Region, and the Shire of Harvey is part of the South West Region. The nearest townships to the refinery are Hamel (located 2 kilometres north of the refinery within the Shire of Waroona) and Yarloop (located 2.5 kilometres south of the refinery in the Shire of Harvey). The nearest regional centre is Waroona, located approximately 5 kilometres north of the refinery.

The Shire of Waroona covers an area of 835 square kilometres. The Shire has a population of 4,148 (Australian Bureau of Statistics, 2017), which is 3.4% of the Peel Region (Peel Development Commission, 2012). The Waroona town site is increasing in size each year due to a steady growth in new housing development. Alcoa is the principle employer of Shire of Waroona residents (Shire of Waroona, 2010). The Shire of Harvey covers an area of 1,766 square kilometres. The Shire has a population of 24,901 (Australian Bureau of Statistics, 2012), which is 15% of the South West Region. The Shire of Harvey is currently experiencing rapid growth (Shire of Harvey, 2011). An overview of Alcoa's economic and social contribution to the Shires of Waroona and Harvey is provided in Section 5.2.

5.2 Overview of Alcoa's Economic and Social Contribution

5.2.1 Economic Contribution

Alcoa contributes to the economy directly through spending on goods and services and by paying salaries and wages to its workforce. Alcoa also contributes indirectly through flow-on spending. Each year, Alcoa contributes more than AUD$2 billion to the WA economy through wages and salaries, taxes and royalties, and the purchase of goods and services.

Wagerup Refinery and Willowdale Mine have a combined workforce of approximately 900 full time employees. Of these 30% live in the Shires of Waroona and Harvey.

Alcoa encourages local suppliers to conduct business with the company and the refinery. It invites local businesses to bid on locally supplied or manufactured goods or services and gives preference to local business in a competitive situation.

Alcoa also works with local business groups to identify and utilise local suppliers and where possible, structures bids to enable local supplier participation.

5.2.2 Wagerup Meeting Global Demand

During the past 50 years Alcoa has grown into one of Australia's major mineral exporters. Alcoa of Australia operates the largest integrated bauxite, alumina refining and alumina smelting system in the world. The Wagerup Refinery is currently one of the world's most efficient alumina refineries. In order to maintain its global competitiveness Alcoa is pursuing ways to further improve efficiencies and increase production to meet global demand at its existing operations, as well as investigating potential new projects.

5.2.3 Partnerships and Volunteering

Wagerup Alumina Refinery contributes to the local community through its partnership and volunteering programs in the areas of environment, leadership, health and safety, and building community capacity. The Wagerup Refinery has several key partnerships in each of these areas and also supports local community events. Some of these key partnerships are outlined below.

Youth Programs

Wagerup Refinery provides financial support to Youth Programs based in the Shire of Harvey and Waroona. Lot 208 operates from a base in Australind and provides important youth outreach services to other venues in the Shire of Harvey dealing with teenagers. In Waroona the youth services are supported by the Shire and the Waroona Community Resource Centre which operate year round support programs along with special initiatives during the holiday periods.

School Related Initiatives

Alcoa supports local schools through the provision of excursions to Sculpture by the Sea, the delivery of the Scitech Maths Enrichment Program and financial support of School Award Evenings. Minor grants are also made to the schools for various initiatives that are tailored to each school's curriculum priorities.

Wagerup Sustainability Funds

Wagerup Refinery contributes to Sustainability Funds that are managed collaboratively with each individual Shire. Grant rounds are held whereby community groups can seek support for projects that meet the agreed guidelines. During the past 5 years the Sustainability Funds have supported Hocart Lodge Aged Care, Quambie Park Age Care, light upgrades at Harvey Oval, resurfacing tennis courts in Australind, upgrades to the Yarloop Bowling Club, expansion of community facilities at Lake Preston, West Waroona Fire Brigade, Waroona Bowling Club, Waroona Community Resource Centre and extensions to the Marchetti Pavillion at Waroona Oval.

Bunbury Regional Entertainment Centre (BREC)

BREC is the major concert facility in the South West region. Located in Bunbury it provides an essential service to the arts and cultural community of the area. Alcoa has partnered with BREC to provide support to the centre for a three year period.

Community Festivals and Events

Alcoa provides financial support to annual festivals held in the local community including the Shire of Waroona's Summer Series, Harvey Mainstreet, Bunbury Multicultural Concert, Harvey Open Water Swim, State Fire and Rescue Championships and the Harvey and Waroona Agricultural Shows.

Employee Volunteers

Alcoa also provides support to employees who volunteer with local community organizations the opportunity to submit applications for $3000 ACTION grants. This involves more than eight employees undertaking a community project beneficial to the community with the community group involved being the beneficiary of a $3000 grant.

6 Environmental, Heritage and Planning Setting

6.1 Climate

Wagerup has a Mediterranean type climate characterised by warm dry summers and mild wet winters. Detailed climatic data is available from the Bureau of Meteorology monitoring location at Wokalup, approximately 22 kilometres south of the Wagerup Refinery.

6.1.1 Temperature and Humidity

Wagerup temperatures are characteristic of the south west region of Western Australia, and are similar to Perth. The warmest months at Wagerup are January and February, when maximum temperatures average over 30 degrees and can exceed 40 degrees (Bureau of Meteorology, 2017). The coldest months are July and August, when the average maximum temperature is around 17 degrees.

Humidity at Wagerup generally peaks in the early mornings and drops during the day. Humidity is higher in winter than summer.

6.1.2 Rainfall

Annual rainfall near Wagerup Refinery averages 944.4 millimetres. On average, rainfall is recorded on 60 days each year. Approximately 75% of the total annual rainfall is recorded between May and September. Although most of the annual rainfall falls in the winter months, the highest daily rainfall totals have occurred during the summer months (Bureau of Meteorology, 2017).

6.1.3 Wind

Winds at Wagerup are controlled by synoptic weather patterns, local features such as the topography, and sea and land breezes. During the summer months, easterly winds are generated from high pressure systems passing over the south west corner of the state. In winter, westerly winds are caused by cold fronts and low pressure systems. Wagerup Refinery is located at the base of the Darling Scarp. This topographical feature:

- Generates very strong local winds during summer, particularly at night and in the early morning. These winds are known as gully or foothill winds.
- Creates rotors or wind reversals near the foothills during easterly winds.
- Channels or deflect westerly winds up the escarpment.
- Creates katabatic flows down the escarpment.

6.2 Topography

Wagerup Refinery is located at the foot of the Darling Scarp where the land slopes gently towards the west. The residue area and surface water detention pond are constructed on the Pinjarra Plain. The natural ground level at the residue area is approximately 15 meters above sea level (15 metres AHD or RL).

6.3 Hydrology

6.3.1 Groundwater

The superficial geological formations in the region are heterogeneous, comprising zones of very permeable clay, sandy clay, laterite and sand. Under the refinery and residue areas, the superficial formations can generally be divided into an upper layer with low permeability and a lower layer with higher permeability. For simplicity, these layers are referred to as the upper and lower superficial formations.

Below the residue area, the low permeability clays and sandy clays of the Guilford Formation generally restrict vertical groundwater movement in the superficial aquifer. This is underlain by sands and clayey sands of the Yoganup and Ascot Formations. These sandy formations intercept and together form a regionally continuous aquifer, which is the main conduit for horizontal groundwater movement in the superficial formations.

This aquifer is confined by the less permeable, overlying clayey materials of the Guildford Formation. The contact between the Leederville and Yoganup formations is generally identifiable due to a layer of carbonaceous or greenish-grey silty clay and shale. This layer restricts the vertical movement of groundwater between the superficial formations and the underlying Leederville Formation. The various geological formations are illustrated in Figure 6-1.


ALCOA
ALCOA

Groundwater salinities in the Wagerup area range between about 500 mg/L and 5,000 mg/L. The most saline groundwater generally occurs in the Guildford Clay, and this is a consequence of evapotranspiration processes. Groundwater in the underlying Yoganup Formation, Ascot Formation and the upper parts of the Leederville Formation generally has salinities less than 1,500 mg/L.

6.3.2 Surface Hydrology

The Wagerup Refinery area is within the lower reaches of the Harvey river catchment, which is the largest catchment draining into the Peel-Harvey Estuary. The main river system in this catchment is the Harvey River, which lies approximately 4 kilometres to the west of the refinery and flows in a north-westerly direction, discharging into the Harvey Estuary.

The North Yalup Brook and Lower Yalup Brook are located to the north of the refinery, and Bancell Brook to the south of the Refinery.

Overflow from the fresh water catchment ponds on Alcoa's property flows south to the Yalup Brook diversion drain and then into the South Samson Drain which ultimately discharges into the Harvey River.

There are no Environmental Protection Policy (EPP) listed wetlands in the immediate vicinity of the Wagerup Refinery or residue area. There is one EPP listed wetland located approximately 1 kilometre south of the residue area, on the northern side of Bancell Road.

This wetland, often referred to as Exelby Wetland, was traditionally an ephemeral wetland, however due to the inflow of excess irrigation water from surrounding farmland, it has become a permanent water body. Other nearby wetlands include four small wetlands near Yarloop (located approximately 3.5 kilometres south of the refinery), and three small wetlands near Hamel (located approximately 4 kilometres north of the refinery).

6.4 Flora and Fauna

6.4.1 Flora

The area surrounding the Wagerup Refinery is predominantly rural, with most of the region cleared for agriculture (ENV Australia, 2008). The vegetation surrounding the Refinery and residue areas now consists of pasture grasses and mixture of Eucalyptus trees and shrubs. Alcoa owns approximately 6,000 hectares of the surrounding rural property and this land is predominantly operated as a beef farming enterprise by Alcoa Farmlands.

ENV Australia (2008) described the area where the Wagerup Refinery and residue areas are located as the Drummond Botanical subdistrict, which prior to clearing consisted mainly of the following vegetation communities:

- Banksia Low Woodland on leached sands;
- Melaleuca Swamps in poorly drained areas;

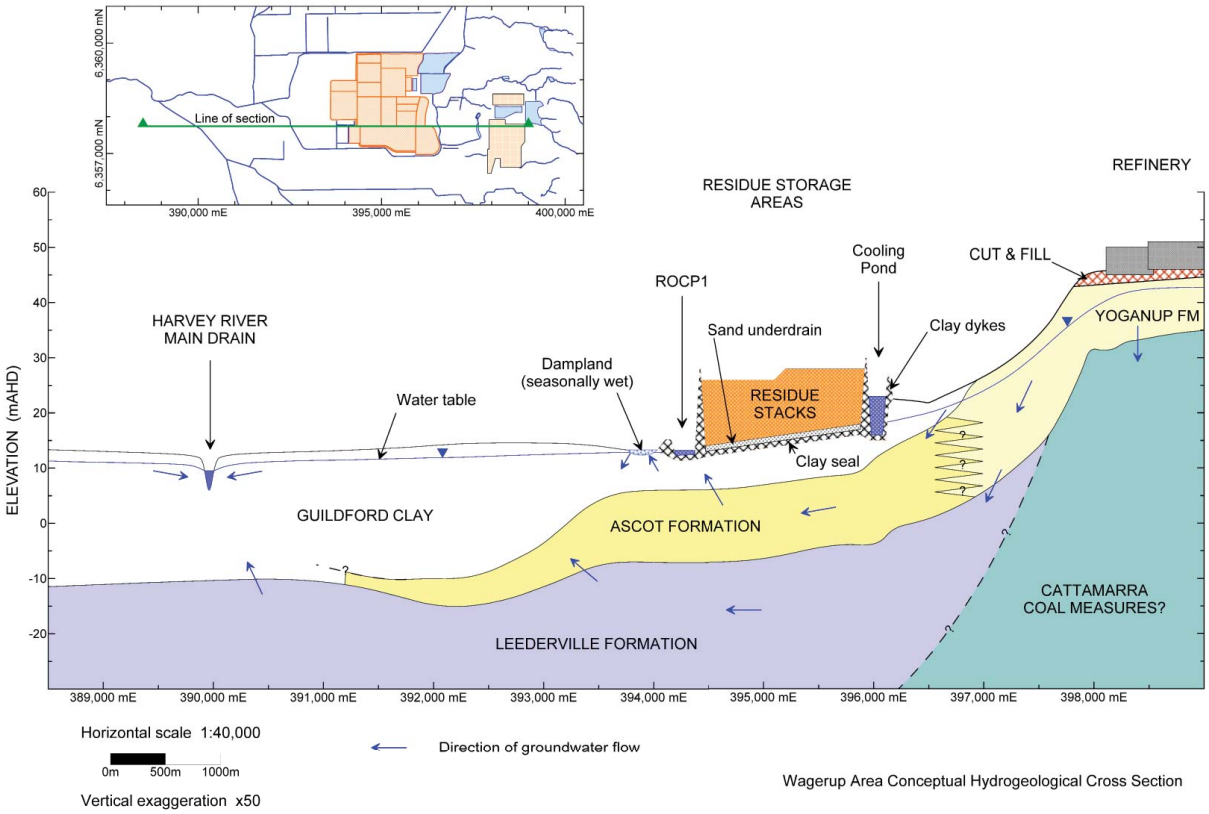

Figure 6-1: Stratigraphic cross section below the residue area.

- Tuart (Eucalyptus gomphocephala) Woodland; and
- Jarrah (Eucalyptus marginata) and Marri (Corymbia calophylla) on the less leached soils.

The majority of the trees located near the residue area have been planted as wind breaks and generally occur along fence lines and roads.

Some remnant stands of native vegetation remain near the Refinery. These remnant areas are mostly confined to road verges (Mattiske, 2011) and vary in condition from Very Good to Completely Degraded, with weed infestation the most common degrading factor (ENV Australia, 2008). Alcoa commissions consultants to undertake periodic flora and vegetation surveys of selected remnant bushland areas on the Alcoa Farmlands adjacent to the Wagerup Refinery. The information collected from these surveys is used to guide future conservation and rehabilitation work in the farmland areas.

Elements of two Threatened Ecological Communities (TECs) are found within the Alcoa Farmlands area: Corymbia calophylla (Marri) – Kingia australis (Kingia) woodlands on heavy soils of the Swan Coastal Plain, and Corymbia calophylla (Marri) – Eucalyptus marginate (Jarrah) woodlands on sandy clay soils of the southern Swan Coastal Plain.

Alcoa protects, restores and enhances the remnant bushland areas located on the Alcoa Farmlands. This is achieved through fencing off areas, planting native species, eradicating exotic species and working with local land care groups including the Peel Harvey Catchment Council, Harvey River Restoration Trust and Harvey Water.

6.4.2 Fauna

Habitat

There are typically four habitat types on the land surrounding the Wagerup Refinery. These are wetlands, drainage lines, shrublands and woodlands.

The wetland habitat areas consist of both open water habitats and damp lands. These areas are typically characterised by trees over a weed understorey. Several sites within the Alcoa Farmland area are in a good to very good condition with shrubs and sedges that provide shelter and habitat for mammals, reptiles, amphibians and birds (ENV Australia 2009).

Drainage line habitats consist of both man-made and natural drainage lines that are usually dominated by weeds up to the water's edge and trees (mature Melaleuca species, Eucalyptus rudis and Corymbia calophylla). The trees offer habitat for avifauna and arboreal species. Some drainage lines have an understory and good litter cover that provides habitat for ground-dwelling fauna, and soils suitable for burrowing species (ENV Australia, 2009).

Only a few shrubland habitats are present around the Refinery and residue areas, and these primarily consist of only Xanthorrhoea species (Grass trees) over weeds and offer limited habitat value (ENV Australia, 2009).

Woodland habitats around the refinery and residue areas are dominated by trees with minimal understory. These areas are therefore of most habitat value to avifauna with a small number of ground dwelling mammals and reptiles because of the lack of shelter for these animals. These woodland areas lack tree hollows, hollowed out logs and leaf litter (ENV Australia, 2009).

Recorded Fauna

Since 1995, Alcoa has conducted fauna monitoring at rehabilitation, control and wetland sites around its Wagerup Refinery. The aim of this monitoring programme has been to gather information on the persistence, distribution and abundance of fauna around the Wagerup Refinery, and particularly to evaluate the impact upon fauna of farmland rehabilitation being carried out by Alcoa (Bamford, Chuk and Everard, 2014).

A 2014 desktop study identified 261 vertebrate fauna species potentially occur in the areas surrounding the Wagerup Refinery and residue areas: 10 frogs, 40 reptiles, 184 birds, 20 native and 7 introduced mammals (Bamford et al 2014).

The vertebrate assemblage includes 85 conservation significant species that are expected to occur in the survey area, 44 have been confirmed, 31 of which were recorded in the 2013-2014 fauna surveys conducted by Bamford et al. The significant species include some species that only visit the area and for which the area is of low importance. However, Bamford et al found species for which the study area is of particular importance include Black-Cockatoos, Rainbow Bee-eater, Brush-tailed Phascogale, Quenda, Rakali (Water-rat), locally significant (CS3) birds and Migratory waterbirds.

Two introduced mammal species are recorded in the area: the European Red Fox (Vulpes vulpes) and the rabbit (Oryctolagus cuniculus). Foxes prey on and compete with native fauna, and rabbits can cause extensive damage to vegetation through grazing (ENV Australia, 2009).

6.5 Heritage Sites

6.5.1 Aboriginal Heritage

Prior to European settlement, the area near the Wagerup Refinery was used by the Noongar Aboriginal people, who moved across the South West of Western Australia.

Surveys of heritage sites are carried out prior to any proposed changes to the refinery and residue footprint. These surveys are conducted according to the Guidelines for Aboriginal Heritage Assessment released by the Minister for Aboriginal Affairs in October 1993, and the survey reports are prepared in accordance with the Guidelines for Preparing Aboriginal Heritage Survey Reports.

The Wagerup Refinery and residue areas have been the subject of a number of heritage studies including those by the Department of Aboriginal Sites (1977), Novak (1975), Pickering (1982), O'Connor (1987), Edwards and Hammond (1995), Carto-Cult (1997), Edwards et al (1997), de Gand (2000), MacIntyre and O'Reilly (2002), and McDonald and Hall (2011).

There are two registered aboriginal heritage sites within the vicinity of the Wagerup Refinery and residue area. One site is located outside the southern edge of the existing residue area, and the other is within the refinery boundary. Both sites have artefact scatters that are believed to have originated from a camp that was located in the area (Government of Western Australia, 2012). The long-term residue footprint will not impact on any known archaeological sites.

6.5.2 European Heritage

Settlers first arrived in the Waroona area in the late 1830s, although the township (formerly known as Drakesbrook) came into its own following the opening of the Pinjarra to Picton railway line in 1893 (Shire of Waroona, 2018). Local timber was milled for the construction of the railway, boosting the town. Many more settlers came to the area when the railway was extended.

Today, the Waroona area's local economy is driven by agriculture (beef and fresh produce), bauxite mining and tourism. The local area has a rich ethnic diversity. Significant numbers of Italian, Yugoslav and other European migrants have settled in the area and the Italian culture remains very strong today.

There are no known European heritage sites located within the current planned long-term residue footprint area.

6.6 Existing Land Use and Tenure

Alcoa's land holdings include the land required for current and future residue areas, refinery activities and surrounding farmlands. The extent of Alcoa's land holdings are shown in Figure 6-2.

Part of Alcoa's land holdings are zoned as "industrial" to allow for operation of the refinery and residue areas. The current industrial boundary is shown in Figure 8-1. Alcoa's future plans for residue storage areas are discussed in Chapter 8.

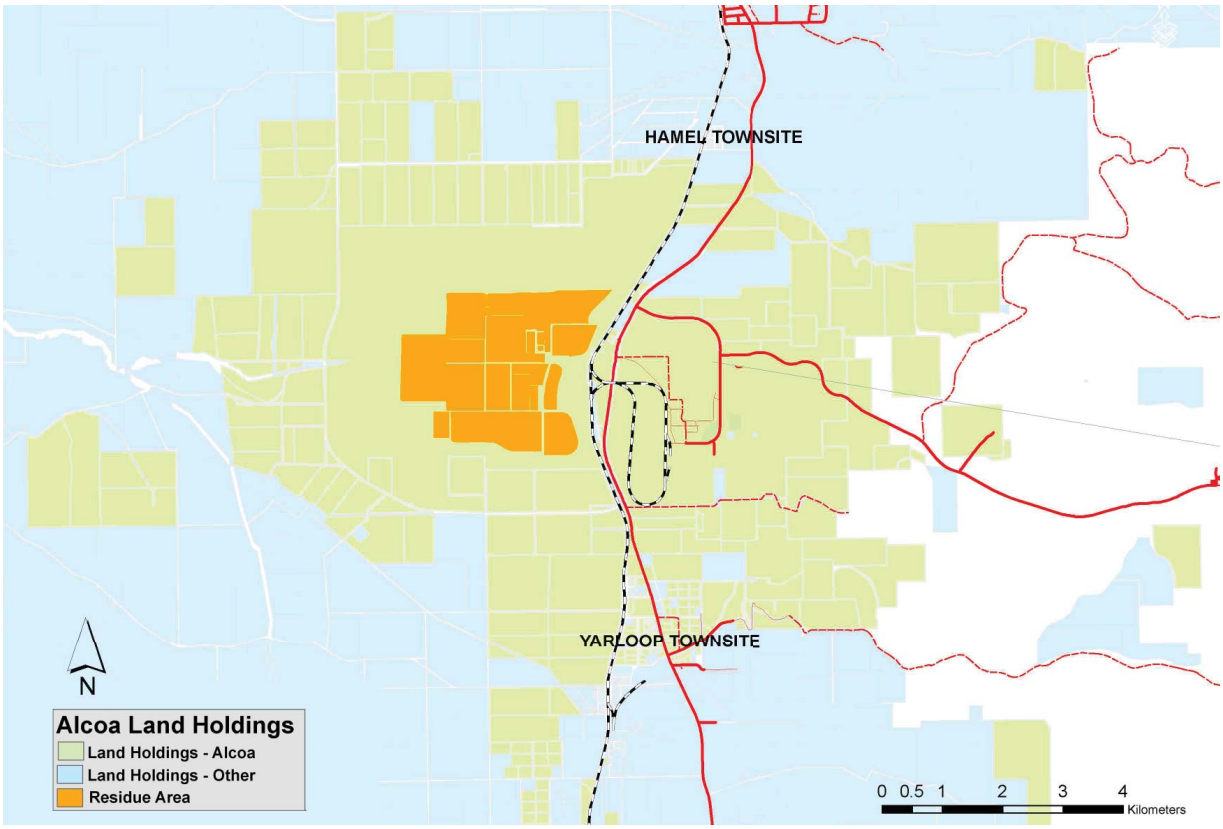

Figure 6-2: Map of Alcoa's land holdings.

6.6.1 Alcoa's Land Management Strategy

In addition to the land required for residue and refinery operations, Alcoa has purchased additional land under Alcoa's Land Management Strategy.

Alcoa implemented a land management strategy in 2001-02 around the Wagerup Refinery which enabled people living in the immediate vicinity who felt impacted by the operations to sell property to Alcoa.

The Strategy comprised of two areas:

1) Area A – immediately surrounding the refinery, and
2) Area B – the townships of Yarloop and Hamel.

The land management strategy is implemented by Alcoa and has no formal status in planning schemes or legislation. The characteristics of Area A and B are outlined below, and the location of each is shown in Figure 6-3

Area A

- Area A was delineated to the north and south based on the 35dB(A) noise contour.
- It allows for future expansion of Alcoa's bauxite residue area to the west (The actual footprint of the refinery will stay the same, even if production is lifted in the future).
- Alcoa does not on-sell properties purchased in Area A.
- Area A properties (northern Yarloop townsite) are rented out by Alcoa, sometimes to the previous owners.

Area B

- Alcoa's land management strategy was extended to the townships of Yarloop and Hamel to enable people who owned property before 1 January 2002, to sell that property to Alcoa at unaffected market value. This area is known locally as Area B.
- No environmental factors influenced Area B boundaries. It was established to help ensure township viability into the future.
- Properties in Area B are re-sold to maintain property values and support the viability of the town sites.
- Alcoa will only purchase a property once.
- The Area B offer expired on December 31, 2011. Alcoa will now only consider purchasing properties in this area after the property owners have demonstrated they have not been able to sell their property on the open market.

6.6.2 Supplementary Property Purchase Program

The Supplementary Property Purchase Program (SPPP) was established by the WA Government as part of the environmental approval, granted in September 2006, for Alcoa's proposed Wagerup Refinery expansion. The SPPP was managed by an administrator appointed by the WA Government.

The SPPP enabled eligible property owners, outside the existing Areas A and B in the localities of Hamel, Wagerup, Yarloop and Cookernup, to sell their property to Alcoa should they wish to do so.

The two key principles underpinned the SPPP, as set out in a Deed of Undertaking between the WA Government and Alcoa. These principles were that the SPPP:

- Should cause minimum impact on the local property market, disruption to the local community or impact on the Wagerup Refinery; and
- Should not create a financial incentive for people to sell to Alcoa rather than through the established property market.

While Alcoa supported the SPPP, extensive research has shown that the Wagerup Refinery is safe for the community and employees and there is no need for people to move away from the area.

The SPPP has closed and is no longer available.

6.7 Local, Regional and State Planning Policies and Visions

Together with a commitment to best practice environmental controls, compatible land use planning is considered necessary to prevent conflict from urban encroachment on industrial operations. Compatible development does not seek to quarantine land from development, but to ensure the development is appropriate in order to protect the interests of potential neighbours, Alcoa's employees and shareholders, local contractors and businesses, and local and state government agencies who field and investigate complaints.

The development of the LTRMS and final land use planning objectives are informed by current planning policies and visions for the region by the Western Australian Planning Commission, Local Government, and the Peel Development Commission.

The sections below provide a brief high level description of the various strategic plans that provide the planning framework for local area. Further information on these plans should be sought from the WA Government's Department of Planning, Lands and Heritage.

6.7.1 South Metropolitan Peel Sub-Regional Planning Framework

The South Metropolitan Peel SubRegional Planning Framework (SMPSPF) was released in March 2018. The SMPSPF identifies proposed industrial investigation areas for the proposed residual storage areas. The Wagerup Refinery industrial area is referred to in the Strategic Industry section, and the proposed future residue areas are shown as an "Industrial Investigation" area.

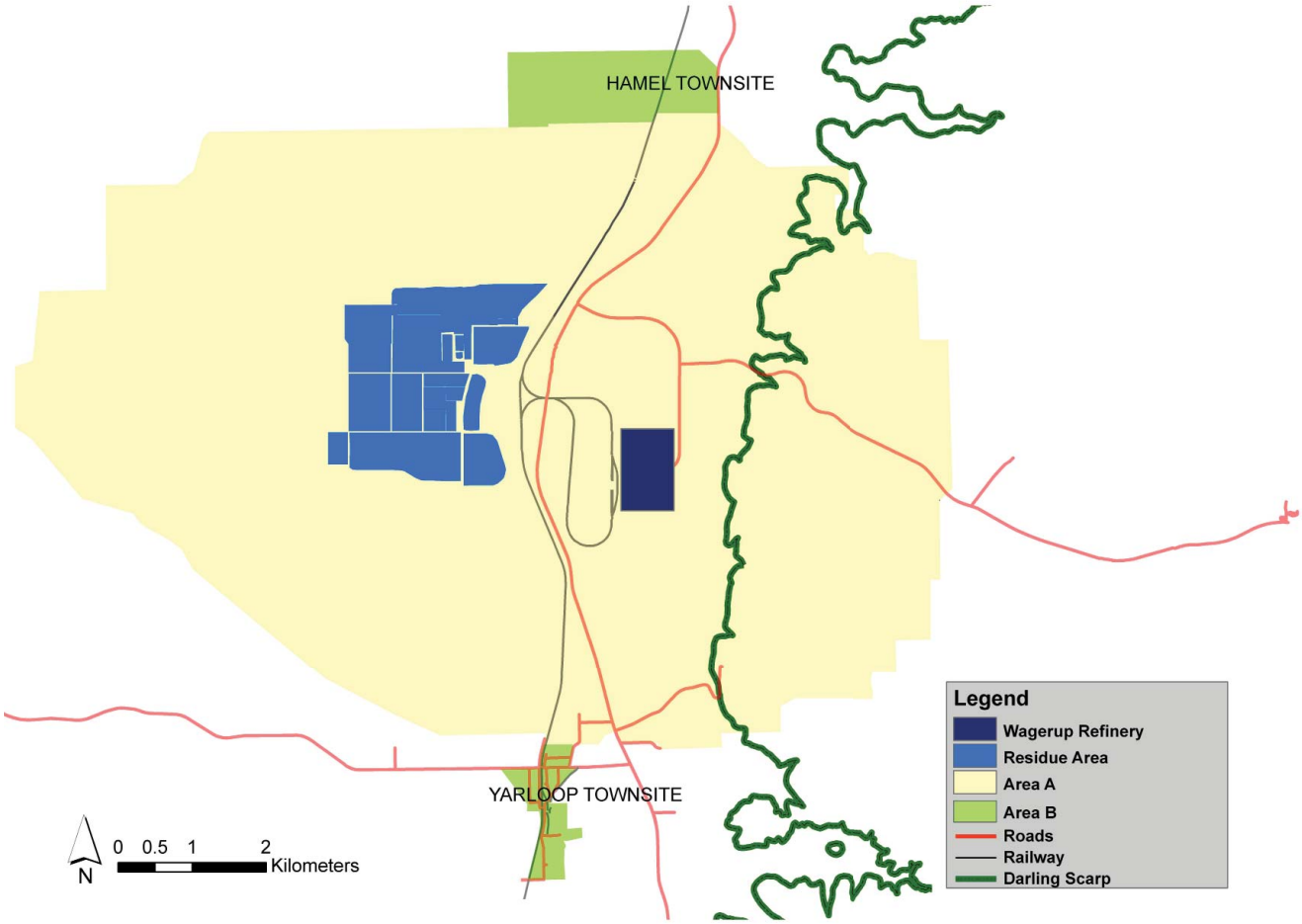

Figure 6-3: Map of Areas A and B in Alcoa's Land Management Strategy.

6.7.2 Peel Region Scheme

The Peel Region Scheme is a large town planning scheme which guides land use in the Peel Region, which includes the local government boundaries of the City of Mandurah and the Shires of Murray and Waroona. The Peel Regional Scheme defines the future use of land by dividing it into broad zones and regions. The local government town planning schemes provide the detailed plans for their respective parts of the region. The Wagerup Refinery and residue area are located on industrial zoned land within the Peel Region Scheme.

6.7.3 Local Planning Schemes

Town of Waroona Town Planning Scheme

The Town of Waroona Town Planning Scheme No 7 establishes Industrial zoning for the Wagerup Refinery and residue area. As part of the future residue development strategy, Alcoa has previously identified the need to extend the residue area, and a rezoning process will be required to extend the industrial zoning boundary to facilitate this. See Section 8.5 for further details.

The area to the west of the existing residue area is currently zoned Rural 1 – General Farming, and the areas to the north and south of the existing residue area are zoned Rural 2 – Irrigated Agriculture.

Town of Harvey Town Planning Scheme

The Shire of Harvey Town Planning Scheme No 1 establishes General Farming zoned land in the area adjacent to the Shire of Harvey's northern boundary, directly south of the Wagerup Refinery and residue area. The area to the west of the towns of Wagerup, Yarloop and Cookernup are zoned for Intensive Farming.

7 Environmental Issues & Management Strategies

7.1 Environmental Management Systems

Environmental issues at the residue facilities are managed through a comprehensive environmental management system (EMS). The EMS was initially developed for the residue area in recognition of the importance of a rigorous, documented process of environment management and certified to ISO 14001 in December 1999. Subsequently, the EMS was extended to the remainder of the Wagerup Refinery, which gained ISO 14001 certification in February 2001. The key elements of the system are:

- an environmental policy;
- processes to identify environmental legislation;
- a risk based process for identifying key environmental aspects and potential impacts;
- detailed procedures for managing key system elements including, but not limited to, environmental training, incident reporting and internal auditing;
- detailed procedures for the control of operations to minimise potential impacts;
- extensive process emission and environmental impact monitoring; and
- an annual process of reviewing key environmental issues and developing environmental management plans for each operating area.

The remainder of this section describes the key environmental issues for the residue area. These have been identified through risk assessment processes and also reflect issues of concern to stakeholders, as identified by the Wagerup LTRMS SRG. The SRG members were provided with detailed information on the current issues and management strategies for the residue areas to assist them to provide informed input to the review of the LTRMS.

7.2 Dust

7.2.1 Background

Dust generated from the residue area mostly consists of fine clay particles and sodium carbonate crystals. The sodium carbonate is precipitated on the surface of residue as entrained moisture evaporates. Residue dust is alkaline and could be an irritant to the eyes, nose, throat and lungs if high enough concentrations occurred, however, extensive monitoring data shows this is very unlikely. If dry residue surfaces are not correctly managed, wind speeds in excess of 6.5 m/s (23 km/h) can lift and transport the fine residue and carbonate particles. The distance over which these particles are transported depends on a variety of factors including atmospheric conditions and the size, shape and mass of the particles.

As well as the residue drying beds, surrounding infrastructure such as roads, embankments and drains can also be a source of airborne dust and are managed accordingly.

October to April is the period when risk of airborne dust generation is potentially greatest, however Alcoa implements a detailed dust management program throughout the year irrespective of the season. In summer, the predominant winds are moderate to strong east-southeasterly winds and moderate southwesterly winds. Strong and gusty southwesterly winds often develop around midday with the onset of the sea breeze which eases in the late evening. The speed of these winds together with the higher ambient temperatures over summer, and therefore faster mud drying rates, require careful control mechanisms to be in place to prevent dust being released.

Alcoa's Wagerup Refinery received a total of 11 complaints from community members relating to dust from the residue areas between 2013 and 2017. 10 of these complaints were received in 2013, and 1 complaint was received between in 2016.

7.2.2 Current Management Strategies

The nature of the residue and the deposition and drying process results in a range of differing materials and surface textures that have the potential to generate dust under windy conditions. As such the dust management systems in place are complex and consist of a range of both proactive and reactive strategies. Significant effort is invested in planning, implementing and monitoring the dust control measures to ensure best possible management of dust generated from the embankments, stockpiles, roads, verges and drains.

Long-term, mid-term and day to day controls are in place to manage residue dust at Wagerup. An overview of each follows.

Long-Term Controls (annual)

On an annual basis, dust control measures for the coming year are planned to ensure:

- dust control mechanisms are in place for any newly constructed or exposed embankments before stronger winds are forecast,
    - o new or exposed internal embankments likely to remain

in place undisturbed for an extended period are planted with native vegetation or grasses during winter to allow them to establish an effective long term dust control cover,

- embankments or areas that are not required in the shorter term are covered with aggregate or mulch, and

- the frequency for application of dust suppressants to exposed surfaces, such as roadways, is specified.

Mid-Term Controls (weekly)

Dust management is reviewed at weekly meetings, which include the personnel involved in dust control. Weekly field inspections and surveys are carried out to check the effectiveness of dust controls and identify areas needing attention. These reviews monitor the ongoing risk of exposure to dust events.

A specialist consulting company supplies seven day and seasonal weather forecasts, which are reviewed weekly and allow Alcoa to maintain preparedness for conditions conducive for dust generation by, for example, operating sprinklers well ahead of forecast winds.

In addition, the following specific midterm dust control methods are employed by Alcoa to minimise dust generation:

- regularly turning over the mud in the drying area thereby leaving wet mud on the surface,

- spraying exposed banks and roads with dust suppressants,

- applying mulch and restricting vehicle access to exposed areas, and

- detailed investigations into exceedances of internal targets to prevent reoccurrences.

Day to Day Controls

On a daily basis the specialist consulting company also supplies a local rolling three day weather forecast, which includes a Dust Risk Rating that takes into account rainfall, wind speed and wind direction.

The main day to day control mechanism to manage dust emissions from the drying beds is the use of the sprinkler system. The sprinkler system is operated in response to daily weather forecasts and residue area conditions, and feedback from continuous dust monitors around the residue area. Internal alarms are triggered in the event of dust levels rising above internal targets. Sprinklers are operated in response to alarms and proactively to wet down areas prior to forecast weather conditions.

Ambient Dust Standards

Ambient dust emissions monitoring at the Wagerup residue area is carried out in accordance with the DWER licence conditions. These conditions specify the maximum target concentration of TSP at the premise boundary as a 24 hour average, as determined by continuous monitoring using high volume air samplers (Hi-Vols).

Dust Performance

All licensed dust monitoring data is presented in annual environment reports to the DWER.

Between 2012 and 2017 there have been no exceedances of Alcoa's licence limit. A number of exceedances of internal targets for the licensed monitors have been recorded and investigated during the period 2012-17. Of these internal exceedances, the primary causes were cattle or mowing activities in the paddocks where the monitors are located or smoke/ash in the surrounding area. Dust monitoring results are presented annually at the CCN meeting.

7.2.3 Residue Dust Studies

Following on from the Wagerup PM_{10} and $PM_{2.5}$ study performed in 2002-03, Alcoa conducted a detailed study into residue dust to quantify the chemical makeup of the dust emissions and the particle size distribution of residue dust. The study aimed to assess the quantity of PM_{10} and $PM_{2.5}$ in dust emissions and at receptors, compare these concentrations to NEPM standards and assess the physical and chemical properties of residue dust. The information was then used in a quantitative HRA of residue emissions and to further understand the impacts on amenity.

The results from the residue dust study and associated health risk assessment are discussed in Section 7.5.

7.2.4 Dust Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed two Guiding Principles relating to dust. These are presented below, together with Alcoa's response.

Guiding Principle: 3a) Dust Management System

Identify opportunities to further improve dust management systems, including sprinkler system and weather forecasting data methods and implement where practicable.

Alcoa's Response

Alcoa accepts and agrees with this principle. As part of the environmental management system, Alcoa regularly reviews its dust management processes and practices with the objective of continuously improving dust containment at the residue areas.

Guiding Principle: 3b) Communication

Communicate dust management improvements and results from dust investigations to the CCN, SRG and surrounding community members in a timely manner.

Alcoa's Response

Alcoa will communicate dust management improvements at least annually to the CCN.

7.3 Odour & VOCs

7.3.1 Background

Odour and VOC emissions from the surface of the residue area are a function of the temperature and odour/VOC concentration at the residue surface. The higher the temperature and compound concentration of the liquor surface, the higher is the emission of odour/VOC to air. The main source of VOC input into the residue area comes from refinery cooling water. In most cases, cooling water that makes contact with refinery liquor streams will condense and absorb VOCs from the liquor.

There are currently no management strategies in place to actively manage VOC concentrations to the residue area via the cooling circuit.

Any expansion of drying areas at current refinery production rates would have a minimal impact on odour and VOC emissions from residue given the amount of fresh mud being deposited remains relatively stable. Residue drying areas have a minimal contribution to odour and VOC emissions from the residue areas. Odour and VOC emissions are more impacted by the temperature of liquor streams and the concentrations of VOCs in the liquor streams. Liquor reporting to residue comes from a number of different sources in the refinery with differing temperatures and concentrations of VOCs.

7.3.2 Odour Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed two Guiding Principles relating to odour and VOCs. These are presented below, together with Alcoa's response.

Guiding Principle: 4a) Odourous Residue Emissions Reduction

Continue to utilise the emissions inventory work to further identify and reduce odourous residue emissions. Implement mitigation strategies to reduce odour and VOC emissions.

Alcoa's Response

Alcoa will continue to utilise the emissions inventory work to further identify odourous emissions and implement reduction strategies where practicable.

Guiding Principle: 4b) Research Communication

Communicate outcomes of research into odour and VOC emissions and mitigation strategies to the community via avenues such as the CCN.

Alcoa's Response

Alcoa accepts and agrees with this principle. Alcoa will communicate information and outcomes of research on odour and VOC emissions subject to commercial confidentiality considerations.

7.4 Radiation

7.4.1 Background

Radiation is widespread in our environment. It comes from sources outside the earth's atmosphere, rocks and soils and from building materials such as bricks, mortar, concrete and tiles. It also comes from the food and drinks we consume, and from man-made sources such as dental and chest x-rays.

Background radioactivity levels are quite variable. Levels associated with the rocks and soils of the Darling Range are usually higher than those found on the coastal plain. Darling Range soils, including the bauxite deposits, contain small amounts of thorium and uranium. The extraction of around 30% of the bauxite as alumina results in a proportional increase in the concentration of these elements per volume of residue. The dry stacked residue mud itself therefore exhibits levels of gamma radiation marginally above background levels found in Darling Range soils (O'Connor, 1989). It should be noted that no radiation is added through the refining process.

The accepted international and national radiation limit for occupational exposure is 20 mSv (millisieverts) averaged over a period of five consecutive calendar years. The accepted international and national radiation limit for the general public is 1 mSv per annum (above background). All personal exposure readings for the Alcoa residue workforce are below the limit set for the general public. That is, readings have been more than 20 times less than the limit allowed for workers.

Studies have also found that in the unlikely event that a member of the public would spend 24 hours per day, 365 days per year at the edge of the residue area, then the exposure received would be approximately 0.12 mSv above local background. This level is well within the limits that are applied to the general public and well below the background levels experienced in many residential areas on the Darling Scarp.

Therefore, while bauxite and bauxite residue contain traces of radioactive materials, exposures associated with this have been comprehensively studied and all levels have been demonstrated to be well within acceptable limits prescribed for both the workforce and the public.

7.4.2 Radiation Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG determined that a Guiding Principle related to radiation was not required.

7.5 Residue Emissions and Health

7.5.1 Background

Air emissions from residue that have the potential to impact on community health include dust from RSAs, embankments and other sources as detailed in Section 7.2, and chemical compounds emitted from wet storage areas and other sources as detailed in Section 7.3.

The potential health impacts of dust are related to the size of the dust particles, their chemical composition, and most importantly their concentration in the air near residential areas. Very small dust particles (PM_{10} and $PM_{2.5}$) can be breathed into the lungs and in major cities have been associated with heart and lung disease. Additionally some chemicals in residue dust and vapour, such as formaldehyde and acetaldehyde, and the alkalinity of the dust, are potentially irritants if high enough concentrations occurred.

Some compounds such as

acetaldehyde have low odour thresholds and can be detected at concentrations which are too low to cause health effects. Similarly larger dust particles can cause an amenity impact even though they do not constitute a potential health impact.

In 2004 Alcoa voluntarily committed to a major research program aimed at further improving its understanding of the contribution made to regional dust by its alumina refineries in WA. An independent Health Risk Assessment (HRA) was then performed to investigate the health risks associated with residue dust. A summary of the results is presented below.

7.5.2 Residue Dust Study

Alcoa conducted a residue dust study from 2005-06 which focussed the research at one refinery, Pinjarra, with input from other sites as necessary to validate the general conclusions.

Monitoring ran over eighteen months from mid 2005 to December 2006, capturing two winter/spring/summer periods and one autumn. It has since been shown that 2006 was an atypical year for dust with stronger winds than average, combined with significant construction activity, problems with parts of the residue area sprinkler control system and other factors leading to higher dust levels. The dust study results can therefore be regarded as conservative.

The program was run for Alcoa by experienced accredited consultants. Three companies were involved, each being highly regarded within their area of expertise:

- Ecowise Pty Ltd – dust sampling and sample analysis;
- Air Assessments Ltd – data evaluation, meteorological and statistical analysis; and
- Environ Ltd – health risk assessment.

All methods, analysis and calculations were performed to Australian Standards and NATA testing accreditation performance requirements. Samples collected to analyse the composition of the dust were performed using:

- High Volume Air Samplers – 7 day and selected 24 hour samples;
- Low Volume Air Samplers – 7 day and selected 24 hour samples;
- Deposition – monthly;
- Grab Samples from the RSAs and surrounding areas; and
- Water – following rain.

The key conclusions from the Residue Dust Study were as follows:

- There is a very low $PM_{2.5}$ fraction in RSA dust. $PM_{2.5}$ emissions from the residue areas are well below advisory criteria and not an issue of any significance;
- Use of up-wind and down-wind TEOMs worked well & indicated that the RSA can contribute the majority of TSP and PM10 during 1-hour and 24-hour dust events, but is a much smaller contribution to annual average concentrations and to $PM_{2.5}$; and
- The best individual chemical marker for residue dust appears to be the trace element thorium, which though present at very low concentrations, is relatively easy to analyse for.

A specialist radiation consultant from Curtin University was invited to review the dust study data to determine if the levels of thorium found were of any concern in terms of radiation exposure. He concluded that the level of radiation expected for such low concentrations of thorium in dust (as found in the Alcoa dust study) was many times lower than the public exposure limit (1 mSv per annum above background), and well below background radiation levels typically expected.

7.5.3 Health Risk Assessment Results

An HRA is a risk assessment process that compares the ground level concentrations (GLCs) of compounds with their health guidelines set by national and international health agencies. The GLCs are predicted by air dispersion computer modelling. The HRA considers the:

- risk of short-term (acute) health effects in relation to short term exposures (one-hour & 24 hour averages),
- risk of long-term (chronic) health effects in relation to long term exposures (annual averages), and
- incremental risk of cancer in relation to long term exposures (annual averages over 70 years).

To increase confidence in the 2008 HRA for dust, the 2008 HRA contained several layers of conservatism. It assumed sources were emitting at peak emission rates simultaneously, and assumed the risks of emissions were additive in nature. The model took into account local meteorological conditions including northerly winds.

The 2008 HRA considered inhalation exposure to the following substances/ elements:

- PM_{10} (Particulate Matter < 10 µm diameter), and
- The metals arsenic, selenium, manganese, cadmium nickel, mercury, chromium, beryllium, lead and vanadium.

Other metals analysed but for which health guidelines were not available were not included in the 2008 HRA (Environ, 2008).

Based upon the results of the HRA it can be concluded that:

- the potential for emissions from the baseline or upgraded RSA to cause acute health effects presents no cause for concern,
- the acute Hazard Index (HI) is primarily driven by exposure to PM_{10}, not to individual metals in RSA dust,
- the potential for emissions from the baseline or upgraded RSA to cause chronic health effects represents no cause for concern, and
- the potential for emissions from the baseline or upgraded RSA to contribute to the incidence of cancer based on inhalation exposure is low, below the USEPA de minimis threshold of one in a million.

These results reinforce that Alcoa's operations are safe for both our employees and neighbouring communities. They indicate that the composition of the dust has extremely low levels of trace metals, and the estimated cancer risk level is well below the global recommendation set by the United States EPA of one in a million.

7.5.4 Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed two Guiding Principles relating to residue emissions and health. These are presented below, together with Alcoa's responses.

Guiding Principle: 5a) Healthwise Study

Continue to monitor employee's health and wellness changes through the Healthwise study as an indicator of broader community health, and provide ongoing reports to the local community.

Alcoa's Response

Healthwise is a long-term research program designed to assess whether there are any relationships between various health outcomes and working at Alcoa in Australia. Alcoa has participated in the Healthwise research program since 1994 and it is one of the largest and most comprehensive occupational health research programs carried out in Australia. The studies are conducted by some of Australia's leading occupational health researchers from Monash University and The University of Western Australia.

Alcoa will report on the outcomes from the research to the local community and other stakeholders.

Guiding Principle: 5b) Community Health Information

Source available health information from public sources to compare the health data from the local community surrounding the Wagerup Refinery to similar communities within Australia. Share the results with the local community.

Alcoa's Response

Cancer incidence and mortality in Western Australia is reported on periodically by the Western Australian Cancer Registry. The latest report is for 2014 and was published in January 2016: http://www.health.wa.gov.au/wacr/statistics/stats_full.cfm. *Cancer incidence and mortality rates for all cancers in the Leschenault and Peel areas were not statistically significantly different to the same rates for Western Australia as a whole. This was the case for males and females.*

Alcoa also refers to health risk assessments of refinery emissions and the Healthwise research program.

When Alcoa presents information to the CCN relating to Alcoa's health studies (such as health risk assessments and Healthwise), Alcoa will present relevant information from public sources when it is available.

7.6 Waste

7.6.1 Background

Waste generated at the Wagerup Refinery can be broadly categorised as either non-process waste or process waste. Non-process waste includes:

- Laboratory wastes;
- Office wastes;
- Sewage;
- Garden wastes;
- Food wastes; and
- Wood wastes.

Process wastes from the refinery include any waste that is derived from an ingredient of the Bayer process. Process wastes include the following:

- Scale (any solid material from process circuits or tanks that contains caustic);
- Bauxite residue;
- Waste alumina and hydrate; and
- Oxalate.

Oxalate originates from broken down organic material (plant and animal matter as humus) in the bauxite. Within the refinery process this organic matter forms sodium oxalate. Over time, the level of oxalate builds up in the recycled caustic liquor circuit, which negatively impacts upon the alumina product quality and the production yield of alumina. Consequently, as part of the alumina refining process, oxalate needs to be removed from the liquor. Although oxalate is a compound commonly found in the environment and is not intrinsically harmful, the oxalate extracted from the refinery process has a high caustic concentration and hence requires appropriate handling, storage and treatment.

7.6.2 Current Management Strategies

Non-Process Waste

The Wagerup residue area operates a licensed Class II landfill area which takes wastes generated from the refinery and residue area. The Class II landfill accepts certain non-recyclable non-process wastes.

On site waste disposal reduces pressure on municipal landfills. The overall volume of waste disposed to the landfill is less than 1% of total residue produced per annum. Alcoa has a significant ongoing focus on reducing waste to landfill. New and improved recycling programs have made advances in the area of waste recycling and minimisation.

Alcoa's waste management program includes the recycling of waste oil, scrap metal, gloves, fluorescent lights, automobile batteries, liquid waste, electronic waste, cardboard, tree/garden clippings, drums, food waste, cooking oil and printer/toner cartridges. Details of waste materials are recorded in a comprehensive database. Recyclable material is classified and separated prior to removal from site and the remnants are disposed to the Class II landfill area within the residue area.

Process Waste

A separate tip face, which does not form part of the Class II landfill, accepts solid process waste such as scale. Bauxite residue is processed and dried in one of the residue storage areas. While Alcoa's corporate goal is to reduce landfilled waste, Alcoa also recognises that there are opportunities to track and reduce process waste (e.g. through residue reuse). The reuse of bauxite residue is discussed in Section 4.6.

Oxalate

In the past, oxalate has been managed at the Wagerup Refinery using several techniques:

- Storage in purpose built oxalate storage ponds;
- Oxidised using an Oxalate Kiln; and
- Reacted with lime (to form calcium oxalate) and stored within residue mud.

Wagerup Refinery's oxalate kiln was recommissioned in 2012. Alcoa has recently committed to the construction of a Biological destruction plant at Wagerup Refinery, with a similar design to Pinjarra Refinery. The capacity of this facility has been designed to match the anticipated oxalate production rate. Oxalate bio- removal plants (Biox plant) use naturally occurring biomass to convert sodium oxalate to sodium carbonate and sodium bicarbonate. The bio-removal plant consumes significantly less energy than the oxalate kiln. This is then converted to sodium hydroxide and returned to the process. Wagerup Refinery's Biox plant is currently anticipated to be commissioned in early 2020.

7.6.3 Waste Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed one Guiding Principle relating to waste. This is presented below, together with Alcoa's response.

Guiding Principle: 6) Biological Oxalate Destruction

Implement biological oxalate destruction capability at Wagerup. Alcoa to set the maximum achievable target for oxalate recovery within 12 months of the implementation of the Bio-oxalate removal plant, in consultation with the local community.

Alcoa's Response

Alcoa has recently committed to the construction of a biological oxalate destruction facility at Wagerup Refinery. The capacity of this facility has been designed to match the oxalate production rate.

7.7 Water Use

7.7.1 Background

The refinery has been designed to operate an efficient closed water circuit, which is supplemented for water losses. Losses of water primarily occur as steam from the process, evaporation from water storage areas and residue surfaces, water bound within the residue mud and sand, and some seepage from the residue area. See Section 7.9 for further details. The largest use of water at the residue facilities is for operating sprinklers to control dust.

Process and potable water supplies at Wagerup Refinery are sourced from rainwater that falls on the refinery and residue areas; surface water sourced under licences from the DWER; licensed ground water recovery bores on site , water brought in with bauxite (% moisture), and water purchased fit for industrial use.

Wagerup Refinery is located within the Harvey River Basin and is licensed by the DWER to divert and abstract surface water. Surface water is taken from the following three licensed sources:

- Yalup Catchment, via the Upper Yalup Dam. This water is used as a source of potable water to the Refinery and for process make up water as required;
- Black Tom Brook Catchment. This water is primarily used for dust control on the residue area and as process make-up water; and
- Harvey River, via the Harvey River Pumpback System. This water is primarily used for dust control on the residue area.
- Fit for purpose purchased water, supplied via the irrigation channels from Harvey Water.

Wagerup Refinery is also licensed to abstract groundwater from depressurising bores at the residue area to ensure groundwater levels remain below the base of the RSAs, and from two groundwater recovery areas in the refinery area.

The RSAs have base drainage systems that collect residue leachate and rainfall infiltration. The majority of rainfall runoff from the refinery, RSAs and process water ponds is transferred to the Cooling Pond or Runoff Water Storage Pond during winter and then used as make-up water for the refinery during summer.

7.7.2 Current Management Strategies

Operation of the residue sprinkler system contributes significantly to water usage volumes. While this results in effective dust management, Alcoa is also focused on maintaining dust performance while using water efficiently.

Alcoa has implemented a number of water efficiency improvements for the residue areas over the past decade including:

- New sprinkler spacing to improve water use efficiency,
- Improved sprinkler use management processes which has improved overall water use, and
- Increased use of mulch, bitumen and aggregates for dust control.

Alcoa conducts ongoing research into alternative water sources and water conservation initiatives, including investigating the effectiveness of a range of dust suppressant products.

The amount of water required for dust suppression is related to the open drying area, and the open drying area is related to the refinery production rate. Over time, with a stable production rate, the amount of drying area will oscillate around a relatively constant area (new areas will increase the open area but will then be consumed over time until new areas are required to offset the losses) and water use will therefore remain relatively constant.

7.7.3 Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed one Guiding Principle relating to water use. This is presented below, together with Alcoa's response.

Guiding Principle: 7) Water Use

Alcoa to continue to focus on water efficiency by maximising water conservation and the use of recycled and fit for purpose water.

Alcoa's Response

Alcoa accepts and agrees with this principle.

7.8 Surface Water

7.8.1 Background

The refinery has been designed to operate an efficient closed water circuit, which is supplemented for

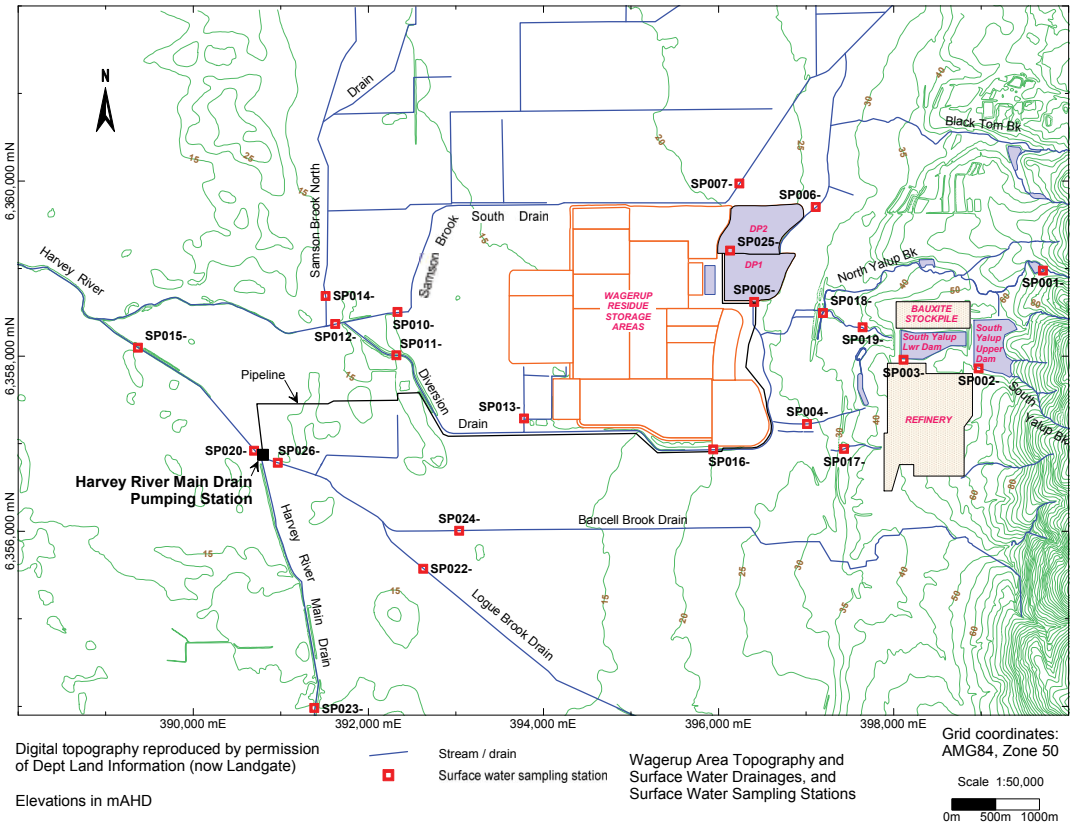

Figure 7-1: Surface water monitoring locations

water losses. See Section 3.8 for further details. Stormwater that runs off the residue or refinery areas is characteristically alkaline. This renders the water unsuitable for direct discharge to the environment. Therefore rainfall runoff from the refinery and residue area is collected and stored in lined ponds within the residue area for recycling via the refinery process as make-up water.

Three significant water transfer systems (drains/pipes) cross Alcoa's Wagerup landholdings:

- South Samson Drain flows from the north eastern corner of the residue area to the western edge of Alcoa's property where it enters the Harvey River.
- The South Samson Diversion Drain was installed by Alcoa as an alternate route to allow water from Black Tom Brook to be harvested, and to allow water from the North Yalup Brook to enter the Harvey River. The South Samson Diversion Drain directs water from Black Tom Brook into Detention Pond 1, as well as providing a flow path for water purchased from Harvey Water to be collected via the South Samson Drain. Overflows from Detention Pond 1 are diverted around the southern side of the residue area.
- Overflows from the Pipe Head Dam (diversion point for North Yalup catchment to the Upper Yalup Dam) flows along the Yalup Brook to the Diversion Drain, traversing the Alcoa property from east to west.

During the winter months, the majority of local stormwater from Alcoa's property not collected within the refinery and residue areas is carried away via the above systems.

7.8.2 Current Management Strategies

Alcoa manages the risk of surface water contamination from the residue facilities by implementing practical measures to ensure no contaminated stormwater is released from the residue area.

The residue area has a 100% surface water containment policy. Surface water runoff and underdrainage is collected in the ROCP and then pumped to the ROWS or Cooling Pond.

Under normal rainfall conditions water collected on the surface of the RSA is allowed to drain freely to the ROCP. Under severe storm conditions water may need to be retained in the RSAs by closing the decant weirs in order to prevent an unmanageable amount of water reporting to the ROCP. Operational guidelines stipulate that storm surge capacity must be maintained on the residue area to capture 100% of any storm event, based on a 1:100 year, 72 hour storm, and a 12 to 13 day recovery period.

The ROWS Pond has three main functions. The primary function of the ROWS pond is to collect surface runoff water and provide bulk storage of water for process requirements. The second function of the ROWS Pond water is to provide make up water to the Cooling Pond. The Cooling Pond make up will normally be required at the end of summer when the Cooling Pond volume is at its lowest level. The third function of the ROWS pond is to accommodate surges in the total water volume in the residue area as evaporation and rainfall vary throughout the year.

The overall stability of the residue storage facilities has been designed in accordance with international standards to accommodate both static and earthquake loadings. The structural integrity of water storage ponds and

RSA embankments are inspected annually by a third party consultant.

An increased residue footprint requires an increased storm surge capacity and increased long term storage capacity for winter rainfall. The amount of required water storage is a function of the total residue footprint, as water is collected from RSAs, embankments and infrastructure areas to prevent any contamination leaving the site.

Future residue areas and associated water storage infrastructure will be constructed in accordance with the current strict residue engineering guidelines and controls outlined in Section 4.5, ensuring no additional likelihood of impact on surface water bodies.

7.8.3 Surface Water Monitoring

An extensive network of surface water monitoring points is established upstream and downstream of Wagerup Refinery's operating areas to measure any long-term water quality changes associated with the refinery and residue operations. The monitoring program also provides data to ensure that abstraction levels do not exceed the water requirements of the local environment. Figure 7-1 shows the location of the 23 surface water monitoring sites.

A comprehensive monitoring program has been developed in accordance with the DWER operating licence and the surface water licence operating strategy which details the frequency of monitoring, parameters to be analysed, and procedures to use for each monitoring location. Water quality monitoring includes measurements of pH, electrical conductivity (EC) and alkalinity and trace elements including aluminium, arsenic, mercury, selenium, vanadium, manganese, molybdenum and uranium. Monitoring results indicate that Wagerup Refinery's operations have not had an impact on surface water quality in the vicinity of the refinery. Surface water monitoring results are collated and reported annually to DWER, in accordance with the DWER operating licence and abstraction licences.

7.8.4 Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG determined that a Guiding Principle relating to surface water was not required.

7.9 Groundwater

7.9.1 Background

Western Australia's water resources are considered a valuable public asset. Groundwater of useable quality is present in the superficial strata within the region of the existing and proposed residue deposits.

Alcoa has a number of management strategies for protecting groundwater, including pipe and process equipment integrity and containment management programs. The potential impact of residue leachate on groundwater quality was recognised when Wagerup was built, and the residue areas were intentionally built in areas of low-permeability clay soils. From the commencement of Alcoa's operations in Western Australia, residue areas have been designed and constructed in accordance with contemporary accepted engineering standards which include containment and leachate recovery systems. These design standards have improved since Alcoa constructed its first residue areas at Wagerup.

The introduction of dry stacking of the residue in 1987 reduced the potential for release of residue leachate to the surrounding environment as the lack of any significant water level within the deposit decreases the pressure on the base liners.

All RSAs have base drainage systems. These drainage systems provide a major defence against seepage to the ground water by substantially lowering the hydraulic head at the base of the deposit. All RSAs constructed since 1983 have included PVC or HDPE liners to further mitigate seepage. A schematic representation of RSA construction is provided in Figure 7-2.

7.9.2 Current Management Strategies

Alcoa has a Groundwater Management Strategy for the Wagerup Refinery. The objective of this plan is to define, monitor, contain, control and reduce

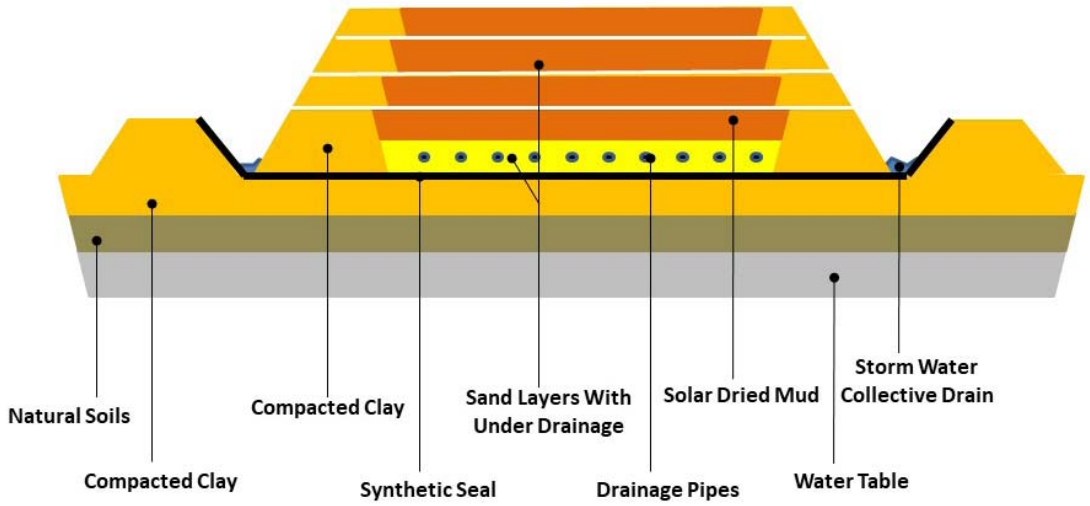

Figure 7-2: Schematic showing construction method of residue drying beds.

the known groundwater plumes originating from Alcoa Wagerup's licensed activities, to protect the environmental values of Alcoa's site and the immediate surrounds. This plan is regularly adjusted in response to feedback from monitoring at key sites. Any losses from the residue areas are typically characterised by elevated total dissolved salts and elevated pH in the groundwater.

Alcoa maintains and operates groundwater depressurising systems around the ROWS Pond, Cooling Pond, and ROCP2. The purpose of the depressurising system is to manage the groundwater levels beneath these facilities, and prevent upward pressures on the clay liners developing to an extent that could compromise liner integrity (Clifton, 2009). Alcoa has a licence issued by the DWER to operate these depressurising bores.

As part of the Groundwater Management Strategy, Alcoa maintains two groundwater recovery systems at Wagerup to recover contaminated groundwater from known groundwater plumes. The performance of the recovery bores is monitored and tracked against target recovery flows. The effectiveness of the recovery bore network is monitored using an extensive network of groundwater monitoring bores; the results from this monitoring are reviewed and reported annually.

Alcoa provided a report in 2007 to the DER in accordance with the requirements of the Contaminated Sites Act 2003, that identified the residue area as "Contaminated – Remediation Required" due to seepage from the RSAs. Alcoa is committed to implementing the requirements of the Contaminated Sites Act 2003, in line with DER Contaminated Sites Guidelines. Alcoa provides regular updates to stakeholders on the progress of these actions through consultation processes such as the CCN, the Wagerup Refinery EIP, and the Wagerup Refinery LTRMS SRG.

Elevated alkalinity has been detected in groundwater in the following areas within the residue area:

- RSA 1, RSA 2 and Sand Area, and
- ROCP 1.

A summary of the strategies put in place to address these issues follows.

RSA 1, RSA 2 and Sand Area

Groundwater quality in the Upper Superficial Formation was previously inferred to have been affected by alkaline residue leachate in the vicinity of the earliest constructed residue facilities at RSA1, RSA2, and the Sand Area. This inference is not supported in general by the results of 2009 investigations in the southern half of RSA2 that concluded groundwater quality in the Upper Superficial Formation in this area has not been noticeably affected by alkaline process fluids (Gerritse and Thomas, 2009a, b). It is thought that presence of alkaline process fluids is a result of ingress into some of the older bores via the annulus around the monitoring casing.

Data from monitor bores around RSA 2 have implied the presence of varying levels of alkaline salts in groundwater samples. It has been unclear whether the elevated alkalinity has been due to leakage from the adjacent RSAs, or due to construction and maintenance issues with the monitor bores allowing alkaline water to enter either the bore casing or the bore annulus, or whether the alkalinity is naturally occurring. Investigations to determine the possible reasons for alkalinity in groundwater samples were carried out in 2007 and 2009. The investigations concluded that:

- The occurrence of elevated levels of alkalinity in some groundwater samples from the earlier monitor bores constructed in 1982 and 1989, particularly on the eastern wall of RSA 2, is localised and due to factors associated with bore construction, and
- There are no widespread effects on groundwater quality due to the presence of alkaline process fluids in either the Guildford Clay or Ascot Formation at RSA 2 South (Clifton, 2009).

Damaged bores around RSA 2 were decommissioned in 2015 and 2017, and groundwater quality continues to be monitored around the external perimeter of the residue area.

ROCP 1

The quality of groundwater in the Upper Superficial Formation around ROCP1 in the residue area has also been affected by residue leachate. The clay liner of this facility is thought to have been damaged by upward groundwater pressures soon after construction in 1992. This has provided an opportunity for alkaline fluid to enter the shallow formations beneath the liner when water levels in ROCP1 exceed groundwater levels.

Alcoa has been managing and minimising the seepage from ROCP1 by keeping the level of water in this facility relatively low. Decommissioning of ROCP1 commenced in 2017 with final capping and underdrain installation planned to be completed in 2019.

7.9.3 Groundwater Monitoring

A comprehensive groundwater monitoring program has been developed which details the frequency of monitoring, parameters to be analysed, and procedures to use for each monitoring location. The primary objective of the Groundwater Monitoring Program is to assess the effectiveness of the groundwater management activities. More specifically this includes:

- Ensuring that groundwater quality is continuously monitored enabling identification of potential risks to environmental values,
- Assessing water quality effects and determine if water quality is changing over time,
- Monitoring the quality of the groundwater entering Alcoa's property,
- Assessing the effectiveness of the management plan in protecting potential receptors i.e. to assess the effectiveness of preventing onsite plumes from spreading and impacting on potential receptors, and
- Assessing the effectiveness of the recovery system in preventing spread of plumes offsite into neighbouring land use areas.

7.9.4 Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed two Guiding Principles relating to Groundwater. These are presented below, together with Alcoa's response.

Guiding Principle: 8a) Water Monitoring

Alcoa to continue regular and systematic surface and groundwater monitoring in and around the RSAs based on Alcoa's environmental licence conditions.

Alcoa's Response

Alcoa accepts and agrees with this principle.

Guiding Principle: 8b) Remediation

Alcoa to commit to action for remediation of any known leaks to prevent migration of contamination from the RSA footprint.

Alcoa's Response

Alcoa is committed to continuing its extensive groundwater monitoring and management strategy and where appropriate will implement remedial actions for identified leaks.

7.10 Land Use Management and Visual Amenity

7.10.1 Background

Alcoa has significant landholdings around the refinery and residue area that have been purchased for future residue storage needs, and as part of the Land Management Strategy. See Section 6.6.1 for more detail on Alcoa's Land Management Strategy.

Wagerup Refinery has a Land Management Program. This long-term planning process focuses on the successful integration of industry, agriculture, landcare and conservation, with the aim of ensuring a sustainable land resource for the future. Landholdings required for future residue storage are incorporated into this Land Management Program.

Due to the relatively flat terrain surrounding the Wagerup residue area and the volume of residue to be stored, the residue area is a prominent feature on the local landscape. The residue area is also visible from viewpoints along the Darling Scarp.

From the Coastal Plain adjacent to the residue areas, the perimeter embankment slopes are visible from some locations. However, the height of the residue area is and will remain low in comparison to the adjacent Darling Scarp which rises to a height of nearly 300 metres above sea level (RL) to the east of the refinery.

7.10.2 Current Management Strategies

A Land Management Program at Pinjarra Refinery has been ongoing for the past 20 years and is focused primarily on the land surrounding the residue area. A number of ecological restoration and visual amenity projects have been undertaken. In some cases, these projects will require ongoing maintenance and management to ensure their ongoing effectiveness. Weed control, feral animal management and fire control activities are also managed under the Land Management Program.

As part of Alcoa's visual amenity planning process, where the refinery creates a visual impact on the rural / natural landscape are identified and prioritised for visual amenity works.

The focus of visual amenity efforts will continue on the rehabilitation of external residue batters which will be increasingly visible as the height of the residue area increases. However landscape planting is also undertaken along roadsides and in farmland areas to complement this.

It is acknowledged that there are locations on private properties surrounding the refinery from which the residue areas and the refinery are visible. Embankment rehabilitation will continue to minimise the visual amenity impact from these locations.

Recent projects completed as part of Land Management Program include:

- Continued infill planting along Somers Roads and South West Highway to improve the visual amenity of the residue area,
- Protection and enhancement of existing wetlands and watercourses by establishing native vegetation / habitat corridors along banks, weed control, fencing to restrict stock access and stock watering facilities designed to minimise stream degradation,
- Monitoring the effectiveness of revegetation projects undertaken,
- Continued support for specific local land care projects including:
    - planting on Alcoa land to create habitat linkages as part of the Bancell Brook restoration project (conducted in partnership with Greening Australia and the Harvey River Restoration Trust (HRRT)),
    - Dan's Block commemorative annual tree planting event, and
    - Installation of a stock exclusion fence on the Samson Northern drain (Somers Road) for a turbidity reduction/visual amenity project in partnership with HRRT.
- Continued feral animal and weed control programs on Alcoa landholdings.

A key objective of the Land Management Program is improving the visual amenity of the residue areas. This residue rehabilitation program is outlined in Section 7.11. Landscape planting along roadsides is used to complement the rehabilitation program in high priority areas.

Alcoa has trialled changing the shape of the residue area by creating contours that match the natural low hills at the base of the Darling Scarp. To do this, slopes and contours in the natural environment were measured and incorporated into the northern embankment of RSA 8 at Wagerup Refinery. In addition, sharp corners have been avoided in new residue developments. However the impact of these variations in embankments depends on the viewing location, and tends to be more effective from a distance.

7.10.3 Visual Amenity Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed three Guiding Principles relating to Visual Amenity. These are presented below, together with Alcoa's response.

Guiding Principle: 9a) Visual Amenity Plan

Alcoa to regularly update the visual amenity plan to create a natural looking landscape. This plan should focus on identifying and developing strategies to enhance visual amenity at current and future visual amenity "hot spots" (including the South Western Hwy) and the maintenance of any established vegetation buffers. Focus should be on existing visual amenity buffers that were affected by the bushfire in January 2016.

Alcoa's Response

Alcoa accepts and agrees with this principle.

Alcoa will continue to develop and regularly update a visual amenity plan that will include progressive embankment rehabilitation and visual screening to make the residue areas appear as natural looking landscape as possible. Focus will continue to be placed on maintaining existing vegetation screening that require remedial works.

Guiding Principle: 9b) Light Emissions

Alcoa to develop and implement a strategy to mitigate unnecessary light emissions from the residue area whilst maintaining a safe work environment. This strategy should include informing the local community how they can provide feedback on light emissions.

Alcoa's Response

Alcoa accepts and agrees with this principle. Alcoa needs to maintain a safe working environment for its employees. Alcoa invites feedback on light emissions from our neighbours.

Guiding Principle: 9c) Fire Resilience of Vegetation Buffers

Alcoa to study the effect of fire on the visual amenity vegetation buffers and apply the outcomes of this work to improve the resilience of the visual amenity vegetation buffers to fire impacts.

Alcoa's Response

Alcoa will continue to adapt the structure of visual amenity screening to improve resilience to impacts such as fire.

7.11 Residue Area Rehabilitation

7.11.1 Background

There are two categories for the rehabilitation of the residue areas; these are progressive rehabilitation and final rehabilitation. Progressive rehabilitation is rehabilitation of an area concurrent with the operation of the area, which is carried out on the external embankments of the upstream sand embankments. Final rehabilitation is the final sand spreading, contour shaping, revegetation and dewatering of the RSA surface after closure.

This section outlines the strategy for progressive rehabilitation of the residue area. Final rehabilitation is addressed as part of the closure strategy discussion in Chapter 9.

The objectives of the residue rehabilitation program are to improve visual amenity of the external embankments, prevent the generation of dust, and enhance the conservation value of the area in order to achieve the progressive rehabilitation of the residue deposits.

7.11.2 Current Management Strategies

The current focus of the rehabilitation work undertaken at the Wagerup residue area is on external embankments (external embankments are embankments on the boundary of the life-of-mine residue footprint which are unlikely to be disturbed in the medium term).

Outer embankments are commonly constructed using residue sand, produced after separation of the residue sand (>150 µm) from the residue mud (<150 µm). The alkaline (pH >10) and saline (> 10 dS/m) nature of residue, coupled with its poor water retention properties, poses numerous restrictions for optimal plant growth. To help overcome these restrictions, the residue sand embankments are left for a minimum of two years to allow leaching of excess alkalinity and salinity. Leaching of the sand prior to final revegetation occurs with within the confines of the residue area, and all leachate is collected and returned to the refinery water circuit. Refer to Sections 3.8 and 9.3 for information about leachate management.

Wagerup's existing rehabilitation program for residue areas uses native species, primarily found on limestone outcrops and in coastal heath lands.

The incorporation of gypsum (Stage 1, Figure 7-3 alters the properties of residue to better reflect those of coastal sandy soils common to the Swan Coastal Plain of Western Australia. Previous rehabilitation practice incorporated gypsum to a depth of 0.8 metres, but this has been increased to 1.5 metres to allow deeper rooting of vegetation.

To provide a supply of plant nutrients at the time of planting, a custom blend of fertiliser is applied (Stage 2, Figure 7-3). Approximately 2.7 t/ha of di-ammonium based inorganic fertiliser is applied and incorporated to a depth of about 0.2 metres.

A mix of native seeds is broadcast over the area. The seed mix contains a range of species found on sandy soils over limestone and is reviewed progressively in response to their relative success.

A 30 millimetre deep layer of coarse wood mulch is subsequently spread to prevent the generation of dust from the bare surface before plant cover has been established (Stage 3, Figure 7-3).

The final step in rehabilitation operations is the hand planting of tree, shrub and groundcover seedlings at an approximate density of 1,200 stems/ha (Stage 4, Figure 7-3). The native species used are adapted to the local climatic conditions and draw the water they need from the residue deposit. Water extraction by native vegetation will assist in reducing the total volume

of water that will eventually need to be treated prior to release or reuse at closure. Alcoa's residue rehabilitation research has shown that rooting depth and therefore available water is strongly linked to the depth of gypsum presence in the soil profile.

After residue rehabilitation has taken place botanical monitoring is undertaken to assess the performance of the rehabilitation. This botanical monitoring covers species diversity, species abundance and percent coverage. (Stage 5, Figure 7-3).

7.11.3 Guiding Principles and Commitments

In response to the information provided, the Wagerup LTRMS SRG developed two Guiding Principles relating to rehabilitation. These are presented below, together with Alcoa's response. Further Guiding Principles focussed on final land use closure and rehabilitation are presented in Section 9.6.

Guiding Principle: 10a) Residue Rehabilitation Prescription

Alcoa to continue to improve its residue rehabilitation prescription with a focus on developing a self-sustaining ecosystem that maximises the use of suitable endemic plant species wherever possible.

Alcoa's Response

Alcoa accepts and agrees with this principle.

Guiding Principle: 10b) Fire Resilience of Residue Rehabilitation

Alcoa to consider the potential fire risk and fire resilience of the residue rehabilitation prescription.

Alcoa's Response

Alcoa accepts and agrees with this principle.

Figure 7-3: Residue rehabilitation process.

Figure 7-4: Contouring external residue embankment trial.

8 Residue Development Strategies

8.1 Residue Planning and Design Framework

Alcoa is currently undertaking the comprehensive residue management planning processes for the short-term (5 year) and longer term, life of the current mining lease (life-of-mine, 2045). These planning processes give consideration to the guidance provided through the LTRMS SRG process. Mud drying, embankment construction, planned maintenance and other sustaining activities are carried out in accordance with a detailed annual program of work, which is developed within the context of the five year residue management planning process.

Planning and design of all new residue facilities is completed in accordance with Alcoa's Bauxite Residue Management Standard as well as relevant regulatory standards and guidelines. In addition to outlining the process to be followed when selecting and confirming the social, environmental and engineering suitability of areas for new residue facilities, these documents prescribe minimum design standards for all new facilities. For instance, detailed analysis is completed to confirm that the short and long term stability of earthen embankments exceeds minimum requirements and investigations are completed to ensure that all storm water generated from the residue area in a 1:100 wet year is able to be contained within the area without release to the environment.

8.2 Constraints on Forward Planning of Residue Operations

Despite the level of effort which goes into forward planning, significant changes are occasionally required as a result of a range of factors including:

- changes in technology,
- changes at the refinery affecting the rate of production,
- changes in quality of bauxite and/ or characteristics of residue material streams (the drying area required can be affected by small changes in the percentage of mud in the residue, with higher percentages of mud requiring a greater drying area),
- weather conditions, in so far as they can affect mud drying rates and the construction schedules of new residue areas,
- input from the community and regulatory agencies while obtaining the necessary statutory approvals for new residue areas,
- internal funding availability which is influenced by a number of factors including the global aluminium market, and
- the availability of key equipment and contractors.The plans presented in the LTRMS are therefore subject to change, particularly the timing and sequence. The five yearly review process undertaken for the LTRMS is designed to allow these changes and their impact on long-term planning for the residue area to be reviewed with community and government stakeholders. In the event that a significant change will impact the five year plan presented in this document, additional consultation may be required.

This LTRMS identifies the:

- current projected residue footprint for 2018-2022, and
- current preferred area over which the residue area may expand during the life-of-mine (2045).

8.3 Future Residue Practice

Alcoa's future residue planning work is focussed on two key streams of work that are progressed in parallel:

(1) Research to identify mechanisms to reduce the area required for future residue storage, and

(2) Future planning based on current storage techniques.

8.3.1 Research to Reduce Residue Areas

Alcoa is dedicated to continually investigating new markets, products and technologies that may lead to a reduction in the area required for future residue storage. This work is currently focused in three key areas:

(1) Alternative uses for residue.

(2) Reducing required drying area/ time.

(3) Alternative storage technologies and processes.

Alternative Uses for Residue

Alcoa has been developing alternative uses for bauxite residue since 1978.

Alcoa recognises that if significant alternative uses of residue can be achieved, the rate of expansion of the residue area can be slowed, and the long-term impacts of residue storage can be reduced. See Section 4.6 for more detail on Alcoa's residue reuse research.

Reducing Required Drying Area and Time

Alcoa uses a drying model formula to assist in its residue planning. This formula helps Alcoa to determine the drying area required to ensure that the mud can dry sufficiently to gain the required strength. This formula can be simplistically represented as:

drying area required = tonnes mud per day x 100 days / mud density / pour depth

Alcoa is continuously looking for ways to reduce the number of days of required drying time, and hence the drying area required. If improved drying times can be achieved whilst maintaining the structural integrity of the residue areas, this would reduce the rate new residue areas are required. Alcoa trialled alternative amphirolling cycles and the use of flocculants to assist with residue dewatering.

A flocculant product called Rheomax was trialled. Rheomax is a polyacrylamide/ acrylate mixture that is chemically equivalent to the flocculants currently used in the super-thickener. It was added at the end of the residue pipe at very low rates, just before the residue is deposited in the RSA. Unfortunately, these trials demonstrated that no significant reduction in drying time was achieved and the use of Rheomax was discontinued.

However, the trials of alternative amphirolling cycles were successful and changes were made to the amphirol operations as a result.

Alternative Storage Technologies and Processes

Alcoa is currently introducing its first large scale filter presses to Alcoa's WA residue operations. The filter presses essentially work by forcing the moisture out of the residue, leaving behind a dry filter cake. If future investigations prove residue filtration is a viable option for the Wagerup Refinery's residue area, this could have a number of advantages:

- Residue operations could be contained within a much smaller life-of-mine footprint,
- Residue water use would be significantly reduced,
- Reduced potential to produce dust from the RSAs, and
- Reduced potential to impact groundwater.

Alcoa introduced residue filtration at the Kwinana Refinery in 2016, and the commissioning of a similar facility at Pinjarra Refinery is currently expected to commence in 2019. During the coming five year period, it is currently anticipated that investigations into the feasibility of introducing large scale filter presses to the Wagerup Refinery will take place as part of the consideration of the next residue storage solution.

8.3.2 Future Planning

Although Alcoa is actively pursuing mechanisms to reduce the area required for future residue storage, due to the long lead times required for planning, Alcoa must continue its future residue planning based on the current storage techniques, until any alternative mechanism is proven and fully implemented.

The future residue strategies presented in Section 8.5 are therefore based on the current residue storage techniques. Information on how these plans would likely be modified if residue filtration is introduced at Wagerup are presented in Section 8.6.

8.3.3 Residue Storage Techniques Guiding Principles

In response to the information provided, the Wagerup LTRMS SRG developed one Guiding Principle relating to the future development of residue storage techniques. This is presented below, together with Alcoa's response.

Guiding Principle: 11) Alternative Residue Storage Techniques

Alcoa to implement residue filtration at Wagerup Refinery.

Alcoa's Response

Alcoa has implemented a residue filtration facility at its Kwinana Refinery, and is currently developing a residue filtration facility at Pinjarra Refinery. Any implementation of residue filtration at the Wagerup Refinery is subject to detailed feasibility studies, internal funding availability, regulatory approval and availability of key equipment and contractors. Current plans indicate that the next residue storage solution would not be required until after 2023.

8.4 Future Development Considerations

As the mud elevation in RSAs increases over time, perimeter embankments progressively move inwards and the net available drying area reduces. As a consequence, to maintain the minimum drying area required to dry mud it is necessary to periodically construct new RSAs. Alcoa uses a number of principles in its planning processes to plan for new residue areas. These include greenfield site assessment, footprint development direction, residue stack heights, and proximity to neighbours. Alcoa assesses the various options for new residue area development based on sustainability criteria. Table 8-1 provides examples of the sustainability criteria that are made in this assessment of each option.

Table 8-1: Sustainability criteria used to assess footprint options.

ECONOMIC	ENVIRONMENTAL	SOCIAL
Cost of construction (pumping, piping, infrastructure relocation). Associated costs such as relocation of key infrastructure such as powerlines and water pipelines.	Potential impact on protected species and ecologically sensitive areas. Potential dust and odour impacts. Ground water levels. Ability to achieve necessary approvals.	Potential impact on any heritage sites (Aboriginal and European). Visual amenity impacts. Potential impact on neighbours.

8.4.1 Development Direction

Alcoa has assessed options to expand the residue area to the north, south, east and west in accordance with Alcoa's sustainability criteria, as outlined in Table 8-1. A summary of this assessment for each option is presented below.

Northern Expansion

Expansion of the residue area to the north has the benefits of allowing the new residue areas to adjoin the existing stack, and having minimal environmental impact due to good hydrogeology in the area, and limited native vegetation. The land in this area is already owned by Alcoa.

Expansion in this direction will be impacted by major powerline infrastructure in the area, and will bring the residue area closer to neighbours and the Hamel township. The land in this area is also considered to be of high agricultural value.

Alcoa currently considers northerly expansion of the residue area a preferable option.

Southern Expansion

Expansion of the residue area to the south has the benefits of allowing the new residue areas to adjoin the existing stack, and having minimal environmental impact due to good hydrogeology in the area. Expansion in this direction would require the relocation of the drain, road and gas infrastructure. Expansion in this direction would also bring the residue area closer to neighbours and would impact on land considered to be of high agricultural value.

Alcoa does not currently consider expansion of the current residue area to the south as a preferable option.

Western Expansion

Expansion of the residue area to the west has the benefits of allowing the new residue areas to adjoin the existing stack, utilising land of lower agricultural value, and maintaining separation of the residue area from the townships of Hamel and Yarloop. The land in this area is already owned by Alcoa.

Expansion in this direction will be impacted by Somers Road and major water pipelines in the area.

Alcoa currently considers westerly expansion of the residue area a preferable option.

East Expansion

Expansion of the residue area to the east would provide the benefit of maintaining separation of the residue area from the townships of Hamel and Yarloop.

Expansion in this direction would be constrained by the presentence of drain, railway, water, gas and power infrastructure, and the South Western Highway. Expansion in this direction would also require the relocation of Alcoa's water storage ponds and would result in an inefficient design of the residue area as the new residue areas would be separated from the existing stack. Furthermore, the hydrogeology in this area is not ideal for residue areas.

Alcoa does not currently consider expansion of the current residue area to the east as a preferable option.

North West Expansion

Expansion of the residue area in a north westerly area would provide the benefits of both the north and west expansion options, and would allow for a smaller expansion of the residue footprint in both of these directions than would occur if expansion was only progressed in one of these directions.

Alcoa currently considers expansion in a westerly direction followed by a northerly expansion the preferred option.

8.4.2 Height

During the 2007 LTRMS review, in response to the feedback received from the 2007 Wagerup LTRMS Working Group, Alcoa committed to not increase the height of the residue stack above 40 metres above natural ground level before 2012. Alcoa fulfilled this 2007 commitment, and the current height of the residue area is 29 metres above natural ground level (43 metres RL). Alcoa also committed at that time that the mid-term residue footprint plans would be developed on a reduced height of 60 metres above natural ground level (74 metres RL) as this will produce the most sustainable outcomes (Alcoa's other WA sites have 25 year life-of-mine footprints based on residue heights of 80 metres).

Residue height versus footprint was a significant issue discussed by the SRG members during the consultation for this LTRMS. Some members of the SRG expressed their preference that the residue areas be made taller rather than wider if they cannot be contained within their current footprint, whereas other SRG members expressed their preference that the height of the residue areas be kept as low as possible, with a maximum height of 40 metres above natural ground level.

Alcoa acknowledges the stakeholder feedback received during the 2007, 2012 and 2017 reviews of the LTRMS and understands the desire for Alcoa to work towards keeping the residue area height as low as possible, whilst keeping the residue area footprint as small as possible.

Economically, an increased stack height has the benefit of requiring less land to store residue, and hence reduces capital costs. Socially, increased stack heights allows greater separation distances from storage areas to neighbours and reduces the overall land area which may have long-term planning constraints. Environmentally, a reduced footprint reduces the area at risk of future groundwater contamination and supports a range of alternate use and land use options.

Alcoa believes the best sustainable outcomes in terms of economic, environmental and social outcomes would be achieved by developing the residue area at Wagerup up to 80 metres above natural ground level. However, Alcoa acknowledges the stakeholder feedback received during this consultation process has indicated the desire for Alcoa to minimise the growth of the residue area footprint, with the height of the area not to exceed 40 metres above natural ground level.

In consideration of this feedback, Alcoa will continue to develop the residue stack to 60 metres above average natural ground level (74 metres RL) as emissions, groundwater contamination risks, proximity to neighbours and closure implications are reduced by maximising stack height.

Having an LTRMS based on these increased stack heights also provides an outcome that fulfils a number of the other Guiding Principles provided by the SRG, such as:

- Residue Odour and VOC Emissions – An increased stack height will result in a reduced surface area from which odour and VOC emissions can potentially be produced,
- Groundwater – An increased stack height reduces the residue footprint and reduces the potential for groundwater contamination,
- Separation Distance – An increased stack height will allow Alcoa to maximise the separation distance between the residue stacks and privately owned property, and
- Closure – An increased stack height reduces the footprint of land occupied by residue at closure, and reduces the surface area that will capture water that will require treatment and disposal post closure of the residue areas.

It is acknowledged that increased stack heights will make the residue area more visible, and may provide greater challenges for dust management. Visual amenity and dust management issues associated with increased residue heights were key concerns raised by the 2017 LTRMS SRG. Continual improvement of visual amenity and dust management, and implementation of the residue rehabilitation program remains a key focus for residue management and Alcoa will continue to keep the community informed of progress in these areas.

8.4.3 Separation Distance to Near Neighbours

The separation distance between the residue area and private property and/or residences was discussed with the 2017 Wagerup LTRMS SRG.

The extent of the residue area is a function of a number of variables including:

- The height that the residue stacks are built to,
- The production rate and commissioning timeframe for the expanded refinery,
- The possible need to realign the Alinta owned power lines along Kubank Road,
- The requirement to maintain an adequate separation distance to near neighbours,
- Zoning approval for the 25 year footprint, and
- Ownership of land, and hence
    - Separation achieved to near neighbours, and
    - Land available for residue storage.

Alcoa implemented a land management strategy in 2001-02 around the Wagerup Refinery which enabled people living in the immediate vicinity who felt impacted by the operations to sell property to Alcoa. The Strategy comprises of two areas:

- Area A – immediately surrounding the refinery, and
- Area B – the townships of Yarloop and Hamel.

The Land Management Strategy is implemented by Alcoa and has no formal status in planning schemes or legislation, and encompasses both the refinery and residue area.

Alcoa will continue to implement the existing Land Management Strategy which was designed to allow for the future expansion of the residue area. See Section 6.6.1 for more information on Alcoa's Land Management Strategy.

8.4.4 Residue Area Planning Guiding Principles

In response to the information provided, the Wagerup LTRMS SRG developed three Guiding Principles relating to the residue area planning. These are presented below, together with Alcoa's response.

Guiding Principle: 12a) Separation Distance

Alcoa to maintain a 2 kilometre separation distance between the boundary of the residue area and private property and/or residences.

Alcoa's Response

Alcoa is committed to the current Land Management Strategy. It must be noted that the extent of the residue area footprint is a function of a number of variables including:

- *The height that the residue stacks are built to;*
- *The refinery production rate;*
- *The possible need to realign the Alinta owned power lines along Kubank Road;*
- *The requirement to maintain an adequate separation distance to near neighbours;*
- *Zoning approval for the life-of-mine footprint; and*
- *Ownership of land, and hence*
    - *Separation achieved to near neighbours, and*
    - *Land available for residue storage.*

Guiding Principle: 12b) Property Purchase

Alcoa to make a genuine effort to negotiate the purchase of whole properties from neighbours within 2 kilometre of the boundary of the residue area who wish to move.

Alcoa's Response

Alcoa will continue to implement the existing Land Management Strategy.

Guiding Principle: 13) Footprint and Height

The Stakeholder Reference Group recommends that residue expansion into the future will be in a westerly direction at 40 metres above natural ground level, but Alcoa needs to:

- *Implement residue filtration (as per the Alternative Residue Storage Techniques Guiding Principle),*
- *Implement a residue reuse program as a matter of urgency (as per the Residue Reuse Guiding Principles),*
- *Improve visual amenity (as per the Visual Amenity Guiding Principles),*
- *Improve dust management (as per the Dust Management Guiding Principles), and*
- *Improve outer bank revegetation (as per the Visual Amenity and Residue Rehabilitation Guiding Principles).*

Alcoa's Response

Alcoa acknowledges that the Stakeholder Reference Group would like to see residue filtration and a residue reuse program implemented, and improvements in visual amenity, dust management and residue rehabilitation. Alcoa is committed to continuing to evaluate improvements in these areas.

Alcoa believes the best sustainable outcomes in terms of economic, environmental and social outcomes will be achieved by developing the residue area at Wagerup up to 80 metres above natural ground level.

Alcoa acknowledges the stakeholder feedback received during this consultation process has indicated the desire for Alcoa to minimise the growth of the residue area footprint, with the height of the area not to exceed 40 metres above natural ground level.

In consideration of this feedback, Alcoa will continue to develop the residue stack to 60 metres above average natural ground level (74 metres RL) as emissions, groundwater contamination risks, proximity to neighbours and closure implications are reduced by maximising stack height.

8.5 Future Plans with Current Technology

This section details Alcoa's future residue plans based on the current storage techniques.

8.5.1 Life-of-Mine Construction Strategy (2045)

Based on the considerations outlined in Section 8.4, Alcoa has developed an indicative life-of-mine strategy for the residue area. This strategy assumes the residue stacks are developed to a height of 60 metres above natural ground level (74 metres RL) and that the footprint is expanded in a westerly then northerly direction.

The key issues to be managed during operations are:

- maintaining the residue storage and drying capacity to meet the requirements of the refinery, and
- maintaining the water storage, surge capacity, cooling and process water supply functions for the refinery, ensuring they can service the increased residue area.

Assuming current production rates, up to 250 hectares of additional drying area is required by 2045, and are presented in Sections 8.5.1. It is currently envisaged that this additional drying area required will be met through development of greenfield drying areas.

Residue Drying and Storage

RSA 10

The development of RSA 10 is currently planned to provide approximately 40 hectares of additional drying area. Current plans indicate that construction of RSA 10 is likely to commence in approximately 2022-2023, however this is subject to the constraints outlined in Section 8.2. The indicative location of RSA 10 is shown in Figure 8-1.

RSA 11

The development of RSA 11 is currently planned to provide approximately 40 hectares of additional drying area. Current plans indicate that construction of RSA 11 is likely to commence in approximately 2026-27, however this

is subject to the constraints outlined in Section 8.2. The indicative location of RSA 11 is shown in Figure 8-1.

RSA 12

The development of RSA 12 is currently planned to provide approximately 45 hectares of additional drying area. Current plans indicate that construction of RSA 12 is likely to commence in approximately 2030-31, however this is subject to the constraints outlined in Section 8.2. The indicative location of RSA 12 is shown in Figure 8-1.

RSA 13

The development of RSA 13 is currently planned to provide approximately 70 hectares of additional drying area. Current plans indicate that construction of RSA 13 is likely to commence in approximately 2034-35, however this is subject to the constraints outlined in Section 8.2. The indicative location of RSA 13 is shown in Figure 8-1.

RSA 14

The development of RSA 14 is currently planned to provide approximately 45 hectares of additional drying area. Current plans indicate that construction of RSA 14 is likely to commence in approximately 2038-39, however this is subject to the constraints outlined in Section 8.2. The indicative location of RSA 14 is shown in Figure 8-1.

Water Storage

ROCP 4

Rain that falls on the RSAs is collected in Runoff Collection Ponds. As the residue footprint expands, increased capacity to store the rainfall runoff is required.

Construction of an additional ROCP (ROCP 4) will be required to provide adequate rainfall runoff storage for the new residue areas that will be built. Construction of ROCP 4 is likely to commence in approximately 2026-27.

Planning Strategy to support Future Residue

Part of the required land for the life-of-mine footprint is currently zoned as Industrial. Alcoa will need to submit applications to rezone the remainder of life-of-mine footprint within the Peel Region Scheme and Shire of Waroona local planning scheme to industrial zoning to facilitate development of the additional areas. Figure 8-1 shows the current industrial zoned area and the area that will require rezoning.

8.5.2 Short Term Construction Strategy (5-7 years)

Key issues to be managed within the short term strategy are:

- maintaining the residue storage capacity to meet the requirements of the refinery,
- maintaining the water storage, surge capacity, cooling and process water supply functions for the refinery, ensuring they can service the RSAs, and
- relocation of infrastructure required to support the provision of adequate residue water storage capacity.

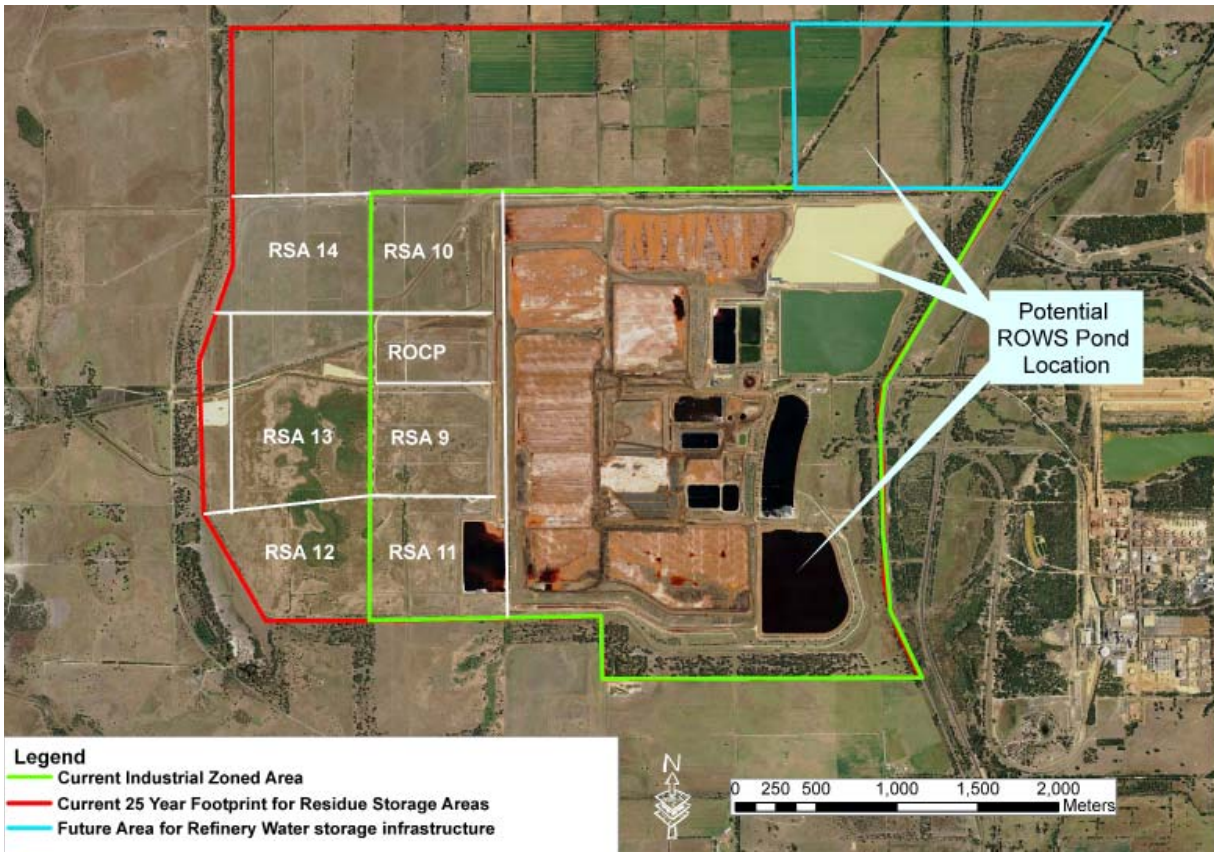

Figure 8-1: Current life-of-mine footprint.

Business as Usual Construction Activities

The following 'business as usual' construction activities will be carried out over the period 2018 to 2022:

- periodic raising of perimeter and internal embankments to maintain the freeboard necessary to support proposed mud deposition activities and provide the capacity needed to contain runoff during extreme 1:100 year, 72 hour storm conditions within the individual RSAs. Individual dyke raises involve construction of a new embankment with a crest level typically between 4m and 10m higher than the previous crest level, construction and/ or relocation of infrastructure associated with the embankment lifts,
- construction of new underdrainage systems associated with hydraulic placement of sand in new embankment walls and/or stockpiles,
- installation of new decant structures, and/or relocation of existing decant structures, and associated pipework,
- extension/modification of mud and sand distribution pipework,
- extension/modification of the groundwater bore monitoring network,
- extension of sprinkler risers, and
- construction of new roads.

A number of techniques are used to raise embankments. Where practical and cost effective, the preferred method is to construct the embankments using hydraulically placed residue sand. However, it is sometimes necessary to construct residue sand embankments using mechanical placement techniques (e.g. using scrapers or dump trucks) and/or raise embankments using mud sourced from the RSAs whereby mechanical placement and compaction techniques are again necessary.

8.6 Future Plans with Residue Filtration

8.6.1 About Filtration

Wagerup Refinery has identified a potential new technology for residue storage (residue filtration) for potential future implementation.

'Residue Filtration' utilises "plate and frame" pressure filtration. The filtration process produces a dry residue cake by filtering mud slurry through a membrane. Introduction of residue filtration to Wagerup's residue operations would involve commissioning a filtration building and mechanical system to place the dried mud in the RSAs (a conveyor system and mechanical spreading equipment).

Residue filtration could provide a number of potential benefits to Wagerup Refinery including:

- a reduction in water usage,
- a reduction in the future residue footprint,
- improved residue dam stability,
- a reduction in dust potential from residue storage areas, and
- reduction of residue storage costs.

The order in which Alcoa's WA refineries have been considered for residue filtration has been determined by the timing of new residue area requirements. A feasibility study has not yet been conducted for introducing residue filtration at Wagerup Refinery, and no definitive timelines are in place. It is currently envisaged that feasibility studies for introducing residue filtration at Wagerup Refinery will likely be conducted during the coming five year period, with 2023 currently earmarked as a potential construction commencement date if the decision is made to introduce residue filtration at Wagerup Refinery. These dates are subject to change.

The location of infrastructure for the potential residue filtration facility has not been decided. The majority of the conveying and dried residue handling system would likely to be located inside the current residue storage footprint. Three possible locations for a residue filtration building have been identified to date and will be subject to evaluation

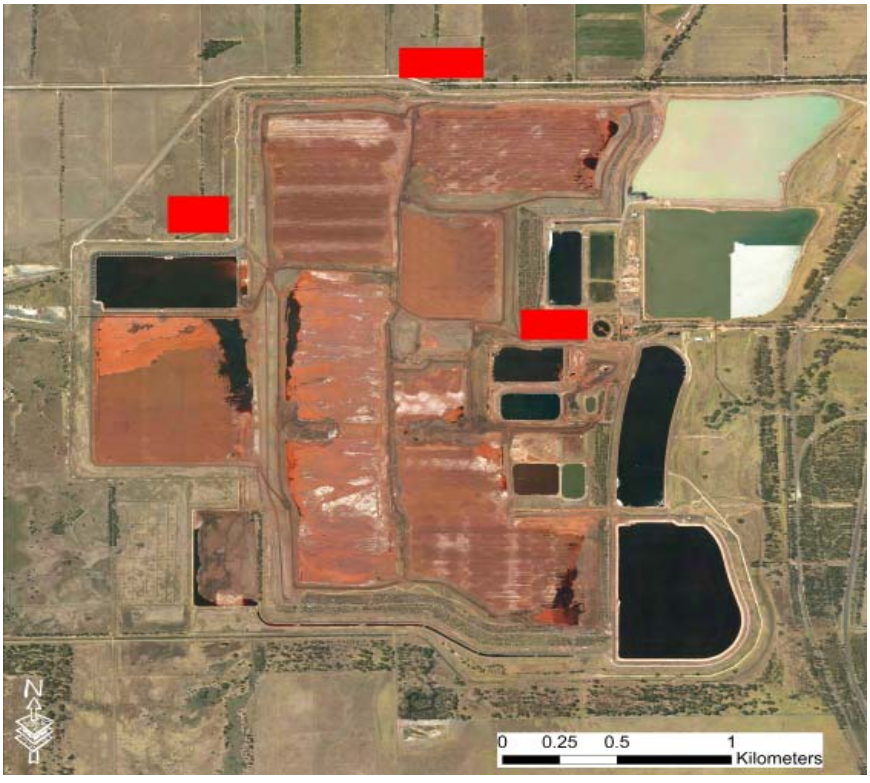

Figure 8-2: Potential Locations for the Residue Filtration Building.

along with any other potential sites identified.

The three sites identified to date are:

(1) On the eastern side of the existing residue area, directly west of the superthickener. This location is within the existing residue footprint and is the current preferred location.

(2) To the north of the existing residue area, adjacent to RSAs 7 and 8.

(3) On the western side of the existing residue area, directly north of ROCP 3 and west of RSA 7.

These areas are shown in Figure 8-2.

8.6.2 Life-of-Mine Construction Strategy (2045) with Filtration

If Alcoa decides to introduce residue filtration at Wagerup Refinery, development of the residue filtration building, and the mechanical system to place the dried mud in the RSAs (a conveyor system and mechanical spreading equipment) will most likely be undertaken within the next 10 years (subject to change).

Residue Drying and Storage

Current plans indicate, that at current production rates and the introduction of residue filtration, at least one additional RSA will be required before 2045. This is based on the assumption the RSAs are developed to 60 metres above natural ground level. No detailed feasibility studies have been conducted to date, however the two locations that have been identified as potential locations for "RSA 10" are directly north of ROCP 3, or directly south of RSA 9. These areas are shown in Figure 8-3. Additional options may be identified in the future.

Alcoa currently has sufficient industrial zoned land to provide RSAs for the life-of-mine at current production rates if a residue filtration facility is developed and implemented.

Water Storage

If residue filtration is introduced, additional capacity will be required to manage accumulated surge. Options to provide this may include:

- Improved recovery of clean water, and/or
- Additional contaminated water storage (ROWS Pond).

This additional accumulated surge capacity will be required at the time residue filtration is introduced. No detailed feasibility studies have been conducted to date, however the three options have been identified as potential solutions for a new ROWs Pond. These are:

(1) Increasing the capacity of the current ROWS Pond,

(2) Conversion of the existing Detention Pond 2 (DP2) to a ROWS Pond, and

(3) A new ROWS Pond, located to the north of the existing residue area, adjacent to DP2.

These areas are shown in Figure 8-1. Additional options may be identified in the future.

If a new ROWS Pond is required and is to be located outside of the existing residue area to the north, rezoning for industrial use will be required.

Short Term Construction Strategy (5-7 years) with Filtration

Given any implementation of residue filtration at Wagerup Refinery is not planned to occur in the coming five year period, the Short Term Construction Strategy for Wagerup Refinery will remain the same for 2018-2022 regardless of whether residue filtration is to be implemented. Details of the short term strategy can be found in Section 8.5.2.

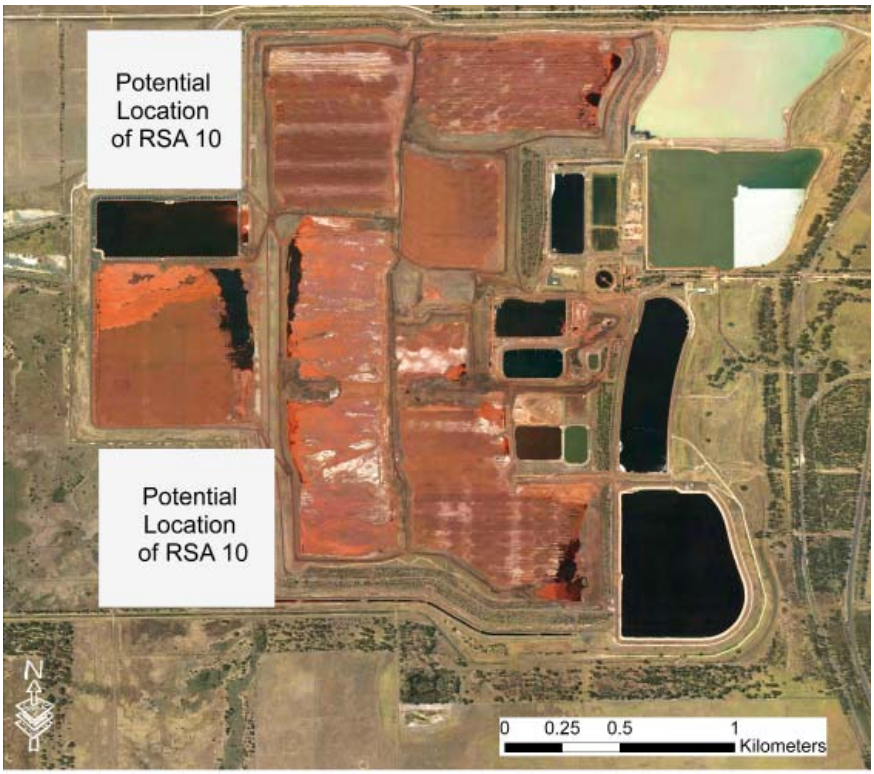

Figure 8-3: Potential locations for RSA 10.

Residue Closure and Rehabilitation 9

At closure, many of the impacts arising during operations will no longer be significant, for example dust generation and water use. Key additional considerations at closure relate to the final form of the residue area, management of contaminated stormwater, management of leachate and final land use. This section outlines the key issues discussed with the Wagerup LTRMS SRG for closure.

The process of defining the closure strategy will be ongoing. Final closure of the Wagerup residue area is many years away, and available technology and community opinions regarding final land use may change over time.

The current closure strategy has three main objectives, being that de-commissioned residue areas should:

- have the capability to be used for productive community benefit,
- be safe and self-sustaining structures in the long term, and
- allow future access to residue for alternate uses.

Development of alternative uses for bauxite residue has been one of the major objectives of Alcoa's residue development program since 1978. The current programs are described in detail in Section 4.6.2. The focus on reuse of the product to reduce the final volume of residue remaining on the site after closure is a key consideration in assessing alternate closure strategies.

9.1 Closure Strategy Options

The rehabilitation of the residue deposits will be ongoing during the operating life of the refinery. The perimeter embankments will be rehabilitated as the height of the stack grows, and revegetation of the surface of the RSAs will occur as each reaches its nominated final elevation. At the time of refinery closure, much of the rehabilitation will be complete with only minimal area remaining to be closed.

At the time the residue deposits are closed, the residue will still contain large quantities of leachable alkali. If rainfall is allowed to infiltrate the deposit, the alkali will be leached from the residue and will report to the underdrainage system. There are two basic options for closure of the residue deposits which have been considered. The first is to provide an impermeable cover to the residue deposits, effectively encapsulating the alkalinity within the deposit and shedding rainfall. The second is to allow rainfall to infiltrate the deposit and set up ongoing collection and treatment facilities for the alkaline water that will be collected. These two options are further discussed below.

9.1.1 Encapsulation

At the time of closure, a surface seal (with similar permeability characteristics to the base seal) would be installed over the deposit and the drainage system turned off. This surface seal would exclude rainfall infiltration to prevent re-saturation of the deposit which, if allowed to occur, would increase the head on the base seal and increase the rate of seepage. The surface seal would be protected by a residue sand layer.

With this option, the leachable alkali remaining in the deposit at the time of closure would be 'encapsulated' within the deposit. The surface runoff water may initially be alkaline due to the alkalinity of the surface residue sand layer. Continuous rainfall leaching of this surface sand layer would, over several years, reduce the alkalinity of the runoff to the point where no treatment would be necessary prior to release.

9.1.2 Continued Leaching

This option assumes that leaching of the deposit would continue beyond the operating life of the refinery. Seepage of rainfall through the residue stack would be encouraged, maximising the recovery of leachable alkali, while maintaining a low hydrostatic head on the base seal.

As for the encapsulation option, it should be possible to release surface runoff water without treatment after several years of rainfall leaching of the residue sand capping layer. However the water which passes through the stack and is collected via the internal drainage system would continue to leach alkalinity from the stack. This water is likely to require treatment for some further period of time if it is to be released to the environment.

9.2 Current Closure Strategy

Based upon current storage technology and the experience Alcoa has gained over the past 50 years in Western Australia, the company presently believes that continued leaching of the deposit beyond the time of closure is the preferred approach for closure of bauxite residue deposits.

A schematic representation of a residue stack area at closure is provided in Figure 9-1. During construction, a sand drainage layer containing drainage pipes is placed above a compacted clay liner and a suitable liner at the base of the stack. Residue is then stacked within the sand dykes which form the perimeter embankments. Upon closure, the area is revegetated in a manner that meets the agreed future land use objectives for the site.

This may include placing a sand capping layer over the stack prior to revegetation, which will assist in controlling wind and water erosion of the stack.

When the refinery closes, the alkaline water collected via surface runoff and

under drainage will no longer have a use as makeup water. If there are no other commercial uses for the water, it will need to be treated and safely released to the environment. The surface runoff water and drainage water from the deposit will be managed to ensure the alkalinity does not cause environmental damage. The volume of water to be collected, the alkalinity of the water, and the timeframe over which treatment will be required are currently unknown. However, options for treatment and discharge of this water have been investigated and a likely range of costs developed for inclusion in closure funding. Options for the treatment of leachate from the residue stack are discussed in Section 9.3.

The advantages of this closure strategy include:

- continued leaching of the residue will reduce its alkalinity, therefore reducing the potential for environmental impacts over time,
- during the life of the refinery the drainage will be returned to the refinery thereby eliminating the need for treatment,
- contouring and revegetation of the outer slopes of the deposits can be done progressively,
- establishment of a wide range of vegetation types will be possible, limited initially by the alkalinity of the residue, but progressively improving as leaching continues,
- the deposit will be suitable for a wider range of end uses, and
- the residue will be readily accessible if alternate uses for the residue are able to be commercialised.

Decommissioned residue areas will have the capability to be used for productive community benefit. Currently, the residue rehabilitation research is focussed on establishing a native vegetation cover using coastal dune species. We consider this to be appropriate as:

- it is self sustaining once established,
- provides an aesthetic buffer to the landform, and
- can be readily adapted to other land uses (agriculture, industrial) at a future time if required.

Alcoa has undertaken research to quantify the soil-water plant dynamics in residue rehabilitation. This research is designed to inform the closure cover vegetation options and our understanding of the post closure water balance within the residue stack.

To date, much of this work has focussed on the residue sand embankments as these areas are being progressively rehabilitated. More complex studies will be required to understand and model water transport in the entire stack.

9.3 Water Balance/ Discharge Management

As the residue deposits are closed, a revegetated surface will be established. Both rainfall and liquor will continue to leach through the deposit and will be collected by the base drainage system as an alkaline leachate. These waters will need to be treated prior to release, or reuse through other industries, once the refinery has closed.

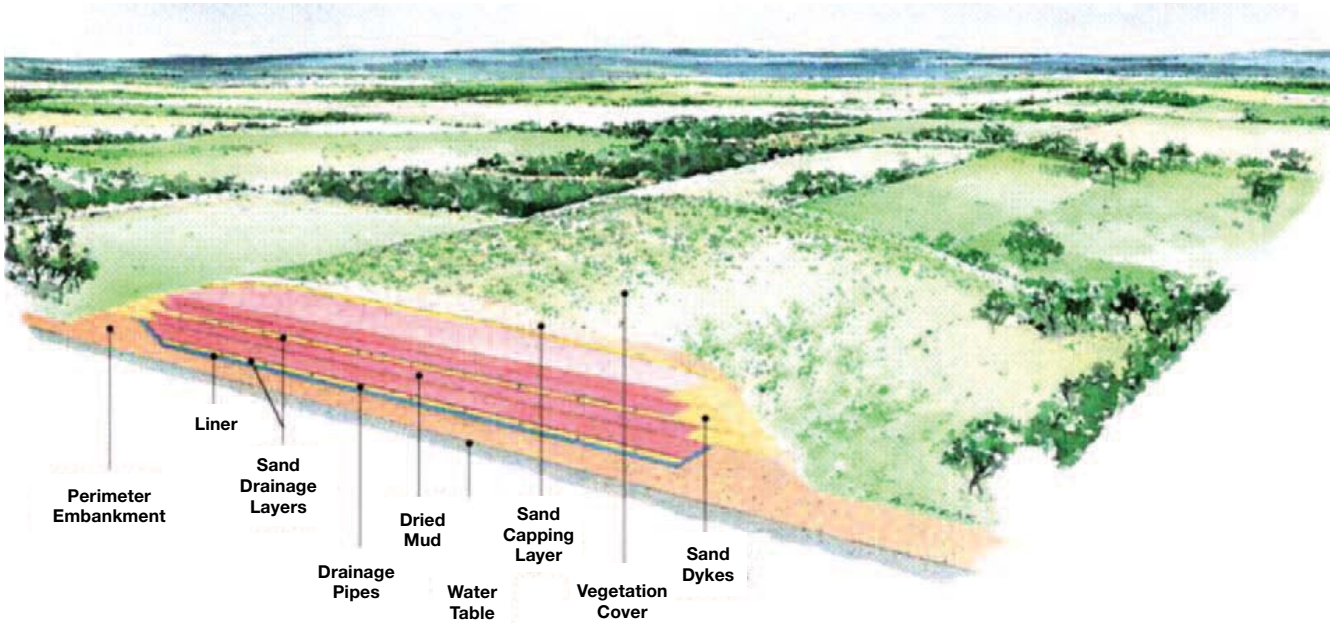

Figure 9-1: A schematic representation of a residue area at closure.

The volume of alkaline drainage water produced will depend on the water use of the established vegetation and the land area covered by residue. Minimising the footprint of the residue area is the most effective way of reducing the volume of alkaline drainage water requiring ongoing management. The selection of vegetation planted on the closed area has the next biggest impact on the volume of water passing through the residue stack.

One of the current focus areas for residue rehabilitation research is to maximise the water use from vegetation so that the volume of leachate requiring treatment is reduced.

A range of options for the management of the excess water have been identified, including:

- treatment and discharge to the ocean or a local surface water source,
- managed aquifer recharge, and
- treatment and reuse (eg for stock and irrigation, industry or potable use).

Further assessment of these options requires identification of background water quality parameters for potential receiving water bodies, a review of the pertinent standards relating to different water sources and their uses, assessment of the treatment options, cost implications and processes for discharge. It is anticipated that further analysis of water management options will be included in future LTRMS reviews.

The benefits of successfully reducing the pH of the residue leachate will be recognised at closure when the level of treatment of waters prior to reuse, and the timeframe over which treatment is required, should be reduced. Water treatment options post closure will be impacted by Alcoa's ability to implement methods of pH reduction of residue or to manage alkalinity levels reporting to the residue area during active operations.

9.4 Future Land Use Options and Revegetation

The Wagerup Refinery is located on land which was used for general agriculture prior to the construction of the refinery. Alcoa continues to graze cattle on parts of the property not currently occupied by the refinery or residue area.

The Wagerup SRG indicated its preference, that after closure and rehabilitation of the residue area, the land will have the capability to be used for productive community benefit without detrimental effect. This recommendation is consistent with Alcoa's commitment to demonstrate a range of possible land use options for the residue deposits. In 1994, a section of closed drying area at Pinjarra Refinery was established to demonstrate a range of land uses for the Western Australian residue areas. These land use options included plantations of native trees, native shelterbelts, irrigated lucerne, olives, vine rootstocks, dryland and irrigated pastures. Soil and plant analyses were undertaken routinely to determine productivity and fertiliser requirements and to monitor soil development on the demonstration area. The results are described in detail in a number of annual reports and triennial reports to the DWER.

Sheep and cattle have also been grazed on pastures on the demonstration area, and blood and tissue samples monitored routinely to identify any effects on animal health. The results show that sheep and cattle grazed on residue areas maintain good health and do not develop marked mineral imbalances. There is also no evidence of heavy metal retention.

In addition, Alcoa's commitment to focussed research will result in the development of guidelines for establishing a sustainable ecosystem on RSAs, both under operating and closed conditions. Current research is identifying ways to improve the characteristics of residue to make it more favourable to plant growth, and to evaluate whether the current rehabilitation prescription can produce an effective store-release cover system to help manage deep drainage.

At Kwinana Refinery, a motor sports complex has been developed on a section of land previously used for residue storage and the requirement for that site is that closed residue areas are suitable for light industrial use.

The dry stacks are being constructed in a manner that leaves the way open for a number of possible future land uses. Residue sand is being used to construct the outer embankments and base drainage systems, and to provide a layer of free draining sand on the outer slopes of the deposits. The high permeability of residue sand ensures all water entering the residue surface is retained within the stack, and negligible runoff occurs. The current design therefore eliminates significant erosion of the embankment surface under wet weather conditions.

The height and shape of the residue area at closure is also an important characteristic. As the height of the stack increases, the outer slopes created by raising the perimeter embankments will be progressively contoured using residue sand and vegetated. Also, any requirements for drainage and runoff control will be installed as the embankments are raised. These outer slopes will comprise approximately one third of the total area occupied by residue.

At each review of the LTRMS the opportunities for future use will be reviewed with the community and strategies will be updated on a five yearly basis. This will ensure the options being investigated remain consistent with the needs of the community and Alcoa.

9.5 Closure Funding

Alcoa will abide by all statutory, corporate and relevant accounting standards that apply to residue management and ensure that adequate provision is made so that there is no liability to the State.

9.6 Closure Guiding Principles and Alcoa's Commitments

In response to the information provided, the Wagerup LTRMS SRG developed five Guiding Principles relating to closure. These are presented below, together with Alcoa's response.

Guiding Principle: 14a) Water Treatment Volume

Alcoa to investigate and pursue strategies to reduce the volume of water that will require treatment both during the life of the refinery and post closure.

Alcoa's Response

In considering any new technology or process, Alcoa evaluates a range of factors including implications for water management both during operation of and post any closure of the refinery. Alcoa is undertaking studies on the water balance of the residue areas with the aim of identifying opportunities to modify the residue rehabilitation prescription and embankment design to reduce volume of drainage water requiring ongoing management.

While the refinery is operating, all water collected from the residue area is recycled to the refinery for reuse, and the residue area is a significant water source for the refinery.

Alcoa will continue to undertake these further investigations to identify and investigate possible options for post closure water management between now and closure of the refinery at the end of its life.

Guiding Principle: 14b) Water Treatment Options

Alcoa to further investigate options for water treatment and discharge post closure of the refinery.

Alcoa's Response

Alcoa accepts and agrees with this principle.

The process of defining the closure strategy will be ongoing, recognising that it will be many years before closure, and that available technology and community attitudes may change.

The current LTRMS review will not be able to identify the appropriate final strategy for post closure water management but will identify the need for further investigations to occur.

Guiding Principle: 14c) Final Land Use and Form

Alcoa to continue to improve residue management to maximise the options for final land use and land form.

Alcoa's Response

Alcoa accepts and agrees with this principle.

Guiding Principle: 14d) Closure Management Plan

Alcoa to develop an adequate closure management plan to ensure the local community is not left with a legacy of adverse impacts after the refinery is closed.

Alcoa's Response

Alcoa accepts and agrees with this principle.

In accordance with conditions of Ministerial Statement No 728, Alcoa has submitted a preliminary decommissioning plan to government. Alcoa is required to submit its final decommissioning plan to the government at least 6 months prior to closure of the refinery.

Guiding Principle: 14e) Closure Provision

Alcoa to continue to build the closure provision to cover the cost of future rehabilitation, closure and ongoing post closure management.

Alcoa's Response

Alcoa recognises its liability for rehabilitation of the residue areas and will continue to maintain a financial provision for this rehabilitation.

10 Stakeholder Reference Group Guiding Principles

10.1 Summary of Guiding Principles and Alcoa's Response

The Wagerup LTRMS has been significantly influenced by input from the community, via the SRG process. As reflected throughout this document, the SRG participated in extensive discussion on residue management and planning issues, enabling them to develop well-informed Guiding Principles for consideration by Alcoa.

These Guiding Principles are discussed further in the body of this document, together with the information discussed on each of the issues to which they relate. The Guiding Principles will be reviewed and updated during the next review of the LTRMS by future SRGs.

Table 10-1: Stakeholder Reference Group Guiding Principles and Alcoa's Response.

GUIDING PRINCIPLE	ALCOA'S RESPONSE
1 REPORTING ON PROGRESS OF GUIDING PRINCIPLES	
a) Alcoa to provide an annual report on progress against the Guiding Principles to the Wagerup CCN. The updates to be provided every 12 months from the date of Ministerial endorsement of the 2017 Wagerup LTRMS.	Alcoa accepts and agrees with this principle. Alcoa will report annually to the CCN on progress against the Guiding Principles.
b) Alcoa to document and share the feedback received from the annual reports for consideration in the development of the next Wagerup LTRMS.	Alcoa accepts and agrees with this principle.
c) Alcoa to use social media (where appropriate) and other communication methods easily accessible by the local community and other stakeholders to communicate progress on the LTRMS.	Alcoa is committed to keeping the local community and other stakeholders informed about the progress of the LTRMS and the Guiding Principles. Alcoa considers the Alcoa website and CCN forums to be the most appropriate methods to ensure that this information is easily accessible.
2 RESIDUE REUSE	
a) Alcoa to actively lobby the Western Australian government to develop a waste materials legislative framework to facilitate the use and commercial production of Red Sand™ and red mud (Alkaloam®).	Seeking approval for the use and commercial production of *Red Sand*™ is a key objective for Alcoa. The regulatory framework for seeking approval for the commercial production of *Red Sand*™ is currently uncertain and incomplete. Alcoa is currently considering how to progress the commercialisation of *Red Sand*™ and red mud (*Alkaloam*®) in the current regulatory environment, and ongoing engagement with government will be a key strategy.
b) Alcoa to urgently pursue all necessary approvals for the use and commercial production of Red Sand™ and red mud (Alkaloam®).	Alcoa accepts and agrees with this principle. Seeking approval for the use and commercial production of *Red Sand*™ and red mud (*Alkaloam*®) is a key objective for Alcoa, however various factors including the current regulatory uncertainty and economic, operational, and other regulatory impacts may impede progress of this action. Alcoa's current focus is to initially seek approval and commercialization of *Red Sand*™ and to then pursue approval and commercialization of red mud (*Alkaloam*®).

GUIDING PRINCIPLE	ALCOA'S RESPONSE
c) Alcoa to identify sustainable markets for the use of Red Sand™ and red mud (Alkaloam®), including business modelling to identify sources and location of demand.	Alcoa accepts and agrees with this principle. Seeking approval for the use and commercial production of *Red Sand*™ and red mud (*Alkaloam*®) is a key objective for Alcoa, however various factors including the current regulatory uncertainty and economic, operational, and other regulatory impacts may impede progress of this action. Alcoa's current focus is to initially seek approval and commercialization of *Red Sand*™ and to then pursue approval and commercialization of red mud (*Alkaloam*®).
3 DUST MANAGEMENT	
a) Identify opportunities to further improve dust management systems, including sprinkler system and weather forecasting data methods and implement where practicable.	Alcoa accepts and agrees with this principle. As part of the environmental management system, Alcoa regularly reviews its dust management processes and practices with the objective of continuously improving dust containment at the residue areas.
b) Communicate dust management improvements and results from dust investigations to the CCN, SRG and surrounding community members in a timely manner.	Alcoa will communicate dust management improvements at least annually to the CCN.
4 RESIDUE ODOUR AND VOC EMISSIONS	
a) Continue to utilise the emissions inventory work to further identify and reduce odourous residue emissions. Implement mitigation strategies to reduce odour and VOC emissions.	Alcoa will continue to utilise the emissions inventory work to further identify odourous emissions and implement reduction strategies where practicable.
b) Communicate outcomes of research into odour and VOC emissions and mitigation strategies to the community via avenues such as the CCN.	Alcoa accepts and agrees with this principle. Alcoa will communicate information and outcomes of research on odour and VOC emissions subject to commercial confidentiality considerations.
5 RESIDUE EMISSIONS AND HEALTH	
a) Continue to monitor employee's health and wellness changes through the Healthwise study as an indicator of broader community health, and provide ongoing reports to the local community.	*Healthwise* is a long-term research program designed to assess whether there are any relationships between various health outcomes and working at Alcoa in Australia. Alcoa has participated in the *Healthwise* research program since 1994 and it is one of the largest and most comprehensive occupational health research programs carried out in Australia. The studies are conducted by some of Australia's leading occupational health researchers from Monash University and The University of Western Australia. Alcoa will report on the outcomes from the research to the local community and other stakeholders.
b) Source available health information from public sources to compare the health data from the local community surrounding the Wagerup Refinery to similar communities within Australia. Share the results with the local community.	Cancer incidence and mortality in Western Australia is reported on periodically by the Western Australian Cancer Registry. The latest report is for 2014 and was published in January 2016 : http://www.health.wa.gov.au/wacr/statistics/stats_full.cfm. Cancer incidence and mortality rates for all cancers in the Leschenault and Peel areas were not statistically significantly different to the same rates for Western Australia as a whole. This was the case for males and females. Alcoa also refers to health risk assessments of refinery emissions and the *Healthwise* research program. When Alcoa presents information to the CCN relating to Alcoa's health studies (such as health risk assessments and *Healthwise*), Alcoa will present relevant information from public sources when it is available.

GUIDING PRINCIPLE	ALCOA'S RESPONSE
6 OXALATE MANAGEMENT	
Implement biological oxalate destruction capability at Wagerup. Alcoa to set the maximum achievable target for oxalate recovery within 12 months of the implementation of the Bio-oxalate removal plant, in consultation with the local community.	Alcoa has recently committed to the construction of a biological oxalate destruction facility at Wagerup Refinery. The capacity of this facility has been designed to match the oxalate production rate.
7 WATER USE	
Alcoa to continue to focus on water efficiency by maximising water conservation and the use of recycled and fit for purpose water.	Alcoa accepts and agrees with this principle.
8 GROUNDWATER	
a) Alcoa to continue regular and systematic surface and groundwater monitoring in and around the RSAs based on Alcoa's environmental licence conditions.	Alcoa accepts and agrees with this principle.
b) Alcoa to commit to action for remediation of any known leaks to prevent migration of contamination from the RSA footprint.	Alcoa is committed to continuing its extensive groundwater monitoring and management strategy and where appropriate will implement remedial actions for identified leaks.
9 VISUAL AMENITY	
a) Alcoa to regularly update the visual amenity plan to create a natural looking landscape. This plan should focus on identifying and developing strategies to enhance visual amenity at current and future visual amenity "hot spots" (including the South Western Hwy) and the maintenance of any established vegetation buffers. Focus should be on existing visual amenity buffers that were affected by the bushfire in January 2016.	Alcoa accepts and agrees with this principle. Alcoa will continue to develop and regularly update a visual amenity plan that will include progressive embankment rehabilitation and visual screening to make the residue areas appear as natural looking landscape as possible. Focus will continue to be placed on maintaining existing vegetation screening that require remedial works.
b) Alcoa to develop and implement a strategy to mitigate unnecessary light emissions from the residue area whilst maintaining a safe work environment. This strategy should include informing the local community how they can provide feedback on light emissions.	Alcoa accepts and agrees with this principle. Alcoa needs to maintain a safe working environment for its employees. Alcoa invites feedback on light emissions from our neighbours.
c) Alcoa to study the effect of fire on the visual amenity vegetation buffers and apply the outcomes of this work to improve the resilience of the visual amenity vegetation buffers to fire impacts.	Alcoa will continue to adapt the structure of visual amenity screening to improve resilience to impacts such as fire.
10 RESIDUE REHABILITATION	
a) Alcoa to continue to improve its residue rehabilitation prescription with a focus on developing a self-sustaining ecosystem that maximises the use of suitable endemic plant species wherever possible.	Alcoa accepts and agrees with this principle.
b) Alcoa to consider the potential fire risk and fire resilience of the residue rehabilitation prescription.	Alcoa accepts and agrees with this principle.

GUIDING PRINCIPLE	ALCOA'S RESPONSE
11 ALTERNATIVE RESIDUE STORAGE TECHNIQUES	
Alcoa to implement residue filtration at Wagerup Refinery.	Alcoa has implemented a residue filtration facility at its Kwinana Refinery, and is currently developing a residue filtration facility at Pinjarra Refinery. Any implementation of residue filtration at the Wagerup Alumina Refinery is subject to detailed feasibility studies, internal funding availability, regulatory approval and availability of key equipment and contractors. Current plans indicate that the next residue storage solution would not be required until after 2023.
12 SEPARATION DISTANCE	
a) Alcoa to maintain a 2 kilometre separation distance between the boundary of the residue area and private property and/or residences.	Alcoa is committed to the current Land Management Strategy. It must be noted that the extent of the residue area footprint is a function of a number of variables including: • The height that the residue stacks are built to; • The refinery production rate; • The possible need to realign the Alinta owned power lines along Kubank Road; • The requirement to maintain an adequate separation distance to near neighbours; • Zoning approval for the life-of-mine footprint; and • Ownership of land, and hence o Separation achieved to near neighbours, and o Land available for residue storage.
b) Alcoa to make a genuine effort to negotiate the purchase of whole properties from neighbours within 2 kilometre of the boundary of the residue area who wish to move.	Alcoa will continue to implement the existing Land Management Strategy.
13 FOOTPRINT AND HEIGHT	
The Stakeholder Reference Group recommends that residue expansion into the future will be in a westerly direction at 40 metres above natural ground level, but Alcoa needs to: · Implement residue filtration (as per the Alternative Residue Storage Techniques Guiding Principle), · Implement a residue reuse program as a matter of urgency (as per the Residue Reuse Guiding Principles), · Improve visual amenity (as per the Visual Amenity Guiding Principles), · Improve dust management (as per the Dust Management Guiding Principles), and · Improve outer bank revegetation (as per the Visual Amenity and Residue Rehabilitation Guiding Principles).	Alcoa acknowledges that the Stakeholder Reference Group would like to see residue filtration and a residue reuse program implemented, and improvements in visual amenity, dust management and residue rehabilitation. Alcoa is committed to continuing to evaluate improvements in these areas. Alcoa believes the best sustainable outcomes in terms of economic, environmental and social outcomes will be achieved by developing the residue area at Wagerup up to 80 metres above natural ground level. Alcoa acknowledges the stakeholder feedback received during this consultation process has indicated the desire for Alcoa to minimise the growth of the residue area footprint, with the height of the area not to exceed 40 metres above natural ground level. In consideration of this feedback, Alcoa will continue to develop the residue stack to 60 metres above average natural ground level (74 metres RL) as emissions, groundwater contamination risks, proximity to neighbours and closure implications are reduced by maximising stack height.

GUIDING PRINCIPLE	ALCOA'S RESPONSE
14 CLOSURE	
a) Alcoa to investigate and pursue strategies to reduce the volume of water that will require treatment both during the life of the refinery and post closure.	In considering any new technology or process, Alcoa evaluates a range of factors including implications for water management both during operation of and post any closure of the refinery. Alcoa is undertaking studies on the water balance of the residue areas with the aim of identifying opportunities to modify the residue rehabilitation prescription and embankment design to reduce volume of drainage water requiring ongoing management. While the refinery is operating, all water collected from the residue area is recycled to the refinery for reuse, and the residue area is a significant water source for the refinery. Alcoa will continue to undertake these further investigations to identify and investigate possible options for post closure water management between now and closure of the refinery at the end of its life.
b) Alcoa to further investigate options for water treatment and discharge post closure of the refinery.	Alcoa accepts and agrees with this principle. The process of defining the closure strategy will be ongoing, recognising that it will be many years before closure, and that available technology and community attitudes may change. The current LTRMS review will not be able to identify the appropriate final strategy for post closure water management but will identify the need for further investigations to occur.
c) Alcoa to continue to improve residue management to maximise the options for final land use and land form.	Alcoa accepts and agrees with this principle.
d) Alcoa to develop an adequate closure management plan to ensure the local community is not left with a legacy of adverse impacts after the refinery is closed.	Alcoa accepts and agrees with this principle. In accordance with conditions of Ministerial Statement No 728, Alcoa has submitted a preliminary decommissioning plan to government. Alcoa is required to submit its final decommissioning plan to the government at least 6 months prior to closure of the refinery.
e) Alcoa to continue to build the closure provision to cover the cost of future rehabilitation, closure and ongoing post closure management.	Alcoa recognises its liability for rehabilitation of the residue areas and will continue to maintain a financial provision for this rehabilitation.

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