2018 Wagerup Refinery Emission Inventory

Prepared for August 2019 Section 46 Review of Conditions

Date: February 2020

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Table of Published Wagerup Refinery Emission Inventories

Title	Date Published	Description
Wagerup Refinery Air Emission Inventory	2002	Results of emissions inventory monitoring program
Wagerup Unit Three Project Environmental Review and Management Plan	2005	ERMP includes summary of existing refinery emissions
Wagerup Refinery Air Dispersion Modelling	2010	Modelling report includes summary of 2008 refinery emissions
Overview of Wagerup Refinery Emission Inventory and proposed updates	2013	Emission Inventory reflecting refinery and residue conditions in 2012
Overview of Wagerup Refinery Emission Inventory 2014	2015	Emission Inventory reflecting refinery and residue conditions in 2014
2018 Wagerup Refinery Emission Inventory: Prepared for August 2019 Section 46 Review of Conditions	2019	Emission Inventory reflecting refinery and residue conditions in 2018
2018 Wagerup Refinery Emission Inventory: Prepared for August 2019 Section 46 Review of Conditions. February 2020 Revision.	Feb 2020	Amended to include ammonia emissions for cooling towers

Executive Summary

This report presents a summary of the Wagerup Refinery Emission Inventory utilising data reflecting refinery and residue conditions in 2018. It describes work that has been conducted since the 2005 Environmental Review and Management Program (ERMP) and additions to the inventory from ongoing monitoring and assessments up to the end of 2018.

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A. Latest source locations
B. Protocol used for calculation of average concentrations
C. 2018 Emission files
D. 2.85 Mtpa Emission files

1. Introduction

The Wagerup Refinery Emission Inventory summarises the state of knowledge of refinery emissions to air. Since emission monitoring processes are ongoing and refinery operating practices can change, knowledge about refinery emissions to air will change over time. As a result, the Emission Inventory will evolve over time to reflect the changed knowledge base.

This document "2018 Wagerup Refinery Emission Inventory: Prepared for August 2019 Section 46 Review of Conditions", updates the inventory to reflect the 2018 operations and emission knowledge base.

Alumina production in 2018 was 2,633,629 tonnes. Alumina production for the licence year (13 November 2017 to 12 November 2018) was 2,659,095 tonnes.

The 2018 Emission Inventory has been developed to support the Section 46 review of conditions, hence its focus on key emissions referenced in Conditions 8 and 9 of Ministerial Statement 728, namely combustion products, particulates, volatile organic compounds (VOCs) and odour.

This February 2020 Revision includes ammonia emissions for cooling towers.

1.1. 2018 Emission Inventory Summary of Changes

The 2018 Wagerup Refinery Emission Inventory builds on the 2014 inventory as documented in the report "Overview of Wagerup Refinery Emission Inventory 2014" that was published in December 2015.

The 2018 inventory includes the following changes:

- A summary of an Improvement Program aimed at further updating emission estimates (**Section 1.3.2**);
- A list of all sources that have been excluded from the Emission Inventory (**Section 2**);
- Use of measured odour data for each source (**Section 4.4; Section 5**);
- Additional reference information for each emission source, including updated flow data for 2018 (**Section 5**);
- Detailed emission concentration data for each source, up to and including data collected in 2018 (**Section 5**);
- New data collected from sources identified for inclusion in the 2018 inventory, namely Liquor Burning Slurry Mixing Tank Vent, Oxalate Filter Press Building Stack and Calciner 1,2 & 3 Pan Filter Exhaust Vents (**Section 5**);

- A modified approach to the calculation of blow-off tank emissions, to account for the intermittent nature of this source (**Section 5.3**);
- A modified approach for determining average VOC concentration for the precipitation cooling towers (**Section 5.9**); and
- A modified approach for determining odour emission rates from calcination (**Section 5.14.1**).

1.2. Pre-2018 Emission Inventory Development

The Wagerup Refinery emission inventory was developed in 2002 and was based on the results of an emission inventory monitoring program as required by the Department of Environmental Water and Catchment Protection (DEWCP) licence 6217/5. The inventory monitoring program involved analysis of 17 emission sources for up to 17 classes of compounds.

In 2006 and 2007 an intensive monitoring campaign was undertaken to extend emissions knowledge. A $1.5M campaign was undertaken focusing on:

- Additional sampling of key sources (15 sources) aimed at improving understanding of variability in emission rates;
- Additional sources added to the emission inventory – including sources in the southern and northern parts of the refinery (sand separation, digestion blow-off, precipitation tanks);
- Calculated flow rates for combustion sources were based on continuous process data;
- Further development and improvement of the odour/odorant model utilised in the 2005 ERMP, including extension to non-volatile organic compound (VOC) odorants; and
- Comprehensive data integrity review undertaken on all emission concentration data.

In 2010 the inventory was updated for the 2008 plant configuration and to include emission sampling data collected up to 2008. The inventory included 38 point sources. The 2008 plant configuration was considered representative of the then current (2010) emissions profile.

In 2013 a report was presented to the Department of Environment Regulation (DER) detailing the emission inventory reflecting 2012 production levels (attributable to 2.65Mtpa[1]).

The report “Overview of Wagerup Refinery Emission Inventory 2014” was published in December 2015. This report contained applicable source monitoring data up to and including 2014 and included:

[1] Actual alumina production in 2012 was 2.523Mtpa.

- New data collected from sources identified for inclusion in the 2014 Emission Inventory based on workshops held in October 2013:
    - Seed filtration Building sources, 48A tank vent, Calciner 4 low volume vent and extraction hood stack;
- Residue storage areas including RSA9 and ROCP3;
- Data post calciner VOC emissions reduction project (Works approval W5391/2013/1);
- Licensed monitoring data to end of 2014; and
- Updated flow data, where applicable.

1.3. Emissions Monitoring Framework

Alcoa continues to refine and improve its monitoring and emissions calculation techniques since the development of the first emission inventory in 2002. Building upon that inventory, a program of routine monitoring is conducted in response to licence mandated monitoring programs, as well as campaign and project focused monitoring additional to routine needs.

1.3.1. 2006 to 2018 Improvement Program

A program of work was conducted from 2006 to 2018 to further improve emission estimates and source characterisation at the Wagerup Refinery. The program is risk based, focusing on emission sources that are significant contributors to refinery emissions of combustion products, particulates, VOCs and odour. Characterisation of less significant sources (or emissions that are less significant for sources included in the improvement program) occurs less frequently. **Table 1** summarises the program that was implemented. Ongoing characterisation meets the requirements of Department of Water and Environmental Protection (DWER) Licence 6217/1983.

Table 1: Emission inventory improvement program 2006-2018

Source	% Contribution to 2018 Total Refinery Average Emission Rates				2006 – 2007	2008 – 2014	2015 - 2018
	Combustion Products	Particulates	VOC	Odour			
Emission Inventory Improvement Program							
Milling Vents (25)	Non-Combustion Source	12	11	1.9	VOCs Ammonia Odour	Particulates Metals	
Slurry Storage Tanks (25A)	Non-Combustion Source	Not characterised	20	16	VOCs Ammonia Odour	Metals	
Sand Separation (26)	Non-Combustion Source	Not characterised	1.5	5.7	VOCs Ammonia Odour		
Causticisation (35J)	Non-Combustion Source	<1	3.1	1.4	VOCs Ammonia Odour	Particulates Metals	
Filtration (35A)	Non-Combustion Source	Not characterised	1.0	<1	VOCs Ammonia Odour		
Seed Filtration (44)	Non-Combustion Source	Not characterised	3.1	1		Priority VOCs[2] Odour	
Precipitation (45)	Non-Combustion Source	Not characterised	<1			VOCs	
Precipitation Cooling Towers (45K)	Non-Combustion Source	Not characterised	13	25	VOCs	Metals	VOCs Ammonia Odour
Oxalate Kiln RTO Stack (47)	<1	<1	<1	<1		Metals	
Oxalate Filter Press Building Stack	Non-Combustion Source	Not characterised	<1	<1			VOCs Ammonia Odour
Liquor Burner	4.3	<1	<1	3.7	VOCs Ammonia Odour	Metals	Metals
Liquor Burning Slurry Mixing Tank (48A)	Non-Combustion Source	Not characterised	<1	<1		Priority VOCs Odour	
Calcination	46	87	34	35	VOCs Ammonia Odour	Metals	Metals
Calciner 1-3 Low Volume Vent Stack	<1	Not characterised	1	<1		VOCs Odour Metals	
Calciner 4 Low Volume Vent Stack	Non-Combustion Source	Not characterised	2.5	<1		Priority VOCs Odour	
Calciner 1-3 Pan Filters Exhaust Vents	Non-Combustion Source	Not characterised	1.9	<1			VOCs Odour
Calciner 4 Extraction Hoods	Non-Combustion Source	Not characterised	0.1	<1		Priority VOCs Odour	

[2] Priority VOCs are acetaldehyde, acetone, 2-butanone, formaldehyde and benzene.

Source	% Contribution to 2018 Total Refinery Average Emission Rates				2006 – 2007	2008 – 2014	2015 - 2018
	Combustion Products	Particulates	VOC	Odour			
Emission Inventory Improvement Program							
Boilers	34	Not characterised	6.1	7.3		Metals	Metals
GT/HRSG	16	Not characterised				Metals	Metals
Ongoing Characterisation							
Liquor Burner	4.3	<1	<1	3.7	Combustion gases Particulates Priority VOCs Odour	Combustion gases Particulates Priority VOCs Odour	Combustion gases Particulates Priority VOCs Odour
Calcination	46	87	34	35	Combustion gases Particulates Priority VOCs Odour	Combustion gases Particulates Priority VOCs Odour	Combustion gases Particulates Priority VOCs Odour
Boilers; GT/HRSG	49	Not characterised	6.1	7.3	Combustion gases	Combustion gases	Combustion gases
Oxalate Kiln	<1	<1	<1	<1		Combustion Gases Particulates Priority VOCs Odour	Combustion gases Particulates Priority VOCs Odour
Calciner 1-3 Low Volume Vent Stack	<1	Not characterised	1	<1	Combustion gases Priority VOCs Odour	Combustion gases Priority VOCs Odour	Combustion gases Priority VOCs Odour

1.3.2. 2019-2021 Improvement Program

A program of work has been identified to further improve emissions estimates. The program aligns with plans previously developed by Alcoa as part of continuous improvement of the Emission Inventory.

The Improvement Program was developed by conducting a high-level review of data included in the Emission Inventory to identify sources with small data sets (less than 10 data points), sources with old data (greater than 10 years old) and sources which prove problematic for application of standard methodologies (e.g. saturated sources and diffuse sources).

Table 2 provides a broad outline of the work program. The program identifies work areas for the next 3 months, 12 months and 24 months. The Wagerup Refinery Emission Inventory will continue to be updated as new information is acquired.

Table 2: Proposed program of further monitoring to improve the Wagerup Emission Inventory

Timing	Source	Analytes
3 months	Calcination	Metals
	Powerhouse	Metals Odour VOCs Ammonia
	Precipitation Cooling Towers (Building 45K)	Odour VOCs Ammonia
	Refinery (multiple sources)	Mercury
12 Months	Mills	Odour VOCs Ammonia
	Seed filtration (Building 44)	Odour VOCs Ammonia
	Filtration (35A tanks)	Odour VOCs Ammonia
	Causticisation (35J tanks)	Odour VOCs Ammonia
24 Months	Sand Separation (Building 26)	Odour VOCs Ammonia
	Blow-off tanks (Building 30)	Odour VOCs Ammonia

2. Emission Sources

The emissions from the Wagerup Refinery fall into two main categories, namely Bayer and non-Bayer process sources. Bayer process sources are all those associated with the Bayer process liquor that is used to digest the bauxite to produce alumina. These sources generate a variety of substances and emissions that are typical of the alumina refining process, as well as other substances that are more generic in industrial and mineral processing. It is these emissions that produce the characteristic odour associated with Bayer process refineries. Non-Bayer process emissions include products of combustion of natural gas fired boilers and gas turbines, and those related to constituents in the fuels consumed in the refinery.

2.1. Sources Included in the Inventory

Emission sources deemed 'significant' are included in the emission inventory. Emission sources are defined as 'significant' if they emit any one of the following key chemicals at levels greater than 1% (>1%) of the total refinery emission for that chemical:

- Oxides of nitrogen (NO_x), carbon monoxide (CO) or total suspended particulates (TSP);
- Odour; or
- Total VOCs.

For example, if the total refinery emission rate for total VOCs coming from the significant sources is 100 g/s, then any source that emits total VOCs at greater than 1 g/s will be defined as 'significant' and therefore will be included in the inventory. Sources categorised as 'insignificant' do not emit any target chemicals at greater than 1% of the total refinery emission for that chemical.

Note that some sources (e.g. Seed filtration and Calciner 4 extraction hoods) do not meet the significance criteria. They have been included in the inventory because they were identified as part of a review of southern refinery sources conducted in 2013.

The 2018 Emission Inventory includes 55 point sources and 12 fugitive sources as listed in **Table 3**.

Table 3: Sources included in the 2018 Wagerup Emission Inventory

Area	Source	Report Section
Milling (Building 25)	Mill 3 Vent	5.1
	Mill 4 Vent	
	Mill 5 Vent	
Slurry Storage (Building 25A)	25A-1 Tank Vent 1	5.2
	25A-1 Tank Vent 2	
	25A-2 Tank Vent	
	25A-3 Tank Vent 1	
	25A-3 Tank Vent 2	
	25A-4 Tank Vent	
Blow-off Tanks (Building 30)	Blow-off Stack 1	5.3
	Blow-off Stack 2	
Sand Separation (Building 26)	Building 26 Stacks	5.4
Causticisation (Building 35J)	35J-11 Tank Vent	5.5
	35 J-12 Tank Vent	
	35J-13 Tank Vent	
	35J-14 Tank Vent	
	35J-15 Tank Vent	
	35J-24 Tank Vent	
	35J-25 Tank Vent	
Filtration (Building 35A)	35A-1 Tank Vent	5.6
	35A-2 Tank Vent	
	35A-1 Overflow Pipe	
	35A-2 Overflow Pipe	
Seed Filtration (Building 44)	44-1 Main Stack	5.7
	44-1 Hood 1	
	44-1 Hood 2	
	44-2 Main Stack	
	44-2 Hood	
Precipitation (Building 45)	Row 0 Precipitation Tanks	5.8
	Row 1 Precipitation Tanks	
	Row 2 Precipitation Tanks	
	Row 3 Precipitation Tanks	
	Row 4 Precipitation Tanks	
	Row 5 Precipitation Tanks	
Precipitation Cooling Towers (Building 45K)	45K Cooling Tower 1	5.9
	45K Cooling Tower 2	
	45K Cooling Tower 3	
Oxalate Removal (Building 47)	Oxalate Kiln RTO Stack	5.10
	47K1 Oxalate Filter Press Building Stack	5.11

Area	Source	Report Section
Liquor Burner (Building 48)	Liquor Burner	5.12
	48A Slurry Mixing Tank	5.13
Calcination (Building 50)	Calciner 1	5.14
	Calciner 2	
	Calciner 3	
	Calciner 4	
	Calciner 1-3 Low Volume Vent Stack	5.15
	Calciner 4 Low Volume Vent Stack	
	Calciner 1,2,3 Pan Filters Exhaust Vents	
	Calciner 4 Extraction Hoods	
	Calcination Cooling Tower 1	5.16
	Calcination Cooling Tower 2	
Powerhouse (Building 110)	Boiler 1	5.17
	Boiler 2	
	Boiler 3	
	Gas Turbine/Heat Recover Steam Generator	5.18
Residue Storage Area	Lower Dam	5.19
	Run-off Collection Pond (ROCP)	
	RSA2 – Liquor Southern	
	RSA2 – Wet Residue North	
	Super Thickener	
	Cooling Pond	
	Oxalate Pond	
	Run-off Water Storage (ROWS)	
	Wet residue	
	Dry Residue 1	
	Dry Residue 2	
	Wet Sand	

2.2. Sources Excluded from the Inventory

The sources that have been excluded from the Wagerup Refinery Emission Inventory are listed in **Table 4**.

Table 4: Sources excluded from the 2018 Wagerup Emission Inventory

Source name	Description	Reason for exclusion from inventory
Milling: 25 Cooling Tower	Cooling tower runs on Upper Dam[3] water exclusively.	No significant odours or emissions expected due to use of Upper Dam water.
Condensate Facilities: 43D Barometric Condenser	Condensate dump tank for B30 and B42 live steam heaters	Only clean condensate used, so expect negligible odours or emissions. Normally an intermittent emission.
Precipitation: 45A	2 x flat bottom tanks	No emissions evident. Low volume, temperature ~85ºC
Precipitation: 45B – 0 to 6	Secondary thickeners with vents and openings	Low volume emission. Temperature of product <60ºC Thickeners 3-6 have covers.
Precipitation: 45C and 45P	Surge tanks – seed and spent liquor slurry. Open tanks	Low volume tanks and low temperature (~60ºC). Droppers added into bottom of tank to reduce odours and turbulence. Only one in use at any point in time.
Precipitation: 45D – 0 to 6	Tray thickeners – closed top tanks with vents and openings	Low volume. Closed top tanks. Low temperature (~60ºC).
Precipitation: 45E	Closed spent liquor tank with vents and openings	Low volume. Closed tank. Low temperature (~60ºC).
Precipitation: 45G	Flat bottomed tank with no vents. Contains cold, low caustic concentration water.	Contains cold (~32ºC), low caustic concentration water.
Precipitation: 45H	Flat bottomed tank with no stacks. Contains low caustic concentration water.	No stacks; contains low caustic concentration water. Temperature ~60-70ºC..
Oxalate press building: 47	Building containing oxalate filters. Six vents around outside of building.	No odours detected during occupational testing in 2012/2013.
Oxalate precipitation: 47A – 0, 1 and 2 tanks	Open top tanks	No significant odours or emissions observed. Temperature ~60-65ºC.
Oxalate: 47U (2 tanks) crystallisers	Seed tanks with 1 vent on each tank	No significant odours or emissions observed. Temperature ~95-100ºC.

[3] The Upper Dam water source is 'fresh surface water' sourced from rainfall runoff and Yalup Brook. This is used predominantly as the Refinery potable water supply.

Source name	Description	Reason for exclusion from inventory
Oxalate: 47T – 1, 2 and 3 tanks	Oxalate thickeners with 2 vents on each tank. Each tank has a series of hatches that can open or close, though standard practice is to have these closed.	No significant odours or emissions observed. Temperature ~60-65ºC.
Oxalate: 47E	Tank with no stack, though does have lid vent	No significant odours or emissions observed. Temperature ~65ºC.
Liquor burning: 48L	Leach tank wet scrubber with one stack with low flow rate. Scrubber uses lower dam water. Closed tank.	No significant odours or emissions observed. Temperature ~90ºC
Liquor burning: 48E cooling tower	Tank runs on Upper Dam water exclusively.	No significant odours or emissions expected due to use of Upper Dam water. Temperature ~50ºC
Liquor burning 48D and 48E	Fugitive emission sources within building	Localised emissions with low volume.
Liquor burning: South side of 48D and 48E	Several vents associated with 48T, 48F tank area.	No significant odours or emissions identified. Temperature ~90-100ºC
Calcination: 50H	Scrubber for particulates. Small stack near 50B and 50C with one vent for two tanks (duty spare).	No significant odours or emissions identified. Temperature ~60-65ºC
Calcination: 50J	Hydrate storage shed	No emissions observed.
51B Alumina storage	Flat bottomed tank with domed roof	No emissions observed.
51A-1 Alumina storage	Includes train loading facility.	Unlikely to be a significant source of particulate emissions. No odours detected.
6C Caustic Storage Tank	Flat bottomed tank.	Caustic not volatile so emissions expected to be negligible.
6D Caustic unloading	Caustic unloading facility.	No odours evident. Caustic not volatile so emissions expected to be negligible.
Powerhouse 110C Cooling Tower	Cooling tower runs on Upper Dam water exclusively.	No significant odours or emissions expected due to use of Upper Dam water.

3. Target Analytes

The procedure used to select the target analytes is derived from that developed during the Wagerup 3 expansion study which is detailed in the Environ report "Compound Selection Procedure: Wagerup Refinery Unit Three Expansion", 2005.

The following target analytes are included in the inventory:

- Combustion Gases – carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NO_x);
- Ammonia;
- Particulates;
- Volatile Organic Compounds (VOCs) – acetaldehyde, acetone, benzene, 2-butanone, ethylbenzene, formaldehyde, toluene, xylenes, styrene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene;
- Polyaromatic Hydrocarbons (PAHs), as measured by naphthalene; and
- Odour.

Acrolein, vinyl chloride and methylene chloride were originally included, but were subsequently removed from the target suite.

Acrolein and vinyl chloride were excluded based on the results of an intensive emissions monitoring program that was carried out in 2006 and 2007 at Wagerup Refinery. For the VOC measurements, US EPA Method 0030 – Volatile Organics Sampling Train (VOST) was employed in preference to the previously utilised Method 18 VOC measurements. The VOST method has a wider range of detectable substances, with lower limits of detection than Method 18. Utilising the VOST method, neither acrolein nor vinyl chloride were detected in any emission sources at above their method limits of detection. Prior to this, these substances had been detected on a few occasions using Method 18. Given that the limits of detection for the VOST method were significantly lower than for the earlier Method 18 tests, and they had only previously been detected on a few occasions, acrolein and vinyl chloride were concluded as unlikely to exist in refinery emissions and were removed from the emission inventory.

Methylene chloride was excluded based on the results of an investigation into the sources and distribution of methylene chloride in refinery emissions and in ambient air, as recommended by CSIRO in its 2004 Air Quality Review (CSIRO, 2004). It was concluded that methylene chloride should be excluded due to (a) the potential for laboratory contamination; and (b) the absence of methylene chloride in refinery emission studies and ambient air studies (Wagerup Air Quality Technical Advisory Panel, 2007).

4. Data Calculations

4.1. Source Information

The 2018 inventory includes the following source information for each emission source, where available:

- Source name and abbreviation;
- Physical characteristics:
    - Number of stacks;
    - Stack height;
    - Stack diameter;
    - Location;
    - Sample plane compliance with AS4323.1-1995 (Stationary Source Emissions – Selection of Sampling Positions); and
    - Source type information (Single/multi-flue, point/volume/area).
- Regulated source. Emission sources have been defined as a “regulated source” if there are conditions in environmental licence L6217/1983 to conduct monitoring for that source;
- CEMS (Continuous Emissions Monitoring System) information;
- Gas stream characteristics:
    - Temperature;
    - Exit velocity;
    - Moisture content; and
    - Flow rate. For all analytes, except for odour, dry flow rates were used for the calculation of emission rates.
- Emission frequency (continuous or intermittent); and
- Emission control – a description of any emission control equipment or systems.

Stack characteristics were reviewed and updated where necessary to reflect 2018 conditions.

A map showing refinery source locations is provided in **Appendix A**.

4.2. Concentration Data

The 2018 inventory includes monitoring data collected up to 2018 (as directed by compliance monitoring in environmental licence L6217/1983) where available. **Table 5** provides a summary of the relevant compliance data applicable to the inventory.

Table 5: Compliance data applicable to Wagerup 2018 emission inventory

	Priority VOCs					Combustion Gases			Dust	Odour
Analytes	Acetaldehyde	Acetone	Formaldehyde	2-Butanone	Benzene	CO	NO_x	SO_2		
Combustion Point Sources										
Liquor Burner	X	X	X	X	X	X	X	X	X	X
Calciner 1	X	X	X	X	X	X	X	X	X	X
Calciner 2	X	X	X	X	X	X	X	X	X	X
Calciner 3	X	X	X	X	X	X	X	X	X	X
Calciner 4	X	X	X	X	X	X	X	X	X	X
Boiler 1						X	X	X		
Boiler 2						X	X	X		
Boiler 3						X	X	X		
Gas Turbine/HRSG						X	X	X		
Oxalate kiln	X	X	X	X	X	X	X	X	X	X
Non-Combustion Point Sources										
Calciner 1-3 Low Volume Vent	X	X	X	X	X	X	X	X		X

Stack testing methods are listed for each source. Note that in some cases a modified or consultant-developed version of the US EPA method has been used.

In the emission information for each source, 'ND' denotes that a compound has not been detected on any sampling occasion.

Naphthalene concentrations are converted to BaP equivalents using a potency factor of 0.001.

4.2.1. Calculation of Average Concentration

The average concentration has been calculated for each dataset using the Alcoa protocol as explained in **Appendix B**.

4.2.2. Calculation of Peak Concentration

In most cases, the 'peak' concentration was deemed to be the maximum measured concentration value identified for each individual source.

It was not considered appropriate to use the above methodology for the 25A tanks and hence these were determined differently, as explained below.

a) 25A Tanks

For most sources, the maximum emission rates occur when the peak flow produces a maximum concentration of an analyte. However, it has been observed for 25A3 and 25A2 that high concentrations do not occur at times of high flow, and in fact there may be an inverse relationship. Consequently, the peak emission rates for 25A (VOCs and ammonia) were calculated differently to the other sources in this report.

Emission rates were calculated for each concentration/flow pair for acetaldehyde and acetone for which sampling data (dates and times) were available. The higher emission rates calculated were nominated as the 'peak mass emission event', and the flow rate measured at this time was considered to be the 'peak flow rate'. This 'peak flow rate' was then applied to the peak concentration data for all VOCs and ammonia to calculate the emissions rates.

The emission rates for all other analytes were calculated as per the standard protocol.

It has been assumed that the flow rates from 25A1 and 25A4 are the same as the flow rates from 25A2.

4.3. Emission Rates

4.3.1. 2018 Emission Rates

For the 2018 calendar year, average and peak emission rates were calculated using the applicable concentration values multiplied by the applicable flow rates, i.e.

Average emission rate for each source = average concentration x average flow rate

Peak emission rate for each source = peak concentration x peak flow rate

The use of the peak concentrations and the peak flows to calculate peak emissions[4] is considered conservative, since in some cases the peak concentrations would not coincide with peak flows.

Where data is available, equipment availability is incorporated into average flow rates.

2018 Average and peak emission rates for each source are provided in **Appendix C**.

[4] Excepting 25A as detailed in text above.

4.3.2. Scaled Emission Rates for 2.85 Mtpa Production Scenario

Scaled emission rates have been provided for the licenced production rate of 2.85 Mtpa (Refer Licence L6217/1983/15 issued by the then Department of Environment Regulation) in **Appendix D**.

The VOC and odour emissions rates estimated for a 2.85 Mtpa production scenario are forecast using a consistent methodology applied to the 2018 Emission Rates (**Appendix C**). Emissions changes are predicted using a defined methodology developed based on refinery production level with aspects of tank surface area changes, flow changes and equipment addition or subtraction specific to each operating building.

4.4. Odour

Odour emission rates have been determined from measurements conducted using dynamic olfactometry (AS4323.3).

Previous versions of the Wagerup Emission Inventory have used a fitted odour model for most emission sources, using the concentrations of specific odorants (mainly VOCs) to calculate the 'fitted' odour (DAA 2008, 2013). For some sources, these specific odorants have not been measured, and so measured odour data was used. To address this discrepancy as well as DWER concerns, odour measured using dynamic olfactometry has been included for all sources in the 2018 Emission Inventory.

A slightly modified approach has been used to determine odour emission rates from calcination. The approach set out in **Section 4.3** is believed to present an unrealistically high peak for odour emission rates from the calciners. To address this, calcination odour emissions have been determined using measured emission rates (i.e. concentration multiplied by the flow rate measured at the time of sampling) rather than average and peak measured concentrations multiplied by the calculated average and peak flow rates. This approach is described in more detail in **Section 5.14.1**.

5. Overview of Emission Sources

5.1. Milling Vents (Building 25)

In milling, crushed bauxite from the stockpile is mixed with hot caustic liquor. VOCs are formed from the breakdown of naturally occurring organic matter in the bauxite as it contacts the hot caustic. As the temperatures and residence times are lower and shorter in the mills compared to subsequent process steps, the concentration and flows of vapour emissions from this source are relatively small.

There are 3 mills in operation at Wagerup (Mill 3, Mill 4 and Mill 5) with the processes in each mill being essentially the same. The emissions from Mill 3 Trommel Vent were sampled because, as the largest mill, it has the highest throughput and emissions. Using concentration and flow rate data from Mill 3 for all other mills is a conservative approach which will slightly overstate their emission rates.

Assumptions:

The gas flow rates and emission concentrations at Mills 4 and 5 were the same as Mill 3.

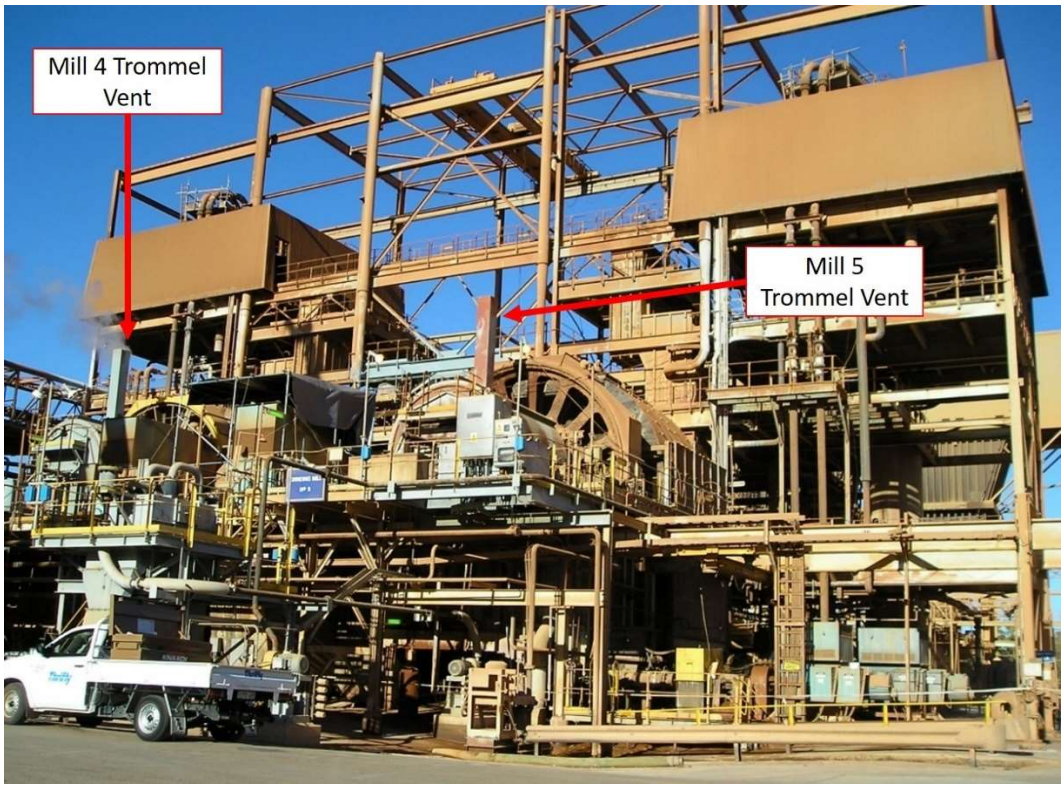

Figure 1: Mills 4 and 5

Table 6: Milling Trommel Vents (Building 25) Source Information

Source Name	**Name**	Milling Trommel Vents – Mill 3, 4 and 5		
	Abbreviation	Building 25		
Physical Characteristics	**No. of Stacks**	3 vents		
	Height (m)	13		
	Stack tip diameter (m)	0.45		
	Location (Easting & Northing)	Mill 3	398,344.046	6,357,977.598
		Mill 4	398,288.396	6,357,994.742
		Mill 5	398,288.396	6,358,010.942
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics		**Average**		**Peak**
	Temp (°C)	68		68
	Exit velocity (m/s)	17.3		22
	Moisture content (%)	24		22
	Flow Rate (Dry Nm^3/hr)	Mill 3	6052	7867
		Mill 4	6052	7867
		Mill 5	6052	7867
	Flow Rate (measured or calculated)	Measured		
Emission Frequency	**Continuous / Intermittent**	Continuous when mills operational		
Emission Control(s)		None		

Table 7: Emission Information for Mill Trommel Vents

Emission Sampling Period	Mid 2002, 2007 and 2008		**Comment**	All sampling conducted on Mill 3.				
Gas Stream Characteristics	2007		**Assumptions**	Mill 3 concentrations are representative of emissions from Mill 4 and 5				
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	3778	4030	3350-4030	4	296
	Ammonia	USEPA CTM-027	mg/m^3	75	83	55 – 83	6	11
	Particulate	USEPA M5	mg/m^3	74	100	39-100	3	32
VOCs	Acetaldehyde	Modified USEPA MTO5[5]	mg/m^3	16	18	14 - 18	5	1.9
	Acetone	Modified USEPA MTO5	mg/m^3	40	56	26 - 56	5	12
	Benzene	USEPA M18 (tube)	mg/m^3	0.050	0.069	ND – 0.069	4	0.033
	2-butanone	Modified USEPA MTO5	mg/m^3	2.1	2.6	1.6-2.6	5	0.38
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	5	-
	Naphthalene	USEPA M30 (VOST)	mg/m^3	0.0083	0.0090	0.0070-0.0090	3	0.0012
	Ethylbenzene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	5	-
	Styrene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	5	-
	Toluene	USEPA M30 (VOST)	mg/m^3	0.12	0.18	0.079-0.18	4	0.048
	1,2,4 Trimethylbenzene	USEPA M30 (VOST)	mg/m^3	0.15	0.65	0.014-0.65	8	0.21
	1,3,5 Trimethylbenzene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	5	-
	Xylenes	USEPA M30 (VOST)	mg/m^3	0.052	0.063	0.043-0.063	3	0.010

[5] US EPA Method TO-5 for sampling aldehydes and ketones in ambient air was modified to allow sampling from a vent

5.2. Slurry Storage Tanks (25A Tanks)

Slurry storage is the next processing step after milling. A series of tanks receive the bauxite slurry to remove dissolved silica from the milled ore. It operates at a lower temperature but has longer residence time than the subsequent digestion process. Excess flash vapour from the digestion process is used to heat the slurry and, consequently, there is release of vapour from the vents associated with each slurry storage tank.

The Wagerup facility comprises four tanks in series: 25A3, 25A1, 25A4 and 25A2. 25A3, the first tank in the series (referred to as the 'head tank'), is the hottest because it receives flash vapour (steam) directly from the digestion process. The digestion flash vapour contains some organics, and some of these are released with excess steam. (Note: When 25A3 is off-line, 25A1 acts as the head tank).

Emissions from the four tanks are via vents. The 25A3 and 25A1 tanks have two vents each, while the remaining tanks have one vent each. Given that 25A3 is the head tank and receives flash vapour from digestion, it has a different emission concentration and flow rate to the remaining three downstream tanks.

Sampling for the slurry storage tanks was performed on a single vent from each of 25A3 and 25A2.

Section 4.2.2 describes how peak emission rates were determined for the 25A tanks. Peak parameters have been selected based on peak flow rates; hence some parameters (e.g. moisture) have peak value lower than the average value.

Assumptions:

Where available, 25A2 concentration and flow data were used for 25A1, 25A2 and 25A4. For parameters that have not been measured at 25A2, including ammonia, 25A3 data were used for all tanks.

Figure 2: (a) 25A Tanks; (b) 25A vent example

Table 8: Slurry Storage Tank Source Information

Source Name	**Name**	Slurry Storage Tanks		
	Abbreviation	25A-1, 25A-2, 25A-3, 25A-4		
Physical Characteristics	**No. of Stacks**	6		
	Height (m)	25.4		
	Stack tip diameter (m)	0.75		
	Location (Easting & Northing)	25A-1 Vent 1	398280.132	6357887.138
		25A-1 Vent 2	398280.132	6357887.138
		25A-2 Vent	398280.132	6357863.138
		25A-3 Vent 1	398256.132	6357887.138
		25A-3 Vent 2	398256.132	6357887.138
		25A-4 Vent	398317.134	6357863.142
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics			**Average**	**Peak**
	Temp (°C)	25A-1	95	94
		25A-2	89	90
		25A-3	98	96
		25A-4	92	92
	Exit velocity (m/s)	25A-1	0.88	1.0
		25A-2	3.9	4.7
		25A-3	6.8	11
		25A-4	3.3	3.9
	Moisture content (%)	25A-1	68	70
		25A-2	68	70
		25A-3	90	86
		25A-4	68	70
	Flow Rate (Dry Nm3/hr)	25A-1 Vent 1	338	372
		25A-1 Vent 2	338	372
		25A-2	676	743
		25A-3 Vent 1	761	1785
		25A-3 Vent 2	761	1785
		25A-4	676	743
	Flow Rate (measured or calculated)	Measured		
Emission Frequency	**Continuous / Intermittent**	Continuous when respective 25A tanks are operational		
Emission Control(s)		None		

Table 9: Emission Information for Slurry Storage Tanks

Emission Sampling Period	2002-2007		**Comment**	Sampling for the slurry storage tanks was performed on a single vent from each of 25A3 and 25A2.					
Gas Stream Characteristics	2007		**Assumptions**	The concentrations measured from 25A2 were assumed to represent the emissions from 25A1 and 25A4. For VOCs and odour, 25A2 concentration data were used for 25A1, 25A2 and 25A4. For ammonia, 25A3 data were used for all tanks.					
Compound Class	**Compound**	**Method**	**Unit**		**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	25A-2	14806	34360	697-34360	18	11372
				25A-3	44257	231700	900-231700	30	57571
	Ammonia	USEPA CTM-027	mg/m^3		2446	5479	371-5479	11	1854
	Particulate	Not characterised							
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	25A-2	57	92	27-92	18	17
				25A-3	227	548[6]	39-648	29	172
	Acetone	Modified USEPA MTO5	mg/m^3	25A-2	480	644	195-644	18	131
				25A-3	292	598[7]	60-966	29	211
	Benzene	USEPA M18 (tube)	mg/m^3		0.58	2.0	0.23-2.0	13	0.44
	2-butanone	Modified USEPA MTO5	mg/m^3	25A-2	52	72	19-72	18	17
				25A-3	24	75	0.23-75	29	21
	Formaldehyde	Modified USEPA MTO5	mg/m^3	25A-2	ND	ND	-	31	-
				25A-3	ND	ND	-	18	-
	Naphthalene	USEPA M18	mg/m^3		ND	ND	-	12	-
	Ethylbenzene	USEPA M18	mg/m^3		0.46	0.80	0.010-0.80	15	0.18
	Styrene	USEPA M18	mg/m^3		0.050	0.10	0.010-0.10	3	0.046
	Toluene	USEPA M18	mg/m^3		5.5	19	0.47-19	14	5.0
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3		0.59	3.7	0.0-3.7	15	1.3
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3		0.82	1.5	0.22-1.5	15	0.43
	Xylenes	USEPA M18	mg/m^3		0.51	2.9	0.22-2.9	14	0.76

[6] This is the concentration at peak emission rate
[7] This is the concentration at peak emission rate

5.3. Blow-off Tanks (30 containment tanks)

Digester slurry exits the digester tanks and goes through a series of flash tanks for cooling. Vapours generated by the reduction in pressure as it passes through the first stages of cooling are directed to heaters to heat incoming digester liquor and other slurry heating functions. The final stage of cooling is via two blow-off tanks (in parallel). The slurry in the blow-off tanks is cooled and pumped to sand removal. The vapour from these tanks goes to the blow-off heater, the washer overflow heater and the vapour condenser via the overflow tank. The vapour in the overflow tank is drawn into the vapour condenser via the vacuum pump.

Emissions from the blow off tank vapour condensers are minimal, however intermittent emissions can occur when heaters are offline, or when heat transfer achieved in the heaters is less than design, such that excess vapour carryover is presented to the condensers.

Blow-off vapour flows have been determined based on a calibrated reference model using annual averages for refinery production and energy flows.

Previous inventory versions included a peak and average emission rate for this source. Since emissions from this source are intermittent, only a peak emission rate has been included in the 2018 emission inventory for this source. Peak emission rates were calculated using the peak measured concentration multiplied by the vapour flow.

Assumptions:

Due to the intermittent nature of this source, it has been assumed that the average flow rate is zero.

Figure 3: Digestion and 30-2 containment tank stack

Table 10: Blow-off tanks Source Information

Source Name	**Name**	Blow-off (stack 1) Blow-off (stack 2)		
	Abbreviation	30 containment tanks 1 & 2		
Physical Characteristics	**No. of Stacks**	2		
	Height (m)	24.3		
	Stack tip diameter (m)	0.730		
	Location (Easting & Northing)	Stack 1	398358	6357829
		Stack 2	398311	6357833
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics		**Average**		**Peak**
	Temp (°C)	101		101
	Exit velocity (m/s)	4.6		4.6
	Moisture content (%)	99		99
	Flow Rate (Dry Nm^3/hr)	Stack 1	0	62
		Stack 2	0	221
	Flow Rate (measured or calculated)	Calculated		
Emission Frequency	**Continuous / Intermittent**	Intermittent		
Emission Control(s)	**Control 1**	Vapour condenser/non-condensable gas destruction system		
	Year of Installation	2002		
	Operating Strategy	Continuous unless maintenance is being undertaken on the condenser or the air feed line to the boilers		
	Purpose	Reduction of VOC emissions		

Table 11: Emission Information for Blow-off Tank Stacks

Emission Sampling Period	2002		**Comment**	No data has been collected since the non-condensable destruction system has been installed.				
Gas Stream Characteristics	2018		**Assumptions**	Assumed that concentrations in Stack 1 and Stack 2 are identical. Only peak concentrations have been used; it has been assumed that average emission rates are zero for this source.				
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	70020	70020	4959-111650	3	57054
	Ammonia	USEPA CTM-027	mg/m^3	3102	3102	2481-3722	2	878
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	274	274	54-705	3	373
	Acetone	Modified USEPA MTO5	mg/m^3	1405	1405	80-3915	3	2175
	Benzene	USEPA M18 (tube)	mg/m^3	ND	ND	-	3	-
	2-butanone	Modified USEPA MTO5	mg/m^3	218	218	23-594	3	326
	Formaldehyde	Modified USEPA MTO5	mg/m^3	6.3	6.3	3.0-12	3	4.9
	Naphthalene	Not characterised						
	Ethylbenzene	Not characterised						
	Styrene	Not characterised						
	Toluene	USEPA M30 (VOST)	mg/m^3	2.4	2.4	0.1-4.7	3	2.3
	1,2,4 Trimethylbenzene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	3	-
	1,3,4 Trimethylbenzene	Not characterised						
	Xylenes	Not characterised						

5.4. Sand Separation (Building 26)

After separation of dissolved silica from the milled ore, the undissolved sand is washed to maximise the recovery of liquor. Vapour can be emitted from the vents and the general building.

Building 26 has five stacks (26-1 A-rake ventilation stack, 26-2 A-rake ventilation stack, 26-3 A-rake ventilation stack, 26-3 belt filter vacuum stack and 26-3 hood stack) which are modelled as a single source. Only one stack was sampled in 2007 and the data used for all five stacks.

Assumptions:

All vent emissions were assumed to have the same concentration as vent 26-1.

Figure 4: Sand Separation (Building 26)

Table 12: Sand Separation Source Information

Source Name	**Name**	Sand separation	
	Abbreviation	Building 26	
Physical Characteristics	**No. of Stacks**	5 (modelled as a single source)	
	Height (m)	27	
	Stack tip diameter (m)	1.13	
	Location (Easting & Northing)	398182.683	6357857.691
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		No	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	82	82
	Exit velocity (m/s)	14	28
	Moisture content (%)	50	50
	Flow Rate (Dry Nm3/hr)[8]	19839	38585
	Flow Rate (measured or calculated)	Measured & calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous when Building 26 operational	
Emission Control(s)		None	

[8] This is the flow rate for all five stacks

Table 13: Emission Information for Sand Separation

Emission Sampling Period	2007		**Comment**	All sampling was done on vent 26-1.				
Gas Stream Characteristics	2018		**Assumptions**	All vent emissions were assumed to have the same concentration as vent 26-1.				
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	6998	13300	4270-13300	4	4287
	Ammonia	ECS Method 1.0	mg/m^3	54	67	42-67	4	13
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	3.0	3.6	2.0-3.6	4	0.73
	Acetone	Modified USEPA MTO5	mg/m^3	4.5	7.1	3.0-7.1	4	1.9
	Benzene	USEPA M18 (tube)	mg/m^3	ND	ND	-	4	-
	2-butanone	Modified USEPA MTO5	mg/m^3	0.30	0.59	0.20-0.59	4	0.20
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	4	-
	Naphthalene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	6	-
	Ethylbenzene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	6	-
	Styrene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	6	-
	Toluene	USEPA M30 (VOST)	mg/m^3	0.046	0.080	0.016-0.080	4	0.030
	1,2,4 Trimethylbenzene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	6	-
	1,3,5 Trimethylbenzene	USEPA M30 (VOST)	mg/m^3	ND	ND	-	6	-
	Xylenes	USEPA M30 (VOST)	mg/m^3	ND	ND	-	4	-

5.5. Causticisation (35J Tanks)

In this processing step, green liquor is dosed with lime to regenerate caustic soda from sodium carbonate. The process takes place above 100°C and is accompanied by the release of vapour.

Wagerup operates two Lime Causticisation units. Unit 1 consists of four tanks in series: 35J-12, 35J-13, 35J-14 and 35J-15. Unit 2 consists of two tanks in series: 35J-24 and 35J-25. An additional tank (35J-11) receives lime and is fitted with a scrubber. 35J-12 is also fitted with a scrubber so is assumed to have the same emission concentration as 35J-11. The remaining tanks are assumed to have emissions concentrations similar to emissions from 35J-13. There is one stack on each tank.

Assumptions:

For VOCs and odour, concentration data for 35J-11 was used to calculate emissions rates from 35J-11 and 35J-12; concentration data from 35J-13 was used for all other tanks. For ammonia, 35J-11 concentration data was used for all tanks.

Figure 5: 35J-12 and 35J-13

Table 14: Causticisation Source Information

Source Name	**Name**	Causticisation		
	Abbreviation	35J		
Physical Characteristics	**No. of Stacks**	7		
	Height (m)	9.7		
	Stack tip diameter (m)	0.49		
	Location (Easting & Northing)	35J-11	398528.228	6357667.915
		35J-12	398518.220	6357672.919
		35J-13	398528.228	6357677.924
		35J-14	398518.238	6357682.928
		35J-15	398528.169	6357688.028
		35J-24	398562.679	6357679.436
		35J-25	398578.502	6357679.480
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics			**Average**	**Peak**
	Temp (°C)	35J-11 & 35J-12	62	60[9]
		35J-13, 35J-14, 35J-15, 35J-24 & 35J-25	92	94
	Exit velocity (m/s)	35J-11	3.5	4.5
		35J-12	3.1	4.0
		35J-13, 35J-14 & 35J-15	2.5	3.3
		35J-24	1.7	2.3
		35J-25	2.5	3.3
	Moisture content (%)	35J-11 & 35J-12	21	19
		35J-13, 35J-14, 35J-15, 35J-24 & 35J-25	67	68

[9] This is the temperature at maximum flow rate

	Flow Rate (Dry Nm3/hr)	35J-11	1514	2017
		35J-12	1352	1801
		35J-13	407	528
		35J-14	407	528
		35J-15	407	528
		35J-24	281	364
		35J-25	407	528
	Flow Rate (measured or calculated)	Measured & calculated		
Emission Frequency	**Continuous / Intermittent**	Continuous when respective 35J tanks are operational		
Emission Control(s)	**Control 1**	Scrubber – 35J-11 and 35J-12		
	Year of Installation	1984		
	Operating Strategy	Continuous when respective 35J tanks are operational		
	Purpose	Removal of lime particles from tank emissions		

Table 15: Emission Information for Causticisation

Emission Sampling Period	2002-2008		**Comment**	All sampling was done on 35J-11 and 35J-13.					
Gas Stream Characteristics	2018		**Assumptions**	For VOCs and odour, concentration data for J-11 was used to calculate emissions rates from J-11 and J-12; concentration data from J13 was used for all other tanks. For ammonia, J-11 concentration data was used for all tanks. For particulates, J-13 data was used for all tanks.					
Compound Class	**Compound**	**Method**	**Unit**		**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	35J-11	11792	28980	843-28980	28	10253
				35J-13	4573	26570	697-26570	36	4909
	Ammonia	ECS Method 1.0	mg/m^3		44	59	18-59	8	13
	Particulate	USEPA M5	mg/m^3		2.1	3.0	1.2-3.0	3	0.90
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	35J-11	10	16	5.2-16	32	3.0
				35J-13	21	41	11-41	18	7.3
	Acetone	Modified USEPA MTO5	mg/m^3	35J-11	39	98	14-98	32	20
				35J-13	46	84	8.7-84	19	18
	Benzene	USEPA M18 (tube)	mg/m^3		ND	ND	-	12	-
	2-butanone	Modified USEPA MTO5	mg/m^3	35J-11	5.3	7.9	0.20-7.9	32	1.8
				35J-13	6.5	8.1	3.7-8.1	18	1.2
	Formaldehyde	Modified USEPA MTO5	mg/m^3	35J-11	0.29	0.90	0.10-0.90	32	0.24
				35J-13	0.35	0.67	0.17-0.67	18	0.16
	Naphthalene	USEPA M30	mg/m^3		0.38	0.91	0.060-0.91	12	0.30
	Ethylbenzene	USEPA M18	mg/m^3		ND	ND	-	12	-
	Styrene	USEPA M18	mg/m^3		ND	ND	-	12	-
	Toluene	USEPA M18	mg/m^3		0.72	2.5	0.070-2.5	12	0.68
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3		0.82	1.7	0.22-1.7	12	0.52
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3		0.23	0.49	0.080-0.49	12	0.13
	Xylenes	USEPA M18	mg/m^3		ND	ND	-	12	-

5.6. Filtration (35A Tanks)

Green liquor from the thickener overflow is filtered in the 35 Filter building to remove any remaining solids after the slurry is settled in the thickener. The filtered green liquor is held in the 35A tank prior to being cooled before precipitation.

Wagerup operates two 35A tanks (35A-1 and 35A-2) interchangeably. All sampling was conducted at 35A-1.

There are two sources of emissions from each tank: firstly, from a vent and secondly, from an overflow pipe. Overflow pipe flows could not be measured so were instead estimated based on the likely frequency and duration of venting. Both sources of emissions are incorporated in the Emission Inventory.

Assumptions:

It has been assumed that the vent flow rate from 35A-2 is equal to the measured flow rate for the 35A-1 vent. Concentration data from 35A-1 was used for 35A-2 and both overflow pipes.

The 35A-1 tank was offline during 2018, so there are no emissions from this source.

Figure 6: 35A-1 tank

Table 16: Filtration Source Information

Source Name	**Name**	Filtration		
	Abbreviation	35A Tanks		
Physical Characteristics	**No. of Stacks**	4		
	Height (m)	16.5		
	Stack tip diameter (m)	0.60		
	Location (Easting & Northing)	35A-1 Vent 35A-2 Vent 35A-1 O/F 35A-2 O/F	398549.553 398527.590 398549.553 398527.590	6357559.268 6357559.268 6357559.268 6357559.268
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics		**Average**		**Peak**
	Temp (°C)	80.1		65.0[10]
	Exit velocity (m/s)	35A-2 Vent 35A-2 O/F	1.3 0.45	1.7 7.1
	Moisture content (%)	37		24[11]
	Flow Rate (Dry Nm3/hr)	35A-2 Vent 35A-2 O/F	652 99	1069 1971
	Flow Rate (measured or calculated)	Measured & Calculated		
Emission Frequency	**Continuous / Intermittent**	Continuous when 35A tanks online		
Emission Control(s)		None		

[10] This is the temperature at peak flow
[11] This is the moisture at peak flow

Table 17: Emission Information for Filtration

Emission Sampling Period	2002-2007		**Comment**	All sampling was done on 35A1.				
Gas Stream Characteristics	2018		**Assumptions**	It was assumed that concentrations are the same for 35A-1 and 35A-2.				
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	32786	114430	760-114430	28	29291
	Ammonia	ECS Method 1.0	mg/m^3	127	255	31-255	8	79
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	20	58	5-58	29	11
	Acetone	Modified USEPA MTO5	mg/m^3	95	201	12-201	29	61
	Benzene	USEPA M18 (tube)	mg/m^3	0.10	0.23	0.040-0.23	12	0.062
	2-butanone	Modified USEPA MTO5	mg/m^3	12	30	2.9-30	29	6.2
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	29	-
	Naphthalene	USEPA M18	mg/m^3	2.1	5.6	0.080-5.6	12	1.6
	Ethylbenzene	USEPA M18	mg/m^3	ND	ND	-	14	-
	Styrene	USEPA M18	mg/m^3	ND	ND	-	14	-
	Toluene	USEPA M18	mg/m^3	6.5	13	0.08-13	13	3.4
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	1.2	3.5	0.080-3.5	14	0.87
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	0.30	0.85	0.080-0.85	14	0.23
	Xylenes	USEPA M18	mg/m^3	0.34	1.2	0.080-1.2	12	0.39

5.7. Seed Filtration (44-1 and 44-2)

After precipitation, the medium sized hydrate crystals are removed and sent to the seed filtration building for further processing before being returned as seed into the process.

44-1 is the fine seed filter building; 44-2 is coarse seed filter building. The filter cake from these buildings gets re-slurried and sent back to Row 0 in precipitation for reprocessing. The filtrate is recycled back to 30A as spent liquor.

There are two sources of emissions from each building: firstly, from a main stack (vacuum pump emissions) and secondly, from a hood stack (re-slurry tank exhaust emissions). Building 44-1 has two hood stacks side by side. Building 44-2 has one hood stack.

Seed filtration was sampled in 2014.

Very low flow rates were recorded for these emission sources, some below the detection limit of the method. For flow rates below the detection limit, the detection limit was used.

Assumptions:

Seed filtration has only been sampled once, so it has been assumed that the peak flow is the same as the average.

Figure 7: (a) 44-1 Stack 1; (b) 44-2 Stack

Table 18: Seed Filtration Source Information

Source Name	**Name**	Seed Filtration		
	Abbreviation	Building 44		
Physical Characteristics	**No. of Stacks**	5		
	Height (m)	44-1 Main	35.1	
		44-1 Hood 1	28.3	
		44-1 Hood 2	28.4	
		44-2 Main	35.1	
		44-2 Hood	35.3	
	Stack tip diameter (m)	44-1 Main	1.10	
		44-1 Hood 1	0.60	
		44-1 Hood 2	0.60	
		44-2 Main	1.08	
		44-2 Hood	1.09	
	Location (Easting & Northing)	44-1 Main	398701.800	6357026.200
		44-1 Hood 1	398700.400	6357022.400
		44-1 Hood 2	398700.500	6357021.500
		44-2 Main	398692.600	6356961.600
		44-2 Hood	398714.800	6356959.700
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics			**Average**	**Peak**
	Temp (°C)	44-1 Main	61	61
		44-1 Hood 1	56	56
		44-1 Hood 2	56	56
		44-2 Main	65	65
		44-2 Hood	41	41
	Exit velocity (m/s)	44-1 Main	<2	<2
		44-1 Hood 1	11	11
		44-1 Hood 2	3	3
		44-2 Main	3	3
		44-2 Hood	6	6
	Moisture content (%)	44-1 Main	20	20
		44-1 Hood 1	17	17
		44-1 Hood 2	15	15
		44-2 Main	23	23
		44-2 Hood	7.3	7.3

	Flow Rate (Dry Nm3/hr)	44-1 Main	<4200	<4200
		44-1 Hood 1	7800	7800
		44-1 Hood 2	1920	1920
		44-2 Main	5400	5400
		44-2 Hood	16200	16200
	Flow Rate (measured or calculated)	Measured		
Emission Frequency	**Continuous / Intermittent**	Continuous when 44 Tanks online		
Emission Control(s)		None		

Table 19: Emission Information for Seed Filtration

Emission Sampling Period	2014		**Comment**						
Gas Stream Characteristics	2014		**Assumptions**						
Compound Class	**Compound**	**Method**	**Unit**		**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	44-1 Main	1600	1600	1600-1600	2	0
				44-1 Hood 1	1200	1200	1100-1200	2	71
				44-1 Hood 2	1300	1300	1200-1300	2	71
				44-2 Main	1200	1300	1100-1300	2	141
				44-2 Hood	1100	1100	1100-1100	2	0
	Ammonia	Not characterised							
	Particulate	Not characterised							
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	44-1 Main	1.5	1.5	1.4-1.5	2	0.071
				44-1 Hood 1	0.40	0.40	0.40-0.40	2	0
				44-1 Hood 2	0.85	0.86	0.84-0.86	2	0.014
				44-2 Main	1.8	1.9	1.6-1.9	2	0.21
				44-2 Hood	0.11	0.17	0.05-0.17	2	0.085
	Acetone	Modified USEPA MTO5	mg/m^3	44-1 Main	12	15	9.9-15	2	3.6
				44-1 Hood 1	2.3	2.3	2.3-2.3	2	0
				44-1 Hood 2	4.1	4.2	4.0-4.2	2	0.14
				44-2 Main	25	26	23-26	2	2.1
				44-2 Hood	0.80	0.80	0.79-0.80	2	0.0071

Compound Class	Compound	Method	Unit		Conc (ave)	Conc (peak)	Conc Range	No. Data points	Standard Deviation
VOCs	Benzene	USEPA M18 (tube)	mg/m^3	44-1 Main	ND	ND	-	2	-
				44-1 Hood 1	ND	ND	-	2	-
				44-1 Hood 2	ND	ND	-	2	-
				44-2 Main	ND	ND	-	2	-
				44-2 Hood	ND	ND	-	2	-
	2-butanone	Modified USEPA MTO5	mg/m^3	44-1 Main	2.4	2.5	2.3-2.5	2	0.14
				44-1 Hood 1	0.57	0.58	0.55-0.58	2	0.021
				44-1 Hood 2	1.1	1.2	1.0-1.2	2	0.16
				44-2 Main	8.8	9.3	8.2-9.3	2	0.78
				44-2 Hood	0.29	0.36	0.22-0.36	2	0.10
	Formaldehyde	Modified USEPA MTO5	mg/m^3	44-1 Main	ND	ND	-	2	-
				44-1 Hood 1	ND	ND	-	2	-
				44-1 Hood 2	ND	ND	-	2	-
				44-2 Main	ND	ND	-	2	-
				44-2 Hood	ND	ND	-	2	-
	Naphthalene	Not characterised							
	Ethylbenzene	Not characterised							
	Styrene	Not characterised							
	Toluene	Not characterised							
	1,2,4 Trimethylbenzene	Not characterised							
	1,3,5 Trimethylbenzene	Not characterised							
	Xylenes	Not characterised							

5.8. Precipitation (Building 45)

The precipitation process provides sufficient time for the hydrate to precipitate out of the solution and provide conditions for low impurity levels. There are 48 precipitators that are divided into two units. Each unit has two banks of 12 tanks, all open top. Liquor and seed enter the first two tanks of each bank, and then flow in series from first tank to last tank in each bank. The precipitators are at different levels so the liquor flows from one tank to another by gravity. The temperature decreases from approximately 82ºC in the front tanks to approximately 58ºC in the back tanks. This progressive cooling is the process employed in the Bayer process to ensure precipitation.

The open top tanks in the north-east side are the most turbulent and hottest in this area. It is expected that other tanks throughout the series have progressively lower odours as they are cooler and less turbulent. These tanks were included in the 2010 inventory update as a single volume source comprised of 48 individual tanks.

Assumptions:

Tanks are considered as a volume source comprised of 48 individual tanks and noted in the inventory as rows 0 to 5.

The tank flows measured in 2008 are believed to be non-representative of operations, so tank flows were calculated based on the YieldMod heat loss modelling program. Each row has 8 tanks; however, two tanks are generally offline at any given time, so it has been assumed that Rows 2 and 3 only have 7 tanks each.

It has been assumed that peak flows are the same as average flows.

Figure 8: Precipitation

Table 20: Precipitation Source Information

Source Name	**Name**	Precipitation		
	Abbreviation	Building 45		
Physical Characteristics	**No. of Stacks**	48 open tanks		
	Height (m)	Row 0	30.2	
		Row 1	29.4	
		Row 2	28.6	
		Row 3	27.8	
		Row 4	26.9	
		Row 5	26.1	
	Stack tip diameter (m)	Row 0	12.5	
		Row 1	11	
		Row 2	11	
		Row 3	11	
		Row 4	11	
		Row 5	11	
	Location (Easting & Northing)	Row 0	398640.984	6357022.954
		Row 1	398623.484	6357022.954
		Row 2	398607.553	6357022.954
		Row 3	398591.179	6357022.954
		Row 4	398575.597	6357022.954
		Row 5	398559.484	6357022.954
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Volume		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics			**Average**	**Peak**
	Temp (°C)	Row 0	31	31
		Row 1	31	31
		Row 2	27	27
		Row 3	24	24
		Row 4	24	24
		Row 5	24	24
	Exit velocity (m/s)	N/A – modelled as volume source		

	Moisture content (%)	Row 0	45.7	45.7
		Row 1	45.7	45.7
		Row 2	40.5	40.5
		Row 3	29.0	29.0
		Row 4	29.0	29.0
		Row 5	29.0	29.0
	Flow Rate (Dry Nm3/hr)	Row 0	35400	35400
		Row 1	27416	27416
		Row 2	25221	25221
		Row 3	26971	26971
		Row 4	30824	30824
		Row 5	30824	30824
	Flow Rate (measured or calculated)	Calculated		
Emission Frequency	**Continuous / Intermittent**	Continuous when precipitation tanks are online		
Emission Control(s)		None		

Table 21: Emission Information for Precipitation

Emission Sampling Period	2008		**Comment**	Samples were extracted from a point above the surface of the tank contents that was equivalent to the distance from the tank lip to the tank content, i.e. on the same horizontal plane as the tank top. The sampling train was set up downwind in an attempt to capture fugitive vapours being emitted from the tanks.					
Gas Stream Characteristics	2014		**Assumptions**						
Compound Class	**Compound**	**Method**	**Unit**		**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	Not characterised							
	Ammonia	Not characterised							
	Particulate	Not characterised							
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3		ND	-	-	2	-
	Acetone	USEPA Method 0030	mg/m^3	Rows 0-1	0.069	0.12	0.018-0.12	2	0.072
				Row 2	0.17	0.18	0.15-0.18	2	0.021
				Rows 3-5	0.063	0.076	0.050-0.076	2	0.018
	Benzene	USEPA Method 0030	mg/m^3	Rows 0-1	0.0031	0.0039	0.0024-0.0039	2	0.0011
				Row 2	ND	-	-	2	-
				Rows 3-5	ND	-	-	2	-
	2-butanone	USEPA Method 0030	mg/m^3	Tank 41	0.021	0.036	0.0060-0.036	2	0.021
				Tank 42	0.045	0.046	0.044-0.046	2	0.0014
				Tank 44	0.018	0.021	0.015-0.021	2	0.0042
	Formaldehyde	USEPA Method 0030	mg/m^3	Tank 41	ND	ND	-	2	-
				Tank 42	ND	ND	-	2	-
				Tank 44	ND	ND	-	2	-

Compound Class	Compound	Method	Unit		Conc (ave)	Conc (peak)	Conc Range	No. Data points	Standard Deviation
VOCs	Naphthalene	USEPA Method 0030	mg/m^3	Tank 41	ND	ND	-	2	-
				Tank 42	ND	ND	-	2	-
				Tank 44	ND	ND	-	2	-
	Ethylbenzene	USEPA Method 0030	mg/m^3	Tank 41	0.0037	0.0051	0.0024-0.0051	2	0.0019
				Tank 42	ND	ND	-	2	-
				Tank 44	ND	ND	-	2	-
	Styrene	USEPA Method 0030	mg/m^3	Tank 41	0.0029	0.0035	0.0024-0.0035	2	0.00081
				Tank 42	ND	ND	-	2	-
				Tank 44	ND	ND	-	2	-
	Toluene	USEPA Method 0030	mg/m^3	Tank 41	0.0059	0.0087	0.0031-0.0087	2	0.0040
				Tank 42	0.015	0.019	0.011-0.019	2	0.0057
				Tank 44	0.0043	0.0048	0.0038-0.0048	2	0.00071
	1,2,4 Trimethylbenzene	USEPA Method 0030	mg/m^3	Tank 41	ND	ND	-	2	-
				Tank 42	ND	ND	-	2	-
				Tank 44	ND	ND	-	2	-
	1,3,5 Trimethylbenzene	USEPA Method 0030	mg/m^3	Tank 41	ND	ND	-	2	-
				Tank 42	ND	ND	-	2	-
				Tank 44	ND	ND	-	2	-
	Xylenes	USEPA Method 0030	mg/m^3	Tank 41	ND	ND	-	2	-
				Tank 42	ND	ND	-	2	-
				Tank 44	ND	ND	-	2	-

5.9. Precipitation Cooling Towers (Building 45K)

Parts of the Bayer process require the cooling of hot caustic liquor, slurries, or calcined alumina. The cooling is undertaken by passing cooled water through non-contact (indirect) heat exchangers. The water that is used for process cooling gains heat and is returned (recirculated) to the cooling towers, where it is cooled again and re-used for process cooling.

The cooling towers are evaporative coolers which cool water to near ambient temperature. Some of the water fed to the cooling tower evaporates into the air (cooling the water in the process). The remaining water circulates through the tower and is used again for indirect cooling. Each evaporative cooling tower requires both make-up water to replace evaporating water, and a blowdown stream to limit the concentration of substances which can build up due to the recirculation of water within the tower. Volatile organic compounds in the make-up water that is fed to the cooling tower can be stripped into the cooling tower air and discharged to atmosphere.

Several cooling towers are in operation at Wagerup. The quality of the make-up water is considered to be a key determinant of emissions from cooling towers. Those cooling towers using Lower Dam water as make-up water and having significant flows (45K Cooling Towers 1, 2 & 3) were included as point sources for the emission inventory. Cooling Tower 45K2 was selected for sampling because it has sampling ports and safe access, and its emissions are assumed to be representative of other towers using Lower Dam make-up water.

Emissions from cooling towers at Buildings 25, 30, 110, 48, 47 and 984Y were considered to be insignificant because they are small and use Upper Dam[12] water as make-up water.

Data for the Calcination Cooling Towers is provided in **Section 5.16**. These cooling towers mostly use Upper Dam water as make-up water, but occasionally use Lower Dam water, and so have been included in the emission inventory with a factor applied to account for emissions only when Lower Dam water is used.

Emissions from the 45K Cooling Towers have proven difficult to characterise due to source characteristics (high moisture, low emission concentrations, non-ideal sample plane due to large diameter and proximity to flow disturbance) and methodology limitations. This has resulted in concerns about the reliability and credibility of the emission data for this source. A separate review of VOC emission estimates from the 45K cooling towers has been conducted (Alcoa, 2019). The approach outlined in this review has been applied in this Emission Inventory.

[12] The Upper Dam water source is 'fresh surface water' sourced from rainfall runoff and Yalup Brook. This is used predominantly as the Refinery potable water supply.

Ammonia emission rates from the Precipitation Cooling Towers have been calculated using a mass balance approach. **Table 24** sets out the calculation of water balance ammonia emission rates.

Figure 9: Precipitation Cooling Towers

Table 22: Precipitation Cooling Towers Source Information

Source Name	**Name**	Precipitation Cooling Towers		
	Abbreviation	45K1, 45K2, 45K3		
Physical Characteristics	**No. of Stacks**	3		
	Height (m)	45K1 45K2 45K3	9.0 17.5 17.5	
	Stack tip diameter (m)	45K1 45K2 45K3	7.25 7.32 7.32	
	Location (Easting & Northing)	45K1 45K2 45K3	398621.788 398642.938 398642.938	6357145.378 6357148.422 6357148.422
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics			**Average**	**Peak**
	Temp (°C)	45K1 45K2 45K3	49 49 49	49 49 49
	Exit velocity (m/s)	45K1 45K2 45K3	9.4 13 14	9.4 13 14
	Moisture content (%)	45K1 45K2 45K3	12 12 12	12 12 12
	Flow Rate (Dry Nm3/hr)	45K1 45K2 45K3	1045812 1509962 1550049	1045812 1509962 1550049
	Flow Rate (measured or calculated)	Calculated		
Emission Frequency	**Continuous / Intermittent**	Continuous when cooling towers operational		
Emission Control(s)		None		

Table 23: Emission Information for Precipitation Cooling Towers

Emission Sampling Period	2001-2007		**Comment**	All data is from 45K2.				
Gas Stream Characteristics	2018		**Assumptions**	45K1 and 45K3 have the same concentrations as 45K2.				
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	256	724	74-724	11	250
	Ammonia	USEPA CTM-027	Wet mg/m^3	0.34	0.36	0.32-0.36	3	0.021
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5 (ECS M6)	mg/m^3	ND	ND	-	44	-
	Acetone	USEPA Method 0030 (VOST)	mg/m^3	0.038	3.5	0.024-3.5	17	1.1
	Benzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	12	-
	2-butanone	USEPA Method 0030 (VOST)	mg/m^3	0.011	0.70	0.0040-0.70	12	0.20
	Formaldehyde	Modified USEPA MTO5 (ECS M6)	mg/m^3	0.26	0.58	0.20-0.58	44	0.11
	Naphthalene	USEPA Method 0030 (VOST)	mg/m^3	0.0032	0.016	0.0018-0.016	13	0.0039
	Ethylbenzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-
	Styrene	USEPA Method 0030 (VOST)	mg/m^3	0.0018	0.0080	0.0010-0.0080	13	0.0018
	Toluene	USEPA Method 0030 (VOST)	mg/m^3	0.0021	0.0090	0.0010-0.0090	13	0.0021
	1,2,4 Trimethylbenzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-
	1,3,5 Trimethylbenzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-
	Xylenes	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-

Table 24: Precipitation Cooling Towers: Ammonia water balance calculations

Sample date	Make-up Water Ammonia Concentration mg/L, g/kL	Make-up Water Flow kL/h	MASS IN Make-up water g/s	Blow-down Ammonia Concentration mg/L, g/kL	Blowdown Water Flow kL/h	MASS OUT Blowdown g/s	MASS OUT Ammonia Emission Rate to Air g/s	Estimated Cooling Tower Air Flow Wet Mm^3/h	Estimated Ammonia Air Emission Concentration Wet mg/m^3
26-Apr-17	13	132.2	**0.477**	5.9	20.0	**0.033**	**0.444**	4.679	0.342
26-Apr-17	13	132.2	**0.477**	2.4	20.0	**0.013**	**0.464**	4.679	0.357
1-May-17	12	138.3	**0.461**	9	20.0	**0.050**	**0.411**	4.679	0.316
Column **Calculation**	**A**	**B**	**C** (A x B) / 3600	**D**	**E**	**F** (D x E) / 3600	**G** C - F	**H**	**I** (G / H) x 3.6

5.10. Oxalate Kiln RTO Stack (Building 47)

The principle of Building 47 is to extract sodium oxalate from the spent liquor by a crystallisation and filtration process. Sodium oxalate is then transferred to the oxalate kiln for combustion, with gaseous vapours from the kiln process directed to a dedicated Regenerative Thermal Oxidiser (RTO) for treatment prior to being released into the atmosphere.

The oxalate kiln was recommissioned under works approval W4587/2009/1, with commissioning and verification conducted in 2012-2013. Data from the quarterly RTO stack testing since commissioning are included in the 2018 emission inventory.

Figure 10: Oxalate Kiln RTO Stack

Table 25: Oxalate Kiln Source Information

Source Name	**Name**	Oxalate Kiln	
	Abbreviation	Building 47	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	36.8	
	Stack tip diameter (m)	1.0	
	Location (Easting & Northing)	398224.93	6357607.97
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS	**CEMS 1**	Dust concentration monitor	
	Purpose	Indicative particulate concentration	
	CEMS 2	RTO temperature monitor	
	Purpose	Indicative of thermal destruction of VOCs	
	CEMS 3	CO monitor	
	Purpose	Indicative of thermal destruction of VOCs	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	101	130
	Exit velocity (m/s)	18	27
	Moisture content (%)	6.4	9.4
	Flow Rate (Dry Nm3/hr)	34650	46902
	Flow Rate (measured or calculated)	Measured	
Emission Frequency	**Continuous / Intermittent**	Continuous	While oxalate kiln operational
Emission Control(s)	**Control 1**	Regenerative thermal oxidiser (RTO)	
	Year of Installation	2012	
	Operating Strategy	Continuous	When oxalate kiln operational
	Purpose	Thermal destruction of VOCs	
	Control 2	Wet scrubber	
	Year of Installation	2012	
	Operating Strategy	Continuous	When oxalate kiln operational
	Purpose	Particulate removal	
	Control 3	Mercury treatment system	
	Year of Installation	2012	
	Operating Strategy	Continuous	When oxalate kiln operational
	Purpose	Reduction of mercury in kiln stack emissions	

Table 26: Emission Information for Oxalate kiln

Emission Sampling Period	Q4 2012 – 2018		**Comment**	Oxalate kiln was recommissioned with RTO in 2012.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	33	49	18-49	25	8.6
	CO	USEPA Method 10	mg/m^3	5.5	24	1.0-24	25	4.9
	SO_2	USEPA Method 6C	mg/m^3	2.6	20	1.0-20	25	4.2
Miscellaneous	Odour	AS 4323.3	$OU/wet/Nm^3$	828	6600	20-6600	25	1431
	Ammonia	Not characterised						
	Particulate	USEPA M5 or 17	mg/m^3	0.91	2.8	0.50-2.8	25	0.61
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	25	-
	Acetone	Modified USEPA MTO5	mg/m^3	0.46	4.9	0.045-4.9	25	1.1
	Benzene	USEPA M18 (tube)	mg/m^3	ND	ND	-	25	-
	2-butanone	Modified USEPA MTO5	mg/m^3	ND	ND	-	25	-
	Formaldehyde	Modified USEPA MTO5	mg/m^3	0.083	0.34	0.040-0.34	25	0.064
	Naphthalene	Not characterised						
	Ethylbenzene	Not characterised						
	Styrene	Not characterised						
	Toluene	Not characterised						
	1,2,4 Trimethylbenzene	Not characterised						
	1,3,5 Trimethylbenzene	Not characterised						
	Xylenes	Not characterised						

5.11. Oxalate Filter Press Building Stack

The oxalate filter press building stack receives all emissions from the oxalate filter press vacuum pumps. When the oxalate kiln RTO is online, emissions are drawn to the RTO, so there are no emissions from the filter press building stack.

The Oxalate filter press building stack has only been sampled once in 2017.

Assumptions:

Design specifications have been used for average and peak flow rates. A factor of 32% has been applied to the average flow rate to account for the time when the oxalate kiln RTO was offline (hence gases were being directed to the filter press building stack).

Figure 11: Oxalate filter press building stack (47K1)

Table 27: Oxalate filter press building stack Source Information

Source Name	**Name**	Oxalate filter press building stack	
	Abbreviation	47K1	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	35.0	
	Stack tip diameter (m)	0.84	
	Location (Easting & Northing)	398248.76	6357605.82
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		No	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	52	52
	Exit velocity (m/s)	3.2	13.1
	Moisture content (%)	8.8	8.8
	Flow Rate (Dry Nm3/hr)	4838	20000
	Flow Rate (measured or calculated)	Measured	
Emission Frequency	**Continuous / Intermittent**	Intermittent	When RTO offline
Emission Control(s)		None	

Table 28: Emission Information for Oxalate filter press building stack

Emission Sampling Period	2017		**Comment**					
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS 4323.3	OU/wet/Nm^3	960	1100	830-1100	2	191
	Ammonia	Ektimo (ETC) 330	mg/m^3	37	42	32-42	2	7.1
	Particulate	Not characterised						
VOCs	Acetaldehyde	Ektimo (ETC) 390	mg/m^3	0.34	0.40	0.28-0.40	2	0.085
	Acetone	Ektimo (ETC) 390	mg/m^3	5.4	5.9	4.8-5.9	2	0.78
	Benzene	Not characterised	mg/m^3					
	2-butanone	Ektimo (ETC) 390	mg/m^3	0.50	0.55	0.44-0.55	2	0.078
	Formaldehyde	Ektimo (ETC) 390	mg/m^3	ND	ND	-	2	-
	Naphthalene	Not characterised						
	Ethylbenzene	USEPA M18	mg/m^3	0.019	0.023	0.015-0.023	2	0.0057
	Styrene	Not characterised						
	Toluene	USEPA M18	mg/m^3	0.047	0.047	0.046-0.047	2	0.00071
	1,2,4 Trimethylbenzene	Not characterised						
	1,3,5 Trimethylbenzene	Not characterised						
	Xylenes	USEPA M18	mg/m^3	ND	ND	-	2	-

5.12. Liquor Burner (Building 48)

At Wagerup Refinery the Liquor Burner is required to control the build-up of organic compounds in recirculating process liquor. These compounds originate from organic material in bauxite and, once formed, reduce the precipitation of aluminium trihydrate from liquor. This reduces plant yield, so the alumina production process becomes inefficient.

The Liquor Burner kiln gases report to an Electrostatic Precipitator (ESP), dehumidifier and RTO for particulate and VOC treatment prior to release through the Liquor Burner stack. The Liquor Burner RTO was commissioned in August 2006. Concentration and mass emission data in the inventory include data collected from Q4 2006 to 2018 as data collected prior to this are not considered representative of current emissions.

Emissions from the Liquor Burner are vented from an individual stack contained in the multi-flue[13]. The Liquor Burner is monitored quarterly under the environmental licence L6217/1983.

Figure 12: (a) Liquor burner stack (in multi-flue) and (b) Liquor burner sampling point

[13] The multi-flue consists of five individual stacks: one for each of the three Calciners, one for the Liquor Burner and one for Calciner 1-3 Low Volume Vent emissions.

Table 29: Liquor Burner Stack (Building 48) Source Information

Source Name	**Name**	Liquor Burning	
	Abbreviation	Building 48	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	100	
	Stack tip diameter (m)	1.1	
	Location (Northing & Easting)	398,317.940	6,357,200.422
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
	CEMS 1	Dust Concentration Monitor	
	Purpose	Indicative particulate concentration	
	CEMS 2	RTO temperature	
	Purpose	Indicative of thermal destruction of VOCs	
	CEMS 3	CO Monitor	
	Purpose	Indicative of thermal destruction of VOCs	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	47	67
	Exit velocity (m/s)	19	29
	Moisture content (%)	5.2	7.6
	Flow Rate (Dry Nm3/hr)	52477	73672
	Flow Rate (measured or calculated)	Calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous	When liquor burning kiln operational
Emission Control(s)	**Control 1**	Regenerative Thermal Oxidiser (RTO)	
	Year of Installation	2006	
	Operating Strategy	Continuous	When liquor burning kiln operational
	Purpose	Thermal destruction of VOCs and CO	
	Control 2	Dehumidifier	
	Year of Installation	2001	
	Operating Strategy	Continuous	When liquor burning kiln operational
	Purpose	Particulate removal	
	Control 3	Electrostatic precipitator	
	Year of Installation	1996	
	Operating Strategy	Continuous	When liquor burning kiln operational
	Purpose	Particulate removal	

Table 30: Emission Information for Liquor Burner Stack

Emission Sampling Period	Q4 2006 to 2018		**Comment**	Data collected prior to RTO installation has been excluded since it is not indicative of current emissions.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	138	259	46-259	48	40
	CO	USEPA Method 10	mg/m^3	15	61	2.5-61	48	12
	SO_2	USEPA Method 6C	mg/m^3	1.6	11	1.0-11	48	1.5
Miscellaneous	Odour	AS4323.3	$OU/wet/Nm^3$	3247	13700	474-13700	60	2817
	Ammonia	ECS Method 1.0	mg/m^3	0.50	1.1	0.045-1.1	9	0.33
	Particulate	USEPA M5 or 17	mg/m^3	1.7	5.9	0.37- 5.9	48	1.3
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	0.16	1.9	0.050-1.9	48	0.26
	Acetone	Modified USEPA MTO5	mg/m^3	0.85	21	0.050-21	46	3.2
	Benzene	USEPA M18 (tube)	mg/m^3	0.074	0.26	0.0050 – 0.26	48	0.053
	2-butanone	Modified USEPA MTO5	mg/m^3	0.12	0.54	0.050 – 0.54	48	0.087
	Formaldehyde	Modified USEPA MTO5	mg/m^3	0.17	1.2	0.050 – 1.2	48	0.18
	Naphthalene	USEPA M18	mg/m^3	0.013	0.034	0.0035-0.034	12	0.013
	Ethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	Styrene	USEPA M18	mg/m^3	ND	ND	-	12	-
	Toluene	USEPA M18	mg/m^3	0.015	0.036	0.0036-0.036	12	0.013
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	Xylenes	USEPA M18	mg/m^3	0.0057	0.0090	0.0048-0.0090	12	0.0016

5.13. Liquor Burning Slurry Mixing Tank (48A Tank)

The 48A Slurry Mixing Tank is a small enclosed vessel with a single vent. It is a flat-bottomed steel tank with an agitator inside. This was identified as a potential emission source in 2013, and sampling was performed in 2014.

Very low flow rates were recorded for this emission source, some below the detection limit of the method. For flow rates below the detection limit, the detection limit was used.

Assumptions:

The 48A tank has only been sampled once, so it has been assumed that the peak flow is the same as the average.

Figure 13: Liquor Burning Slurry Mixing Tank (48A)

Table 31: Liquor Burning Slurry Mixing Tank Exhaust Source Information

Source Name	**Name**	Liquor Burning Slurry Mixing Tank	
	Abbreviation	48A	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	9.5	
	Stack tip diameter (m)	0.30	
	Location (Easting & Northing)	398276.5	6357160.2
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		No	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	75	75
	Exit velocity (m/s)	<2	<2
	Moisture content (%)	35	35
	Flow Rate (Dry Nm3/hr)	<240	<240
	Flow Rate (measured or calculated)	Measured	
Emission Frequency	**Continuous / Intermittent**	Continuous	
Emission Control(s)		None	

Table 32: Emission Information for Liquor Burning Slurry Mixing Tank Exhaust

Emission Sampling Period	2014		**Comment**					
Gas Stream Characteristics	2014		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	6800	6800	6800-6800	2	0
	Ammonia	Not characterised						
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	1.4	1.4	1.4-1.4	2	0.0
	Acetone	Modified USEPA MTO5	mg/m^3	15	16	14-16	2	1.4
	Benzene	USEPA M18 (tube)	mg/m^3	0.60	0.61	0.58-0.61	2	0.021
	2-butanone	Modified USEPA MTO5	mg/m^3	5.3	5.7	4.9-5.7	2	0.57
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	2	-
	Naphthalene	Not characterised						
	Ethylbenzene	Not characterised						
	Styrene	Not characterised						
	Toluene	Not characterised						
	1,2,4 Trimethylbenzene	Not characterised						
	1,3,5 Trimethylbenzene	Not characterised						
	Xylenes	Not characterised						

5.14. Calciners (Building 50)

Calcination is a dehydration step involving conversion of aluminium trihydrate ($Al_2O_3.3H_2O$) to alumina (Al_2O_3). This is done by heating the hydrate in a fluidised bed furnace at approximately 1000°C to drive off the water of crystallisation to form alumina.

Four calciners were in operation in 2018. The emissions from Calciners 1, 2 and 3 are vented from individual stacks contained in the multi-flue[14]. The emissions from Calciner 4 are vented from a stand-alone stack.

Calciners are monitored quarterly under the environmental licence L6217/1983 and data have been included in the 2018 updated emission inventory.

Odour emissions from calcination were treated slightly differently to other sources. A summary is provided in **Section 5.14.1**.

Assumptions:

For ammonia and naphthalene, Calciner 3 concentration data was used for all calciners. For ethylbenzene, styrene, toluene, xylenes, 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene, Calciner 3 concentration data was used for Calciners 1 and 2.

Figure 14: (a) Calciner 1-3 multi-flue stack and (b) Calciner 4 stack

[14] The multi-flue consists of five individual stacks: one for each of the three Calciners, one for the Liquor Burner and one for Calciner 1-3 Low Volume Vent emissions.

Table 33: Calciner 1 Source Information

Source Name	**Name**	Calciner 1	
	Abbreviation	50-1	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	100	
	Stack tip diameter (m)	1.90	
	Location (Easting & Northing)	398317.940	6357200.422
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS	**CEMS 1**	Dust concentration monitor	
	Purpose	Indicator of particulate concentration	
	CEMS 2	Furnace temperature monitor	
	Purpose	Indicator of VOC destruction	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	172	187
	Exit velocity (m/s)	20	29
	Moisture content (%)	50	57
	Flow Rate (Dry Nm3/hr)	64625	75418
	Flow Rate (measured or calculated)	Calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous	
Emission Control(s)	**Control 1**	100m multi-flue stack	
	Year of Installation	2002	
	Operating Strategy	Continuous	When calciner operational
	Purpose	Improved dispersion of calciner emissions	
	Control 2	Electrostatic precipitator	
	Year of Installation	1984	
	Operating Strategy	Continuous	When calciner operational
	Purpose	Particulate removal	

Table 34: Calciner 2 Source Information

Source Name	**Name**	Calciner 2	
	Abbreviation	50-2	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	100	
	Stack tip diameter (m)	1.90	
	Location (Easting & Northing)	398317.940	6357200.422
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS	**CEMS 1**	Dust concentration monitor	
	Purpose	Indicator of particulate concentration	
	CEMS 2	Furnace temperature monitor	
	Purpose	Indicator of VOC destruction	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	180	198
	Exit velocity (m/s)	22	31
	Moisture content (%)	49	56
	Flow Rate (Dry Nm3/hr)	68141	80859
	Flow Rate (measured or calculated)	Calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous	
Emission Control(s)	**Control 1**	100m multi-flue stack	
	Year of Installation	2002	
	Operating Strategy	Continuous	When calciner operational
	Purpose	Improved dispersion of calciner emissions	
	Control 2	Electrostatic precipitator	
	Year of Installation	1984	
	Operating Strategy	Continuous	When calciner operational
	Purpose	Particulate removal	

Table 35: Calciner 3 Source Information

Source Name	**Name**	Calciner 3	
	Abbreviation	50-3	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	100	
	Stack tip diameter (m)	2.15	
	Location (Easting & Northing)	398317.940	6357200.422
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS	**CEMS 1**	Dust concentration monitor	
	Purpose	Indicator of particulate concentration	
	CEMS 2	Furnace temperature monitor	
	Purpose	Indicator of VOC destruction	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	213	220
	Exit velocity (m/s)	23	30
	Moisture content (%)	40	46
	Flow Rate (Dry Nm3/hr)	98733	117000
	Flow Rate (measured or calculated)	Calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous	
Emission Control(s)	**Control 1**	100m multi-flue stack	
	Year of Installation	2002	
	Operating Strategy	Continuous	When calciner operational
	Purpose	Improved dispersion of calciner emissions	
	Control 2	Electrostatic precipitator	
	Year of Installation		
	Operating Strategy	Continuous	When calciner operational
	Purpose	Particulate removal	

Table 36: Calciner 4 Source Information

Source Name	**Name**	Calciner 4	
	Abbreviation	50-4	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	48.8	
	Stack tip diameter (m)	2.35	
	Location (Easting & Northing)	398396.031	6357099.742
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS	**CEMS 1**	Dust concentration monitor	
	Purpose	Indicator of particulate concentration	
	CEMS 2	Furnace temperature monitor	
	Purpose	Indicator of VOC destruction	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	150	169
	Exit velocity (m/s)	22	30
	Moisture content (%)	47	55
	Flow Rate (Dry Nm3/hr)	116528	132738
	Flow Rate (measured or calculated)	Calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous	
Emission Control(s)	**Control 1**	Electrostatic precipitator	
	Year of Installation		
	Operating Strategy	Continuous	When calciner operational
	Purpose	Particulate removal	

Table 37: Emission Information for Calciner 1 Stack

Emission Sampling Period	2002-2018		**Comment**	Most data are from 2005-2018. For compounds not measured in regular compliance sampling, data dates to 2002. Ammonia, naphthalene, ethylbenzene, styrene, toluene, xylenes,1,2,4-trimethylbenzene and 1,3,5 trimethylbenzene data are from Calciner 3.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	95	398	8.0-398	63	48
	CO	USEPA Method 10	mg/m^3	160	653	15-653	63	98
	SO_2	USEPA Method 6C	mg/m^3	7.1	66	1.0-66	62	10
Miscellaneous	Ammonia	ECS Method 1.0	mg/m^3	2.7	5.3	0.40-5.3	16	1.3
	Particulate	USEPA M5 or 17	mg/m^3	33	72	4.8-72	63	19
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	4.0	10	0.19-10	63	1.5
	Acetone	Modified USEPA MTO5	mg/m^3	2.0	10	0.16-10	62	1.4
	Benzene	USEPA M18 (tube)	mg/m^3	0.27	1.0	0.0012-1.0	63	0.18
	2-butanone	Modified USEPA MTO5	mg/m^3	0.19	0.80	0.050-0.80	63	0.11
	Formaldehyde	Modified USEPA MTO5	mg/m^3	4.5	17	0.19-17	63	2.6
	Naphthalene	USEPA M18	mg/m^3	0.012	0.045	0.0024-0.045	12	0.016
	Ethylbenzene	USEPA M18	mg/m^3	0.0041	0.0080	0.0024-0.0080	12	0.0019
	Styrene	USEPA M18	mg/m^3	0.0071	0.017	0.0036-0.017	12	0.0049
	Toluene	USEPA M18	mg/m^3	0.029	0.086	0.0036-0.086	12	0.030
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	Xylenes	USEPA M18	mg/m^3	0.018	0.045	0.0050-0.045	12	0.014

Table 38: Emission Information for Calciner 2 Stack

Emission Sampling Period	2002-2018		**Comment**	Most data are from 2005-2018. For compounds not measured in regular compliance sampling, data dates to 2002. Ammonia, naphthalene, ethylbenzene, styrene, toluene, xylenes, 1,2,4-trimethylbenzene and 1,3,5-trimethylbenzene data are from Calciner 3.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	89	163	19-163	63	30
	CO	USEPA Method 10	mg/m^3	151	910	10-910	63	134
	SO_2	USEPA Method 6C	mg/m^3	4.5	49	1.0-49	62	7.6
Miscellaneous	Ammonia	ECS Method 1.0	mg/m^3	2.7	5.3	0.40-5.3	16	1.3
	Particulate	USEPA M5 or 17	mg/m^3	34	80	5.2-80	63	18
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	3.8	10	0.19-10	63	1.5
	Acetone	Modified USEPA MTO5	mg/m^3	1.8	9.9	0.050-9.9	62	1.4
	Benzene	USEPA M18 (tube)	mg/m^3	0.25	1.4	0.021-1.4	62	0.19
	2-butanone	Modified USEPA MTO5	mg/m^3	0.20	1.5	0.050-1.5	63	0.19
	Formaldehyde	Modified USEPA MTO5	mg/m^3	4.8	16	0.19-16	63	2.9
	Naphthalene	USEPA M18	mg/m^3	0.012	0.045	0.0024-0.045	12	0.016
	Ethylbenzene	USEPA M18	mg/m^3	0.0041	0.0080	0.0024-0.0080	12	0.0019
	Styrene	USEPA M18	mg/m^3	0.0071	0.017	0.0036-0.017	12	0.0049
	Toluene	USEPA M18	mg/m^3	0.029	0.086	0.0036-0.086	12	0.030
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	Xylenes	USEPA M18	mg/m^3	0.018	0.045	0.0050-0.045	12	0.014

Table 39: Emission Information for Calciner 3 Stack

Emission Sampling Period	2002-2018		**Comment**	Most data are from 2005-2018. For compounds not measured in regular compliance sampling, data dates to 2002.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	122	289	47-289	63	46
	CO	USEPA Method 10	mg/m^3	43	100	0.60-100	63	21
	SO_2	USEPA Method 6C	mg/m^3	3.5	40	1.0-40	62	5.8
Miscellaneous	Ammonia	ECS Method 1.0	mg/m^3	2.7	5.3	0.40-5.3	16	1.3
	Particulate	USEPA M5 or 17	mg/m^3	20	59	4.6-59	63	11
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	2.8	14	0.19-14	75	1.7
	Acetone	Modified USEPA MTO5	mg/m^3	1.3	11	0.050-11	75	1.3
	Benzene	USEPA M18 (tube)	mg/m^3	0.14	0.92	0.0036-0.92	73	0.14
	2-butanone	Modified USEPA MTO5	mg/m^3	0.16	0.62	0.050-0.62	75	0.084
	Formaldehyde	Modified USEPA MTO5	mg/m^3	2.9	16	0.19-16	75	2.1
	Naphthalene	USEPA M18	mg/m^3	0.012	0.045	0.0024-0.045	12	0.016
	Ethylbenzene	USEPA M18	mg/m^3	0.0041	0.0080	0.0024-0.0080	12	0.0019
	Styrene	USEPA M18	mg/m^3	0.0071	0.017	0.0036-0.017	12	0.0049
	Toluene	USEPA M18	mg/m^3	0.029	0.086	0.0036-0.086	12	0.030
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	12	-
	Xylenes	USEPA M18	mg/m^3	0.018	0.045	0.0050-0.045	12	0.014

Table 40: Emission Information for Calciner 4 Stack

Emission Sampling Period	2002-2018		**Comment**	Most data are from 2005-2018. For compounds not measured in regular compliance sampling, data dates to 2002. Ammonia and naphthalene data are from Calciner 3.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	124	270	25-270	63	61
	CO	USEPA Method 10	mg/m^3	188	870	3.8-870	63	172
	SO_2	USEPA Method 6C	mg/m^3	3.1	24	1.0-24	62	3.9
Miscellaneous	Ammonia	ECS Method 1.0	mg/m^3	2.7	5.3	0.40-5.3	16	1.3
	Particulate	USEPA M5 or 17	mg/m^3	29	79	3.8-79	63	18
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	3.2	6.7	0.19-6.7	63	1.4
	Acetone	Modified USEPA MTO5	mg/m^3	2.0	11	0.075-11	62	1.7
	Benzene	USEPA M18 (tube)	mg/m^3	0.21	0.42	0.0050-0.42	63	0.11
	2-butanone	Modified USEPA MTO5	mg/m^3	0.16	0.50	0.050-0.50	63	0.087
	Formaldehyde	Modified USEPA MTO5	mg/m^3	4.7	14	0.30-14	63	2.8
	Naphthalene	USEPA M18	mg/m^3	0.012	0.045	0.0024-0.045	12	0.016
	Ethylbenzene	USEPA M18	mg/m^3	0.0083	0.020	0.0025-0.020	3	0.010
	Styrene	USEPA M18	mg/m^3	0.0090	0.020	0.0-0.020	5	0.010
	Toluene	USEPA M18	mg/m^3	0.10	0.10	0.090-0.10	2	0.0071
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	0.0024	0.0070	0.0-0.0070	5	0.0029
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	5	-
	Xylenes	USEPA M18	mg/m^3	0.033	0.050	0.015-0.050	2	0.025

5.14.1. Calcination Odour Emissions

Average annual odour concentrations measured in Calcination are shown in **Figure 15**. The trends show that there has been a significant reduction in average calciner odour emissions since 2010. To ensure that the emission inventory is representative of current refinery conditions, data from 2010-2018 have been used to determine peak and average odour emission rates from the calciners.

The approach for determining emission rates set out in **Section 4.3** is believed to present an unrealistically high peak for odour concentration from the calciners. To address this, calcination odour emissions have been determined using measured emission rates (i.e. concentration multiplied by the flow rate measured at the time of sampling) rather than average and peak measured concentrations multiplied by the calculated average and peak flow rates.

Odour emission rates for each of the calciners are presented in **Table 41**.

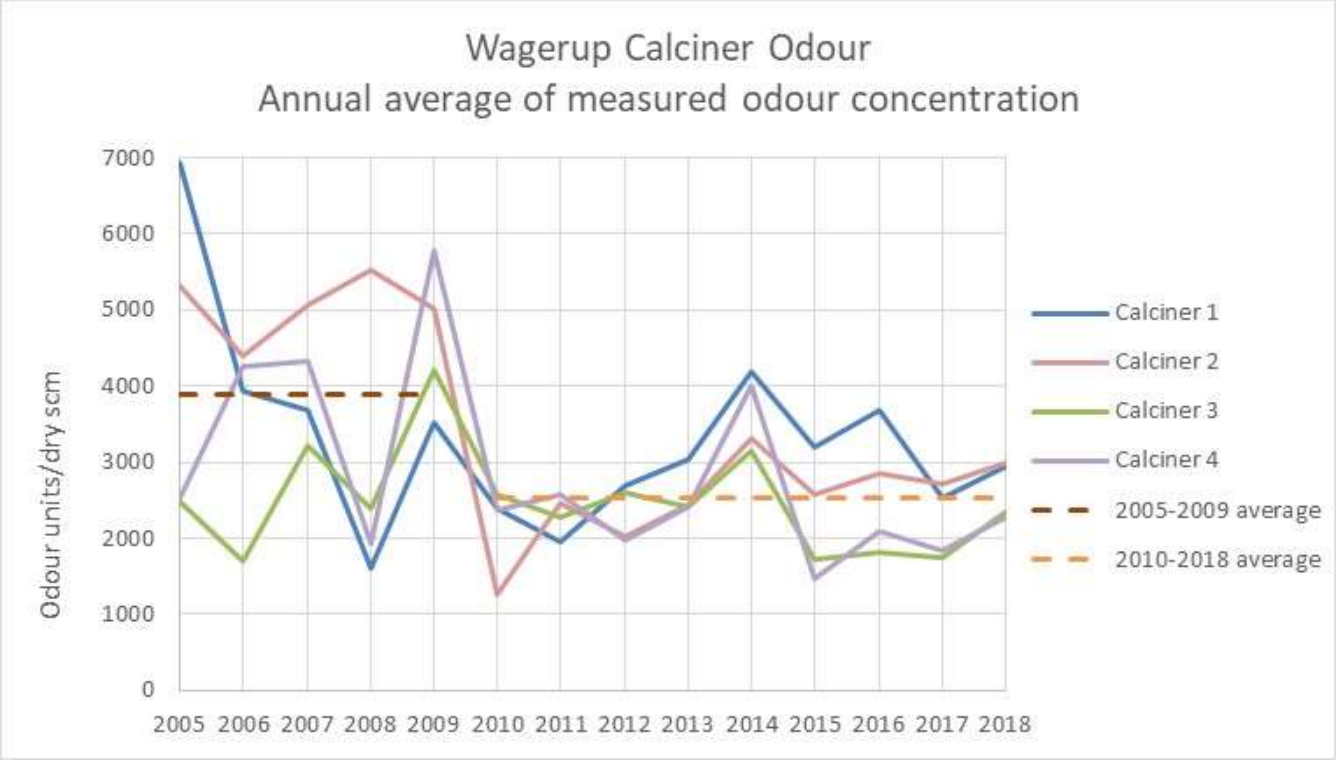

Figure 15: Calcination odour concentration trends 2005-2018

Table 41: Calcination odour emission rates

Emission Sampling Period	2010-2018		Comment	Average and peak values were determined using measured odour emission rates.				
Source	**Compound**	**Method**	**Unit**	**Emission rate (ave)**	**Emission rate (peak)**	**Emission rate Range**	**No. Data points**	**Standard Deviation**
Calciner 1	Odour	AS4323.3	OU/s	118302	330000	12000-330000	36	70656
Calciner 2	Odour	AS4323.3	OU/s	99559	210000	13500-210000	36	57064
Calciner 3	Odour	AS4323.3	OU/s	98636	274000	10900-274000	36	55804
Calciner 4	Odour	AS4323.3	OU/s	150455	307000	14900-307000	36	73187

5.15. Calciner Low Flow Emissions

Calciner feed (alumina trihydrate ($Al_2O_3.H_2O$)) is washed on vacuum filters to reduce entrained caustic. The calciner low flow emissions consist of the 50B tank vents, hood collection vents from the Dorrco horizontal pan filters, and the pan filter vacuum pump discharges. The purpose of each of these is outlined below:

- The 50B tank supplies wash water to the pan filters.
- The filter hoods collect steam coming off the pan filters and these emissions are vented to the atmosphere. The venting reduces the steam vapours in the vicinity of the filters. The Calciner 1-3 pan filter vents were measured in 2017 and found to be significant.
- The pan filter vacuum pumps are used to pull spent liquor and wash waste from the hydrate filter cake. This collected liquid is hot and some of the water vaporizes from the liquid and is pulled though the vacuum pump. In addition to the water vapour, some of the organics in the liquor are also vaporized and pulled through the vacuum pump. These organics are a significant emission source. The vacuum exhaust is collected and emitted to air.

Four calciners, each with its own vacuum pumps, are in operation at Wagerup Refinery. The vacuum exhaust emissions from Calciners 1, 2 and 3, the 50B tank and the Dorrco filter hoods were combined and emitted from a single vent within the multi-flue (via the Low Volume Vent (LVV)). In 2013 a works approval was issued by the DER (W5391/2013) in which construction was approved to redirect the emissions from the LVV to Calciners 1 – 3 for combustion. This project was completed in 2015 and the environmental licence (L6217/1983) amended accordingly. The 2018 emission inventory has been updated to reflect the changes in emissions.

Flow measurements for the LVV are taken from the duct exiting the 50B condensate tank. All other sampling is performed from the multi-flue sampling location.

The vacuum exhaust emissions from Calciner 4 are vented to air via its own 41.7m high stack and the vacuum pump and Dorrco filter stack were included in the 2010 model. Both stacks for Calciner 4 were discussed during the 2013 workshops, though there were no visual emissions from the filter stack during the workshop (this is considered normal by operating centre personnel).

Data documented in the 2012 inventory for both the Calciner 4 vacuum exhaust emissions and the extraction hoods were re-evaluated in 2014 with measurements undertaken.

Very low flow rates were recorded for the Calciner 4 extraction hoods, below the detection limit of the method. The detection limit was used in this case.

Assumptions:

For the Calciner 1,2,3 pan filter exhaust vent flows, it has been assumed that there are three pan filters online for the average case, and five pan filters online for the peak case

Figure 16: Calcination multi-flue stack (includes Calciner 1-3 LVV)

Figure 17: 50B Tank

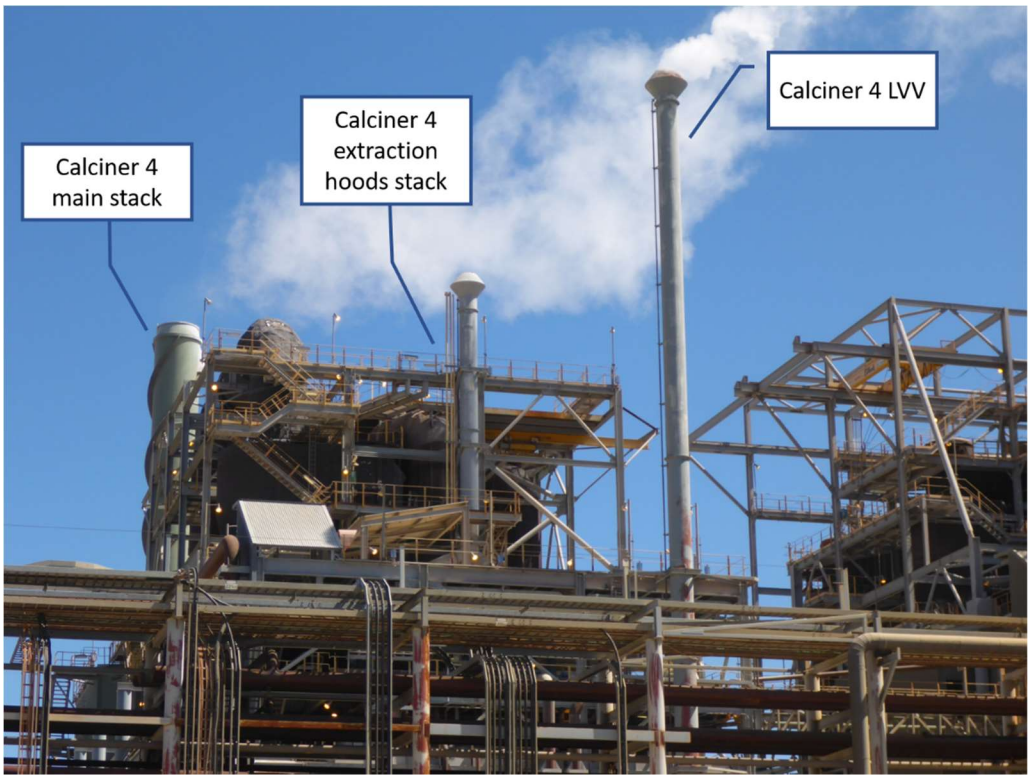

Figure 18: Calciner 4 stacks

Table 42: Calciner 1-3 Low Volume Vent Stack Source Information

Source Name	**Name**	Calciner 1-3 Low Volume Vent Stack	
	Abbreviation	Cal 1-3 LVV	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	100	
	Stack tip diameter (m)	0.925	
	Location (Easting & Northing)	398317.940	6357200.422
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source			
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	95	103
	Exit velocity (m/s)	13	33
	Moisture content (%)	42	61
	Flow Rate (Dry Nm3/hr)	1841	3132
	Flow Rate (measured or calculated)	Measured	
Emission Frequency	**Continuous / Intermittent**	Continuous	
Emission Control(s)	**Control 1**	VOC emission reduction system	
	Year of Installation	2015	
	Operating Strategy	Continuous	95% availability target
	Purpose	Reduction of VOC emissions	

Table 43: Emission Information for Calciner 1-3 Low Volume Vent Stack

Emission Sampling Period	2002-2018		**Comment**	Most data are from Q4 2014 – 2018, after the 2014 VOC emission reduction project was commissioned. For compounds not measured after 2014 historic data has been used.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA M7E	mg/m^3	1.7	3.5	1.5-3.5	16	0.48
	CO	USEPA M10	mg/m^3	ND	ND	-	16	-
	SO_2	USEPA M6C	mg/m^3	ND	ND	-	16	-
Miscellaneous	Odour	AS4323.3	$OU/wet/Nm^3$	6520	18000	1100-18000	30	4449
	Ammonia	Not characterised						
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	6.4	20	0.52-20	30	5.7
	Acetone	Modified USEPA MTO5	mg/m^3	40	180	2.5-180	30	43
	Benzene	USEPA M18 (tube)	mg/m^3	0.0088	0.037	0.0034-0.037	30	0.0076
	2-butanone	Modified USEPA MTO5	mg/m^3	3.0	10	0.050-10	30	3.1
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	30	-
	Naphthalene	Not characterised						
	Ethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Styrene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Toluene	USEPA M18	mg/m^3	5.1	10	0.10-10	2	7.0
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Xylenes	USEPA M18	mg/m^3	2.3	2.3	2.3	1	-

Table 44: Calciner 4 Low Volume Vent Stack Source Information

Source Name	**Name**	Calciner 4 Low Volume Vent	
	Abbreviation	Cal 4 LVV	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	41.7	
	Stack tip diameter (m)	0.89	
	Location (Easting & Northing)	398384.0	6357161.3
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		No	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	68	68
	Exit velocity (m/s)	5.5	5.5
	Moisture content (%)	24	24
	Flow Rate (Dry Nm3/hr)	7800	7800
	Flow Rate (measured or calculated)	Measured	
Emission Frequency	**Continuous / Intermittent**	Continuous	
Emission Control(s)		None	

Table 45: Emission Information for Calciner 4 Low Volume Vent Stack

Emission Sampling Period	2014		**Comment**					
Gas Stream Characteristics	2014		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	1800	1900	1700-1900	2	141
	Ammonia	Not characterised						
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	3.3	3.4	3.1-3.4	2	0.21
	Acetone	Modified USEPA MTO5	mg/m^3	25	27	23-27	2	2.8
	Benzene	USEPA M18 (tube)	mg/m^3	ND	ND	-	2	-
	2-butanone	Modified USEPA MTO5	mg/m^3	3.8	4.0	3.6-4.0	2	0.28
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	2	-
	Naphthalene	Not characterised						
	Ethylbenzene	Not characterised						
	Styrene	Not characterised						
	Toluene	Not characterised						
	1,2,4 Trimethylbenzene	Not characterised						
	1,3,5 Trimethylbenzene	Not characterised						
	Xylenes	Not characterised						

Table 46: Calciner 1,2,3 Pan Filters Exhaust Vents Source Information

Source Name	**Name**	Calciner 1,2,3 Pan Filters Exhaust Vents	
	Abbreviation	50 Pan Filter Vents	
Physical Characteristics	**No. of Stacks**	5	
	Height (m)	20.1	
	Stack tip diameter (m)	0.31	
	Location (Easting & Northing)	398316.05	6357142.25
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		No	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	71	71
	Exit velocity (m/s)	6.2	6.2
	Moisture content (%)	32	32
	Flow Rate (Dry Nm3/hr)	3420	5700
	Flow Rate (measured or calculated)	Measured	
Emission Frequency	**Continuous / Intermittent**	Continuous	When pan filters online
Emission Control(s)		None	

Table 47: Emission Information for Calciner 1,2,3 Pan Filters Exhaust Vents

Emission Sampling Period	2017		**Comment**					
Gas Stream Characteristics	2017		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	4400	4600	4200-4600	2	283
	Ammonia	Not characterised						
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	11	11	10-11	2	0.71
	Acetone	Modified USEPA MTO5	mg/m^3	39	42	36-42	2	4.2
	Benzene	USEPA M18 (tube)	mg/m^3	ND	ND	-	2	-
	2-butanone	Modified USEPA MTO5	mg/m^3	5.3	5.4	5.1-5.4	2	0.21
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	2	-
	Naphthalene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Ethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Styrene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Toluene	USEPA M18	mg/m^3	0.057	0.063	0.051-0.063	2	0.0085
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Xylenes	USEPA M18	mg/m^3	ND	ND	-	2	-

Table 48: Calciner 4 Extraction Hoods Source Information

Source Name	**Name**	Calciner 4 Extraction Hoods	
	Abbreviation		
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	37.8	
	Stack tip diameter (m)	0.88	
	Location (Easting & Northing)	398388.6	6357145.3
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		No	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	24	24
	Exit velocity (m/s)	<2	<2
	Moisture content (%)	1.3	1.3
	Flow Rate (Dry Nm3/hr)	<4200	<4200
	Flow Rate (measured or calculated)	Measured	
Emission Frequency	**Continuous / Intermittent**	Continuous	When Calciner 4 online
Emission Control(s)		None	

Table 49: Emission Information for Calciner 4 Extraction Hoods

Emission Sampling Period	2014		**Comment**					
Gas Stream Characteristics	2014		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	610	640	590-640	2	35
	Ammonia	Not characterised						
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	2	-
	Acetone	Modified USEPA MTO5	mg/m^3	2.1	2.2	1.9-2.2	2	0.21
	Benzene	USEPA M18 (tube)	mg/m^3	ND	ND	-	2	-
	2-butanone	Modified USEPA MTO5	mg/m^3	0.26	0.26	0.25-0.26	2	0.0071
	Formaldehyde	Modified USEPA MTO5	mg/m^3	ND	ND	-	2	-
	Naphthalene	Not characterised						
	Ethylbenzene	Not characterised						
	Styrene	Not characterised						
	Toluene	Not characterised						
	1,2,4 Trimethylbenzene	Not characterised						
	1,3,5 Trimethylbenzene	Not characterised						
	Xylenes	Not characterised						

5.16. Calcination Cooling Towers (Building 50)

A description of cooling towers at Wagerup Refinery is provided in **Section 5.9**.

The Calcination Cooling Towers use mostly Upper Dam water as make-up water, so emissions from this source are not expected to be significant. There are occasions when Lower Dam water is used, so a factor has been applied to the flow data to allow for this. In 2018, Lower Dam water was used for 1.9% of the time, so a factor of 1.9% has been applied to the average source flow rate.

Assumptions:

This source has never been measured, so it has been assumed that the concentration is the same as the Precipitation Cooling Towers 45K2 and 45K3 (see **Section 5.9**).

Figure 19: Calcination cooling towers

Table 50: 50 Cooling Towers Source Information

Source Name	**Name**	50 Cooling Tower 1 & 2		
	Abbreviation	50 CT1 & 50 CT2		
Physical Characteristics	**No. of Stacks**	2		
	Height (m)	4.9		
	Stack tip diameter (m)	3.0		
	Location (Easting & Northing)	CT1	398356.326	6357195.000
		CT2	398356.155	6357195.000
	Single/Multi-flue	Single		
	Sample Plane (Ideal/Non-ideal)	Non-ideal		
	Source Type (Point/ volume/ Area)	Point		
Regulated Source		No		
CEMS		None		
Gas Stream Characteristics		**Average**		**Peak**
	Temp (°C)	57		57
	Exit velocity (m/s)	0.16		8.6
	Moisture content (%)	17		17
	Flow Rate (Dry Nm3/hr)	2824		148643
	Flow Rate (measured or calculated)	Calculated		
Emission Frequency	**Continuous / Intermittent**	Continuous		
Emission Control(s)		None		

Table 51: Emission Information for 50 Cooling Tower 1 & 2 Stacks

Emission Sampling Period	2001-2007		**Comment**	No data is available for 50 Cooling Towers, so 45K Cooling Tower data has been used.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Miscellaneous	Odour	AS4323.3	OU/wet/Nm^3	256	724	74-724	11	250
	Ammonia	USEPA CTM-027	Wet mg/m^3	0.34	0.36	0.32-0.36	3	0.021
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5 (ECS M6)	mg/m^3	ND	ND	-	44	-
	Acetone	USEPA Method 0030 (VOST)	mg/m^3	0.038	3.5	0.024-3.5	17	1.1
	Benzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	12	-
	2-butanone	USEPA Method 0030 (VOST)	mg/m^3	0.011	0.70	0.0040-0.70	12	0.20
	Formaldehyde	Modified USEPA MTO5 (ECS M6)	mg/m^3	0.26	0.58	0.20-0.58	44	0.11
	Naphthalene	USEPA Method 0030 (VOST)	mg/m^3	0.0032	0.016	0.0018-0.016	13	0.0039
	Ethylbenzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-
	Styrene	USEPA Method 0030 (VOST)	mg/m^3	0.0018	0.0080	0.0010-0.0080	13	0.0018
	Toluene	USEPA Method 0030 (VOST)	mg/m^3	0.0021	0.0090	0.0010-0.0090	13	0.0021
	1,2,4 Trimethylbenzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-
	1,3,5 Trimethylbenzene	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-
	Xylenes	USEPA Method 0030 (VOST)	mg/m^3	ND	ND	-	11	-

5.17. Boilers (Building 110)

The Wagerup powerhouse generates electricity and process steam (for process heating and generation of electricity) for the refining process by means of natural gas fired boilers and a Gas Turbine Heat Recovery Steam Generator. Currently, three boilers are in operation at Wagerup: Boilers 1, 2 and 3.

Non-condensable gases[15] from digestion, evaporation and heat exchange and collected tank vapours from the 984Y mercury removal system are diverted to Boilers 2 and 3 to destroy their organic/VOC content prior to atmospheric release. Depending on process requirements/conditions, the non-condensable gases can be sent either 100% to Boiler 2, 100% to Boiler 3, or a 50% allocation to each Boiler 2 and 3.

The boilers are monitored quarterly under the environmental licence L6217/1983.

Assumptions:

Ammonia concentration data from Boiler 3 were used for Boilers 1 and 2.

Figure 20: Boilers 1-3 Stack

[15] Non-condensable gases are gases that will not condense to a liquid at ambient temperatures (including VOCs)

Table 52: Boiler 1 Source Information

Source Name	**Name**	Boiler 1	
	Abbreviation		
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	65	
	Stack tip diameter (m)	2.40	
	Location (Easting & Northing)	398760.939	6357660.418
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	116	130
	Exit velocity (m/s)	16	22
	Moisture content (%)	17	19
	Flow Rate (Dry Nm3/hr)	153796	195350
	Flow Rate (measured or calculated)	Calculated	
	Other	Non-condensable gases sent to this boiler	
Emission Frequency	**Continuous / Intermittent**	Continuous when Boiler 1 is operational	
Emission Control(s)	**Control 1**	Low NO_x burners	
	Year of Installation	1992	
	Operating Strategy	Continuous	When Boiler 1 is operational
	Purpose	Reduce NO_x emissions	

Table 53: Boiler 2 Source Information

Source Name	**Name**	Boiler 2	
	Abbreviation		
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	65	
	Stack tip diameter (m)	2.00	
	Location (Easting & Northing)	398760.939	6357660.418
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	110	121
	Exit velocity (m/s)	17	21
	Moisture content (%)	16	17
	Flow Rate (Dry Nm3/hr)	111609	136504
	Flow Rate (measured or calculated)	Calculated	
	Other	Non-condensable gases sent to this boiler	
Emission Frequency	**Continuous / Intermittent**	Continuous when Boiler 2 is operational	
Emission Control(s)	**Control 1**	Low NO_x burners	
	Year of Installation	2004	
	Operating Strategy	Continuous	When Boiler 2 is operational
	Purpose	Reduce NO_x emissions	

Table 54: Boiler 3 Source Information

Source Name	**Name**	Boiler 3	
	Abbreviation		
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	65	
	Stack tip diameter (m)	2.00	
	Location (Easting & Northing)	398760.939	6357660.418
	Single/Multi-flue	Multi-flue	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	137	152
	Exit velocity (m/s)	17	22
	Moisture content (%)	17	18
	Flow Rate (Dry Nm3/hr)	104589	128650
	Flow Rate (measured or calculated)	Calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous	When Boiler 1 is operational
Emission Control(s)	**Control 1**	Low NO_x burners	
	Year of Installation	2002	
	Operating Strategy	Continuous	When Boiler 3 is operational
	Purpose	Reduce NO_x emissions	

Table 55: Emission Information for Boiler 1 Stack

Emission Sampling Period	2002-2018		**Comment**	Ammonia data are from Boiler 3.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	241	320	180-320	56	33
	CO	USEPA Method 10	mg/m^3	2.4	19	0.60-19	56	3.7
	SO_2	USEPA Method 6C	mg/m^3	1.5	2.9	1.0-2.9	56	0.49
Miscellaneous	Odour	AS4323.3	$OU/wet/Nm^3$	809	1799	317-1799	9	432
	Ammonia	USEPA CTM-027	mg/m^3	4.1	4.2	4.1-4.2	2	0.035
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20-0.20	2	0.0
	Acetone	Modified USEPA MTO5	mg/m^3	0.73	1.0	0.20-1.0	3	0.46
	Benzene	USEPA M18 (tube)	mg/m^3	0.13	0.15	0.10-0.15	2	0.035
	2-butanone	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20-0.20	2	0.0
	Formaldehyde	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20-0.20	2	0.0
	Naphthalene	Not characterised						
	Ethylbenzene	USEPA M18	mg/m^3	ND	ND	-	4	-
	Styrene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Toluene	USEPA M18	mg/m^3	ND	ND	-	2	-
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	5	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Xylenes	Not characterised						

Table 56: Emission Information for Boiler 2 Stack

Emission Sampling Period	2002-2018		**Comment**	Ammonia data are from Boiler 3.				
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	84	118	65-118	56	10
	CO	USEPA Method 10	mg/m^3	18	150	0.65-150	56	32
	SO_2	USEPA Method 6C	mg/m^3	1.6	5.2	1.0-5.2	56	0.82
Miscellaneous	Odour	AS4323.3	$OU/wet/Nm^3$	938	3142	376-3142	13	743
	Ammonia	USEPA CTM-027	mg/m^3	4.1	4.2	4.1-4.2	2	0.035
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	0.30	0.40	0.20-0.40	2	0.14
	Acetone	Modified USEPA MTO5	mg/m^3	0.85	0.90	0.80-0.90	2	0.071
	Benzene	USEPA M18 (tube)	mg/m^3	0.13	0.15	0.10-0.15	2	0.035
	2-butanone	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20-0.20	2	0.0
	Formaldehyde	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20-0.20	2	0.0
	Naphthalene	Not characterised						
	Ethylbenzene	USEPA M18	mg/m^3	ND	ND	-	6	-
	Styrene	USEPA M18	mg/m^3	ND	ND	-	4	-
	Toluene	USEPA M18	mg/m^3	ND	ND	-	2	-
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	6	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	6	-
	Xylenes	Not characterised						

Table 57: Emission Information for Boiler 3 Stack

Emission Sampling Period	2002-2018		**Comment**					
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	114	171	86-171	56	14
	CO	USEPA Method 10	mg/m^3	26	192	0.65-192	56	35
	SO_2	USEPA Method 6C	mg/m^3	1.6	5.3	1.0-5.3	56	0.75
Miscellaneous	Odour	Alcoa developed	$OU/wet/Nm^3$	600	1233	209-1233	12	304
	Ammonia	USEPA CTM-027	mg/m^3	4.1	4.2	4.1-4.2	2	0.035
	Particulate	Not characterised						
VOCs	Acetaldehyde	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20	2	0.0
	Acetone	Modified USEPA MTO5	mg/m^3	1.2	1.2	1.1-1.2	2	0.071
	Benzene	USEPA M18 (tube)	mg/m^3	0.13	0.15	0.10-0.15	2	0.035
	2-butanone	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20-0.20	2	0.0
	Formaldehyde	Modified USEPA MTO5	mg/m^3	0.20	0.20	0.20-0.20	2	0.0
	Naphthalene	Not characterised						
	Ethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Styrene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Toluene	USEPA M18	mg/m^3	ND	ND	-	1	-
	1,2,4 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	1,3,5 Trimethylbenzene	USEPA M18	mg/m^3	ND	ND	-	2	-
	Xylenes	Not characterised						

5.18. Gas Turbine/Heat Recovery Steam Generation (Building 110)

The Wagerup powerhouse generates process steam and electricity for the refining process by means of natural gas fired boilers and a Gas Turbine/Heat Recovery Steam Generator (GT/HRSG).

The GT/HRSG is monitored quarterly under the environmental licence L6217/1983.

Odour and VOC emissions from this source have not been characterised. Emissions are expected to be low. Measurements will be undertaken as part of the Improvement Program (see **Section 1.3.1**).

Figure 21: GT/HRSG stack

Table 58: Gas Turbine 1 Source Information

Source Name	**Name**	Gas Turbine 1	
	Abbreviation	GT/HRSG	
Physical Characteristics	**No. of Stacks**	1	
	Height (m)	40	
	Stack tip diameter (m)	3.05	
	Location (Easting & Northing)	398721.938	6357543.419
	Single/Multi-flue	Single	
	Sample Plane (Ideal/Non-ideal)	Non-ideal	
	Source Type (Point/ volume/ Area)	Point	
Regulated Source		Yes	
CEMS		None	
Gas Stream Characteristics		**Average**	**Peak**
	Temp (°C)	144	160
	Exit velocity (m/s)	23	28
	Moisture content (%)	7.8	10
	Flow Rate (Dry Nm3/hr)	366186	419957
	Flow Rate (measured or calculated)	Calculated	
Emission Frequency	**Continuous / Intermittent**	Continuous	When Gas Turbine is operational
Emission Control(s)	**Control 1**	Low NO_x burners	
	Year of Installation	2002	
	Operating Strategy	Continuous	When Gas Turbine is operational
	Purpose	Reduce NO_x emissions	

Table 59: Emission Information for Gas Turbine 1 Stack

Emission Sampling Period	2002-2018		**Comment**					
Gas Stream Characteristics	2018		**Assumptions**					
Compound Class	**Compound**	**Method**	**Unit**	**Conc (ave)**	**Conc (peak)**	**Conc Range**	**No. Data points**	**Standard Deviation**
Combustion Products	NO_x	USEPA Method 7E	mg/m^3	29	60	5.1-60	55	12
	CO	USEPA Method 10	mg/m^3	52	280	2.0-280	56	56
	SO_2	USEPA Method 6C	mg/m^3	2.5	31	1.0-31	54	4.3
Miscellaneous	Odour	Not characterised						
	Ammonia	Not characterised						
	Particulate	Not characterised						
VOCs	Acetaldehyde	Not characterised						
	Acetone	Not characterised						
	Benzene	Not characterised						
	2-butanone	Not characterised						
	Formaldehyde	Not characterised						
	Naphthalene	Not characterised						
	Ethylbenzene	Not characterised						
	Styrene	Not characterised						
	Toluene	Not characterised						
	1,2,4 Trimethylbenzene	Not characterised						
	1,3,5 Trimethylbenzene	Not characterised						
	Xylenes	Not characterised						

5.19. Residue Storage Areas

Residue is the common term for the material remaining after the alumina has been extracted from the bauxite ore. This material is stored at the residue area adjacent to the refinery. Residue consists of a coarse sand fraction (often termed 'red sand') and a fine silt fraction (often termed 'red mud'). The mud density is increased at the residue area by thickening prior to its final discharge to residue storage areas (RSAs). The sand is stockpiled and subsequently used for internal construction activities at the RSAs. Oxalate, another by-product, is also stored in approved areas on site (oxalate storage ponds).

Several other facilities that support the refining operations are located in the residue area. These include ponds designed to cool refinery process liquor (cooling pond), and to store rainfall run-off water from both the refinery site and residue area (run-off water storage (ROWS) pond and run-off collection ponds (ROCPs)). Water is recycled back to the refinery via the cooling pond. Fresh water storage areas are also within the residue storage areas (detention ponds).

The Lower Dam has also been included in the residue area assessment, even though it lies within the refinery boundary, as it is a source of fugitive VOC emissions.

RSA9 and ROCP3 were commissioned in 2014, bringing the total residue footprint to 379.22 hectares.

Decommissioning of ROCP1 commenced in 2017. Most of this pond is now covered with dry sand, with negligible emissions. The wet area of the pond is estimated to be 2 hectares.

Areas of the RSAs and other residue facilities are provided in **Table 60**. Locations of each of the RSAs and other residue facilities are shown in **Figure 22**. The Lower Dam is shown in **Figure 23**.

Assumptions:

No formaldehyde emissions from Lower Dam or Cooling Pond. Oxalate ponds and ROCPs to have same emissions as ROWs pond. Wet mud and dry mud have different emissions.

Table 60: 2018 Wagerup Residue Areas for Fugitive VOC Emissions

Wagerup Residue Source	Area (ha)
Super Thickener	0.461
Cooling Pond	15.13
Residue Mud	233.36
ROWS	25.64
ROCP 1	2.0
ROCP 2	4.86
ROCP 3	9.11
Spent Liquor Pond	2.08
Lower Dam	17.7
Oxalate Pond 1	0.3
Oxalate Pond 2	1.45
Oxalate Pond 3	2.76
Sand Lake	4.54
Wet Area at Sand Canon	0.5

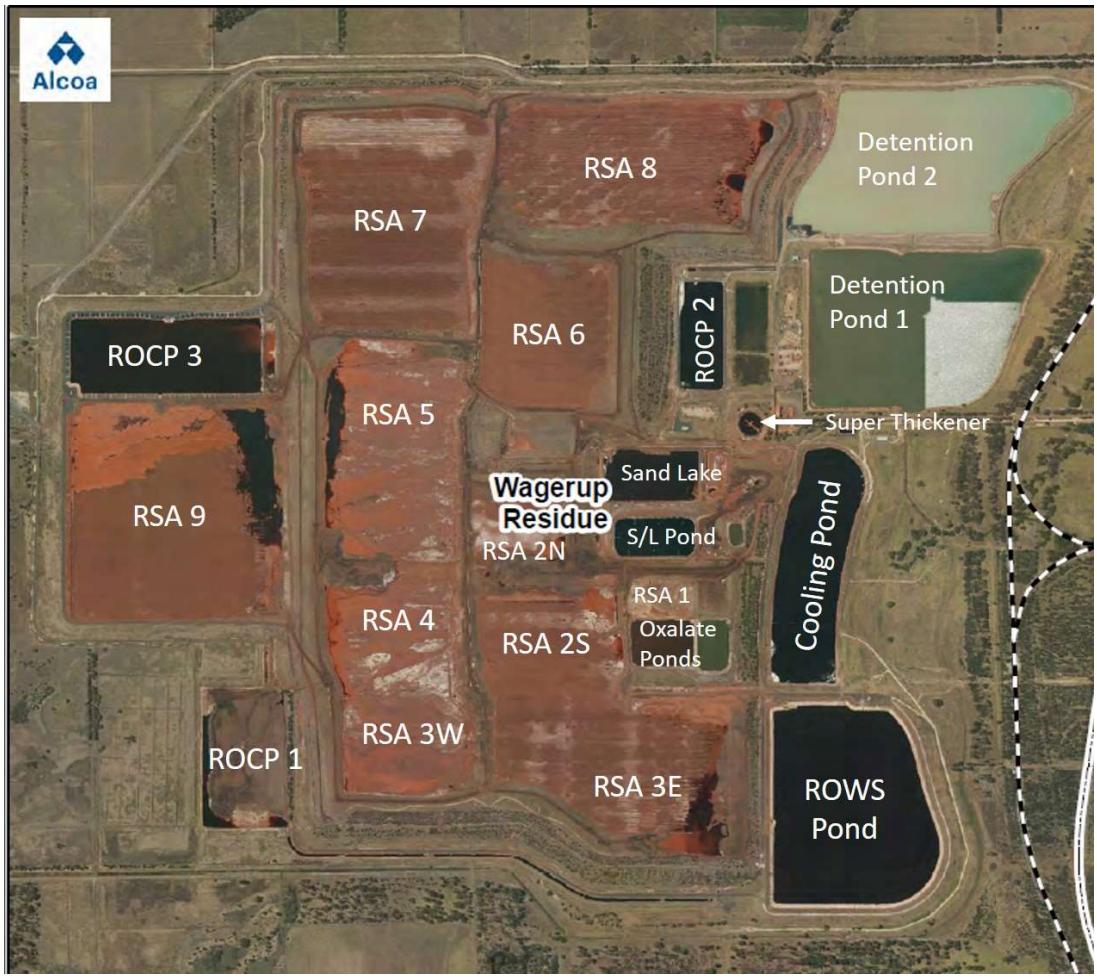

Figure 22: Wagerup Residue Area

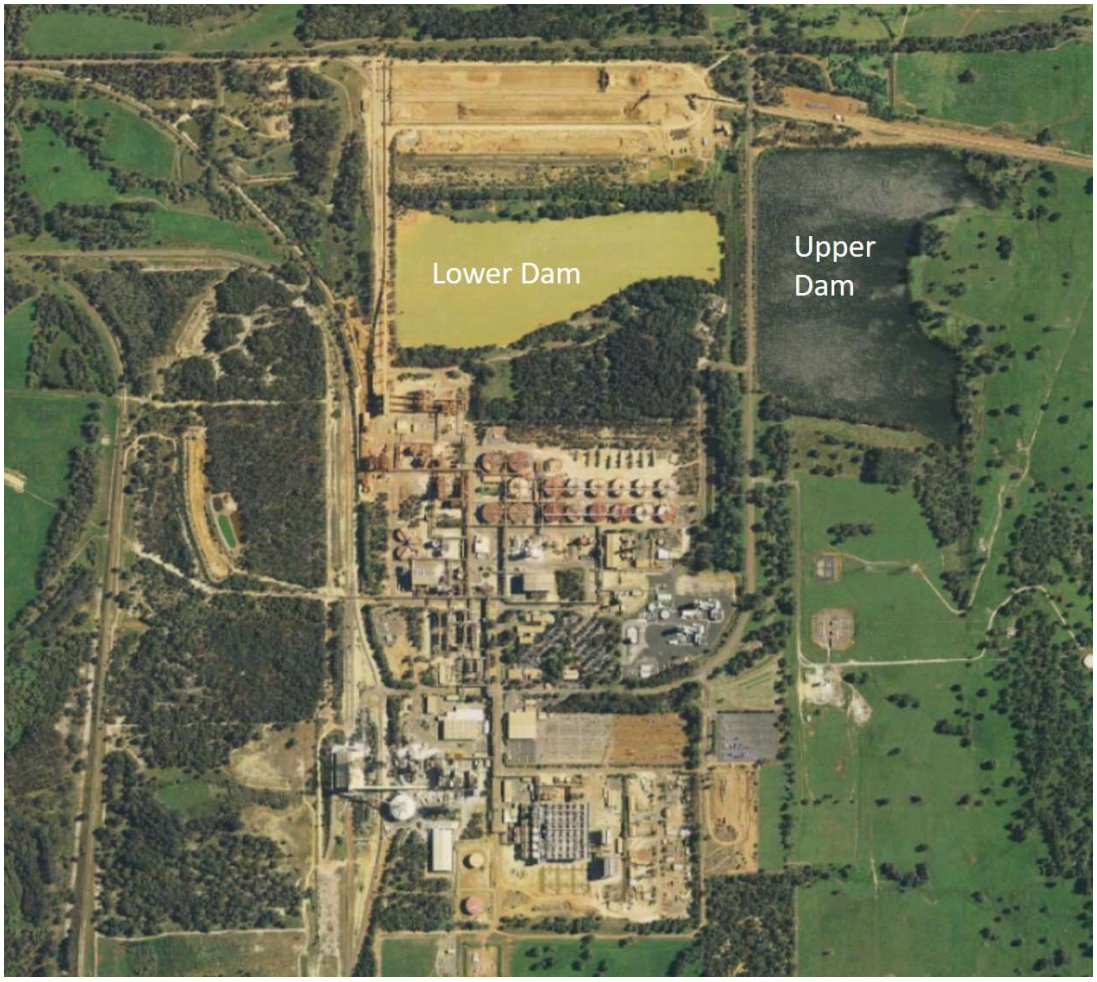

Figure 23: Wagerup Refinery

Emissions from the drying area have been determined for three surface types, selected to represent various stages of drying. These are:

- Wet residue – taken as the residue up to several days after pouring depending on the conditions;
- Dry residue 1 – the period following this; and
- Dry residue 2 – towards the end of the drying cycle.

Estimates of the percentage of the total RSA at each of the three stages were revised in 2008 and are provided in **Table 61.**

Table 61: Percentage of Dry Stacked Areas Covered by the Three Residue Classes

Source	Wet Residue (%)	Dry Residue 1 (%)	Dry Residue 2 (%)
Summer	27	36	37
Winter	35	51	14

Residue area VOC emission rates are provided in **Table 62**. VOC emissions from the various RSA surfaces were estimated from measurements using an isolation flux hood to determine emissions per unit area. Measurements were undertaken in three phases in 2004 and 2005.

Table 62: Residue Area VOC Emission Rates

Source	BaP Equivalents	Acetone	Acetaldehyde	Formaldehyde	2-Butanone	Benzene	Toluene	Xylenes	Odour
	($\mu g/m^2/min$)								($OU/m^2/min$)
Lower Dam		0.25	2.8						***6.7-56.3***
ROCP		0.25	0.07	0.55					1.85
RSA2 – Liquor Southern		11.60	8.70	0.13	1.47	0.05	0.16		37
RSA2 – Wet Residue - North	2.0E-05	2.52	0.8	0.4	0.28	0.09	0.18		16.78
Super Thickener	1.38E-04	77.35	56.73	0.78	7.63	1.10	4.50	0.71	86.8
Cooling Pond	1.4E-04	13.24	8.9	1.5	1.97	1.24	0.9	0.07	***13.8-66.7***
Oxalate Pond		0.25	0.07	0.55					0.37
ROWS		0.25	0.07	0.55					0.36
Wet Residue	2.0E-05	2.52	0.8	0.4	0.28	0.09	0.18		***15.1***
Dry Residue 1		0.11	0.42	***0.90***		0.01	0.01		0.6
Dry Residue 2		0.42	0.05	***0.08***		0.01	0.06		***1.46***
Wet Sand	2.0E-05	2.52	0.8	0.4	0.28	0.09	0.18		16.78

Note: Bolded and italicised emissions are dependent on temperature and/or season. The residue values given here are based on a temperature of 25ºC with lower dam and cooling pond emissions for the range of winter and summer emission values.

6. References

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Environ, 2005. Compound Selection Procedure: Wagerup Refinery Unit Three Expansion. for Alcoa World Alumina Australia, 2005. Environ Australia Pty Ltd

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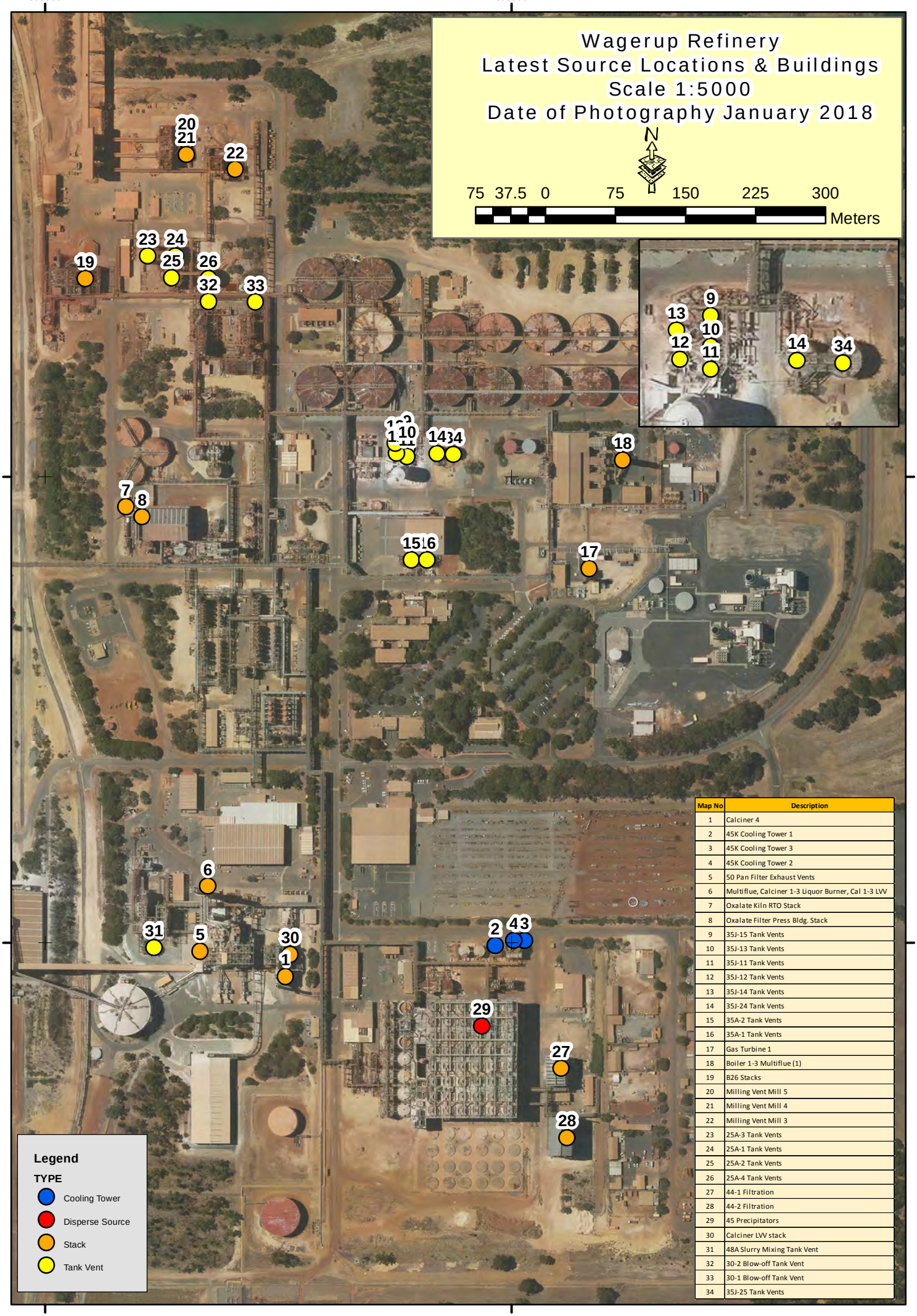
Appendix A

Latest source locations



Map No	Description
1	Calciner 4
2	45K Cooling Tower 1
3	45K Cooling Tower 3
4	45K Cooling Tower 2
5	50 Pan Filter Exhaust Vents
6	Multiflue, Calciner 1-3 Liquor Burner, Cal 1-3 LVV
7	Oxalate Kiln RTO Stack
8	Oxalate Filter Press Bldg. Stack
9	35J-15 Tank Vents
10	35J-13 Tank Vents
11	35J-11 Tank Vents
12	35J-12 Tank Vents
13	35J-14 Tank Vents
14	35J-24 Tank Vents
15	35A-2 Tank Vents
16	35A-1 Tank Vents
17	Gas Turbine 1
18	Boiler 1-3 Multiflue (1)
19	B26 Stacks
20	Milling Vent Mill 5
21	Milling Vent Mill 4
22	Milling Vent Mill 3
23	25A-3 Tank Vents
24	25A-1 Tank Vents
25	25A-2 Tank Vents
26	25A-4 Tank Vents
27	44-1 Filtration
28	44-2 Filtration
29	45 Precipitators
30	Calciner LVV stack
31	48A Slurry Mixing Tank Vent
32	30-2 Blow-off Tank Vent
33	30-1 Blow-off Tank Vent
34	35J-25 Tank Vents

Appendix B

Protocol used for calculation of average concentrations

With the exception of odour, laboratories report concentration data either as a measured value (usually mg/m3) or as 'nd' (not detected). An 'nd' is assigned when an analyte is not detected above the method detection limit (MDL) of the analysis. It is more accurate to report this value as, say <0.2 mg/m^3, rather than '0' as the substance may be present, but at levels which are not detectable.

The average concentration over a time period must be calculated from individual concentration data points. For any series of data, it is possible to have some concentrations which have been reported as measured values (e.g. 0.2 mg/m^3) as well as some 'nd' values. The following protocol was used in calculating average concentrations in the Concentration Masterfile:

1 All data measured above the method detection limit were inputted as a numerical value and the cell highlighted in orange.
2 All data reported as 'nd' were inputted as 'half the method detection limit' and the cell was left un-coloured. For example, if an analyte was reported as 'nd' and the method detection limit was 0.1 mg/m^3, the value was inputted as 0.05 mg/m^3. A comment was added to the cell to indicate what the original MDL was and to highlight that the value was a '½ MDL' value.
3 Once all concentration data for an analyte/source had been collated in the Concentration Masterfile, if all data points for that analyte/source had been reported as a measured value, then the average was calculated from all measured values.
4 Alternatively, if all data points for that analyte/source had been reported as 'nd', the average concentration was reported as '0'. The justification for this is that if an analyte has been measured multiple times, and on all occasions has not been present above its MDL, it is very unlikely that this analyte is present in the emissions.
5 Alternatively, if at least one measured value above the MDL had been reported (together with a number of 'nd' values), the average was calculated from the measured value and all 'nd' results been given a value of 'half the MDL'.

In some cases, discretion may be used to determine if/how a particular data point would be included. For example:

1 In some cases where a reported result is obviously different to all other data points (assuming a large data set), then this data point could be considered to be an outlier and may be excluded from the average calculation. In general, 9 'nd' data points were

needed for every 1 measured data point to justify being excluded. A comment was added to the cell to indicate the original value and why it had been excluded.

2 In some cases where all bar one result was reported as 'nd' and the other result was reported at the MDL (e.g. a measured value of 0.1 mg/m^3 was reported and the MDL of the analysis was 0.1 mg/m^3), the result reported at the MDL was assumed to be '½ MDL' in the average calculation.

Appendix C

2018 Emission files

2018 Base Case Emission Rates – Average

2018 Base Case Emission Rates – Peak

2018 BASE CASE EMISSION RATES - AVERAGE

Legend: 0 denotes measured but not detected; N/A denotes that the source has not been characterised; '-' denotes not applicable where a source did not exist.

Source	Stack Diameter	Stack Height	Average Stack Flow - DRY	Average Stack Gas Moisture	Average Stack Flow - WET	Products of Combustion			Miscellaneous		
						NOx	CO	SO2	Dust	Measured Odour	Ammonia
	m	m	Dry Nm3/hr	%	Wet Nm3/hr	g/s	g/s	g/s	g/s	OU/sec	g/s
Combustion Equipment Point Sources:											
Liquor Burning	1.10	100.0	52477	5%	55355	2.02	0.22	0.024	0.024	49924	7.22E-03
Calciner 1	1.90	100.0	64625	50%	128224	1.70	2.86	0.14	0.59	118302	4.91E-02
Calciner 2	1.90	100.0	68141	49%	133872	1.68	2.85	0.10	0.65	99559	5.17E-02
Calciner 3	2.15	100.0	98733	40%	165382	3.34	1.18	0.10	0.55	98636	7.50E-02
Calciner 4	2.35	48.8	116528	47%	218217	4.00	6.08	0.12	0.93	150455	8.85E-02
Boiler 1	2.40	65.0	153796	17%	185969	10.32	0.10	0.062	N/A	41808	1.77E-01
Boiler 2	2.00	65.0	111609	16%	133185	2.61	0.57	0.050	N/A	34702	1.28E-01
Boiler 3	2.00	65.0	104589	17%	125406	3.32	0.75	0.045	N/A	20907	1.20E-01
Gas Turbine 1	3.05	40.0	366186	8%	397079	2.90	5.27	0.25	N/A	N/A	N/A
Oxalate Kiln	1.00	36.8	34650	6%	37019	0.32	0.053	0.025	8.79E-03	8509	N/A
Non-Combustion Equipment Point Sources:											
Calciner 1-3 Low Volume Vent	0.35	100.0	1841	42%	3174	8.69E-04	0.00	0.00	N/A	5749	N/A
45K Cooling Tower 2	7.32	17.5	1509962	12%	1723701	N/A	N/A	N/A	N/A	122574	1.62E-01
45K Cooling Tower 3	7.32	17.5	1550049	12%	1769462	N/A	N/A	N/A	N/A	125828	1.66E-01
45K Cooling Tower 1	7.25	9.0	1045812	12%	1185997	N/A	N/A	N/A	N/A	84338	1.11E-01
50 Cooling Tower 1	3.00	4.9	2824	17%	3420	N/A	N/A	N/A	N/A	243.17	3.21E-04
50 Cooling Tower 2	3.00	4.9	2824	17%	3420	N/A	N/A	N/A	N/A	243.17	3.21E-04
Building 45 - Row 0 precip tanks	12.5	30.2	35400	46%	65133	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 1 precip tanks	11.0	29.35	27416	46%	50443	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 2 precip tanks	11.0	28.5	25221	41%	42388	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 3 precip tanks	11.0	27.7	26971	29%	37961	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 4 precip tanks	11.0	26.9	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 5 precip tanks	11.0	26.1	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
44-1 Main Stack	1.10	35.1	4200	20%	5250	N/A	N/A	N/A	N/A	2333	N/A
44-1 LVV1	0.60	28.3	7800	17%	9398	N/A	N/A	N/A	N/A	3133	N/A
44-1 LVV2	0.60	28.4	1920	15%	2259	N/A	N/A	N/A	N/A	816	N/A
44-2 Main Stack	1.08	35.1	5400	23%	7013	N/A	N/A	N/A	N/A	2338	N/A
44-2 LVV	1.09	35.3	16200	7%	17476	N/A	N/A	N/A	N/A	5340	N/A
Calciner 4 LVV	0.89	41.7	7800	24%	10263	N/A	N/A	N/A	N/A	5132	N/A
Calciner 4 Extraction Hoods	0.88	37.8	4200	1%	4255	N/A	N/A	N/A	N/A	721	N/A
48A Tank Exhaust	0.30	9.5	240	35%	369	N/A	N/A	N/A	N/A	697	N/A
47K1 oxalate filter press building stack	0.84	35.0	4837.5	9%	5304	N/A	N/A	N/A	N/A	1414	4.97E-02
Grouped Sources:											
Mill 3 Trommel Vent	0.45	13.0	6052	24%	7921	N/A	N/A	N/A	0.12	8311	1.26E-01
Mill 4 Trommel Vent	0.45	13.0	6052	24%	7921	N/A	N/A	N/A	0.12	8311	1.26E-01
Mill 5 Trommel Vent	0.45	13.0	6052	24%	7921	N/A	N/A	N/A	0.12	8311	1.26E-01
25A-1 Tank Vents (Vent 1)	0.75	25.4	338	68%	1042	N/A	N/A	N/A	N/A	4285	2.30E-01
25A-1 Tank Vents (Vent 2)	0.75	25.4	338	68%	1042	N/A	N/A	N/A	N/A	4285	2.30E-01
25A-2 Tank Vents	0.50	25.4	676	68%	2084	N/A	N/A	N/A	N/A	8570	4.59E-01
25A-3 Tank Vents (Vent 1)	0.75	25.4	761	90%	7940	N/A	N/A	N/A	N/A	97605	5.17E-01
25A-3 Tank Vents (Vent 2)	0.75	25.4	761	90%	7940	N/A	N/A	N/A	N/A	97605	5.17E-01
25A-4 Tank Vents	0.55	25.4	676	68%	2084	N/A	N/A	N/A	N/A	8570	4.59E-01
Blow-off (stack 1)	0.73	24.3	0	99%	0	N/A	N/A	N/A	N/A	0	0.00E+00
Blow-off (stack 2)	0.73	24.3	0	99%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35J-11 Tank Vents (Non cons)	0.49	9.7	1514	21%	1923	N/A	N/A	N/A	8.97E-04	6300	1.84E-02
35J-12 Tank Vents (Non cons)	0.49	9.7	1352	21%	1718	N/A	N/A	N/A	8.01E-04	5626	1.64E-02
35J-13 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
35J-14 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
35J-15 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
35J-24 Tank Vents (Non cons)	0.49	9.7	281	67%	859	N/A	N/A	N/A	1.67E-04	1091	3.42E-03
35J-25 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
B26 Stacks (Existing)	1.13	27.0	19839	50%	39678	N/A	N/A	N/A	N/A	77124	2.96E-01
35A-1 Tank Vent (Non cons)	0.60	16.5	0	37%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 Tank Vent (Non cons)	0.60	16.5	652	37%	1032	N/A	N/A	N/A	N/A	9400	2.29E-02
35A-1 overflow pipe	0.40	0.10	0	37%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 overflow pipe	0.40	0.10	99	37%	157	N/A	N/A	N/A	N/A	1427	3.48E-03
Calciner 1-3 Pan Filter Exhaust Vents	0.31	20.1	3420	32%	5029	N/A	N/A	N/A	N/A	6147	N/A

2018 BASE CASE EMISSION RATES - AVERAGE

Legend: 0 denotes measured but not detected; N/A denotes that the source has not been characterised; '-' denotes not applicable where a source did not exist.

Source	Volatile Organic Compounds											
	Acetaldehyde	Acetone	BaP Equivalents	Benzene	2-Butanone	Ethylbenzene	Formaldehyde	Styrene	Toluene	1,2,4 Trimethylbenzene	1,3,5 Trimethylbenzene	Xylenes
	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
Combustion Equipment Point Sources:												
Liquor Burning	2.38E-03	1.25E-02	1.95E-07	1.08E-03	1.77E-03	0.00E+00	2.53E-03	0.00E+00	2.18E-04	0.00E+00	0.00E+00	8.25E-05
Calciner 1	7.14E-02	3.68E-02	2.17E-07	4.91E-03	3.45E-03	7.43E-05	8.03E-02	1.28E-04	5.18E-04	0.00E+00	0.00E+00	3.16E-04
Calciner 2	7.29E-02	3.48E-02	2.29E-07	4.65E-03	3.83E-03	7.84E-05	9.16E-02	1.35E-04	5.47E-04	0.00E+00	0.00E+00	3.33E-04
Calciner 3	7.67E-02	3.68E-02	3.32E-07	3.95E-03	4.39E-03	1.14E-04	8.05E-02	1.96E-04	7.92E-04	0.00E+00	0.00E+00	4.82E-04
Calciner 4	1.03E-01	6.44E-02	3.92E-07	6.93E-03	5.05E-03	2.70E-04	1.52E-01	2.91E-04	3.08E-03	7.77E-05	0.00E+00	1.05E-03
Boiler 1	8.54E-03	3.13E-02	N/A	5.34E-03	8.54E-03	0.00E+00	8.54E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 2	9.30E-03	2.64E-02	N/A	3.88E-03	6.20E-03	0.00E+00	6.20E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 3	5.81E-03	3.34E-02	N/A	3.63E-03	5.81E-03	0.00E+00	5.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Gas Turbine 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oxalate Kiln	0.00E+00	4.43E-03	N/A	0.00E+00	0.00E+00	N/A	7.97E-04	N/A	N/A	N/A	N/A	N/A
Non-Combustion Equipment Point Sources:												
Calciner 1-3 Low Volume Vent	3.26E-03	2.04E-02	N/A	4.52E-06	1.56E-03	0.00E+00	0.00E+00	0.00E+00	2.58E-03	0.00E+00	0.00E+00	1.18E-03
45K Cooling Tower 2	0.00E+00	1.59E-02	1.33E-06	0.00E+00	4.47E-03	0.00E+00	1.07E-01	7.55E-04	8.69E-04	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 3	0.00E+00	1.63E-02	1.36E-06	0.00E+00	4.59E-03	0.00E+00	1.10E-01	7.75E-04	8.92E-04	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 1	0.00E+00	1.10E-02	9.21E-07	0.00E+00	3.10E-03	0.00E+00	7.43E-02	5.23E-04	6.02E-04	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 1	0.00E+00	2.96E-05	2.49E-09	0.00E+00	8.36E-06	0.00E+00	2.01E-04	1.41E-06	1.63E-06	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 2	0.00E+00	2.96E-05	2.49E-09	0.00E+00	8.36E-06	0.00E+00	2.01E-04	1.41E-06	1.63E-06	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 0 precip tanks	0.00E+00	6.76E-04	N/A	3.07E-05	2.07E-04	3.66E-05	0.00E+00	2.88E-05	5.80E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 1 precip tanks	0.00E+00	5.24E-04	N/A	2.38E-05	1.60E-04	2.84E-05	0.00E+00	2.23E-05	4.49E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 2 precip tanks	0.00E+00	1.16E-03	N/A	0.00E+00	3.15E-04	0.00E+00	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 3 precip tanks	0.00E+00	4.72E-04	N/A	0.00E+00	1.35E-04	0.00E+00	0.00E+00	0.00E+00	3.22E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 4 precip tanks	0.00E+00	5.39E-04	N/A	0.00E+00	1.54E-04	0.00E+00	0.00E+00	0.00E+00	3.68E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 5 precip tanks	0.00E+00	5.39E-04	N/A	0.00E+00	1.54E-04	0.00E+00	0.00E+00	0.00E+00	3.68E-05	0.00E+00	0.00E+00	0.00E+00
44-1 Main Stack	1.69E-03	1.45E-02	N/A	0.00E+00	2.80E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV1	8.67E-04	4.98E-03	N/A	0.00E+00	1.22E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV2	4.53E-04	2.19E-03	N/A	0.00E+00	5.79E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 Main Stack	2.63E-03	3.68E-02	N/A	0.00E+00	1.31E-02	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 LVV	4.95E-04	3.58E-03	N/A	0.00E+00	1.31E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 LVV	7.04E-03	5.42E-02	N/A	0.00E+00	8.23E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 Extraction Hoods	0.00E+00	2.39E-03	N/A	0.00E+00	2.98E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
48A Tank Exhaust	9.33E-05	1.00E-03	N/A	3.97E-05	3.53E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
47K1 oxalate filter press building stack	4.57E-04	7.19E-03	N/A	N/A	7.12E-03	2.55E-05	0.00E+00	N/A	6.25E-05	N/A	N/A	0.00E+00
Grouped Sources:												
Mill 3 Trommel Vent	2.71E-02	6.80E-02	1.40E-08	8.40E-05	3.45E-03	0.00E+00	0.00E+00	0.00E+00	2.01E-04	2.56E-04	0.00E+00	8.74E-05
Mill 4 Trommel Vent	2.71E-02	6.80E-02	1.40E-08	8.40E-05	3.45E-03	0.00E+00	0.00E+00	0.00E+00	2.01E-04	2.56E-04	0.00E+00	8.74E-05
Mill 5 Trommel Vent	2.71E-02	6.80E-02	1.40E-08	8.40E-05	3.45E-03	0.00E+00	0.00E+00	0.00E+00	2.01E-04	2.56E-04	0.00E+00	8.74E-05
25A-1 Tank Vents (Vent 1)	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-1 Tank Vents (Vent 2)	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-2 Tank Vents	1.07E-02	9.01E-02	0.00E+00	1.09E-04	9.72E-03	8.62E-05	0.00E+00	9.38E-06	1.04E-03	1.10E-04	1.54E-04	9.67E-05
25A-3 Tank Vents (Vent 1)	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-3 Tank Vents (Vent 2)	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-4 Tank Vents	1.07E-02	9.01E-02	0.00E+00	1.09E-04	9.72E-03	8.62E-05	0.00E+00	9.38E-06	1.04E-03	1.10E-04	1.54E-04	9.67E-05
Blow-off (stack 1)	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	N/A
Blow-off (stack 2)	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	N/A
35J-11 Tank Vents (Non cons)	4.41E-03	1.62E-02	1.60E-07	0.00E+00	2.22E-03	0.00E+00	1.23E-04	0.00E+00	3.04E-04	3.46E-04	9.76E-05	0.00E+00
35J-12 Tank Vents (Non cons)	3.94E-03	1.45E-02	1.43E-07	0.00E+00	1.98E-03	0.00E+00	1.09E-04	0.00E+00	2.71E-04	3.09E-04	8.72E-05	0.00E+00
35J-13 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
35J-14 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
35J-15 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
35J-24 Tank Vents (Non cons)	1.67E-03	3.59E-03	2.97E-08	0.00E+00	5.10E-04	0.00E+00	2.74E-05	0.00E+00	5.64E-05	6.43E-05	1.81E-05	0.00E+00
35J-25 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
B26 Stacks (Existing)	1.63E-02	2.47E-02	0.00E+00	0.00E+00	1.64E-03	0.00E+00	0.00E+00	0.00E+00	2.51E-04	0.00E+00	0.00E+00	0.00E+00
35A-1 Tank Vent (Non cons)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 Tank Vent (Non cons)	3.64E-03	1.72E-02	3.75E-07	1.78E-05	2.11E-03	0.00E+00	0.00E+00	0.00E+00	1.17E-03	2.14E-04	5.35E-05	6.15E-05
35A-1 overflow pipe	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 overflow pipe	5.53E-04	2.61E-03	5.69E-08	2.71E-06	3.20E-04	0.00E+00	0.00E+00	0.00E+00	1.78E-04	3.24E-05	8.13E-06	9.34E-06
Calciner 1-3 Pan Filter Exhaust Vents	9.98E-03	3.71E-02	0.00E+00	0.00E+00	4.99E-03	0.00E+00	0.00E+00	0.00E+00	5.42E-05	0.00E+00	N/A	0.00E+00

2018 BASE CASE EMISSION RATES - PEAK

Legend: 0 denotes measured but not detected; N/A denotes that the source has not been characterised; '-' denotes not applicable where a source did not exist.

Source	Stack Diameter	Stack Height	Peak Stack Flow - DRY	Peak Stack Gas Moisture	Peak Stack Flow - WET	Products of Combustion			Miscellaneous		
						NOx	CO	SO2	Dust	Measured Odour	Ammonia
	m	m	Dry Nm3/hr	%	Wet Nm3/hr	g/s	g/s	g/s	g/s	OU/sec	g/s
Combustion Equipment Point Sources:											
Liquor Burning	1.10	100.0	73672	8%	79732	5.30	1.25	0.22	0.12	303423	2.17E-02
Calciner 1	1.90	100.0	75418	57%	176623	8.34	13.67	1.38	1.51	330000	1.11E-01
Calciner 2	1.90	100.0	80859	56%	182526	3.66	20.44	1.09	1.80	210000	1.19E-01
Calciner 3	2.15	100.0	117000	46%	217877	9.39	3.25	1.30	1.92	274000	1.72E-01
Calciner 4	2.35	48.8	132738	55%	293668	9.96	32.08	1.00	2.91	307000	1.95E-01
Boiler 1	2.40	65.0	195350	19%	241173	17.36	1.03	0.16	N/A	120519	2.26E-01
Boiler 2	2.00	65.0	136504	17%	165059	4.47	5.69	0.20	N/A	144060	1.58E-01
Boiler 3	2.00	65.0	128650	18%	156129	6.11	6.86	0.19	N/A	53474	1.49E-01
Gas Turbine 1	3.05	40.0	419957	10%	466774	7.00	32.66	3.64	N/A	N/A	N/A
Oxalate Kiln	1.00	36.8	46902	9%	51768	0.64	0.31	0.26	0.04	94908	N/A
Non-Combustion Equipment Point Sources:											
Calciner 1-3 Low Volume Vent	0.35	100.0	3132	61%	8031	3.05E-03	0.0000	0.00	N/A	40153.85	N/A
45K Cooling Tower 2	7.32	17.5	1509962	12%	1723701	N/A	N/A	N/A	N/A	3.47E+05	1.71E-01
45K Cooling Tower 3	7.32	17.5	1550049	12%	1769462	N/A	N/A	N/A	N/A	3.56E+05	1.75E-01
45K Cooling Tower 1	7.25	9.0	1045812	12%	1185997	N/A	N/A	N/A	N/A	2.39E+05	1.18E-01
50 Cooling Tower 1	3.00	4.9	148643	17%	179977	N/A	N/A	N/A	N/A	3.62E+04	1.78E-02
50 Cooling Tower 2	3.00	4.9	148643	17%	179977	N/A	N/A	N/A	N/A	3.62E+04	1.78E-02
Building 45 - Row 0 precip tanks	12.5	30.2	35400	46%	65133	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 1 precip tanks	11	29.35	27416	46%	50443	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 2 precip tanks	11	28.5	25221	41%	42388	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 3 precip tanks	11	27.7	26971	29%	37961	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 4 precip tanks	11	26.9	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 5 precip tanks	11	26.1	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
44-1 Main Stack	1.100	35.1	4200	20%	5250	N/A	N/A	N/A	N/A	2.33E+03	N/A
44-1 LVV1	0.60	28.3	7800	17%	9398	N/A	N/A	N/A	N/A	3.13E+03	N/A
44-1 LVV2	0.60	28.4	1920	15%	2259	N/A	N/A	N/A	N/A	8.16E+02	N/A
44-2 Main Stack	1.080	35.1	5400	23%	7013.0	N/A	N/A	N/A	N/A	2.53E+03	N/A
44-2 LVV	1.09	35.3	16200	7%	17475.7	N/A	N/A	N/A	N/A	5.34E+03	
Calciner 4 LVV	0.890	41.7	7800	24%	10263.2	N/A	N/A	N/A	N/A	5.42E+03	N/A
Calciner 4 Extraction Hoods	0.88	37.8	4200	1%	4255.3	N/A	N/A	N/A	N/A	7.57E+02	N/A
48A Tank Exhaust	0.295	9.5	240	35%	369.2	N/A	N/A	N/A	N/A	6.97E+02	N/A
47K1 oxalate filter press building stack	0.840	35.0	20000	9%	21929.8	N/A	N/A	N/A	N/A	6.70E+03	2.33E-01
Grouped Sources:											
Mill 3 Trommel Vent	0.45	13.0	7867	22%	10022	N/A	N/A	N/A	0.22	11219	1.81E-01
Mill 4 Trommel Vent	0.45	13.0	7867	22%	10022	N/A	N/A	N/A	0.22	11219	1.81E-01
Mill 5 Trommel Vent	0.45	13.0	7867	22%	10022	N/A	N/A	N/A	0.22	11219	1.81E-01
25A-1 Tank Vents (Vent 1)	0.75	25.4	372	70%	1238	N/A	N/A	N/A	N/A	11819	5.65E-01
25A-1 Tank Vents (Vent 2)	0.75	25.4	372	70%	1238	N/A	N/A	N/A	N/A	11819	5.65E-01
25A-2 Tank Vents	0.50	25.4	743	70%	2477	N/A	N/A	N/A	N/A	23638	1.13E+00
25A-3 Tank Vents (Vent 1)	0.75	25.4	1785	86%	12750	N/A	N/A	N/A	N/A	820604	2.72E+00
25A-3 Tank Vents (Vent 2)	0.75	25.4	1785	86%	12750	N/A	N/A	N/A	N/A	820604	2.72E+00
25A-4 Tank Vents	0.55	25.4	743	70%	2477	N/A	N/A	N/A	N/A	23638	1.13E+00
Blow-off (stack 1)	0.73	24.3	62	99%	6029	N/A	N/A	N/A	N/A	186984	6.44E-02
Blow-off (stack 2)	0.73	24.3	221	99%	21387	N/A	N/A	N/A	N/A	663297	2.28E-01
35J-11 Tank Vents (Non cons)	0.49	9.7	2017	19%	2490	N/A	N/A	N/A	1.68E-03	20045	3.31E-02
35J-12 Tank Vents (Non cons)	0.49	9.7	1801	19%	2223	N/A	N/A	N/A	1.50E-03	17899	2.95E-02
35J-13 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
35J-14 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
35J-15 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
35J-24 Tank Vents (Non cons)	0.49	9.7	364	68%	1138	N/A	N/A	N/A	3.03E-04	8395	5.97E-03
35J-25 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
B26 Stacks (Existing)	1.13	27.0	38585	50%	77170	N/A	N/A	N/A	N/A	285100	7.21E-01
35A-1 Tank Vent (Non cons)	0.60	16.5	0	24%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 Tank Vent (Non cons)	0.60	16.5	1069	24%	1407	N/A	N/A	N/A	N/A	44710	7.58E-02
35A-1 overflow pipe	0.40	0.10	0	24%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 overflow pipe	0.40	0.10	1971	24%	2593	N/A	N/A	N/A	N/A	82435	1.40E-01
Calciner 1-3 Pan Filter Exhaust Vents	0.31	20.1	5700	32%	8382	N/A	N/A	N/A	N/A	10711	N/A

2018 BASE CASE EMISSION RATES - PEAK

Legend: 0 denotes measured but not detected; N/A denotes that the source has not been characterised; '-' denotes not applicable where a source did not exist.

Source	Volatile Organic Compounds											
	Acetaldehyde	Acetone	BaP Equivalents	Benzene	2-Butanone	Ethylbenzene	Formaldehyde	Styrene	Toluene	1,2,4 Trimethylbenzene	1,3,5 Trimethylbenzene	Xylenes
	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
Combustion Equipment Point Sources:												
Liquor Burning	3.89E-02	4.30E-01	7.04E-07	5.32E-03	1.11E-02	0.00E+00	2.46E-02	0.00E+00	7.37E-04	0.00E+00	0.00E+00	1.84E-04
Calciner 1	2.09E-01	2.09E-01	9.43E-07	2.09E-02	1.68E-02	1.68E-04	3.56E-01	3.56E-04	1.80E-03	0.00E+00	0.00E+00	9.43E-04
Calciner 2	2.25E-01	2.22E-01	1.01E-06	3.19E-02	3.35E-02	1.80E-04	3.59E-01	3.82E-04	1.93E-03	0.00E+00	0.00E+00	1.01E-03
Calciner 3	4.67E-01	3.58E-01	1.46E-06	3.00E-02	2.02E-02	2.60E-04	5.06E-01	5.53E-04	2.80E-03	0.00E+00	0.00E+00	1.46E-03
Calciner 4	2.47E-01	4.06E-01	1.66E-06	1.55E-02	1.84E-02	7.37E-04	5.16E-01	7.37E-04	3.69E-03	2.58E-04	0.00E+00	1.84E-03
Boiler 1	1.09E-02	5.43E-02	N/A	8.14E-03	1.09E-02	0.00E+00	1.09E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 2	1.52E-02	3.41E-02	N/A	5.69E-03	7.58E-03	0.00E+00	7.58E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 3	7.15E-03	4.29E-02	N/A	5.36E-03	7.15E-03	0.00E+00	7.15E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Gas Turbine 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oxalate Kiln	0.00E+00	6.38E-02	N/A	0.00E+00	0.00E+00	N/A	4.43E-03	N/A	N/A	N/A	N/A	N/A
Non-Combustion Equipment Point Sources:												
Calciner 1-3 Low Volume Vent	1.74E-02	1.57E-01	N/A	3.22E-05	8.70E-03	0.00E+00	0.00E+00	0.00E+00	8.70E-03	0.00E+00	0.00E+00	2.00E-03
45K Cooling Tower 2	0.00E+00	1.47E+00	6.71E-06	0.00E+00	2.94E-01	0.00E+00	2.43E-01	3.36E-03	3.77E-03	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 3	0.00E+00	1.51E+00	6.89E-06	0.00E+00	3.01E-01	0.00E+00	2.50E-01	3.44E-03	3.88E-03	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 1	0.00E+00	1.02E+00	4.65E-06	0.00E+00	2.03E-01	0.00E+00	1.68E-01	2.32E-03	2.61E-03	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 1	N/A	1.45E-01	6.61E-07	0.00E+00	2.89E-02	0.00E+00	2.39E-02	3.30E-04	3.72E-04	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 2	N/A	1.45E-01	6.61E-07	0.00E+00	2.89E-02	0.00E+00	2.39E-02	3.30E-04	3.72E-04	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 0 precip tanks	0.00E+00	1.18E-03	N/A	3.84E-05	3.54E-04	5.02E-05	0.00E+00	3.44E-05	8.56E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 1 precip tanks	0.00E+00	9.14E-04	N/A	2.97E-05	2.74E-04	3.88E-05	0.00E+00	2.67E-05	6.63E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 2 precip tanks	0.00E+00	1.26E-03	N/A	0.00E+00	3.22E-04	0.00E+00	0.00E+00	0.00E+00	1.33E-04	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 3 precip tanks	0.00E+00	5.69E-04	N/A	0.00E+00	1.57E-04	0.00E+00	0.00E+00	0.00E+00	3.60E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 4 precip tanks	0.00E+00	6.51E-04	N/A	0.00E+00	1.80E-04	0.00E+00	0.00E+00	0.00E+00	4.11E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 5 precip tanks	0.00E+00	6.51E-04	N/A	0.00E+00	1.80E-04	0.00E+00	0.00E+00	0.00E+00	4.11E-05	0.00E+00	0.00E+00	0.00E+00
44-1 Main Stack	1.75E-03	1.75E-02	N/A	0.00E+00	2.92E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV1	8.67E-04	4.98E-03	N/A	0.00E+00	1.26E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV2	4.59E-04	2.24E-03	N/A	0.00E+00	6.40E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 Main Stack	2.85E-03	3.90E-02	N/A	0.00E+00	1.40E-02	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 LVV	7.65E-04	3.60E-03	N/A	0.00E+00	1.62E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 LVV	7.37E-03	5.85E-02	N/A	0.00E+00	8.67E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 Extraction Hoods	0.00E+00	2.57E-03	N/A	0.00E+00	3.03E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
48A Tank Exhaust	9.33E-05	1.07E-03	N/A	4.07E-05	3.80E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
47K1 oxalate filter press building stack	2.22E-03	3.28E-02	N/A	N/A	3.17E-02	1.28E-04	0.00E+00	N/A	2.61E-04	N/A	N/A	0.00E+00
Grouped Sources:												
Mill 3 Trommel Vent	3.93E-02	1.23E-01	1.97E-08	1.51E-04	5.59E-03	0.00E+00	0.00E+00	0.00E+00	3.93E-04	1.43E-03	0.00E+00	1.38E-04
Mill 4 Trommel Vent	3.93E-02	1.23E-01	1.97E-08	1.51E-04	5.59E-03	0.00E+00	0.00E+00	0.00E+00	3.93E-04	1.43E-03	0.00E+00	1.38E-04
Mill 5 Trommel Vent	3.93E-02	1.23E-01	1.97E-08	1.51E-04	5.59E-03	0.00E+00	0.00E+00	0.00E+00	3.93E-04	1.43E-03	0.00E+00	1.38E-04
25A-1 Tank Vents (Vent 1)	9.46E-03	6.65E-02	0.00E+00	2.06E-04	7.38E-03	8.26E-05	0.00E+00	1.03E-05	1.99E-03	3.82E-04	1.55E-04	2.99E-04
25A-1 Tank Vents (Vent 2)	9.46E-03	6.65E-02	0.00E+00	2.06E-04	7.38E-03	8.26E-05	0.00E+00	1.03E-05	1.99E-03	3.82E-04	1.55E-04	2.99E-04
25A-2 Tank Vents	1.89E-02	1.33E-01	0.00E+00	4.13E-04	1.48E-02	1.65E-04	0.00E+00	2.06E-05	3.98E-03	7.64E-04	3.10E-04	5.99E-04
25A-3 Tank Vents (Vent 1)	2.72E-01	2.97E-01	0.00E+00	9.92E-04	3.74E-02	3.97E-04	0.00E+00	4.96E-05	9.57E-03	1.83E-03	7.44E-04	1.44E-03
25A-3 Tank Vents (Vent 2)	2.72E-01	2.97E-01	0.00E+00	9.92E-04	3.74E-02	3.97E-04	0.00E+00	4.96E-05	9.57E-03	1.83E-03	7.44E-04	1.44E-03
25A-4 Tank Vents	1.89E-02	1.33E-01	0.00E+00	4.13E-04	1.48E-02	1.65E-04	0.00E+00	2.06E-05	3.98E-03	7.64E-04	3.10E-04	5.99E-04
Blow-off (stack 1)	1.22E-02	6.78E-02	N/A	0.00E+00	1.03E-02	N/A	2.08E-04	N/A	8.13E-05	0.00E+00	N/A	N/A
Blow-off (stack 2)	4.33E-02	2.40E-01	N/A	0.00E+00	3.65E-02	N/A	7.37E-04	N/A	2.89E-04	0.00E+00	N/A	N/A
35J-11 Tank Vents (Non cons)	8.96E-03	5.51E-02	5.10E-07	0.00E+00	4.41E-03	0.00E+00	5.04E-04	0.00E+00	1.38E-03	9.56E-04	2.76E-04	0.00E+00
35J-12 Tank Vents (Non cons)	8.00E-03	4.92E-02	4.56E-07	0.00E+00	3.94E-03	0.00E+00	4.50E-04	0.00E+00	1.24E-03	8.54E-04	2.47E-04	0.00E+00
35J-13 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
35J-14 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
35J-15 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
35J-24 Tank Vents (Non cons)	4.12E-03	8.54E-03	9.21E-08	0.00E+00	8.15E-04	0.00E+00	6.77E-05	0.00E+00	2.50E-04	1.73E-04	4.98E-05	0.00E+00
35J-25 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
B26 Stacks (Existing)	3.88E-02	7.60E-02	0.00E+00	0.00E+00	6.32E-03	0.00E+00	0.00E+00	0.00E+00	8.57E-04	0.00E+00	0.00E+00	0.00E+00
35A-1 Tank Vent (Non cons)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 Tank Vent (Non cons)	1.73E-02	5.95E-02	1.66E-06	6.68E-05	8.89E-03	0.00E+00	0.00E+00	0.00E+00	3.88E-03	1.02E-03	2.52E-04	3.48E-04
35A-1 overflow pipe	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 overflow pipe	3.19E-02	1.10E-01	3.07E-06	1.23E-04	1.64E-02	0.00E+00	0.00E+00	0.00E+00	7.14E-03	1.89E-03	4.64E-04	6.42E-04
Calciner 1-3 Pan Filter Exhaust Vents	1.74E-02	6.65E-02	0.00E+00	0.00E+00	8.55E-03	0.00E+00	0.00E+00	0.00E+00	9.98E-05	0.00E+00	N/A	0.00E+00

Appendix D

2.85 Mtpa Emission files

2.85 Mtpa Base Case Emission Rates – Average

2.85 Mtpa Base Case Emission Rates – Peak

2018 s.46 2.85Mtpa FORECAST EMISSION RATES - AVERAGE

Legend: 0 denotes measured but not detected; N/A denotes no data gathered as it is presumed negligible; '-' denotes not applicable where a source did not exist.

						Products of Combustion			Miscellaneous		
Source	**Stack Diameter**	**Stack Height**	**Average Stack Flow - DRY**	**Average Stack Gas Moisture**	**Average Stack Flow - WET**	**NOx**	**CO**	**SO2**	**Dust**	**Measured Odour**	**Ammonia**
	m	**m**	**Dry Nm3/hr**	**%**	**Wet Nm3/hr**	g/s	g/s	g/s	g/s	OU/sec	g/s
Combustion Equipment Point Sources:											
Liquor Burning	1.10	100.0	52477	5%	55355	2.02	0.22	0.024	0.024	49924	7.22E-03
Calciner 1	1.90	100.0	69265	50%	137430	1.83	3.07	0.15	0.70	126795	5.26E-02
Calciner 2	1.90	100.0	73033	49%	143483	1.80	3.06	0.10	0.67	106707	5.54E-02
Calciner 3	2.15	100.0	105821	40%	177255	3.58	1.27	0.10	0.78	105718	8.03E-02
Calciner 4	2.35	48.8	124894	47%	233884	4.29	6.52	0.13	1.19	161256	9.48E-02
Boiler 1	2.40	65.0	164838	17%	199320	10.32	0.10	0.062	N/A	41808	1.77E-01
Boiler 2	2.00	65.0	119622	16%	142747	2.61	0.57	0.050	N/A	34702	1.28E-01
Boiler 3	2.00	65.0	112098	17%	134410	3.32	0.75	0.045	N/A	20907	1.20E-01
Gas Turbine 1	3.05	40.0	392476	8%	425586	2.90	5.27	0.25	N/A	N/A	N/A
Oxalate Kiln	1.00	36.8	34650	6%	37019	0.32	0.053	0.025	8.79E-03	8509	N/A
Non-Combustion Equipment Point Sources:											
Calciner 1-3 Low Volume Vent (100m multiflue)	0.35	100.0	1841	42%	3174	0.00	0.00	0.00	N/A	5749	N/A
45K Cooling Tower 2	7.32	17.5	1509962	12%	1723701	N/A	N/A	N/A	N/A	131378	1.73E-01
45K Cooling Tower 3	7.32	17.5	1550049	12%	1769462	N/A	N/A	N/A	N/A	134866	1.78E-01
45K Cooling Tower 1	7.25	9.0	1045812	12%	1185997	N/A	N/A	N/A	N/A	90395	1.19E-01
50 Cooling Tower 1	3.00	4.9	2824	17%	3420	N/A	N/A	N/A	N/A	260.63	3.44E-04
50 Cooling Tower 2	3.00	4.9	2824	17%	3420	N/A	N/A	N/A	N/A	260.63	3.44E-04
Building 45 - Row 0 precip tanks	12.5	30.2	35400	46%	65133	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 1 precip tanks	11.0	29.35	27416	46%	50443	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 2 precip tanks	11.0	28.5	25221	41%	42388	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 3 precip tanks	11.0	27.7	26971	29%	37961	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 4 precip tanks	11.0	26.9	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 5 precip tanks	11.0	26.1	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
44-1 Main Stack	1.10	35.1	4200	20%	5250	N/A	N/A	N/A	N/A	2333	N/A
44-1 LVV1	0.60	28.3	7800	17%	9398	N/A	N/A	N/A	N/A	3133	N/A
44-1 LVV2	0.60	28.4	1920	15%	2259	N/A	N/A	N/A	N/A	816	N/A
44-2 Main Stack	1.08	35.1	5400	23%	7013	N/A	N/A	N/A	N/A	2338	N/A
44-2 LVV	1.09	35.3	16200	7%	17476	N/A	N/A	N/A	N/A	5340	N/A
Calciner 4 LVV	0.89	41.7	7800	24%	10263	N/A	N/A	N/A	N/A	5132	N/A
Calciner 4 Extraction Hoods	0.88	37.8	4200	1%	4255	N/A	N/A	N/A	N/A	721	N/A
48A Tank Exhaust	0.30	9.5	240	35%	369	N/A	N/A	N/A	N/A	697	N/A
47K1 oxalate filter press building stack	0.83	35.0	4837.5	9%	5304	N/A	N/A	N/A	N/A	1414	4.97E-02
Grouped Sources:											
Mill 3 Trommel Vent	0.45	13.0	6052	24%	7921	N/A	N/A	N/A	0.12	8311	1.26E-01
Mill 4 Trommel Vent	0.45	13.0	6052	24%	7921	N/A	N/A	N/A	0.12	8311	1.26E-01
Mill 5 Trommel Vent	0.45	13.0	6052	24%	7921	N/A	N/A	N/A	0.12	8311	1.26E-01
25A-1 Tank Vents (Vent 1)	0.75	25.4	338	68%	1042	N/A	N/A	N/A	N/A	4285	2.30E-01
25A-1 Tank Vents (Vent 2)	0.75	25.4	338	68%	1042	N/A	N/A	N/A	N/A	4285	2.30E-01
25A-2 Tank Vents	0.50	25.4	676	68%	2084	N/A	N/A	N/A	N/A	8570	4.59E-01
25A-3 Tank Vents (Vent 1)	0.75	25.4	761	90%	7940	N/A	N/A	N/A	N/A	97605	5.17E-01
25A-3 Tank Vents (Vent 2)	0.75	25.4	761	90%	7940	N/A	N/A	N/A	N/A	97605	5.17E-01
25A-4 Tank Vents	0.55	25.4	676	68%	2084	N/A	N/A	N/A	N/A	8570	4.59E-01
Blow-off (stack 1)	0.73	24.3	0	99%	0	N/A	N/A	N/A	N/A	0	0.00E+00
Blow-off (stack 2)	0.73	24.3	0	99%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35J-11 Tank Vents (Non cons)	0.49	9.7	1514	21%	1923	N/A	N/A	N/A	8.97E-04	6300	1.84E-02
35J-12 Tank Vents (Non cons)	0.49	9.7	1352	21%	1718	N/A	N/A	N/A	8.01E-04	5626	1.64E-02
35J-13 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
35J-14 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
35J-15 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
35J-24 Tank Vents (Non cons)	0.49	9.7	281	67%	859	N/A	N/A	N/A	1.67E-04	1091	3.42E-03
35J-25 Tank Vents (Non cons)	0.49	9.7	407	67%	1244	N/A	N/A	N/A	2.41E-04	1581	4.95E-03
B26 Stacks (Existing)	1.13	27.0	19839	50%	39678	N/A	N/A	N/A	N/A	77124	2.96E-01
35A-1 Tank Vent (Non cons)	0.60	16.5	0	37%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 Tank Vent (Non cons)	0.60	16.5	652	37%	1032	N/A	N/A	N/A	N/A	9400	2.29E-02
35A-1 overflow pipe	0.40	0.10	0	37%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 overflow pipe	0.40	0.10	99	37%	157	N/A	N/A	N/A	N/A	1427	3.48E-03
Calciner 1-3 Pan Filter Exhaust Vents	0.31	20.1	3420	32%	5029	N/A	N/A	N/A	N/A	6147	N/A

2018 s.46 2.85Mtpa FORECAST EMISSION RATES - AVERAGE

Legend: 0 denotes measured but not detected; N/A denotes no data gathered as it is presumed negligible; '-' denotes not applicable where a source did not exist.

	Volatile Organic Compounds											
Source	**Acetaldehyde**	**Acetone**	**BaP Equivalents**	**Benzene**	**2-Butanone**	**Ethylbenzene**	**Formaldehyde**	**Styrene**	**Toluene**	**1,2,4 Trimethylbenzene**	**1,3,5 Trimethylbenzene**	**Xylenes**
	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
Combustion Equipment Point Sources:												
Liquor Burning	2.38E-03	1.25E-02	1.95E-07	1.08E-03	1.77E-03	0.00E+00	2.53E-03	0.00E+00	2.18E-04	0.00E+00	0.00E+00	8.25E-05
Calciner 1	7.65E-02	3.94E-02	2.33E-07	5.26E-03	3.69E-03	7.97E-05	8.61E-02	1.37E-04	5.56E-04	0.00E+00	0.00E+00	3.38E-04
Calciner 2	7.81E-02	3.72E-02	2.46E-07	4.99E-03	4.10E-03	8.40E-05	9.81E-02	1.45E-04	5.86E-04	0.00E+00	0.00E+00	3.57E-04
Calciner 3	8.22E-02	3.95E-02	3.56E-07	4.24E-03	4.71E-03	1.22E-04	8.63E-02	2.10E-04	8.49E-04	0.00E+00	0.00E+00	5.17E-04
Calciner 4	1.11E-01	6.90E-02	4.20E-07	7.43E-03	5.41E-03	2.89E-04	1.62E-01	3.12E-04	3.30E-03	8.33E-05	0.00E+00	1.13E-03
Boiler 1	8.54E-03	3.13E-02	N/A	5.34E-03	8.54E-03	0.00E+00	8.54E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 2	9.30E-03	2.64E-02	N/A	3.88E-03	6.20E-03	0.00E+00	6.20E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 3	5.81E-03	3.34E-02	N/A	3.63E-03	5.81E-03	0.00E+00	5.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Gas Turbine 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oxalate Kiln	0.00E+00	4.43E-03	N/A	0.00E+00	0.00E+00	N/A	7.97E-04	N/A	N/A	N/A	N/A	N/A
Non-Combustion Equipment Point Sources:												
Calciner 1-3 Low Volume Vent (100m multiflue)	3.26E-03	2.04E-02	N/A	4.52E-06	1.56E-03	0.00E+00	0.00E+00	0.00E+00	2.58E-03	0.00E+00	0.00E+00	1.18E-03
45K Cooling Tower 2	0.00E+00	1.70E-02	1.42E-06	0.00E+00	4.79E-03	0.00E+00	1.15E-01	8.09E-04	9.31E-04	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 3	0.00E+00	1.74E-02	1.46E-06	0.00E+00	4.92E-03	0.00E+00	1.18E-01	8.31E-04	9.56E-04	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 1	0.00E+00	1.18E-02	9.87E-07	0.00E+00	3.32E-03	0.00E+00	7.97E-02	5.60E-04	6.45E-04	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 1	0.00E+00	3.18E-05	2.66E-09	0.00E+00	8.96E-06	0.00E+00	2.15E-04	1.51E-06	1.74E-06	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 2	0.00E+00	3.18E-05	2.66E-09	0.00E+00	8.96E-06	0.00E+00	2.15E-04	1.51E-06	1.74E-06	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 0 precip tanks	0.00E+00	6.76E-04	N/A	3.07E-05	2.07E-04	3.66E-05	0.00E+00	2.88E-05	5.80E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 1 precip tanks	0.00E+00	5.24E-04	N/A	2.38E-05	1.60E-04	2.84E-05	0.00E+00	2.23E-05	4.49E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 2 precip tanks	0.00E+00	1.16E-03	N/A	0.00E+00	3.15E-04	0.00E+00	0.00E+00	0.00E+00	1.05E-04	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 3 precip tanks	0.00E+00	4.72E-04	N/A	0.00E+00	1.35E-04	0.00E+00	0.00E+00	0.00E+00	3.22E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 4 precip tanks	0.00E+00	5.39E-04	N/A	0.00E+00	1.54E-04	0.00E+00	0.00E+00	0.00E+00	3.68E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 5 precip tanks	0.00E+00	5.39E-04	N/A	0.00E+00	1.54E-04	0.00E+00	0.00E+00	0.00E+00	3.68E-05	0.00E+00	0.00E+00	0.00E+00
44-1 Main Stack	1.69E-03	1.45E-02	N/A	0.00E+00	2.80E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV1	8.67E-04	4.98E-03	N/A	0.00E+00	1.22E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV2	4.53E-04	2.19E-03	N/A	0.00E+00	5.79E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 Main Stack	2.63E-03	3.68E-02	N/A	0.00E+00	1.31E-02	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 LVV	4.95E-04	3.58E-03	N/A	0.00E+00	1.31E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 LVV	7.04E-03	5.42E-02	N/A	0.00E+00	8.23E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 Extraction Hoods	0.00E+00	2.39E-03	N/A	0.00E+00	2.98E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
48A Tank Exhaust	9.33E-05	1.00E-03	N/A	3.97E-05	3.53E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
47K1 oxalate filter press building stack	4.57E-04	7.19E-03	N/A	N/A	7.12E-03	2.55E-05	0.00E+00	N/A	6.25E-05	N/A	N/A	0.00E+00
Grouped Sources:												
Mill 3 Trommel Vent	2.71E-02	6.80E-02	1.40E-08	8.40E-05	3.45E-03	0.00E+00	0.00E+00	0.00E+00	2.01E-04	2.56E-04	0.00E+00	8.74E-05
Mill 4 Trommel Vent	2.71E-02	6.80E-02	1.40E-08	8.40E-05	3.45E-03	0.00E+00	0.00E+00	0.00E+00	2.01E-04	2.56E-04	0.00E+00	8.74E-05
Mill 5 Trommel Vent	2.71E-02	6.80E-02	1.40E-08	8.40E-05	3.45E-03	0.00E+00	0.00E+00	0.00E+00	2.01E-04	2.56E-04	0.00E+00	8.74E-05
25A-1 Tank Vents (Vent 1)	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-1 Tank Vents (Vent 2)	5.37E-03	4.50E-02	0.00E+00	5.44E-05	4.86E-03	4.31E-05	0.00E+00	4.69E-06	5.19E-04	5.51E-05	7.70E-05	4.83E-05
25A-2 Tank Vents	1.07E-02	9.01E-02	0.00E+00	1.09E-04	9.72E-03	8.62E-05	0.00E+00	9.38E-06	1.04E-03	1.10E-04	1.54E-04	9.67E-05
25A-3 Tank Vents (Vent 1)	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-3 Tank Vents (Vent 2)	4.79E-02	6.18E-02	0.00E+00	1.22E-04	5.07E-03	9.71E-05	0.00E+00	1.06E-05	1.17E-03	1.24E-04	1.73E-04	1.09E-04
25A-4 Tank Vents	1.07E-02	9.01E-02	0.00E+00	1.09E-04	9.72E-03	8.62E-05	0.00E+00	9.38E-06	1.04E-03	1.10E-04	1.54E-04	9.67E-05
Blow-off (stack 1)	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	N/A
Blow-off (stack 2)	0.00E+00	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	0.00E+00	N/A	0.00E+00	0.00E+00	N/A	N/A
35J-11 Tank Vents (Non cons)	4.41E-03	1.62E-02	1.60E-07	0.00E+00	2.22E-03	0.00E+00	1.23E-04	0.00E+00	3.04E-04	3.46E-04	9.76E-05	0.00E+00
35J-12 Tank Vents (Non cons)	3.94E-03	1.45E-02	1.43E-07	0.00E+00	1.98E-03	0.00E+00	1.09E-04	0.00E+00	2.71E-04	3.09E-04	8.72E-05	0.00E+00
35J-13 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
35J-14 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
35J-15 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
35J-24 Tank Vents (Non cons)	1.67E-03	3.59E-03	2.97E-08	0.00E+00	5.10E-04	0.00E+00	2.74E-05	0.00E+00	5.64E-05	6.43E-05	1.81E-05	0.00E+00
35J-25 Tank Vents (Non cons)	2.41E-03	5.19E-03	4.30E-08	0.00E+00	7.39E-04	0.00E+00	3.96E-05	0.00E+00	8.17E-05	9.31E-05	2.62E-05	0.00E+00
B26 Stacks (Existing)	1.63E-02	2.47E-02	0.00E+00	0.00E+00	1.64E-03	0.00E+00	0.00E+00	0.00E+00	2.51E-04	0.00E+00	0.00E+00	0.00E+00
35A-1 Tank Vent (Non cons)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 Tank Vent (Non cons)	3.64E-03	1.72E-02	3.75E-07	1.78E-05	2.11E-03	0.00E+00	0.00E+00	0.00E+00	1.17E-03	2.14E-04	5.35E-05	6.15E-05
35A-1 overflow pipe	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 overflow pipe	5.53E-04	2.61E-03	5.69E-08	2.71E-06	3.20E-04	0.00E+00	0.00E+00	0.00E+00	1.78E-04	3.24E-05	8.13E-06	9.34E-06
Calciner 1-3 Pan Filter Exhaust Vents	9.98E-03	3.71E-02	0.00E+00	0.00E+00	4.99E-03	0.00E+00	0.00E+00	0.00E+00	5.42E-05	0.00E+00	N/A	0.00E+00

2018 s.46 2.85Mtpa FORECAST EMISSION RATES - PEAK

Legend: 0 denotes measured but not detected; N/A denotes no data gathered as it is presumed negligible; '-' denotes not applicable where a source did not exist.

Source	Stack Diameter	Stack Height	Peak Stack Flow - DRY	Peak Stack Gas Moisture	Peak Stack Flow - WET	Products of Combustion			Miscellaneous		
						NOx	CO	SO2	Dust	Measured Odour	Ammonia
	m	m	Dry Nm3/hr	%	Wet Nm3/hr	g/s	g/s	g/s	g/s	OU/sec	g/s
Combustion Equipment Point Sources:											
Liquor Burning	1.10	100.0	73672	8%	79732	5.30	1.25	0.22	0.12	303423	2.17E-02
Calciner 1	1.90	100.0	75418	57%	176623	8.34	13.67	1.38	1.51	330000	1.11E-01
Calciner 2	1.90	100.0	80859	56%	182526	3.66	20.44	1.09	1.80	210000	1.19E-01
Calciner 3	2.15	100.0	117000	46%	217877	9.39	3.25	1.30	1.92	274000	1.72E-01
Calciner 4	2.35	48.8	132738	55%	293668	9.96	32.08	1.00	2.91	307000	1.95E-01
Boiler 1	2.40	65.0	195350	19%	241173	17.36	1.03	0.16	N/A	120519	2.26E-01
Boiler 2	2.00	65.0	136504	17%	165059	4.47	5.69	0.20	N/A	144060	1.58E-01
Boiler 3	2.00	65.0	128650	18%	156129	6.11	6.86	0.19	N/A	53474	1.49E-01
Gas Turbine 1	3.05	40.0	419957	10%	466774	7.00	32.66	3.64	N/A	N/A	N/A
Oxalate Kiln	1.00	36.8	46902	9%	51768	0.64	0.31	0.26	0.04	94908	N/A
Non-Combustion Equipment Point Sources:											
Calciner 1-3 Low Volume Vent (100m multiflue)	0.35	100.0	3132	61%	8031	0.0030	0.0000	0.00	N/A	40153.85	N/A
45K Cooling Tower 2	7.32	17.5	1509962	12%	1723701	N/A	N/A	N/A	N/A	3.47E+05	1.71E-01
45K Cooling Tower 3	7.32	17.5	1550049	12%	1769462	N/A	N/A	N/A	N/A	3.56E+05	1.75E-01
45K Cooling Tower 1	7.25	9.0	1045812	12%	1185997	N/A	N/A	N/A	N/A	2.39E+05	1.18E-01
50 Cooling Tower 1	3.00	4.9	148643	17%	179977	N/A	N/A	N/A	N/A	3.62E+04	1.78E-02
50 Cooling Tower 2	3.00	4.9	148643	17%	179977	N/A	N/A	N/A	N/A	3.62E+04	1.78E-02
Building 45 - Row 0 precip tanks	12.5	30.2	35400	46%	65133	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 1 precip tanks	11	29.35	27416	46%	50443	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 2 precip tanks	11	28.5	25221	41%	42388	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 3 precip tanks	11	27.7	26971	29%	37961	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 4 precip tanks	11	26.9	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
Building 45 - Row 5 precip tanks	11	26.1	30824	29%	43384	N/A	N/A	N/A	N/A	N/A	N/A
44-1 Main Stack	1.100	35.1	4200	20%	5250	N/A	N/A	N/A	N/A	2.33E+03	N/A
44-1 LVV1	0.60	28.3	7800	17%	9398	N/A	N/A	N/A	N/A	3.13E+03	N/A
44-1 LVV2	0.60	28.4	1920	15%	2259	N/A	N/A	N/A	N/A	8.16E+02	N/A
44-2 Main Stack	1.080	35.1	5400	23%	7013.0	N/A	N/A	N/A	N/A	2.53E+03	N/A
44-2 LVV	1.09	35.3	16200	7%	17475.7	N/A	N/A	N/A	N/A	5.34E+03	N/A
Calciner 4 LVV	0.890	41.7	7800	24%	10263.2	N/A	N/A	N/A	N/A	5.42E+03	N/A
Calciner 4 Extraction Hoods	0.88	37.8	4200	1%	4255.3	N/A	N/A	N/A	N/A	7.57E+02	N/A
48A Tank Exhaust	0.295	9.5	240	35%	369.2	N/A	N/A	N/A	N/A	6.97E+02	N/A
47K1 oxalate filter press building stack	0.840	35.0	20000	9%	21929.8	N/A	N/A	N/A	N/A	6.70E+03	2.33E-01
Grouped Sources:											
Mill 3 Trommel Vent	0.45	13.0	7867	22%	10022	N/A	N/A	N/A	0.22	11219	1.81E-01
Mill 4 Trommel Vent	0.45	13.0	7867	22%	10022	N/A	N/A	N/A	0.22	11219	1.81E-01
Mill 5 Trommel Vent	0.45	13.0	7867	22%	10022	N/A	N/A	N/A	0.22	11219	1.81E-01
25A-1 Tank Vents (Vent 1)	0.75	25.4	372	70%	1238	N/A	N/A	N/A	N/A	11819	5.65E-01
25A-1 Tank Vents (Vent 2)	0.75	25.4	372	70%	1238	N/A	N/A	N/A	N/A	11819	5.65E-01
25A-2 Tank Vents	0.50	25.4	743	70%	2477	N/A	N/A	N/A	N/A	23638	1.13E+00
25A-3 Tank Vents (Vent 1)	0.75	25.4	1785	86%	12750	N/A	N/A	N/A	N/A	820604	2.72E+00
25A-3 Tank Vents (Vent 2)	0.75	25.4	1785	86%	12750	N/A	N/A	N/A	N/A	820604	2.72E+00
25A-4 Tank Vents	0.55	25.4	743	70%	2477	N/A	N/A	N/A	N/A	23638	1.13E+00
Blow-off (stack 1)	0.73	24.3	62	99%	6029	N/A	N/A	N/A	N/A	186984	6.44E-02
Blow-off (stack 2)	0.73	24.3	221	99%	21387	N/A	N/A	N/A	N/A	663297	2.28E-01
35J-11 Tank Vents (Non cons)	0.49	9.7	2017	19%	2490	N/A	N/A	N/A	1.68E-03	20045	3.31E-02
35J-12 Tank Vents (Non cons)	0.49	9.7	1801	19%	2223	N/A	N/A	N/A	1.50E-03	17899	2.95E-02
35J-13 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
35J-14 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
35J-15 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
35J-24 Tank Vents (Non cons)	0.49	9.7	364	68%	1138	N/A	N/A	N/A	3.03E-04	8395	5.97E-03
35J-25 Tank Vents (Non cons)	0.49	9.7	528	68%	1650	N/A	N/A	N/A	4.40E-04	12178	8.65E-03
B26 Stacks (Existing)	1.13	27.0	38585	50%	77170	N/A	N/A	N/A	N/A	285100	7.21E-01
35A-1 Tank Vent (Non cons)	0.60	16.5	0	24%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 Tank Vent (Non cons)	0.60	16.5	1069	24%	1407	N/A	N/A	N/A	N/A	44710	7.58E-02
35A-1 overflow pipe (during filter press dumps)	0.40	0.10	0	24%	0	N/A	N/A	N/A	N/A	0	0.00E+00
35A-2 overflow pipe (during filter press dumps)	0.40	0.10	1971	24%	2593	N/A	N/A	N/A	N/A	82435	1.40E-01
Calciner 1-3 Pan Filter Exhaust Vents	0.31	20.1	5700	32%	8382	N/A	N/A	N/A	N/A	10711	N/A

2018 s.46 2.85Mtpa FORECAST EMISSION RATES - PEAK

Legend: 0 denotes measured but not detected; N/A denotes no data gathered as it is presumed negligible; '-' denotes not applicable where a source did not exist.

Source	Volatile Organic Compounds											
	Acetaldehyde	Acetone	BaP Equivalents	Benzene	2-Butanone	Ethylbenzene	Formaldehyde	Styrene	Toluene	1,2,4 Trimethylbenzene	1,3,5 Trimethylbenzene	Xylenes
	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s	g/s
Combustion Equipment Point Sources:												
Liquor Burning	3.89E-02	4.30E-01	7.04E-07	5.32E-03	1.11E-02	0.00E+00	2.46E-02	0.00E+00	7.37E-04	0.00E+00	0.00E+00	1.84E-04
Calciner 1	2.09E-01	2.09E-01	9.43E-07	2.09E-02	1.68E-02	1.68E-04	3.56E-01	3.56E-04	1.80E-03	0.00E+00	0.00E+00	9.43E-04
Calciner 2	2.25E-01	2.22E-01	1.01E-06	3.19E-02	3.35E-02	1.80E-04	3.59E-01	3.82E-04	1.93E-03	0.00E+00	0.00E+00	1.01E-03
Calciner 3	4.67E-01	3.58E-01	1.46E-06	3.00E-02	2.02E-02	2.60E-04	5.06E-01	5.53E-04	2.80E-03	0.00E+00	0.00E+00	1.46E-03
Calciner 4	2.47E-01	4.06E-01	1.66E-06	1.55E-02	1.84E-02	7.37E-04	5.16E-01	7.37E-04	3.69E-03	2.58E-04	0.00E+00	1.84E-03
Boiler 1	1.09E-02	5.43E-02	N/A	8.14E-03	1.09E-02	0.00E+00	1.09E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 2	1.52E-02	3.41E-02	N/A	5.69E-03	7.58E-03	0.00E+00	7.58E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Boiler 3	7.15E-03	4.29E-02	N/A	5.36E-03	7.15E-03	0.00E+00	7.15E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	N/A
Gas Turbine 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oxalate Kiln	0.00E+00	6.38E-02	N/A	0.00E+00	0.00E+00	N/A	4.43E-03	N/A	N/A	N/A	N/A	N/A
Non-Combustion Equipment Point Sources:												
Calciner 1-3 Low Volume Vent (100m multiflue)	1.74E-02	1.57E-01	N/A	3.22E-05	8.70E-03	0.00E+00	0.00E+00	0.00E+00	8.70E-03	0.00E+00	0.00E+00	2.00E-03
45K Cooling Tower 2	0.00E+00	1.47E+00	6.71E-06	0.00E+00	2.94E-01	0.00E+00	2.43E-01	3.36E-03	3.77E-03	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 3	0.00E+00	1.51E+00	6.89E-06	0.00E+00	3.01E-01	0.00E+00	2.50E-01	3.44E-03	3.88E-03	0.00E+00	0.00E+00	0.00E+00
45K Cooling Tower 1	0.00E+00	1.02E+00	4.65E-06	0.00E+00	2.03E-01	0.00E+00	1.68E-01	2.32E-03	2.61E-03	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 1	0.00E+00	1.45E-01	6.61E-07	0.00E+00	2.89E-02	0.00E+00	2.39E-02	3.30E-04	3.72E-04	0.00E+00	0.00E+00	0.00E+00
50 Cooling Tower 2	0.00E+00	1.45E-01	6.61E-07	0.00E+00	2.89E-02	0.00E+00	2.39E-02	3.30E-04	3.72E-04	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 0 precip tanks	0.00E+00	1.18E-03	N/A	3.84E-05	3.54E-04	5.02E-05	0.00E+00	3.44E-05	8.56E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 1 precip tanks	0.00E+00	9.14E-04	N/A	2.97E-05	2.74E-04	3.88E-05	0.00E+00	2.67E-05	6.63E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 2 precip tanks	0.00E+00	1.26E-03	N/A	0.00E+00	3.22E-04	0.00E+00	0.00E+00	0.00E+00	1.33E-04	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 3 precip tanks	0.00E+00	5.69E-04	N/A	0.00E+00	1.57E-04	0.00E+00	0.00E+00	0.00E+00	3.60E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 4 precip tanks	0.00E+00	6.51E-04	N/A	0.00E+00	1.80E-04	0.00E+00	0.00E+00	0.00E+00	4.11E-05	0.00E+00	0.00E+00	0.00E+00
Building 45 - Row 5 precip tanks	0.00E+00	6.51E-04	N/A	0.00E+00	1.80E-04	0.00E+00	0.00E+00	0.00E+00	4.11E-05	0.00E+00	0.00E+00	0.00E+00
44-1 Main Stack	1.75E-03	1.75E-02	N/A	0.00E+00	2.92E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV1	8.67E-04	4.98E-03	N/A	0.00E+00	1.26E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-1 LVV2	4.59E-04	2.24E-03	N/A	0.00E+00	6.40E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 Main Stack	2.85E-03	3.90E-02	N/A	0.00E+00	1.40E-02	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
44-2 LVV	7.65E-04	3.60E-03	N/A	0.00E+00	1.62E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 LVV	7.37E-03	5.85E-02	N/A	0.00E+00	8.67E-03	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
Calciner 4 Extraction Hoods	0.00E+00	2.57E-03	N/A	0.00E+00	3.03E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
48A Tank Exhaust	9.33E-05	1.07E-03	N/A	4.07E-05	3.80E-04	N/A	0.00E+00	N/A	N/A	N/A	N/A	N/A
47K1 oxalate filter press building stack	2.22E-03	3.28E-02	N/A	N/A	3.17E-02	1.28E-04	0.00E+00	N/A	2.61E-04	N/A	N/A	0.00E+00
Grouped Sources:												
Mill 3 Trommel Vent	3.93E-02	1.23E-01	1.97E-08	1.51E-04	5.59E-03	0.00E+00	0.00E+00	0.00E+00	3.93E-04	1.43E-03	0.00E+00	1.38E-04
Mill 4 Trommel Vent	3.93E-02	1.23E-01	1.97E-08	1.51E-04	5.59E-03	0.00E+00	0.00E+00	0.00E+00	3.93E-04	1.43E-03	0.00E+00	1.38E-04
Mill 5 Trommel Vent	3.93E-02	1.23E-01	1.97E-08	1.51E-04	5.59E-03	0.00E+00	0.00E+00	0.00E+00	3.93E-04	1.43E-03	0.00E+00	1.38E-04
25A-1 Tank Vents (Vent 1)	9.46E-03	6.65E-02	0.00E+00	2.06E-04	7.38E-03	8.26E-05	0.00E+00	1.03E-05	1.99E-03	3.82E-04	1.55E-04	2.99E-04
25A-1 Tank Vents (Vent 2)	9.46E-03	6.65E-02	0.00E+00	2.06E-04	7.38E-03	8.26E-05	0.00E+00	1.03E-05	1.99E-03	3.82E-04	1.55E-04	2.99E-04
25A-2 Tank Vents	1.89E-02	1.33E-01	0.00E+00	4.13E-04	1.48E-02	1.65E-04	0.00E+00	2.06E-05	3.98E-03	7.64E-04	3.10E-04	5.99E-04
25A-3 Tank Vents (Vent 1)	2.72E-01	2.97E-01	0.00E+00	9.92E-04	3.74E-02	3.97E-04	0.00E+00	4.96E-05	9.57E-03	1.83E-03	7.44E-04	1.44E-03
25A-3 Tank Vents (Vent 2)	2.72E-01	2.97E-01	0.00E+00	9.92E-04	3.74E-02	3.97E-04	0.00E+00	4.96E-05	9.57E-03	1.83E-03	7.44E-04	1.44E-03
25A-4 Tank Vents	1.89E-02	1.33E-01	0.00E+00	4.13E-04	1.48E-02	1.65E-04	0.00E+00	2.06E-05	3.98E-03	7.64E-04	3.10E-04	5.99E-04
Blow-off (stack 1)	1.22E-02	6.78E-02	N/A	0.00E+00	1.03E-02	N/A	2.08E-04	N/A	8.13E-05	0.00E+00	N/A	N/A
Blow-off (stack 2)	4.33E-02	2.40E-01	N/A	0.00E+00	3.65E-02	N/A	7.37E-04	N/A	2.89E-04	0.00E+00	N/A	N/A
35J-11 Tank Vents (Non cons)	8.96E-03	5.51E-02	5.10E-07	0.00E+00	4.41E-03	0.00E+00	5.04E-04	0.00E+00	1.38E-03	9.56E-04	2.76E-04	0.00E+00
35J-12 Tank Vents (Non cons)	8.00E-03	4.92E-02	4.56E-07	0.00E+00	3.94E-03	0.00E+00	4.50E-04	0.00E+00	1.24E-03	8.54E-04	2.47E-04	0.00E+00
35J-13 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
35J-14 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
35J-15 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
35J-24 Tank Vents (Non cons)	4.12E-03	8.54E-03	9.21E-08	0.00E+00	8.15E-04	0.00E+00	6.77E-05	0.00E+00	2.50E-04	1.73E-04	4.98E-05	0.00E+00
35J-25 Tank Vents (Non cons)	5.98E-03	1.24E-02	1.34E-07	0.00E+00	1.18E-03	0.00E+00	9.83E-05	0.00E+00	3.62E-04	2.50E-04	7.23E-05	0.00E+00
B26 Stacks (Existing)	3.88E-02	7.60E-02	0.00E+00	0.00E+00	6.32E-03	0.00E+00	0.00E+00	0.00E+00	8.57E-04	0.00E+00	0.00E+00	0.00E+00
35A-1 Tank Vent (Non cons)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 Tank Vent (Non cons)	1.73E-02	5.95E-02	1.66E-06	6.68E-05	8.89E-03	0.00E+00	0.00E+00	0.00E+00	3.88E-03	1.02E-03	2.52E-04	3.48E-04
35A-1 overflow pipe (during filter press dumps)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
35A-2 overflow pipe (during filter press dumps)	3.19E-02	1.10E-01	3.07E-06	1.23E-04	1.64E-02	0.00E+00	0.00E+00	0.00E+00	7.14E-03	1.89E-03	4.64E-04	6.42E-04
Calciner 1-3 Pan Filter Exhaust Vents	1.74E-02	6.65E-02	0.00E+00	0.00E+00	8.55E-03	0.00E+00	0.00E+00	0.00E+00	9.98E-05	0.00E+00	0.00E+00	0.00E+00