

5 Year Environmental Implementation Plan

2019 – 2023
Version 1.0
15 November 2018

Environment Improvement Projects

The environmental improvement project outlined in this implementation plan have been grouped into key focus areas shown in Table 1.

Table 1: Summary of improvement projects

Focus Area	Key Objective
Organisation cultural change	Risk reduction through empowering the entire workforce
Air Quality Management	Emission/particulate and risk reduction
Water Management	Impact mitigation
Land Management	Mitigate contamination: safe, stable and sustainable
Other	Amenity impact reduction

Explanation of the Implementation Schedule

The implementation schedule shown after each project table shows the study, engineering or execution phase, which are described below:

Projects shown in study phase are at the earliest part of the implementation process and require work to identify and assess options that will deliver the required environmental outcome. The outcome of the study phase is to determine the option that best meets the defined performance criteria. In selecting the preferred option during the study phase to take to the engineering phase, options are assessed against a number of criteria, including,

- How effectively each option mitigates the risk,
- Can the project be delivered in the required timeframe?
- What is the cost of each option compared to the expected environmental outcome?
- Can the option be practically constructed?
- Can the option be implemented within an operating refinery?
- What approvals will be required to deliver the option?
- Can the option be delivered safely?

Some projects are quite complex requiring more time and resources in determining the right option. Consequently the outcome of the study phase for a project will deliver the option to take forward to the engineering phase.

Engineering Phase

The engineering phase is where the detailed work is carried out and a set of documents is developed to allow the project to move into the final execution phase. The engineering phase covers traditional mechanical, civil, structural, process and electrical engineering input, which will provide a detailed design that can be constructed to meet applicable Australian, Queensland and QAL standards. Other aspects covered in the engineering phase include any required Commonwealth, Queensland and Local government approvals pertaining to environmental, planning and cultural heritage legislation. These approvals can only commence once the project design is nearing completion.

The output from the engineering phase will be a detailed design and issued for construction drawings (where required) that are based on risk reviews (process, safety, health, environmental and cultural), constructability reviews as well as hazard and operability assessments.

As stated, some projects will require a number of approvals from the Commonwealth, State and Local governments with approval time frames that may extend up to a year during the engineering phase for some of the more complex projects.

Towards the completion of the engineering phase QAL will be able to determine a more detailed performance indicator to demonstrate the environmental improvement at the completion of execution.

Execution Phase

The output of the engineering phase will be a package of work that will generally include a number of deliverables that will be tracked during the execution phase. The type and complexity of the project will determine the number of deliverables required and how the deliverables are phased, as some may need to be finished before another can begin.

How to Interpret the Tables

The study (gold) and engineering (blue) phase schedules are based on delivering milestones at the end of a specified quarter, i.e 2019 Q1 means Quarter 1 2019 January to March. The execution phase (green) schedules are based on delivering milestones within a calendar month.

This example shows the study phase milestone for a project is due in quarter 4 in 2018. This means that during quarter 4 the project will transition into the engineering phase and the implementation plan will be updated accordingly.

	Project Name						
Task	2018		2019				
	Q3	Q4	Q1	Q2	Q3	Q4	
Description	■	■					

This example shows the engineering phase milestone due in 2019 quarter 2 and the implementation plan will be updated in quarter 2 to show the execution phase.

	Project Name						
Task	2018		2019				
	Q3	Q4	Q1	Q2	Q3	Q4	
Description			■	■			

This example shows the execution phase will take 10 months with the completion date of the project in April 2020.

Task	Project																													
	2018						2019												2020											
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Description													■	■	■	■	■	■	■	■	■	■	■							

Organisational Cultural Change

QAL recognises that the culture of an organisation is a significant factor impacting the environmental performance of a business. While leadership commitment and governance structures are important to ensure that environmental improvement projects are effectively executed; our environmental improvement program will only succeed if we empower all of our employees to have due and proper consideration of environmental obligations and risks in their everyday tasks.

Redefining our site culture begins with our workforce having a greater understanding of the process safety aspects of our operation, and the significant potential environmental and community impact our operations can have. We then need to empower our workforce to reduce risk around process and environmental concerns to avoid them and respond when potential process safety and environmental concerns arise. The introduction of a disciplined system for organizing workplaces and the broader QAL operating environment is underway.

Improved housekeeping and understanding of process safety critical controls will lead to early detection of leaks, spillage and situations that could lead to potential environmental impacts.

Project (C1)	Site Cultural Change
Risk class	- IV/Critical
Environmental risks	- Failure of systems causing environmental incidents that impact on the receiving environment and community
Project solution / options	<ul style="list-style-type: none"> - Improve process safety and environmental risk detection for all QAL employees through a Process Safety Management System (PSMS) that ensures critical controls are identified and verified. - All QAL employees involved with ensuring critical controls are in place are aware of the importance of these controls and that they will be verified. - The process will be incorporated into the operations systems including: <ul style="list-style-type: none"> • 5S housekeeping work program <ul style="list-style-type: none"> ▪ 5S is a specific housekeeping program that allow teams to systematically organise their work areas – Sort, set, shine, standardize and sustain. • Annual environmental training for all employees • Daily HSE meetings (environment in work preparation) • Quarterly business updates, led by site senior executives • Bi-annual engagement survey • Purple banner reporting which includes the introduction of reporting category focused exclusively on environmental incidents
Objective / performance outcome	- Improved culture relating to process safety and environmental risk management throughout the entire organisation through the implementation of a PSMS.
Performance Indicator	<ul style="list-style-type: none"> - Completion of pilot studies for digestion and RDA leading to the implementation across the operation. - 90% of major hazard critical control health completed within the first 12 months after the PSMS is implemented across site.
Cost estimate A\$ million	- \$0.5 annually
Project Stage	- Study
Comments	- Pilot studies for two major hazards have been developed in digestion for a digester failure and at the RDA for a dam wall failure. Data from the pilots will be reviewed and the PSMS will be implemented across all areas and major hazards throughout 2019.

Site Cultural Change					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Site Cultural Change					

Implementation Schedule

Study
Engineering
Execution

Air Quality Improvement Projects

QAL's 5-year air quality improvement plan, supported by targets, actions and programme of works is summarised below. Capital spend is estimated at between A\$19 million to A\$38 million.

Project (A1)	Alkali Release Off-Site
Risk class	- IV/Critical
Environmental risks	- Alkali release to atmosphere with potential to impact air quality and property in the surrounding communities
Project solution / options	Identify sources at the refinery that can release alkali and put in place measures to reduce the risk of the release occurring. An initial suite of alkali emissions reduction projects are in execution. Stage 2 of the alkali emissions reduction project will include further study to identify further alkali sources where the risk of release can be reduced
Objective / performance outcome	<ul style="list-style-type: none"> - Sources will be identified where actions can be taken to reduce likelihood and consequence of alkali release - Reduce identified Class III and IV alkali release risks to Class I and II to mitigate impact to the community
Performance Indicator	<ul style="list-style-type: none"> - Study phase identifies options to reduce emissions from alkali sources in the refinery and they are progressed to engineering. - No alkali release events from completed projects due to QAL operations or maintenance activities - All emission sources assess as Class III and IV risk are identified and an engineering solution is developed or investigations exhausted to reduce risk to Class I and II.
Cost estimate A\$ million	- 8.0
Project Stage	<p>Study</p> <ul style="list-style-type: none"> - Bottom fill of precipitation tanks to reduce alkali mist. - Stage 2 study to identify further alkali sources and investigate options for mitigation <p>Execution</p> <ul style="list-style-type: none"> - Replace existing equipment (identified as Class III and IV Risk) including piping, valving and fixtures on the Digester Pilot Steam Lines and the Flash Tank pilot steam lines. - Upgrade of expansion joints where possible and add shrouding as containment measure until replacement - Replace oxalate vent tank with a new design that is expected to remove 95% of alkali droplets.
Comments	- Timing for completion of high risk piping and expansion joints dependent on 2019 shut down schedule.

Implementation Schedule

Alkali Release Off-Site

Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Bottom Fill Precipitators project	Study	Study							
Stage 2 Alkali Emissions Study	Study	Study	Engineering	Engineering					
Replace high risk pipelines in Digestion	Execution	Execution	Execution	Execution	Execution				
Upgrade and install shrouds on expansion joints	Execution	Execution	Execution	Execution	Execution				
Oxalate vent tank capture	Execution	Execution							

Study
Engineering
Execution



Alkali Release Off-Site

Legend

Alkali and Odour Emissions Reduction

Queensland Alumina Limited (QAL) is a subsidiary of Alcoa of Australia Limited (AAL). AAL is a listed company on the Australian Securities Exchange (ASX) and is a member of the Alcoa Group. QAL is a public company and is listed on the ASX. QAL is a subsidiary of Alcoa of Australia Limited (AAL). AAL is a listed company on the Australian Securities Exchange (ASX) and is a member of the Alcoa Group. QAL is a public company and is listed on the ASX.

Coordinate System: GDA 1984 UTM Zone 58
 Scale at A3: 1:8,119
 0 45 90 180 270
 Meters

Review: J. J. J. J.
 Created By: J. J. J. J.
 Approved By: J. J. J. J.

Project (A2)	Alumina Dust Emission Reduction
Risk class	- III/High
Environmental risks	- Alumina dust emissions from Boyne Smelters Limited (BSL) conveyor transfer points, product load-out and island and mainland alumina storage A-frames have a potential to impact on the air quality of surrounding communities.
Project solution / options	- Identify options to reduce alumina dust emissions from high risk release points.
Objective / performance outcome	- Mitigation of alumina dust emissions
Performance Indicator	- Study phase identifies options to reduce emissions from alumina dust sources in the refinery and South Trees Island and they are progressed to engineering. - No visible dust emissions from release points from completed projects.
Cost estimate A\$ million	- 13.0
Project Stage	- Execution <ul style="list-style-type: none"> • Improvements and upgrades to dust collectors at BSL transfer points • One BSL belt conveyor to be replaced with air slide conveyor, - Study <ul style="list-style-type: none"> • Alumina ship loading, • Island and Mainland A-frames
Comments	

Implementation Schedule






Alumina Dust Emissions Reduction									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Alumina Dust Reduction Study									
BSL alumina transfer upgrade									
	Study	Engineering	Execution						



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Alumina Dust Emissions

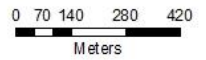
Legend

-  Ship Loadout
-  Island A Frame
-  BSL Conveyor and Transfer Points
-  Conveyors and Transfer Points
-  Mainland A Frame

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Scale at A3 1:12,834



N ↑	Revision	A
	Date	21/10/2018
	Created By	Jonathan Dalton
	Approved By	Jonathan Dalton

Project (A3)	Odour Emission to Community
Risk class	- III/High
Environmental risks	- Odour releases with potential for impact on air quality of surrounding communities.
Project solution / options	<ul style="list-style-type: none"> - Conduct an odour study including comparative analysis with previous 2006 study to determine an odour baseline - Capture current uncaptured organic emission sources, and - Address redundancy concerns with current treatment system
Objective / performance outcome	- Minimise QAL odour profile within the community
Performance Indicator	<ul style="list-style-type: none"> - Odour baseline is established when refinery is operating on Amrun bauxite. - Study phase identifies options to reduce emissions from odour sources in the refinery and they are progressed to engineering.
Cost estimate A\$ million	- 4.25
Project Stage	Study <ul style="list-style-type: none"> - Investigate sources of uncaptured organic emissions at the refinery and determine a new odour emission baseline.
Comments	

Implementation schedule



Odour Emission to Community									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Odour emissions identificaion and options analysis									
Study									



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Odour Emissions to Community

Legend

-  Alkali and Odour Emissions Reduction
-  Thermal Oxidiser

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 Scale at A3: 1:5,553
 0 30 60 120 180
 Meters

Revision	A
Date	21/10/2018
Created By	Jonathan Dalton
Reviewed By	
Approved By	Jonathan Dalton

Project (A4)	Coal Stockpile Dust Emissions
Risk class	- III/High
Environmental risks	- Fugitive dust emissions from working and strategic coal stockpiles have the potential to impact on the air quality of surrounding communities.
Project solution / options	- Investigate options for dust mitigation, including dust suppression and prevention measures on working and strategic coal stockpiles.
Objective / performance outcome	- Improved monitoring capability and reduction of potential for dust emissions
Performance Indicator	- Study phase identifies options to reduce emissions from coal dust sources in the refinery and they are progressed to engineering..
Cost estimate A\$ million	- 0.75
Project Stage	Study - Investigate dust reduction options for the coal stockpiles
Comments	

Implementation Schedule



Coal Stockpile Dust Mitigation					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Options study for dust mitigation					
Study					
Engineering					
Execution					



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**Coal Stockpile
Dust Emissions**

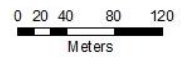
Legend

-  Strategic Coal Stockpile
-  Working Coal Stockpile

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Scale at A3 1:3,946



Revision: A
Date: 21/11/2018
Created By: Jonathan Dalton
Reviewed By: Jonathan Dalton
Approved By: Jonathan Dalton

Project (A5)	Bauxite Transfer Dust Emissions
Risk class	- III/High
Environmental risks	- Fugitive dust emissions from bauxite transfer system have the potential to impact on air quality in the surrounding community.
Project solution / options	- Investigate options for reduction of dust emissions from the bauxite transfer system.
Objective / performance outcome	- Reduced dust emissions from bauxite transfer systems
Performance Indicator	- Study phase identifies options to reduce emissions from bauxite dust sources in the refinery and South Trees Island and they are progressed to engineering.
Cost estimate A\$ million	- 0.7
Project Stage	Study - Identify dust sources and dust reduction options for the bauxite transfer system
Comments	

Implementation Schedule


Bauxite Transfer Dust Reduction Study					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Options study for dust mitigation					
Study					
Engineering					
Execution					



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Bauxite Transfer Dust Emissions

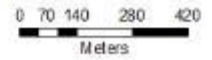
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 Bauxite conveyor and transfer points

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Scale at A3 1:12,500



	Revision:	1
	Date:	20/11/2018
	Created by:	Jonathan DeLore
	Approved by:	Jonathan DeLore

Project (A6)	Ash Dam Dust Emissions
Risk class	- III/High
Environmental risks	- Fugitive dust (ash) emission emissions have the potential to impact on air quality of surrounding communities.
Project solution / options	- Investigate options for reduction of dusting events from the ash through dust suppression and mitigation options
Objective / performance outcome	- Minimise dust generation from #4 Ash Dam
Performance Indicator	- Study phase identifies options to reduce emissions from the ash dam and they are progressed to engineering.
Cost estimate A\$ million	- 0.9
Project Stage	Study - Investigate dust reduction options for the ash dams
Comments	

Implementation Schedule

Ash Dam Dust Emissions					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Options study for dust mitigation on ash dam					
	Study	Engineering	Execution		



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**Ash Dam
Dust Emissions**

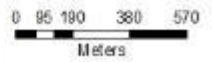
Legend

 Ash ponds

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Scale at A3 1:16,763



	Review By:	J. J. J.
	Created By:	Jonathan Delle
	Checked By:	Jonathan Delle
	Approved By:	Jonathan Delle

Water Management Improvement Projects

QAL's plan to improve water quality management over the next five years is supported by targets, actions and a program of works summarised below. Capital spend is estimated at between A\$90 million to A\$175 million.

Project (W1)	Raw Material Spill from Wharf
Risk class	- IV/Critical
Environmental risks	- Release of raw materials including caustic and bauxite to Gladstone harbour during unloading operations has the potential to impact on the water quality of Port Curtis.
Project solution / options	- Investigate options for reduction of spillage of raw materials (bauxite) from the wharf during unloading activities and mitigate the potential for release of caustic during unloading
Objective / performance outcome	- Reduce risk of release of raw material spills during unloading operations
Performance Indicator	- Study phase identifies current state for operations and identifies options to reduce spills and releases from raw material handling at the wharf at South Trees Island and they are progressed to engineering. Study phase
Cost estimate A\$ million	- 0.55
Project Stage	Study - Third party review of operating practices relating to all unloading aspects of raw materials
Comments	

Implementation Schedule

Raw Material Spill from Wharf					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
3rd Party Review and Report					
Study					
Engineering					
Execution					



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Raw Material Spill from Wharf

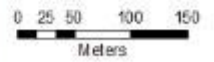
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 Wharf - Raw Material Spill

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Coordinate System: GDA 1984 UTM Zone 58

Scale at A3 1:4,442



	Revision:	1
	Date:	20/11/2018
	Created By:	Jonathan DeLore
	Approved By:	Jonathan DeLore

Project W2	Coal Stockpile Stormwater Runoff
Risk class	- III/High
Environmental risks	- Release of coal contaminated stormwater to receiving environment has the potential to impact on the water quality in Port Cutis.
Project solution / options	<ul style="list-style-type: none"> - Investigate options for reduction in total suspended solids load from the coal stockpiles into the east and west coal stilling ponds, which allows ponds to meet release limits - Investigate options to improve west coal stilling pond neutralisation capability
Objective / performance outcome	- Mitigate risk of coal contaminated stormwater leaving the coal stockpile catchment area
Performance Indicator	- Study phase identifies options to reduce coal fines runoff from coal stockpiles in the refinery and improve neutralisation capacity of the west coal stilling pond and they are progressed to engineering. .
Cost estimate A\$ million	- 0.1
Project Stage	Study Phase 1 investigate: <ul style="list-style-type: none"> - Improvements to west coal stilling pond functionality Phase 2 investigate: <ul style="list-style-type: none"> - Improvement in neutralisation capacity in the west coal stilling pond - Investigate reduction of coal contaminated stormwater entering the west and east coal stilling pond
Comments	

Implementation Schedule

Coal Stockpile Stormwater Runoff									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase 1 Study									
Phase 2 Study									


Study
Engineering
Execution



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Coal Stockpile Runoff

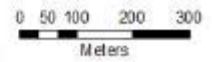
Legend

-  East Coal Stilling Pond
-  West Coal Stilling Pond
-  Strategic Coal Stockpile
-  Working Coal Stockpile

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Scale at A3 1:8,884



N 	Revision:	1
	Date:	20/11/2018
	Created By:	Jonathan Dallas
	Approved By:	Jonathan Dallas

Project (W3)	Waste line 4 Integrity
Risk class	- IV/Critical
Environmental risks	- Failure of Waste Line 4 into marine or terrestrial environments will result in release of partially neutralised red mud with a potential to contaminate land or water and impact on the water quality in South Trees Inlet and Port Curtis.
Project solution / options	- Investigate options for replacement of waste line 4 capacity that includes options that further reduces the risk of a pipeline failure. - Ensure integrity of pipeline supports
Objective / performance outcome	- No loss of containment incidents
Performance Indicator	- Study phase identifies options to reduce risk of a pipeline failure from waste line 4 and they are progressed to engineering.
Cost estimate A\$ million	- 10.5
Project Stage	- Study
Comments	

Implementation Schedule

Waste Line 4 Capacity					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Waste line 4 capacity replacement options selection					
Study	Engineering	Execution			



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Waste Line 4

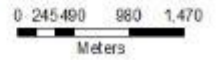
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 Waste Line 4

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Scale at A3: 1:44,421



N 	Revised By:	J. DELANEY
	Created By:	JONATHAN DELANEY
	Checked By:	JONATHAN DELANEY
	Approved By:	JONATHAN DELANEY

Project (W4)	East & West Contaminants Ponds
Risk class	- III/High
Environmental risks	- The East and West contaminants ponds capture contaminated stormwater runoff for recycling into the process. Insufficient capacity has the potential to impact the capability of the contaminated stormwater treatment system prior to release and has a potential to impact on the water quality in Port Curtis. A further potential impact exists for groundwater from the unlined east contaminants pond.
Project solution / options	<ul style="list-style-type: none"> - Investigate options to ensure that all core refinery process areas are directed to a contaminants pond, - Options for lining and expanding the east contaminants pond, and - Investigate options to increase the pump and pipe capacity from the ponds to the process.
Objective / performance outcome	- Ensure containment ponds prevent land and groundwater contamination and mitigates the risk of stormwater contamination
Performance Indicator	- Study phase identifies options to prevent land and groundwater contamination from contaminants ponds and they are progressed to engineering.
Cost estimate A\$ million	- 8.5
Project Stage	- Study
Comments	

Implementation Schedule

East and West Contaminants Ponds									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Identify options for upgrade of contaminants ponds									
Study	Engineering	Execution							



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Contaminants Ponds

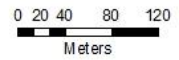
Legend

-  East Pond
-  West Pond

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Scale at A3 1:4,274



	Revision	A
	Date	21/10/2018
	Created By	Jonathan Dalton
	Approved By	Jonathan Dalton

Project (W5)	Refinery Water Release Management
Risk class	- III/High
Environmental risks	- Releases from the sweetening bauxite pond and the west gate wetland have the potential to impact on water quality in Port Cutis.
Project solution / options	- Investigate options to improve monitoring at the sweetening bauxite pond and the wetland release - Identify options to upgrade mill sump water system to minimise release to the stormwater system
Objective / performance outcome	- Ensure pH, suspended solids and other release water quality parameters are maintained within limits and no uncontrolled release to receiving environment
Performance Indicator	- Study phase identifies options to improve water quality at the west gate wetland, mill 10 area and sweetening bauxite pond and they are progressed to engineering. - 85% availability of online instruments at the sweetening bauxite pond and wetland release point
Cost estimate A\$ million	- 3.75
Project Stage	<p>Study – Phase 2</p> <ul style="list-style-type: none"> - Investigate reduction of refinery runoff to west gate wetland and improved pond functionality - Investigate improvement to Mill 10 sump management to reduce overflow to the neutralising pond - Investigate options to reduce solids to the Sweetening bauxite pond <p>Execution – Phase 1</p> <ul style="list-style-type: none"> - Wetland Release: <ul style="list-style-type: none"> • Install v-notch weir and flow meter, • Install continuous water quality monitoring. - Sweetening Bauxite Pond <ul style="list-style-type: none"> • Install continuous water quality monitoring, and • Install a level sensor.
Comments	

Implementation Schedule




Refinery water release improvement									
Task	2018	2019			2020				
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Phase 2 Study									
Install V notch weir and continuous monitoring at Westgate Release Point									
Install continuous monitoring at sweetening bauxite pond Release Point									

Study
Engineering
Execution



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**Refinery
Stormwater
Legend**

-  Mill 10 Area
-  Sweetwater Bauxite Pond
-  West Gate Release

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Coordinate System: GDA 1984 UTM Zone 58
 Scale at A3: 1:11,105
 0 62.5 125 250 375
 Meters

Revision	1	2018/11/15
Created By	Jonathan Dallas	
Checked By		
Approved By	Jonathan Dallas	

Project (W6)	RDA Surface/Ground water Impacts
Risk class	- IV/Critical
Environmental risks	- Impacts to surface and groundwater from the RDA that have the potential to impact on the water quality in South Trees Inlet and Port Curtis and terrestrial ecosystems surrounding the RDA.
Project solution / options	- Identify the sources, pathways and receptors of potential RDA surface and groundwater impacts and options for any required mitigation.
Objective / performance outcome	- Prevent impact of contaminants from RDA on groundwater - Mitigate the impact of the RDA on adjacent surface water systems and ensure relevant environmental values are protected
Performance Indicator	- Vegetation in Black Breasted Button Quail (BBBQ) habitat do not show any signs of degradation and rehabilitated areas (to be completed) show no sign of impact after cut off wall is installed and soil in impacted areas is flushed. - A robust monitoring program is in place for the early detection of impact to vegetation, groundwater and marine communities. - Study phase (Environmental Evaluation) identifies options to address any areas of concern and these options are progressed to engineering.
Cost estimate A\$ million	- 40
Project Stage	- Study/Execution
Comments	- Stage 1 of the EE requires mitigation options for the BBBQ habitat on the northern east area of RDA 1. Option to install a cut-off wall has been selected and is undergoing execution.

Implementation Schedule

RDA Surface/Groundwater Impacts									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Complete environmental evaluation	Study	Study	Study	Study	Study	Study	Study		
EE Stage 1 - Install cut-off wall to mitigate impact on BBBQ habitat and recovery pumps	Execution	Execution	Execution	Execution					
	Study	Engineering	Execution						



 **QUEENSLAND ALUMINA LIMITED**

**RDA
Groundwater
Impacts**

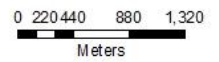
Legend

-  EE Stage 1
-  EE Stage 2

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Coordinate System: GDA 1994 MGA Zone 58

Scale at A3: 1:39,597



	Revision	A
	Date	21/10/2018
	Created By	Jonathan Dalton
	Approved By	Jonathan Dalton

Project (W7)	RDA Release to Receiving Environment
Risk class	- IV/Critical
Environmental risks	- The chemistry of the red mud dam discharge into South trees Inlet has been changing over the past 5 to 10 years. This, together with the siltation of South Trees Inlet and decrease in water flow, has resulted in low dissolved oxygen between the discharge site and confluence of the Boyne River and has the potential to impact on the water quality in South Trees Inlet and the Boyne River.
Project solution / options	- Identify the cause of the change in water quality and investigate mitigation options, including improvements to release water quality, alternative release point locations or improving flow in South Trees Inlet.
Objective / performance outcome	- Ensure the environmental values of South Trees Inlet are protected in the long term
Performance Indicators	- Study phase identifies options to reduce the impact of the RDA discharge and options are progressed to engineering.
Cost estimate A\$ million	- 68.0
Project Stage	- Study
Comments	

Implementation Schedule

RDA Alternative Discharge Location									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Identify options for relocation of the RDA discharge location									
Study Engineering Execution									



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RDA Discharge

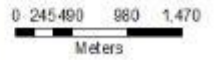
Legend

-  Licenced Discharge Point

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Coordinate System: GDA 1984 UTM Zone 58

Scale at A3 1:44,421



	Revision:	1
	Date:	20/11/2018
	Created By:	Jonathan DeLore
	Approved By:	Jonathan DeLore

Project (W8)	High Risk Pipelines
Risk class	- IV/Critical
Environmental risks	- Caustic release to the environment as a result of failure of pipeline from the storage area (island) to refinery (mainland) across causeway with potential to impact on the water quality in Port Curtis.
Project solution / options	- Investigate options to upgrade high risk pipelines (caustic and contaminated water) to reduce the risk of a pipeline failure
Objective / performance outcome	- Reduce the risk of off-site contamination
Performance Indicator	- Study phase identifies options to reduce the risk of contaminants being released to waters and options are progressed to engineering.
Cost estimate A\$ million	- 10.5
Project Stage	- Study
Comments	

Implementation Schedule


High Risk Pipelines					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Investigate options for replacement of high risk pipelines					
	Study	Engineering	Execution		



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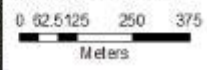
High Risk Pipelines

Legend

 High Risk Pipelines

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Coordinate System: GDA 1984 UTM Zone 58
Scale at A3: 1:11,096



N 	Revision:	1
	Date:	20/11/2018
	Created By:	Jonathan Dallas
	Approved By:	Jonathan Dallas

Land management improvement projects

QAL's five-year land stewardship programme, supported by targets, actions and a programme of works is summarised below. Capital spend is estimated at between A\$20 million to A\$35 million.

Project (L1)	Integrity of Bunds and Drains
Risk class	- IV/Critical
Environmental risks	- Seepage from bunded refinery areas has the potential to contaminate groundwater.
Project solution / options	- Bunded refinery area and drainage integrity rectification.
Objective / performance outcome	- Restore the integrity of refinery area bunds and drains
Performance Indicator	- All areas identified for remediation are repaired
Cost estimate A\$ million	- 7.5
Project Stage	<p>Study</p> <ul style="list-style-type: none"> - - Study phase identifies options to improve integrity of bunds and drains from inspections in the refinery and they are progressed to engineering. <p>Engineering</p> <ul style="list-style-type: none"> - Complete engineering design for bunds and drains that were identified during the study phase requiring repairs. <ul style="list-style-type: none"> • Complete engineering design on high risk (Class IV) bunds and drains • Complete engineering design on lower risk (Class I, II and III) bunds and drains. <p>Execution</p> <ul style="list-style-type: none"> - High risk bunds and drains will be prioritised for repair works and will move from engineering into execution once a construction package has been prepared. - High risk bunds and drains in execution: <ul style="list-style-type: none"> • HID 3/4 • Above ground section of 7th Street drain
Comments	- Bund and drain inspection program is identifying high, medium and low risk bunds and drains requiring remediation.

Implementation Schedule

Task	Integrity of bunds and Drains																
	2018	2019				2020				2021				2022			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Complete inspection of all refinery bunds and drains	Study	Study															
Complete design on remaining high risk (class IV)	Engineering	Engineering	Engineering	Engineering	Engineering												
Complete design package for Class I, II and III						Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering	Engineering
HID 3/4 bund repair	Execution	Execution	Execution	Execution													
Above Ground Section of Seventh Street Drain repair	Execution	Execution	Execution	Execution													



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Integrity of Bunds and Drains

Legend

- Bunds and Drains

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Geographic System: GDA 1984 UTM Zone 58

Scale at A3: 1:9,359

0 50 100 200 300
Meters

N

Revision: 1
 Date: 26/11/2018
 Created by: Jonathan Dallas
 Approved by: Jonathan Dallas

Project (L2)	Ground Water Impact to South Trees Island Tank Farm
Risk class	- III/High
Environmental risks	- Caustic impact to ground water and potential to migrate to receiving environment (DES EPO STAT 1249 related) and has the potential to impact on groundwater quality.
Project solution / options	- Maintain and monitor current extraction program beneath bund 4, South Trees Island - Review integrity of existing groundwater monitoring wells reinstate/upgrade as necessary and recommence monitoring program
Objective / performance outcome	- Historic ground water impact to South Trees Island does not migrate and is reduced over time
Performance Indicator	- No increase in pH in groundwater bores outside of bund with extraction system operational
Cost estimate A\$ million	- 1.0
Project Stage	- Execution
Comments	-

Implementation Schedule



South Trees Inlet Groundwater Remediation					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Groundwater Extraction system installation					
	Study	Engineering	Execution		



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Groundwater Impacts at South Trees Island Tank Farm

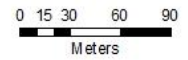
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-  Bund 2
-  Bund 4

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Coordinate System: GDA 1994 MGA Zone 58

Scale at A3 1:2,981



	Revision	A
	Date	21/10/2016
	Created By	Jonathan Dalton
	Approved By	Jonathan Dalton

Project (L3)	Mineral Waste Disposal Facility – Stage 2
Risk class	- III/High
Environmental risks	- Potential for land contamination from landfilled mineral wastes and potential for impact on water quality in South Trees Inlet; secondary potential impact to effectiveness of current recycling program
Project solution / options	- Investigate the options for location of another mineral waste disposal facility - Investigate options to ensure design improves land contamination controls
Objective / performance outcome	- Identify the most suitable option for expanding the mineral waste disposal facility that meets the design requirements to mitigate land contamination and includes capping design for the entire mineral waste disposal facility
Performance Indicator	- Study phase identifies options to mitigate the potential for release of contaminants from stage 2 mineral waste disposal facility in the refinery and they are progressed to engineering.
Cost estimate A\$ million	- 2.25
Project Stage	- Engineering
Comments	- Options investigated in study phase included siting and interface with the existing facility

Implementation Schedule


Mineral Waste Disposal Facility					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Develop design for stage 2 of the mineral waste disposal facility					
	Study	Engineering	Execution		



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Mineral Waste Facility - Stage 2

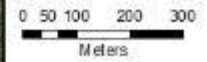
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 Mineral Waste Facility

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Coordinate System: GDA 1984 UTM Zone 58

Scale at A3 1:9,359



Revision	1	01/11/2018
Created By	Jonathan Deane	
Checked By	Jonathan Deane	
Approved By	Jonathan Deane	

Project (L4)	Sewerage System Upgrade
Risk class	- III/High
Environmental risks	<ul style="list-style-type: none"> - Potential for land contamination from sewerage system installed during initial and subsequent plant construction phases and potential to contaminate groundwater. - Introduction of inadequately treated effluent to the RDA
Project solution / options	<ul style="list-style-type: none"> - Investigate the condition of the sewerage system to identify issues and assess options to rectify identified issues - Review the current operation of the sewage treatment system and look at requirement for upgrade
Objective / performance outcome	- Reduce the risk of the release of sewage to land
Performance Indicator	- Study phase identifies current state of sewerage system integrity and identifies options to improve sewage treatment plant and prevent sewage leaks in the refinery and they are progressed to engineering.
Cost estimate A\$ million	- 1.1
Project Stage	- Study
Comments	

Implementation Schedule


Sewerage System									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Investigate the current state of the sewerage system at the refinery									
	Study	Engineering	Execution						



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Sewerage System Review

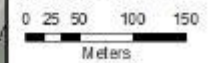
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 Sewage Treatment Plant

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Coordinate System: GDA 1984 UTM Zone 58

Scale at A3: 1:4,600



	Reviewed By:	J. DELANEY
	Checked By:	JONATHAN DELANEY
	Drawn By:	JONATHAN DELANEY
	Approved By:	JONATHAN DELANEY

Project (L6)	Closure Pilot - RDA rehabilitation
Risk class	- II/medium
Environmental risks	- Implementation of a long term effective cover system for closure at the RDA
Project solution / options	- Undertake research of cover systems for closure of the RDA.
Objective / performance outcome	- Determine if a long term cover system can be sustained at the RDA.
Performance Indicator	- Study phase identifies options for long term remediation of the red mud dams. - Trial plot at RDA sustains vegetation to show proof of concept for the project.
Cost estimate A\$ million	- 1.75
Project Stage	- Study
Comments	- A Pilot rehabilitation trial is being established at the Residue Disposal Area.

Implementation Schedule


RDA Closure Rehabilitation					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Investigate closure cover options for the RDA					
Study Engineering Execution					



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RDA Rehabilitation - Pilot Study

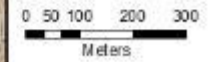
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 Rehabilitation Trial Area

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Coordinate System: GDA 1984 UTM Zone 58

Scale at A3 1:9,359



	Revised By:	J. DELANEY
	Created By:	JONATHAN DELANEY
	Checked By:	JONATHAN DELANEY
	Approved By:	JONATHAN DELANEY

Project (L7)	Oil/water facility resizing
Risk class	- II/Medium
Environmental risks	- Land contamination from oily wastes with the potential to impact groundwaters and the water quality in South Trees Inlet.
Project solution / options	- Install an oil/water separator at the waste transfer facility
Objective / performance outcome	- To improve management of oily wastes.
Performance Indicator	- Engineering package for oily water separate finalised and handed over to execution team.
Cost estimate A\$ million	- 0.45
Project Stage	- Engineering
Comments	- Options investigated: <ul style="list-style-type: none"> • Continue to store and transport oily/water waste off site with larger bunded area, • Install an oil water separator.

Implementation Schedule


Oil/water Separation Facility					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Complete design for upgrade to oil/water separator at waste transfer station					
Study	Engineering	Execution			



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Proposed Oil Water Facility

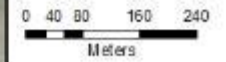
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 Oil water facility

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Coordinate System: GDA 1984 UTM Zone 58

Scale at A3 1:7,019



N 	Revision:	1
	Date:	20/11/2018
	Created By:	Jonathan DeLore
	Approved By:	Jonathan DeLore

Project (L8)	Strategy for Caustic Storage
Risk class	- III/High
Environmental risks	- Current South Trees Island storage location has risks (substrate) for location of a tank farm and a risk of groundwater contamination.
Project solution / options	- Investigate options for a long term caustic storage tank farm.
Objective / performance outcome	- Confirm current locations suitability for the tank farm or; - Identify suitable alternate locations for the caustic storage tank farm
Performance Indicator	- Study phase identifies long term viability of caustic storage tanks at South Trees Island and any recommendations are progressed to engineering as required and/or maintenance and operational recommendations are adopted.
Cost estimate A\$ million	- 10.0
Project Stage	- Study
Comments	

Implementation Schedule



Caustic Storage Strategy					
Task	2018	2019			
	Q4	Q1	Q2	Q3	Q4
Investigate suitability of South Trees Island for long term caustic storage					
	Study	Engineering	Execution		




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Groundwater Impacts at South Trees Island Tank Farm

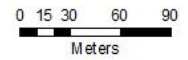
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-  Bund 2
-  Bund 4

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Coordinate System: GDA 1994 MGA Zone 58

Scale at A3: 1:2,981



N 	Revision	A
	Date	21/10/2018
	Created By	Jonathan Dalton
	Approved By	Jonathan Dalton

Other Environmental Improvement Projects

In addition to projects that address the specific environmental parameters of air, water and land, projects that address other aspects of the operation have also been identified below.

Project (O1)	Noise Emissions
Risk class	- III/High
Environmental risks	- Community noise impact from operational and maintenance works
Project solution / options	- Review current noise impact management including: <ul style="list-style-type: none"> • Efficacy of implemented controls on hydro-blasting • Adequacy of noise monitoring program; • Noise source assessment; • Plant and equipment noise mitigation options; and • Operational improvements (e.g. timing of noisy work practices)
Objective / performance outcome	- Reduce QAL noise footprint
Performance Indicator	- Study phase – <ul style="list-style-type: none"> • Verifies high risk noise sources are adequately managed.
Cost estimate A\$ million	- 0.4
Project Stage	- Execution <ul style="list-style-type: none"> • Emergency diesel generator building cladding - Study phase to commence at the beginning of 2020
Comments	

Implementation Schedule

Noise Emissions									
Task	2018	2019				2020			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Review current noise impact management									
EDG building noise reduction									
Study Engineering Execution									