Intended for
Alcoa of Australia Ltd

Document type
Final Report

Date
December 2024

Project Number
318001068

PINJARRA ALUMINA REFINERY REVISED PROPOSAL
HEALTH RISK SCREENING ASSESSMENT

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PINJARRA ALUMINA REFINERY REVISED PROPOSAL HEALTH RISK SCREENING ASSESSMENT

Project name	**Pinjarra Alumina Refinery Revised Proposal Health Risk Screening Assessment**
Project no.	**318001068**
Document type	**Final Report**
Version	**Final**
Date	**20/12/2021**
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Document File Name	**Date Issued**	**Version**	**Author**	**Reviewer**
318001068 – Pinjarra Alumina Refinery Revised Proposal Health Risk Screening Assessment (Update)	20 December 2024	Draft	Adam Wightwick	Angela Ruthenberg / John Miragliotta
318001068 – Pinjarra Alumina Refinery Revised Proposal Health Risk Screening Assessment (Update)	09 June 2023	Draft	Anand Chandra / Chris Cook	Martin Parsons
318001068 – Pinjarra Alumina Refinery Revised Proposal Health Risk Screening Assessment	22 December 2021	Final	Hozefa Daginawala	Martin Parsons
318001068 – Pinjarra Alumina Refinery Revised Proposal Health Risk Screening Assessment	20 August 2021	C	Hozefa Daginawala	Martin Parsons
318001068 – Pinjarra Alumina Refinery Revised Proposal Health Risk Screening Assessment	4 August 2021	B	Hozefa Daginawala	Martin Parsons
318001068 – Pinjarra Alumina Refinery Revised Proposal Health Risk Screening Assessment	3 June 2021	A	Hozefa Daginawala	Martin Parsons

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EXECUTIVE SUMMARY

Alcoa of Australia Limited (Alcoa) is proposing to increase production at the Pinjarra Alumina Refinery (Refinery) by 5 per cent from 5.0 million tonnes per annum (Mtpa) to 5.25 Mtpa and extend the Huntly Bauxite Mine to the proposed Myara North and Holyoake mine regions (the Proposal). The Proposal is located in the Peel Region of Western Australia (WA), approximately 100 km southeast of Perth. The Proposal will be assessed by the Environmental Protection Authority (EPA) under Part IV of the *WA Environmental Protection Act 1986* (EP Act), and the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) via the bilateral agreement. The Proposal will be assessed via a Public Environmental Review (PER).

In 2014, Ramboll Australia Pty Ltd (formerly ENVIRON Australia) (Ramboll) conducted a screening assessment of the potential health risks arising from atmospheric emissions from the Refinery operating at a nominal alumina production rate of 5 Mtpa. (ENVIRON, 2014). GHD on behalf of Alcoa have commissioned Ramboll to revise the screening assessment to determine the potential health risks arising from atmospheric emissions associated with the proposed increase up to 5.25 Mtpa alumina production capacity of the Refinery.

The approach used to conduct the screening assessment is broadly consistent with the approach used for the previous (ENVIRON, 2014) screening assessment. Changes to the health protective guidelines that have occurred since 2014 have been identified and incorporated into the screening assessment, to ensure the most current guideline values are applied.

The screening assessment of the potential health risk arising from atmospheric emissions from the Refinery has been conducted using updated emission estimates derived by Alcoa for refinery point sources, fugitive sources including the Residue Storage Area (RSA) and bauxite stockpiles.

The screening assessment considered the health risk associated with the same list of compounds that was considered in the previous screening assessment with the addition of hydrogen sulphide (H_2S). The list of compounds comprised of 21 individual compounds (or groups of compounds), that are grouped into the following classes: particulates, products of combustion, metals, ammonia (NH_3), H_2S, organic compounds, Polycyclic Aromatic Hydrocarbons (PAHs), and dioxins and furans. A number of different scenarios were defined which allowed comparison of these emissions from the Refinery for the proposed increase in the alumina production capacity up to 5.25 Mtpa against previous assessment and the current operations.

Discrete receptor locations were identified around the Refinery to represent the populations or individual residences that could be potentially exposed to atmospheric emissions.

The potential health effects arising from the predicted short-term (acute) and long-term (chronic) exposure to non-carcinogenic compounds, and potential carcinogenic risks were considered in the screening assessment. The potential health effects were assessed by comparing the predicted exposure concentrations at the discrete receptor locations with health protective guidelines for ambient air developed by reputable authorities such as the National Environment Protection Council (NEPC), World Health Organisation (WHO) and the U.S Environmental Protection Agency (US EPA).

The results of the health risk screening assessment for atmospheric emissions from the Refinery indicate that, in relation to the proposed increase in the alumina production capacity of up to 5.25 Mtpa, the potential for emissions to cause acute or chronic non-carcinogenic health effects is low and acceptable. The results of the screening assessment indicate that the potential for emissions to contribute to the incidence of cancer in the exposed population is so low as to be almost negligible.

In general, production at the higher alumina production rate of 5.25 Mtpa at the Refinery is expected to result in a small increase in the quantitative health risk indicators at some of the receptor locations and a decrease at other locations (due to changes in the RSA). The increases are not considered significant as they do not affect the outcomes of the previous assessment (ENVIRON, 2014) in terms of risk of potential health effects.

As with any risk evaluation, there are areas of uncertainty in this screening assessment. To ensure that potential risks are not underestimated, uniformly conservative assumptions have been used to characterise exposure and toxicity. Due to the inherent conservatism in the methodology, it is reasonable to assume that the actual risk to exposed populations is lower than that presented in the health risk assessment.

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ACRONYMS AND ABBREVIATIONS

ATSDR	Agency for Toxic Substances and Disease Registry
BaP	Benzo(a)pyrene
CO	Carbon monoxide
CICAD	Concise Internal Chemical Assessment Document
GLC	Ground-level Concentration
HI	Hazard Index
HRA	Health Risk Assessment
H_2S	Hydrogen Sulphide
IRIS	Integrated Risk Information System
IPCS	International Programme on Chemical Safety
IOMC	Inter-Organization Programme for the Sound Management of Chemicals
IARC	International Agency for Research on Cancer
ICR	Incremental Carcinogenic Risk
LOAEL	Lowest dose level that produces an observable adverse effect
Mtpa	Million tonnes per annum
MRL	Minimal Risk Levels
NEPC	National Environment Protection Council
NH_3	Ammonia
NOAEL	Highest dose level that produces no observable adverse effect
NO_x	Oxides of nitrogen
NO_2	Nitrogen dioxide
OEHHA	Office of Environmental Health Hazarded Assessment
PAH	Polycyclic Aromatic Hydrocarbon
$PM_{2.5}$	Particulate Matter with an equivalent aerodynamic diameter of 2.5µm
PM_{10}	Particulate Matter with an equivalent aerodynamic diameter of 10µm
PEU	Pinjarra Efficiency Upgrade
REL	Reference Exposure Level
RIVM	Dutch National Institute of Public Health and the Environment
RSA	Residue Storage Area
RTO	Regenerative Thermal Oxidiser
SO_2	Sulphur Dioxide
US EPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compound
WHO	World Health Organisation

1. INTRODUCTION

Alcoa of Australia Limited (Alcoa) is proposing to increase production at the Pinjarra Alumina Refinery (Refinery or site) by 5 per cent from 5.0 million tonnes per annum (Mtpa) to 5.25 Mtpa and extend the Huntly Bauxite Mine to the proposed Myara North and Holyoake mine regions (the Proposal). The Proposal is located in the Peel Region of Western Australia (WA), approximately 100 km southeast of Perth. The Proposal will be assessed by the Environmental Protection Authority (EPA) under Part IV of the *WA Environmental Protection Act 1986* (EP Act), and the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act) via the bilateral agreement. The Proposal will be assessed via a Public Environmental Review (PER).

In 2014, Ramboll Australia Pty Ltd (formerly ENVIRON Australia) (Ramboll) conducted a screening assessment of the potential health risks arising from atmospheric emissions from the Refinery, operating at a nominal alumina production rate of 5 Mtpa (ENVIRON, 2014). GHD on behalf of Alcoa commissioned Ramboll to revise the screening assessment to determine the potential health risks arising from atmospheric emissions associated with the proposed increase up to 5.25 Mtpa alumina production capacity of the Refinery. The approach used to conduct the screening assessment is broadly consistent with the approach used for the previous (ENVIRON, 2014) screening assessment.

Changes to the health protective guidelines and updated emission estimates that have occurred since 2014, due to advancement in scientific understanding of the potential health effects of certain compounds have been identified and incorporated into the screening assessment, to ensure the most current guideline values are applied.

This report outlines the approach used to conduct the health risk screening assessment and presents the results of potential acute and chronic non-carcinogenic and carcinogenic health risks arising from atmospheric emissions from the Refinery at discrete receptor locations in the vicinity of the Refinery.

2. OVERVIEW OF THE SCREENING ASSESSMENT APPROACH

Risk assessment provides a systematic approach for characterising the nature and magnitude of the risks associated with environmental health hazards and is an important tool for decision-making. The generic steps involved in health risk assessment (HRA) include:

Exposure Assessment:	defines the amount, frequency, duration and routes of exposure to compounds present in environmental media. In this assessment, exposure is estimated as the concentration of a compound that a person may be exposed to over both short- (i.e. acute) and long-term (i.e. chronic) exposure periods;
Toxicity Assessment:	identifies the nature and degree of toxicity of chemical compounds, and characterises the relationship between magnitude of exposure and adverse health effects (i.e. the dose-response relationship);
Risk Characterisation:	the combining of exposure and toxicity data to estimate the magnitude of potential health risks associated with exposure periods of interest; and
Uncertainty Assessment:	identification of potential sources of uncertainty and qualitative discussion of the magnitude of uncertainty and expected effects on risk estimates.

This screening HRA conducted using the Refinery's emissions is considered to be a screening-level assessment in that it makes generally conservative default assumptions regarding the potential magnitude of exposure and uses conservative toxicity criteria. The quantitative health risk indicators calculated for potential acute and chronic health effects assume that the health effects arising from exposure to each of the individual compounds emitted from the Refinery are additive. The additive approach is considered to be appropriate for screening assessment purposes and is considered to be conservative (i.e. health protective) in most circumstances. It should however be noted that it does not account for potential synergistic effects.

Furthermore, the health risk evaluation allows for the determination of the incremental increase (or decrease) in health risk associated with the proposed increase in the alumina production rate by comparing the results of the previous screening HRA completed for the original 5 Mtpa proposal (ENVIRON, 2014), to the results determined for the current proposal. The previous screening HRA results will be updated to take account of changes to the health protection guidelines.

On account of the conservatism of such a screening assessment, the results are considered more likely to over- than under-estimate the potential health risks associated with atmospheric emissions from the Refinery. The results of the screening assessment are able to be used to assess the relative change to potential health risks associated with the proposed increase in the alumina production capacity, and identify the individual sources and compounds exhibiting the highest contribution to potential health risks in order to help define atmospheric emissions management strategies.

3. EXPOSURE ASSESSMENT

3.1 Conceptual Site Model

A conceptual site model provides a description of the source(s) of chemical compounds, the environmental pathway(s) of migration through various media and identifies the populations (human or ecological receptor) that may potentially be exposed. A complete source-pathway-receptor (SPR) linkage indicates potential for exposure, requiring further detailed investigation or exposure control. If any element of this relationship is missing, then an exposure risk does not exist and further assessment is not required.

The source of compounds in this HRA is from atmospheric emissions from the site. Further details of the CSM is discussed in proceeding Sections.

3.1.1 Compounds Considered

The same list of compounds that was considered in the previous screening assessment has been included in the screening assessment with the addition of hydrogen sulphide (H_2S). The list of compounds comprised of 21 individual compounds (or groups of compounds), that are grouped into the following classes:

- particulates;
- products of combustion;
- metals;
- ammonia (NH_3);
- H_2S;
- organic compounds;
- Polycyclic Aromatic Hydrocarbons (PAHs); and
- dioxins and furans.

This list of compounds was originally derived for a previous screening HRA conducted for the Refinery in 2003 (Toxikos, 2003) (excluding Particulate Matter with an equivalent aerodynamic diameter of 2.5 µm ($PM_{2.5}$)) on the basis that the emissions of these compounds represented over 90% of the total mass of emissions previously estimated for the Refinery (ENVIRON, 2003). Toxikos (2003) assessed 142 different compounds that could potentially be released from the Pinjara refinery. Of these, about 120 compounds did not have any associated guideline values; however Toxikos (2003) derived screening level guideline, known as "concentration of no toxicological concern" (CoNTC) for assessment. 84 compounds had predicted ground level concentrations (GLCs) below the CoNTC with majority having concentrations near zero. 22 out of the remaining 142 compounds accounted for more than 90% of the total mass of emissions from the refinery (ENVIRON 2003). The remaining compounds had very low concentrations that were not found to have any significant contribution towards calculated risks (acute, chronic or carcinogenic) at maximally exposed receptor location (Toxikos, 2003). The list of 22 compounds adopted since 2003 has undergone some refinement (Environ 2014), however the compounds that contribute the most towards any potential acute, chronic or carcinogenic risks continue to be included in the assessments. Toxikos (2003) further concludes that given the comprehensive assessment of the compounds, it was unlikely that any significant emission points or compounds were overlooked and any minor constituents were not expected to make any significant contribution towards GLCs or calculated risks.

It should be noted that this previous screening HRA (Toxikos, 2003) also considered the health risk associated with $PM_{2.5}$ and a number of additional Volatile Organic Compounds (VOCs). However, that assessment found that exposure to $PM_{2.5}$ was a minor contributor to the overall health risk from refinery point sources. In addition, the Pinjarra Residue Storage Area (RSA) particulate study (Ecowise, 2007) found that the ambient monitoring results showed that the ratio of $PM_{2.5}$ to particulate matter with an equivalent aerodynamic diameter of 10 µm (PM_{10}) was less than 0.1. Therefore, compliance with the PM_{10} 24-hour standard will mean that the $PM_{2.5}$ guideline will also be complied with. As such $PM_{2.5}$ has not been considered further in this screening assessment.

A previous screening HRA (Toxikos, 2003) also estimated the exposure concentrations for a number of additional VOC compounds[1] based on the application of minimum dilution factors, providing a conservative (i.e. overestimate) of the exposure concentration for these VOC compounds. The health risk associated with the exposure to these additional VOC compounds has not been considered in this assessment as emissions data were not available and the results of the previous screening HRA (Toxikos, 2003) found that the cumulative health risk associated with these additional VOC compounds is likely to be well below levels representing cause for concern.

Table 3-1 further shows the list of compounds that made notable contribution (>10%) towards calculated acute and chronic hazard index and incremental cancer risk in 2014 (ENVIRON 2014) and is a total of 9 compounds. Given the comprehensive historical reviews undertaken, the adoption of the 21 compounds for assessment is considered to provide a near-complete representation of refinery emissions, GLCs and potential risks at the identified receptor locations. As shown by Table 3-1, the list of 21 compounds is also comprehensive as less than 50% of the adopted compounds account for a large percentage of calculated potential risks.

Table 3-1: Compounds that made the most contribution towards calculated risks (>10%) in 2014.

Acute	**Chronic**	**Carcinogenic**
Arsenic	NO2	Arsenic
Mercury	PM10	Acetaldehyde
Nickel		Formaldehyde
NO2		Chromium (VI)
PM10		PAH

3.1.2 Potential Receptor Locations

Discrete receptor locations were identified around the Refinery to represent the populations or individual residences that could be potentially exposed to atmospheric emissions, as presented in Table 3-2. The locations of the receptors in relation to the Refinery are presented in Figure 1, overlain on an aerial photograph of the region.

[1] Methylene chloride (dichloromethane), ethylbenzene, isopropanol, hexane, styrene and acrolein.

Table 3-2 - Sensitive Receptor Locations

Receptor	Approximate Number of Individuals for which Receptor Representative	Description of Use
2	15	Fairbridge farm, permanent & short stay accommodation
3	500	Nearest residence in Carcoola town site
4	2,000	Nearest residence in Pinjarra town site
5	4	Residence, farmhouse
6	5	Residence, farmhouse
7	4	Residence, farmhouse
8	4	Residence, farmhouse
9	4	Residence, farmhouse
10	4	Residence, farmhouse
11	4	Residence, farmhouse
12	5	Residence, farmhouse

Notes:

1. Receptor 1, Receptor 13 and Receptor 14 are no longer used as residences, and therefore have not been included in this screening assessment.

It should be noted that three of the discrete receptor locations that were included in the previous screening assessment (ENVIRON, 2008) have not been included in this screening assessment as they are no longer used as residences, as follows:

Receptor 1: the farmhouse residence located north east of the Refinery, has since been purchased by Alcoa and is no longer inhabited;

Receptor 13: the former residence of an Alcoa employee and family, has since been demolished; and

Receptor 14: a former residence of the Alcoa farmlands manager and family, is no longer occupied, and may be demolished as the building is in poor condition.

For purposes of the screening assessment, all receptors are assumed to be residences, including potentially sensitive subpopulations such as children and the elderly. This assumption is inherent in the health protective guidelines selected (refer to Section 5).

3.1.3 Potentially Complete Exposure Pathways

Atmospheric emissions from source facilities, such as the site, include gaseous compounds and particulates, which creates an inhalation exposure pathway for exposed individuals. While compounds with higher vapour pressure remain in vapour phase, substances with lower vapour pressure may adsorb onto atmospheric particulate matter. Emitted particulates and adsorbed compounds tend to undergo deposition on vegetation, soil and water with distance travelled away from the emission source and deposit at a rate proportional to particle size (OEHHA, 2015). These mainly include heavy metals and certain semi-volatile organic compounds. In addition to inhalation exposure pathway, these multipathway compounds, create secondary exposure pathways including ingestion and dermal contact pathways.

For atmospheric emissions, where gaseous compounds or particulates travel long distances to sensitive receptors, inhalation exposure pathway and associated potential toxicities is expected to be the most significant route of intake. This is because gaseous and particulates can either be deposited on upper or lower respiratory tract where adverse effects can occur or enter systemic circulation via lung-blood interface, including particulates with very small diameters (eg. PM_{10} or $PM_{2.5}$). On the other hand, only the bioavailable[2] fraction of the multipathway compounds in exposure matrix is expected to reach systemic circulation via oral ingestion or dermal contact route. For example, only a certain percentage of arsenic in soil or dust will enter systemic circulation upon oral ingestion, due to the form arsenic is present in soil and dust. Furthermore, the multipathway compounds present in the Pinjara emissions, mostly heavy metals/metalloids, are also expected to be naturally present in the local environment and any atmospheric deposition is likely to make insignificant contribution towards soil and water concentrations. This is particularly true for the modelled emissions as the GLCs predicted at receptor locations are very low.

Furthermore, it has previously been demonstrated by ENVIRON (2004) that exposure pathways other than inhalation were insignificant for the Pinjara emissions scenario. The Hot Spots Analysis and Reporting Program (HARP) methodology developed by the Californian Office of Environmental Health Hazard Assessment (OEHHA) was used to provide a quantitative evaluation of arsenic intake via inhalation, ingestion (soil, water and vegetable) and dermal absorption routes. It was shown using very conservative deposition rates that arsenic inhalation accounted for 75% of carcinogenic exposure risks while 25% was potentially from non-inhalation pathways. The latter included soil ingestion (14%), vegetable ingestion (8%), dermal absorption (2%), and drinking water ingestion (1%).

Therefore, based on previous studies conducted by ENVIRON (2005, 2007) inhalation is expected to represent the most significant exposure route in relation to emissions from the Refinery, and the exposure assessment has been confined to the inhalation pathway.

Further assessment of the potential exposure via alternative exposure routes has not been included in the scope of this assessment as no changes have occurred since the previous assessments that would invalidate the conclusions of the previous studies.

Table 3-3 shows a summary of the CSM with SPR linkages (also see Section 5.6.6).

[2] Bioavailable – fraction of a contaminant that is absorbed into the body following dermal contact, ingestion or inhalation (enHealth 2012).

Table 3-3: Summary of the CSM showing potentially complete SPR linkages.

OEHHA (2015) Exposure Pathways	Potentially Complete Source-Pathway-Receptor Link? (Y/N)											Justification
	2	3	4	5	6	7	8	9	10	11	12	
Inhalation	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	Dispersion of emission creates a direct exposure pathway for identified receptors
Soil ingestion	N	N	N	N	N	N	N	N	N	N	N	Local soil concentrations not likely to be significantly impacted based on low GLCs
Vegetable ingestion	N	N	N	N	N	N	N	N	N	N	N	No soil uptake or direct fallout intake expected based on the low GLCs
Water ingestion	N	N	N	N	N	N	N	N	N	N	N	Local water sources are not expected to be significantly impacted based on the low GLCs
Fish ingestion	N	N	N	N	N	N	N	N	N	N	N	No uptake from water or sediments expected based on low GLCs
Meat, milk & egg ingestion	N	N	N	N	N	N	N	N	N	N	N	Local produce is not considered to be impacted based on low GLCs
Breast milk ingestion	N	N	N	N	N	N	N	N	N	N	N	Exposure via breast milk is not expected based on low GLCs and low inhalation risks

3.2 Emission Estimates

Emission estimates for the 21 individual compounds (or groups of compounds) considered in the screening assessment were based on a review of emission monitoring data obtained for the Refinery (GHD, 2021). The emissions estimates for the majority of the pollutants have been updated in this screening HRA compared to the previously completed HRA's. Furthermore, there are updated emissions from numerous additional sources (i.e. bioreactor) and there has been an addition of one new compound, hydrogen sulphide, when compared to the previous screening assessment (ENVIRON, 2014). This additional compound is included due to an addition of two new sources which were added for two of the scenarios (Scenarios 2 and 3). These sources were not present or were not considered significant sources at the time of the previous assessment.

- Third Bioreactor unit within the Oxalate Bioremoval Facility – This is a new source that was not present at the time of the previous assessment. Pollutants emitted from this source include NH_3, H_2S, toluene and xylene.
- B42 condensate tanks – historically has not been included previously in air quality modelling, however, a review of the sources to be included in the 2021 air quality modelling determined that B42 condensate tank was potentially a significant source that should be included. Therefore, following stack sampling at Tank 42C1 (intermediate quality condensate), the pollutants to be modelled were NH_3, aldehydes and ketones (except formaldehyde) and VOCs.

Emission estimates were derived for refinery point sources, fugitive sources including the RSA and bauxite stockpiles.

Additionally, it is important to note that in the 2004, 2008 and 2014 screening HRA, mercury that was not attributed to a point source or residue, was attributed to emission to air from lakes. That protocol has not been applied in 2020 data set, and thus, has resulted in some apparent reduction in mercury emissions from the lakes area.

3.3 Scenarios

The screening assessment has considered the potential health risks associated with the scenarios defined for the Refinery, as presented in Table 3-4.

For this assessment, Scenarios 1-3 utilised a new meteorological year (from March 2018 to February 2019 (2018-19)) in the air quality modelling developed using the WRF meteorological model. All past air quality modelling studies used the CSIRO's The Air Pollution Model (TAPM) v3.0.7 to generate meteorological input data for air dispersion modelling.

The scenarios have been named to align with the naming structure outlined in the air quality assessment (GHD, 2021) for consistency, with the exception of Scenario 0 which is used to represent the results from the previous assessment:

- Scenario 0 – Represents the results of the modelling from the previous (ENVIRON, 2014) assessment. This has been presented for comparative purposes;
- Scenario 1A – to reflect the change of a new meteorological year at 5 Mtpa operations based on the 2014 air quality modelling;
- Scenario 1B – Same as Scenario 1A but with updated health protective guidelines;
- Scenario 2 – Same as Scenario 1B but with updated average and peak emission rates for 5 Mtpa; and
- Scenario 3 – Increased throughput to 5.25 Mtpa.

Table A-1 in Appendix A lists the individual compounds or groups of compounds for which emissions have been quantified, and the corresponding total mass emission rate for each of the scenarios. Table A-1 to Table A-10 provide the mass emission rates of each compound from each source modelled.

Table 3-4 – Modelled Scenarios

Scenario	Alumina Production Rate	Emissions	Meteorology	Health Protective Guidelines
0	5 Mtpa	2014 Projections	2006	previous
1A	5 Mtpa	2014 Projections	2018-19	previous
1B	5 Mtpa	2014 Projections	2018-19	current
2	5 Mtpa	2014-2021 Monitored Average	2018-19	current
3	5.25 Mtpa	Predicted	2018-19	current

3.4 Estimated Concentrations in Air

Concentrations of pollutants of concern in the ambient air have been estimated based on the results of air dispersion modelling conducted by GHD (2021). Concentrations of pollutants of concern in ambient air representative of acute exposure have been derived using the 1-hour or 24-hour average GLCs predicted by the air dispersion modelling based on the peak emission estimates for the Refinery. Pollutant concentrations in ambient air representative of chronic exposure have been derived using the annual average GLCs predicted by the air dispersion modelling using the average emission estimates for the Refinery.

Appendix B presents details of the approach used to post process the modelling files, to derive the concentrations in ambient air.

3.4.1 Chemical Transformation

The air dispersion modelling has assumed that the gaseous emissions do not undergo chemical transformation once released into the atmosphere, except in the case of emissions of oxides of nitrogen (NO_x)and formaldehyde.

To estimate the amount of nitrogen dioxide (NO_2) that would be formed from NO_x emissions, in the presence of ozone (O_3) ($NO + O_3 \rightarrow NO_2 + O_2$), Ramboll has used the Ozone Limiting Method, as per the previous screening assessment (ENVIRON, 2014). This method assumes that the post-emission generation of NO_2 in atmosphere will be limited by the available amount of NO and O_3 with the lowest concentration of either NO or O_3 for each hour inferred to be equal to the maximum amount of NO_2 able to be formed. Further details of the approach are provided in Appendix B.

To account for the decay of formaldehyde concentrations in ambient air with time, GHD (2021) has assumed a decay rate of 5.7% per hour.

Potential chemical transformations of compounds that made the most contribution towards calculated risks (see Table 3-1) were also reviewed with details provided in Appendix A (Table A-18). It was found that most compounds tend to undergo photolytic and/or photochemical degradation, and wet/dry deposition. The exclusion of these processes from the emissions modelling is considered to result in a conservative estimate of GLCs and potential risks at receptor points (also see Section 5.6.6).

Furthermore, the HRA approach includes adding risks from exposure to individual compounds, which provides an assessment of cumulative risks from simultaneous exposure to multiple compounds. While the approach assumes that health effects are additive, in reality different compounds or groups of compounds may have different modes of action and impact different target organ systems. Therefore, the approach of adding individual chemical risks (acute, chronic and carcinogenic) is considered to be conservative.

4. TOXICITY ASSESSMENT

The toxicity assessment determines the relationship between the magnitude of exposure to a chemical of interest and the nature and severity of adverse health effects that may result from such exposure. Chemical toxicity is divided into two categories for purposes of risk assessment: carcinogenic and non-carcinogenic. Some chemicals exert both types of effects. Whilst all non-carcinogenic effects are assumed to occur only at exposure levels greater than some threshold at which defence mechanisms are overwhelmed, carcinogens are thought to act via both threshold and non-threshold mechanisms. By convention, exposure to even one molecule of a genotoxic carcinogen is assumed to incur some small but finite risk of causing cancer; hence, the action of such compounds is considered to lack a threshold below which adverse effects are not expected to occur. In contrast, the effects of non-genotoxic carcinogens are thought to be manifested only at exposures in excess of compound-specific thresholds. Potential health risks are calculated differently for threshold and non-threshold effects because their toxicity criteria are based on different mechanistic assumptions and expressed in different units.

A number of national and international regulatory agencies have reviewed the toxicity of environmental chemicals and developed acceptable exposure criteria (herein referred to as 'health protective guidelines') in accordance with both carcinogenic and non-carcinogenic endpoints. Health protective guidelines from the following reputable authorities were considered for use in the screening assessment:

- National Environment Protection Council (NEPC);
- World Health Organisation (WHO);
- U.S. Environment Protection Agency's (US EPA) Integrated Risk Information System (IRIS);
- U.S. Agency for Toxic Substances and Disease Registry's (ATSDR);
- Dutch National Institute of Public Health and the Environment (RIVM) (2001);
- Concise Internal Chemical Assessment Document (CICAD) and Environmental Health Criteria reports published under the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) and International Programme on Chemical Safety (IPCS); and
- California Office of Environmental Health Hazard Assessment's (OEHHA).

The health protective guidelines applied for the screening assessment are presented in Table A.11 of Appendix A, and briefly discussed in the following sections. The health protective guidelines that have been applied in this assessment are taken from the same reputable authorities referenced in the previous screening assessment (ENVIRON, 2014), and incorporating revisions to the health protective guidelines that have since occurred to ensure the most current guidelines have been applied (refer to Section 4.5). A summary of toxicity associated with compounds that contributed most towards calculated risks (see Table 3-1) is provided in Table A-18 (Appendix A).

4.1 Non-Carcinogenic Effects

A non-carcinogenic effect is defined as any adverse response to a chemical that is not cancer. Any chemical can cause adverse health effects if given at a high enough dose. When the dose is sufficiently low, no adverse effect is observed. Thus, in characterising the non-carcinogenic effects of a chemical, the key parameter is the threshold dose at which an adverse effect first becomes evident. Doses below the threshold are considered to be "safe" (i.e., not associated with adverse effects), while doses above the threshold may cause an adverse effect.

For chemicals that may exert non-cancer health effects, and for potentially carcinogenic chemicals deemed to act by a threshold mechanism, the potential hazard will be evaluated as the ratio of estimated exposure to the tolerable or acceptable exposure level (this ratio is termed a hazard quotient). A hazard quotient of one or below indicates that exposure is not anticipated to exceed acceptable levels. Hazard quotients for acute and chronic effects will be separately summed to calculate total hazard indices. The potential cancer risks associated with non-threshold chemicals will be summed for a conservative estimate of total incremental cancer risk and assessed according to the *de minimus* risk criteria of one in a million ($1x10^{-6}$).

The threshold dose is typically estimated from toxicological or epidemiological data by finding the highest dose level that produces no observable adverse effect (a NOAEL) or the lowest dose level that produces an observable adverse effect (a LOAEL). Where more than one such value is available, preference is given to studies using most sensitive species, strain and sex of experimental animal known, the assumption being that humans are no less sensitive than the most sensitive animal species tested. For the guidelines developed by all the authorities considered, NOAELs or LOAELs are divided by the product of a series of uncertainty factors representing experimental vs. environmental exposure duration, inter- and intra-species variability and the quality and completeness of the toxicological database. This procedure ensures that the resultant health protective guidelines are not higher than (and may be orders of magnitude lower than) the threshold level for adverse effects in the most sensitive potential receptor. Thus, there is a "margin of safety" built into the guideline, and doses equal to or less than that level are nearly certain to be without any adverse effect. The likelihood of an adverse effect at doses higher than the guideline increases, but because of the margin of safety, a greater dose does not mean that such an effect will necessarily occur.

4.2 Short-term (Acute) Exposure

Health protective guidelines for acute non-carcinogenic health effects are expressed as concentrations in air that are not expected to cause any adverse effects as a result of continuous exposure over a defined averaging period (typically 24 hours or less). These guidelines are appropriate for comparison with exposure estimates predicted by the air dispersion modelling for averaging periods of between 1-hour and 24-hours. Although obtained from different organisations/reference sources, the guidelines selected for this assessment are all intended to be protective of continually exposed (i.e. residential) receptors, including potentially sensitive subpopulations.

4.3 Long-term (Chronic) Exposure

Health protective guidelines for chronic non-carcinogenic health effects are expressed as concentrations in air that are not expected to cause any adverse health effects as a result of continuous long-term exposure (a year or more). These guidelines are appropriate for comparison with annual average exposure estimates predicted by the air dispersion modelling.

4.4 Carcinogenic Effects

Cancers are generally defined as diseases of mutation affecting cell growth and differentiation. Although many chemicals are known to cause cancer at high doses in studies with experimental animals, relatively few chemicals have been shown to be carcinogenic in humans at doses likely to be encountered in the ambient environment. Cancers are relatively slow to develop, and usually require prolonged exposure to carcinogenic chemicals. As a result, potential carcinogenic risks are only calculated for long-term exposures.

For potentially carcinogenic chemicals deemed to act by a non-threshold mechanism, potential cancer risks (the incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to the emitted carcinogen(s)) will be calculated as the product of estimated exposure and cancer potency factor, with probabilities ranging from one in a million ($1x10^{-6}$) to one in ten thousand ($1x10^{-4}$) generally considered to be acceptable.
The International Agency for Research on Cancer (IARC) classifies substances according to their potential for human carcinogenicity as indicated in Table 4-1.

Table 4-1 - IARC Classification Criteria

Group	Description
1	Carcinogenic to humans (sufficient evidence of carcinogenicity to humans)
2A	Probably carcinogenic to humans (sufficient evidence of carcinogenicity in animals, limited evidence of carcinogenicity in humans)
2B	Possibly carcinogenic to humans (less than sufficient evidence of carcinogenicity in animals, limited evidence of carcinogenicity in humans)
3	Not classifiable as to carcinogenicity in humans (inadequate or limited evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans)
4	Probably not carcinogenic to humans (evidence suggesting lack of carcinogenicity in animals and humans)

Those compounds present in the emissions from the Refinery included in this assessment that are classified by the IARC as Group 1, Group 2A or Group 2B are presented in Table 4-2.

Table 4-2 - IARC Compound Classifications

Compound Name	IARC Classification
arsenic	1 (Carcinogenic)
benzene	1 (Carcinogenic)
cadmium	1 (Carcinogenic)
chromium (VI)	1 (Carcinogenic)
formaldehyde	1 (Carcinogenic)
nickel	1 (nickel compounds) (Carcinogenic) 2B (nickel, metallic and alloys) (Possibly carcinogenic)
acetaldehyde	2B (Possibly carcinogenic)
mercury (inorganic)	Group 3 (Not classifiable as carcinogenic)
selenium and selenium compounds	Group 3 (Not classifiable as carcinogenic)
sulfur dioxide (SO_2)	Group 3 (Not classifiable as carcinogenic)
toluene	Group 3 (Not classifiable as carcinogenic)
xylene	Group 3 (Not classifiable as carcinogenic)
PM10	Not listed. Carcinogenic effects assessment by the individual constituents / compounds in particulate matter.
acetone	Not listed
ammonia (NH_3)	Not listed

Compound Name	IARC Classification
carbon monoxide	Not listed
hydrogen sulfide (H_2S)	Not listed
manganese	Not listed
2-butanone	Not listed

The IARC has classified nickel compounds as a Group 1 carcinogen and nickel , metallic and alloys as a Group 2B carcinogen. The most recent IARC (2012) evaluation of the carcinogenicity of nickel and compounds found that there is sufficient evidence in humans for the carcinogenicity of mixtures that include nickel compounds and nickel metal. The ultimate carcinogenic species in nickel carcinogenesis is the ion nickel (II). The evidence is strongest for water-soluble nickel compounds and risk for lung cancer, however it is not possible to entirely separate various nickel compounds in dose-response analysis for specific nickel compounds (IARC, 2012).

Health protective guidelines for genotoxic carcinogens are expressed as unit risk factors. A UR factor is defined as the theoretical upper bound probability of extra cases of cancer occurring in the exposed population assuming lifetime exposure by inhalation to 1 $\mu g/m^3$ of the chemical (hence units are per $\mu g/m^3$) (WHO, 2000). These guidelines are appropriate for comparison with annual average exposure estimates predicted by the air dispersion modelling.

4.4.1 Polycyclic Aromatic Hydrocarbons

Some individual PAHs are clearly carcinogenic, and others appear not to cause cancer, but the majority of this large class of chemicals cannot be classified as to potential carcinogenicity due to lack of sufficient data. The relative carcinogenic potency of specific PAHs has been published by the WHO relative to Benzo[a]pyrene (BaP), a widely reported PAH known for its carcinogenic potency.

The complex and variable composition and behaviour of PAH mixtures in the environment hinder attribution of health consequences to specific compounds. As a result, no one risk assessment approach is universally accepted. Three principal approaches reviewed by WHO (1998) are (1) toxicity equivalence factors, (2) comparative potency, and (3) use of BaP as a surrogate. WHO used the BaP surrogate approach in its Air Quality Guidelines for Europe (2000). The BaP surrogate approach has been applied for this assessment.

4.4.2 Dioxins and Furans

Dioxins (polychlorinated dibenzo-p-dioxins [PCDDs]) and furans (polychlorinated dibenzofurans [PCDFs]) are a group of toxic organic chemicals that remain in the environment for a long time and can accumulate in the body fat of animals and humans. Low levels of dioxins and furans were detected in emissions from the Oxalate kiln prior to the Pinjarra Efficiency Upgrade (PEU).[3] The Oxalate kiln was found to be the only Refinery emission source with detectable levels of dioxins and furans.

[3] In the 2002 Wagerup Air Emissions Inventory monitoring campaign, as well as other sampling undertaken for Alcoa on selected sources with potential to emit dioxins and furans, trace quantities of polychlorinated dioxins and furans were identified in Wagerup liquor burning (Coffey *et al*. 2002), Kwinana liquor burning (Ioppolo-Armanios and Coffey 2002); Wagerup Calciner 4 (Coffey *et al*. 2002) and Pinjarra oxalate kiln (Ioppolo-Armanios 2002) air emissions (stack analyses). In general, only the non-toxic congeners were detected, however the Pinjarra oxalate kiln stack air contained trace amounts of some toxic 2378-substituted-congeners.

The potential for dioxins and furans to be emitted from Alcoa's refineries has been eliminated by identifying and eliminating the chemical additives that were the precursors to the dioxin and furan emissions detected from the oxalate kiln (Alcoa, 2005). In addition, as part of the PEU the Oxalate kiln was fitted with a High Efficiency Wet Scrubber and Regenerative Thermal Oxidiser (RTO) to treat waste gases from this source, which provide an added level of protection from such emissions. Consistent with this, subsequent monitoring of emissions from the upgraded Oxalate kiln found no detectable levels of dioxins and furans. Therefore, it can be concluded that the combination of the changes to the Refinery inputs and the addition of the RTO has resulted in the elimination of measurable levels of dioxins and furans.

4.5 Revisions to Health Protective Guidelines

The review of current health protective guidelines revealed that since the previous screening assessment (ENVIRON, 2014), revised guidelines for acute and/or chronic non-carcinogenic health effects and incremental carcinogenic risk (IRC) have been published for a number of the compounds considered in the screening assessment. Table 4-3 presents a summary of the revisions to the health protective guidelines that are relevant to this screening assessment.

A number of the compounds have had updated guidelines based on revisions in the OEHHA. The OEHHA has developed guidelines for conducting a HRAs under California's Air Toxics Hot Spots Program, which include prescribed Reference Exposure Levels (RELs) for acute and chronic exposures. An inhalation REL is an airborne level of a chemical that is not anticipated to present a significant risk of an adverse non-cancer health effect.

Table 4-3 - Revisions to Health Protective Guidelines

Compound Name	Guideline (µg/m³)	Averaging Period	Reference	Guideline (µg/m³)	Averaging Period	Reference
	Acute Non-Carcinogenic					
	Current Guideline			Previous Guideline		
SO_2	5.20E+01	24-hour	NEPC (2021)	5.23E+02	1-hour	NEPC
NO_2	1.50E+02	1-hour	NEPC (2021)	2.25E+02	1-hour	NEPC
Acetaldehyde	4.70E+02	24-hour	OEHHA	2.00E+03	24-hour	WHO
NH_3	1.18E+03	24-hour	ATSDR	1.18E+03	24-hour	ATSDR
Xylenes	1.09E+03	24-hour	NEPC	1.08E+03	24-hour	NEPC
H_2S	4.20E+01	1-hour	OEHHA	No Previous Guideline(s)		
	Chronic Non-Carcinogenic					
	Current Guideline			Previous Guideline		
NO_2	2.80E+01	Annual	NEPC (2021)	5.70E+01	Annual	NEPC
PM_{10}	2.50E+01	Annual	NEPC (2021)	No Previous Guideline(s)		
Arsenic	1.50E-02	Annual	OEHHA	1.00E+00	Annual	RIVM
Mercury	3.00E-02	Annual	OEHHA	2.00E-01	Annual	WHO
Manganese	5.00E-02	Annual	IRIS	1.50E-01	Annual	WHO
Chromium (VI)	5.00E-03	Annual	ATSDR	1.00E-01	Annual	IRIS
Nickel	1.40E-02	Annual	OEHHA	9.00E-02	Annual	ATSDR
Selenium	2.00E+01	Annual	OEHHA	2.00E+01	Annual	OEHHA
NH_3	7.60E+01	Annual	ATSDR	1.00E+02	Annual	IRIS
Acetaldehyde	9.00E+00	Annual	IRIS	5.00E+01	Annual	WHO
Formaldehyde	9.00E+00	Annual	OEHHA	1.10E+01	Annual	IRIS
Benzene	1.00E+01	Annual	ATSDR	3.00E+00	Annual	OEHHA
Xylenes	8.68E+02	Annual	NEPC	8.67E+02	Annual	NEPC
H_2S	2.00E+00	Annual	OEHHA	No Previous Guideline(s)		
BaP	2.74E-04	Annual	NEPC	No Previous Guideline(s)		

Incremental Carcinogenic Risk						
Compound Name	Unit Risk Factor per µg/m³	Averaging Period	Reference	Unit Risk Factor per µg/m³	Averaging Period	Reference
	Current Guideline			Previous Guideline		
Chromium (VI)	1.20E-02	Annual	OEHHA	4.00E-02	Annual	WHO
Nickel	2.60E-04	Annual	OEHHA	3.80E-04	Annual	WHO
Formaldehyde	6.00E-06	Annual	OEHHA	1.30E-05	Annual	IRIS
BaP	6.00E-04	Annual	NEPC	8.70E-02	Annual	WHO

5. RISK CHARACTERISATION

Screening-level quantitative health risk indicators have been calculated for potential acute and chronic non-carcinogenic health effects, and carcinogenic health effects for each of the defined scenarios (refer to Section 0).

The quantitative risk indicators are described in Section 5.1, and the findings of the risk characterisation are presented in Sections 5.2 to 5.6. The sections focus on the maximally affected receptors, and the least affected receptors, as this represents the range of quantitative health risk indicators calculated for all of the discrete receptor locations. The calculated health risk indicators at all of the receptor locations and for each compound individually are presented in Table A-12, Table A-13, and Table A-14 of Appendix A. Table A-15, Table A-16, and Table A-17 of Appendix A presents the per cent contribution of individual compounds to the quantitative risk indicators at all of the receptor locations.

Figure 3, Figure 4, Figure 6 and Figure 8 present contours of the calculated health risk indicators for selected scenarios, overlain on an aerial photograph of the region.

5.1 Quantitative Risk Indicators

The Hazard Index (HI) is calculated to evaluate the potential for non-carcinogenic adverse health effects from simultaneous exposure to multiple compounds by summing the ratio of the estimated concentration in air to the health protective guidelines for individual compounds. The HI is calculated for acute (Equation 1) and chronic (Equation 2) exposures.

$$HI_{Acute} = \sum \frac{C_{\leq 24h}}{Gdl_{Acute}}$$ ***Equation 1***

$$HI_{Chronic} = \sum \frac{C_{Annual}}{Gdl_{Chronic}}$$ ***Equation 2***

Where:

HI_{Acute} = acute Hazard Index

$C_{\leq 24h}$ = ground level concentration predicted over an averaging period of typically ≤ 24 hours, matching the averaging time of the health protective guideline for compound (μg/m^3)

Gdl_{Acute} = acute health protective guideline for compound (μg/m^3)

$HI_{Chronic}$ = chronic Hazard Index

C_{Annual} = annual average ground level concentration for compound (μg/m^3)

$Gdl_{Chronic}$ = chronic health protective guideline for compound (μg/m^3)

For this screening assessment, similar to previous assessment (ENVIRON, 2014) the acute HI for each hour and model receptor has been calculated by summing the individual acute hazard quotients derived from the predicted GLCs for each individual compound. The calculated acute HIs for each of the modelled hours was analysed to determine the maximum and 9th highest value, at each modelled grid point and discrete receptor location. Appendix B presents details of the approach used to post process the modelling files, to derive the maximum and 9th highest acute HIs.

The maximum acute HI is predicted to occur once per year under "worst case" meteorological and peak emission conditions from all sources and therefore is still considered to be a conservative (over) estimate of actual acute exposure health risk. Whilst the 9th highest acute HI represents a more realistic, yet still conservative estimate of the risk of potential acute health effects. The CSIRO (2005) state that the 9th highest concentration or robust highest concentration (RHC) is often chosen as the key statistic to represent the extremes, rather than the modelled or observed maximum.

There has also been no change to the approach used to derive the chronic HI, in that the predicted annual average GLCs have been used to derive the chronic HI at the discrete receptor locations.

The general rule of thumb for interpreting the HI is that:

- values of 1 or less means air toxics are unlikely to cause adverse noncancer health effects over a lifetime of exposure, hence the risks are considered low and acceptable.;
- values greater than 1 do not necessarily mean adverse effects are likely, as this is evaluated on a case-by-case basis. For this report, due to the inherent conservatism embedded in the exposure and toxicity assessments, values minorly greater than 1 do not represent cause for concern (i.e. risks acceptable) (EPA's 2014 National Air Toxics Assessment 2018).

The carcinogenic risk provides an indication of the incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens and is expressed as a unitless probability. The ICR for individual compounds is summed to calculate the potential total ICR from exposure to multiple compounds (Equation 3).

$$Risk = \sum_{1}^{i} C_{i\ Annual} \times \frac{EF \times ED}{AT} \times UR_i$$

Equation 3

Where:

$Risk$	= lifetime incremental total cancer risk
C_{Annual}	= annual average ground level concentration for compound (µg/m^3)
EF	= exposure frequency (365 days/year)
ED	= exposure duration (70 years)
AT	= averaging time (365 days/year x 70 years, or 25,550 days)
UR_i	= Unit Risk factor for compound (per µg/m^3)

The ICR that is considered acceptable varies amongst jurisdictions, typically ranging from one in a million ($1x10^{-6}$) to one in ten thousand ($1x10^{-4}$). EnHealth (2012) suggests that in the case of an assessment for multiple chemical exposures, a combined risk of $1x10^{-5}$ may be considered acceptable by Australian environmental regulatory authorities. The most stringent criterion of one in a million represents the US EPA's *de minimis*, or essentially negligible incremental risk level, and has therefore been adopted for this screening assessment as a conservative (i.e. health protective) indicator of acceptable IRC.

5.2 Acute Non-Carcinogenic Effects

Acute HIs have been calculated for each of the defined scenarios based on peak emission estimates for the Refinery. Receptors 2 and 12 exhibit the highest acute HIs, and Receptors 5 and 6 exhibit the lowest acute HIs, thereby representing the range of calculated acute HIs for all the receptor locations. Table 5-1 presents the range of maximum and 9th highest acute HIs calculated for the defined scenarios.

Table 5-1 - Summary of Acute Hazard Indices

Scenario	Highest			Lowest		
	Acute HI Maximum	Acute HI 9th Highest	Receptor [1]	Acute HI Maximum	Acute HI 9th Highest	Receptor [1]
Scenario 0	0.65	0.53	2	0.36	0.29	6
Scenario 1A	0.72	0.55	12	0.42	0.29	5
Scenario 1B	0.83	0.66	12	0.50	0.34	5
Scenario 2	0.83	0.68	12	0.52	0.38	5
Scenario 3	0.84	0.71	12	0.55	0.40	5

Notes:

1. The receptor where the maximum predicted HI concentration has been presented.

From Table 5-1 it can be seen that the acute HI is less than one for all of the scenarios and receptor locations considered in the assessment, indicating the risks are low and acceptable in terms of potential acute non-carcinogenic health effects.

Figure 3 and Figure 4 present the contours of the maximum acute HIs (Figure 3) and 9th highest acute HIs (Figure 4) for Scenario 0 to Scenario 3, overlain on an aerial photograph of the Pinjarra region, to show the change from the current to the proposed increase in the alumina production rate of the Refinery. It can also be seen that the highest acute HIs are predicted to occur in the immediate vicinity of the Refinery plant site and the RSA.

Figure 3 presents the maximum acute HI calculated for all of the scenarios. The figure shows that from Scenario 0 to Scenario 1A, the change in the meteorological data file results in a general increase in the predicted maximum acute HI across the grid except on the western edge of the facility near the RDA's.

From Figure 3 it can be seen that the acute HI for Scenario 1B is higher than for Scenario 1A at each of the receptor locations which is associated with the revision in the associated acute health protective guidelines for arsenic , cadmium , nickel, mercury, NH_3, benzene and H_2S (refer to Section 4.5). As the acute HI for Scenario 1B does not increase above a value of one, the revisions to the acute health protective guidelines do not alter the outcome of the previous assessment (ENVIRON, 2014).

Scenario 2 is representative of the Refinery at the current 5 Mtpa alumina production rate but with refined emissions estimates based on more recent monitoring that has been conducted at the refinery. From Figure 3 it can be seen that at most of the eastern receptor locations, the maximum acute HI was predicted to increase based on updated emissions estimates but decrease on the western edge of the facility.

Scenario 3 is representative of alumina at the proposed production rate of 5.25 Mtpa which shows a small increase in Figure 3 in the predicted except near the RSA where due to changes in operations, a reduction in emissions is expected.

As the acute HIs for Scenario 3 do not increase above a value of one at sensitive receptor locations, the proposed increase in the alumina production rate of the Refinery does not indicate cause for concern in terms of potential acute non-carcinogenic health effects.

The pollutants that contribute most significantly to the acute HI include NO_2, PM_{10}, nickel and mercury, although the relative contribution of these compounds varies for the different scenarios and receptor locations. Table 5-1 presents a summary of the per cent contribution of the compounds of most significance to the maximum acute HI for all scenarios 1 to 3.

Table 5-2 - Contribution of Individual Compounds to Acute HI – Scenarios 0 to 3

Scenario 0											
Maximum Values	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	<1%	<1%	<1%	2%	2%	1%	<1%	<1%	<1%	<1%	1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	3%	2%	<1%	6%	11%	11%	4%	4%	4%	3%	3%
Benzene	<1%	<1%	<1%	1%	2%	2%	<1%	<1%	<1%	<1%	<1%
Cadmium	<1%	<1%	<1%	2%	2%	1%	<1%	<1%	<1%	<1%	1%
Carbon Monoxide	<1%	<1%	<1%	2%	2%	2%	<1%	<1%	<1%	<1%	1%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	41%	55%	9%	4%	7%	12%	35%	36%	37%	29%	36%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	16%	8%	<1%	3%	7%	9%	8%	8%	8%	6%	24%
NO_2	27%	9%	0%	35%	46%	54%	31%	33%	30%	33%	18%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	11%	25%	90%	43%	18%	5%	18%	15%	18%	27%	14%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	<1%	0%	1%	2%	2%	<1%	<1%	<1%	<1%	1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
99.9th Highest	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	1%	1%	<1%	2%	1%	5%	3%	2%	3%	1%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	2%	7%	<1%	5%	12%	6%	7%	8%	8%	9%	11%
Benzene	<1%	2%	<1%	1%	3%	1%	2%	2%	2%	2%	2%
Cadmium	1%	1%	<1%	2%	1%	4%	2%	2%	3%	<1%	<1%
Carbon Monoxide	2%	1%	<1%	<1%	<1%	2%	2%	1%	1%	<1%	<1%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	35%	9%	<1%	6%	9%	6%	6%	9%	10%	9%	13%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	5%	5%	<1%	6%	9%	5%	5%	9%	9%	8%	7%
NO_2	33%	56%	0%	36%	55%	30%	40%	46%	46%	47%	43%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	21%	16%	99%	40%	7%	38%	31%	21%	16%	21%	19%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	2%	0%	1%	3%	1%	2%	2%	2%	2%	2%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Scenario 1A											
Maximum Values	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	<1%	<1%	<1%	4%	<1%	4%	4%	5%	3%	2%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	4%	8%	3%	5%	3%	7%	3%	3%	2%	6%	3%
Benzene	<1%	2%	<1%	1%	<1%	2%	<1%	<1%	<1%	1%	<1%
Cadmium	<1%	0%	<1%	1%	<1%	2%	2%	2%	1%	<1%	<1%
Carbon Monoxide	<1%	3%	1%	2%	<1%	3%	<1%	<1%	<1%	2%	1%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	27%	6%	2%	7%	16%	3%	19%	17%	23%	6%	20%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	17%	7%	1%	7%	15%	3%	17%	15%	22%	6%	12%
NO_2	12%	32%	36%	39%	31%	40%	25%	29%	16%	34%	31%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	38%	41%	54%	32%	33%	34%	29%	27%	30%	40%	29%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	2%	<1%	2%	<1%	2%	<1%	<1%	<1%	1%	1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
99.9th Highest	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	1%	<1%	<1%	4%	6%	6%	4%	5%	4%	3%	1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	1%	3%	<1%	3%	5%	5%	7%	5%	6%	4%	4%
Benzene	<1%	<1%	<1%	<1%	1%	1%	2%	1%	1%	<1%	<1%
Cadmium	<1%	<1%	<1%	2%	3%	2%	2%	2%	2%	1%	<1%
Carbon Monoxide	<1%	<1%	0%	<1%	2%	2%	2%	2%	2%	1%	2%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	39%	9%	33%	27%	6%	7%	4%	4%	4%	5%	13%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	7%	8%	0%	11%	6%	6%	4%	3%	4%	5%	9%
NO_2	12%	29%	0%	7%	32%	31%	39%	40%	38%	36%	37%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	39%	48%	66%	46%	38%	39%	34%	35%	35%	42%	30%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	<1%	0%	<1%	1%	1%	2%	1%	2%	1%	1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Scenario 1B											
Maximum Values	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	<1%	<1%	<1%	3%	4%	4%	3%	4%	3%	2%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	4%	7%	3%	4%	3%	6%	6%	3%	6%	5%	3%
Benzene	<1%	1%	<1%	1%	<1%	1%	1%	<1%	1%	1%	<1%
Cadmium	<1%	0%	<1%	1%	2%	1%	1%	2%	1%	<1%	<1%
Carbon Monoxide	1%	2%	1%	2%	<1%	2%	2%	<1%	2%	2%	1%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	3%	5%	2%	6%	14%	3%	4%	15%	4%	5%	17%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	2%	6%	1%	6%	13%	3%	4%	13%	4%	5%	11%
NO_2	54%	42%	46%	49%	40%	49%	51%	37%	50%	44%	40%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	34%	36%	46%	26%	22%	28%	25%	23%	26%	34%	25%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	0%	<1%	2%	2%	2%	2%	3%	2%	1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
99.9th Highest	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	1%	<1%	<1%	3%	<1%	5%	7%	4%	3%	5%	4%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	3%	3%	3%	5%	5%	5%	5%	6%	5%	2%	3%
Benzene	<1%	<1%	<1%	1%	1%	<1%	1%	1%	1%	<1%	<1%
Cadmium	<1%	<1%	<1%	1%	<1%	2%	3%	2%	1%	2%	2%
Carbon Monoxide	1%	<1%	<1%	2%	2%	2%	2%	2%	2%	<1%	1%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	5%	8%	1%	3%	5%	5%	3%	3%	4%	9%	11%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	2%	7%	1%	4%	5%	5%	3%	3%	4%	5%	8%
NO_2	49%	38%	30%	38%	41%	41%	48%	45%	48%	43%	47%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	36%	42%	62%	39%	41%	33%	21%	29%	29%	30%	18%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	<1%	<1%	2%	<1%	3%	5%	3%	2%	3%	3%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Scenario 2											
Maximum Values	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	<1%	<1%	<1%	<1%	1%	<1%	1%	1%	<1%	1%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	2%	5%	2%	4%	4%	4%	4%	4%	4%	3%	2%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Cadmium	<1%	0%	<1%	3%	4%	3%	3%	4%	3%	4%	<1%
Carbon Monoxide	5%	2%	9%	3%	2%	2%	3%	1%	2%	2%	7%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	<1%	0%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Mercury	4%	9%	3%	6%	6%	7%	6%	7%	6%	5%	4%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	3%	10%	3%	6%	7%	6%	7%	8%	8%	8%	4%
NO_2	52%	43%	45%	46%	41%	43%	46%	39%	45%	41%	53%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	33%	31%	36%	29%	32%	32%	27%	31%	29%	33%	29%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	0%	<1%	1%	2%	2%	2%	2%	1%	2%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
99.9th Highest	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	<1%	<1%	<1%	<1%	<1%	1%	2%	1%	2%	<1%	1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	1%	5%	2%	2%	4%	4%	4%	2%	3%	3%	3%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Cadmium	2%	<1%	2%	3%	<1%	4%	6%	4%	6%	2%	4%
Carbon Monoxide	5%	2%	4%	6%	1%	2%	1%	3%	1%	1%	1%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	<1%	0%	0%	0%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Mercury	2%	8%	2%	2%	7%	7%	7%	3%	6%	6%	7%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	3%	6%	2%	2%	7%	7%	9%	5%	8%	7%	14%
NO_2	45%	35%	35%	47%	34%	34%	40%	43%	41%	38%	42%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	40%	43%	51%	36%	45%	39%	27%	36%	29%	41%	25%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	<1%	<1%	1%	<1%	2%	3%	2%	3%	<1%	2%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Scenario 3											
Maximum Values	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	<1%	<1%	<1%	2%	2%	2%	2%	2%	3%	2%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	2%	6%	2%	4%	4%	4%	4%	4%	4%	3%	2%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Cadmium	<1%	0%	<1%	3%	4%	3%	3%	4%	5%	4%	<1%
Carbon Monoxide	5%	2%	9%	3%	2%	2%	2%	1%	2%	1%	7%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	<1%	0%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Mercury	4%	10%	3%	6%	6%	6%	7%	7%	6%	6%	4%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	3%	10%	3%	6%	7%	6%	8%	8%	8%	7%	4%
NO_2	53%	46%	45%	47%	42%	45%	44%	40%	44%	42%	52%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	31%	26%	37%	28%	30%	30%	27%	30%	25%	32%	29%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	0%	<1%	1%	2%	2%	2%	2%	2%	2%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
99.9th Highest	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	1%	<1%	1%	1%	2%	3%	3%	2%	1%	<1%	2%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	2%	<1%	2%	2%	4%	4%	3%	2%	4%	3%	4%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Cadmium	2%	<1%	2%	3%	3%	5%	6%	4%	3%	2%	4%
Carbon Monoxide	5%	<1%	4%	2%	2%	1%	4%	3%	2%	1%	3%
Chromium (VI)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
H_2S	<1%	0%	0%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Mercury	3%	2%	2%	5%	7%	6%	5%	3%	6%	6%	6%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	3%	8%	2%	7%	8%	7%	4%	5%	7%	7%	6%
NO_2	47%	54%	35%	43%	37%	35%	45%	43%	40%	37%	48%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	37%	34%	51%	35%	37%	35%	26%	35%	34%	41%	25%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	<1%	<1%	<1%	1%	1%	3%	3%	2%	2%	<1%	2%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

The approach used to derive the acute HIs for this assessment has resulted, at least in-part, to some significant changes to the per cent contribution predicted for individual compounds at the discrete receptor locations, compared to the previous assessment. For example, for Scenario 1A the previous assessment indicated that the per cent contribution of PM_{10} to the maximum acute HI at Receptor 4 (90.3%) is much higher compared to that predicted for this assessment (54%). The previous assessment also indicated that NO_2 had no contribution (0%) to the maximum acute HI at Receptor 4, whilst for this assessment the contribution of NO_2 is predicted to be much higher (36%) at this same receptor location. Such variations in the results are related to the different meteorological conditions that the acute HIs have been predicted to occur under and the updates to the health guidelines.

5.3 Chronic Non-Carcinogenic Effects

Chronic HIs have been calculated for each of the defined scenarios based on average emission estimates for the Refinery. Receptors 2 (scenario 0 and 1B) and 12 (scenario 1A, 2 and 3) exhibit the highest chronic HI, and Receptor 6 exhibits the lowest Chronic HI, thereby representing the range of calculated chronic HIs for all the receptor locations. Table 5-3 presents the range of chronic HIs calculated for the defined scenarios.

Table 5-3 - Summary of Chronic Hazard Indices

Scenario	Highest		Lowest	
	Chronic HI	Receptor	Chronic HI	Receptor
Scenario 0	0.07	2	0.02	6
Scenario 1A	0.06	12	0.01	6
Scenario 1B	0.25	2	0.07	6
Scenario 2	0.19	12	0.05	6
Scenario 3	0.19	12	0.05	6

From Table 5-3 it can be seen that the chronic HI is comfortably less than one for all of the scenarios and at all of the receptor locations considered in the assessment, indicating risks are low and acceptable in terms of potential chronic non-carcinogenic health effects. The highest chronic HI for the proposed Scenario 3 is predicted to be 0.19 and occurs at Receptor 12.

Figure 5 presents the chronic HI calculated for all of the scenarios, at each of the receptor locations considered in the assessment, to illustrate the change in the chronic HI from Scenario 1A to Scenario 1B associated with the use of revised health protective guidelines, and also the change from Scenarios 1 (A & B) and 2 (associated with revised emissions parameters based on recent monitoring), to Scenario 3 (associated with the proposed increased in alumina production at the Refinery).

From Figure 5 it can be seen that the chronic HI for Scenario 1B is higher than Scenario 1A at each of the receptor locations. The increase is associated with revisions to the chronic health protective guidelines (refer to Section 4.5). As the chronic HI for Scenario 1B remains well below one, the revision to the chronic health protective guidelines do not alter the outcome of this assessment (or previous assessments).

The chronic HIs for Scenario 1A, 1B and Scenario 2 are representative of the Refinery at 5 Mtpa alumina production rate, and the chronic HIs for Scenario 3 is representative of an alumina production rate of 5.25 Mtpa. From Figure 5 it can be seen when comparing Scenario 2 and Scenario 3 that the Scenario 3 chronic HI is predicted to decrease or remain constant based on the proposed increase in the alumina production rate at the receptor locations.

As the chronic HIs for Scenario 3 do not increase above a value of one, the proposed increase in the alumina production rate of the Refinery does not indicate cause for concern in terms of potential chronic non-carcinogenic health effects.

Figure 6 present the contours of the Chronic HIs for Scenario 0 to Scenario 3, overlain on an aerial photograph of the Pinjarra region, to show the change from the current to the proposed increase in the alumina production rate of the Refinery. The chronic HI contours for Scenario 2 and Scenario 3 are not significantly different.

From Figure 6 it can be seen that a small increase is evident in the contours of the chronic HIs for Scenario 3 compared to Scenario 2, most evident to the north of the Refinery plant site. It can also be seen that the highest chronic HIs are predicted to occur in the immediate vicinity of the Refinery plant site.

The pollutants that contribute most significantly to the chronic HI include NO_2, mercury (primarily scenario 1A and 1B), and PM_{10}, although the relative contribution of these pollutants varies for the different scenarios and receptor locations. Table 5-3 presents a summary of the per cent contribution of the compounds of most significance to the chronic HI for each of the scenarios.

Table 5-4 - Contribution of Individual Compounds to Chronic HI for Scenario 0 to 3

Scenario 0											
Chronic	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	6%	7%	8%	7%	8%	8%	8%	8%	8%	7%	6%
Acetaldehyde	5%	5%	5%	3%	5%	5%	4%	5%	4%	4%	5%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	3%	3%	4%	3%	4%	4%	3%	3%	3%	3%	3%
Cadmium	5%	5%	7%	8%	8%	8%	10%	10%	10%	9%	7%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	38%	38%	27%	18%	32%	32%	19%	21%	19%	18%	26%
Manganese	1%	2%	2%	2%	2%	2%	3%	2%	2%	2%	2%
NH_3	3%	2%	2%	1%	2%	2%	2%	2%	2%	2%	3%
Nickel	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
NO_2	36%	34%	42%	53%	36%	37%	47%	44%	46%	50%	45%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
SO_2	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Scenario 1A											
Chronic	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	13%	16%	16%	14%	16%	16%	16%	16%	16%	15%	13%
Acetaldehyde	5%	4%	4%	3%	4%	5%	3%	3%	3%	3%	4%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Arsenic	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	4%	3%	4%	2%	4%	4%	3%	3%	2%	2%	3%
Cadmium	4%	7%	7%	8%	8%	8%	10%	10%	10%	9%	8%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	40%	25%	20%	14%	24%	24%	13%	15%	13%	12%	17%
Manganese	<1%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
NH_3	3%	2%	2%	1%	2%	2%	2%	2%	2%	2%	3%
Nickel	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
NO_2	28%	37%	43%	52%	37%	37%	47%	45%	48%	51%	48%
PAH	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
SO_2	<1%	1%	1%	2%	1%	1%	2%	2%	2%	2%	2%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Scenario 1B											
Chronic	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	3%	4%	3%	4%	4%	4%	5%	5%	5%	4%	4%
Acetaldehyde	5%	4%	4%	4%	5%	5%	5%	5%	5%	4%	5%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	1%	2%	2%	3%	2%	2%	3%	3%	4%	3%	3%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Cadmium	<1%	1%	1%	2%	2%	2%	3%	3%	3%	2%	2%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	47%	31%	23%	22%	32%	33%	24%	26%	23%	19%	27%
Manganese	<1%	1%	<1%	1%	1%	1%	2%	2%	2%	2%	1%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	1%	2%	1%	2%	2%	2%	3%	3%	3%	3%	3%
NO_2	10%	14%	15%	25%	15%	15%	25%	24%	26%	25%	23%
PAH	2%	1%	1%	<1%	1%	1%	1%	1%	1%	<1%	2%
PM_{10}	29%	38%	47%	34%	33%	32%	28%	26%	28%	36%	30%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
SO_2	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Scenario 2											
Chronic	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	4%	4%	4%	4%	4%	4%	5%	5%	5%	4%	4%
Acetaldehyde	7%	5%	4%	3%	5%	6%	4%	5%	4%	3%	5%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Cadmium	1%	2%	2%	3%	2%	2%	3%	3%	3%	3%	2%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Mercury	4%	5%	4%	5%	5%	5%	6%	6%	6%	6%	6%
Manganese	2%	3%	2%	4%	3%	3%	5%	5%	5%	4%	3%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	2%	2%	2%	3%	2%	3%	3%	3%	3%	3%	3%
NO_2	17%	21%	20%	33%	21%	21%	31%	31%	31%	29%	29%
PAH	3%	2%	2%	1%	2%	2%	2%	2%	2%	1%	3%
PM_{10}	58%	54%	58%	42%	51%	51%	37%	37%	38%	45%	43%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
SO_2	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

Scenario 3											
Chronic	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	4%	5%	4%	4%	4%	4%	5%	5%	5%	4%	4%
Acetaldehyde	8%	5%	5%	3%	6%	6%	4%	5%	4%	3%	5%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Cadmium	1%	2%	2%	3%	3%	2%	3%	3%	3%	3%	3%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Mercury	4%	5%	4%	5%	5%	5%	6%	6%	6%	6%	6%
Manganese	2%	3%	2%	4%	3%	3%	5%	5%	5%	4%	3%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	2%	3%	2%	3%	3%	3%	3%	3%	3%	3%	3%
NO_2	19%	24%	22%	33%	22%	22%	31%	31%	31%	29%	29%
PAH	3%	2%	2%	1%	2%	2%	2%	2%	2%	1%	3%
PM_{10}	55%	48%	56%	42%	50%	50%	37%	36%	37%	45%	42%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
SO_2	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%

From Table 5-4 it can be seen that the chronic HI is attributable largely to NO_2 and PM_{10} emissions, with PM_{10} accounting for over half of the chronic HI at some of the receptor locations. When comparing against the previous assessment conducted in 2014, it is important to note that there was no chronic health guideline for PM_{10}, and the marked increase in its prominence now is due to the introduction of an annual PM_{10} standard.

At Receptors 2 and 3 however, the chronic HI is attributable largely to mercury emissions for both Scenarios 1A and 1B. As previously noted, in the 2004, 2008 and 2014 screening HRA, mercury that was not attributed to a point source or residue, was attributed to emission to air from the lakes. That protocol has not been applied in 2020 data set, and thus, has resulted in some apparent reduction in mercury from the lakes area.

5.4 Carcinogenic Effects

The ICR has been calculated for each of the defined scenarios based on average emission estimates for the Refinery. Receptor 2 (scenario 0) and 12 (scenario 1A to 3) exhibit the highest ICR values, and Receptors 6 (all scenarios) exhibits the lowest ICR values. Table 5-5 presents the range of ICR values calculated for the defined scenarios.

Table 5-5 - Summary of Incremental Carcinogenic Risk

Scenario	Highest		Lowest	
	ICR	Receptor	ICR	Receptor
Scenario 0	1.39E-06	2	3.64E-07	6
Scenario 1A	1.23E-06	12	3.11E-07	6
Scenario 1B	6.48E-07	12	1.72E-07	6
Scenario 2	4.56E-07	12	1.19E-07	6
Scenario 3	4.63E-07	12	1.21E-07	6

The ICR values presented in Table 5-5 are best explained by way of example, with the ICR calculated for Scenario 1A at Receptor 2 of 1.45×10^{-6} (0.00000145 or 0.000145%) which can also be interpreted as a risk of 1 more person in 689,655 people developing cancer as a result of a lifetime of continuous exposure.

From Table 5-5 it can be seen that the highest ICR values were predicted to occur at Receptor 2 (Fairbridge farm) and Receptor 12. These values are only marginally above the *de minimis* threshold of one in a million. EnHealth (2012) suggests that in the case of an assessment for multiple chemical exposures, a combined risk of one in one hundred thousand (1×10^{-5}) may be considered acceptable by Australia environmental regulatory authorities, and all the predicted ICR values comply with this target risk level.

The ICR values predicted to occur at the other receptor locations comply with the *de minimis* threshold for all of the scenarios considered in the assessment. The potential for emissions from the Refinery to contribute to the incidence of cancer in the exposed population is therefore considered to be almost negligible.

Figure 7 presents the ICR calculated for all of the scenarios, at each of the receptor locations considered in the assessment, to illustrate the change in the ICR from all scenarios, that is associated with the proposed increased in alumina production at the Refinery. It should be noted that a minor change occurs in the ICR for Scenario 1A to Scenario 1B as this assessment compares the similar feed parameters but with revised health protective guidelines.

Figure 8 presents the contours of the ICR for scenario 0 to 3, overlain on an aerial photograph of the Pinjarra region, to show the change from the current to the proposed increase in the alumina production capacity of the Refinery. From Figure 8 it can be seen that although a minor increase is evident in the contours of ICR for Scenario 3 compared to Scenario 2, the difference is considered negligible.

When comparing scenario 3 to 1A, 1B and 0 it can be observed that the Scenario 3 ICR values are significantly lower than Scenarios 1A, 1B and 0. It can also be seen from Figures 8 and 9 that the highest ICR is predicted to occur in the immediate vicinity of the Refinery plant site and the RSA.

The pollutants that contribute most significantly to the ICR include formaldehyde, acetaldehyde, arsenic, PAHs and chromium (VI) (primarily in scenario 1A), although the relative contribution of these pollutants varies for the different scenarios and receptor locations.

From Table 5-6 it can be seen that emissions of formaldehyde account for nearly half of the ICR at many of the receptor locations, with emissions of acetaldehyde, PAH, arsenic and chromium (VI) (most prominent in scenario 1A and 1B) being the next most significant contributors to the ICR for all the proposed scenarios. Additionally, from Table 5-6 it can be seen that for Scenarios 2 and 3, the benzene emissions represented relatively greater contributions compared to Scenarios 0 to 1B.

Table 5-6 - Contribution of Individual Compounds to ICR – Scenarios 0 - 3

Scenario 0											
ICR	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	36%	41%	44%	48%	47%	47%	48%	48%	47%	45%	38%
Acetaldehyde	10%	10%	9%	8%	10%	10%	8%	9%	8%	8%	10%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	10%	11%	12%	13%	11%	11%	13%	12%	13%	13%	10%
Benzene	2%	3%	3%	2%	3%	3%	2%	2%	2%	2%	2%
Cadmium	2%	2%	3%	4%	3%	3%	4%	4%	4%	4%	3%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	26%	22%	20%	16%	14%	14%	16%	14%	16%	19%	21%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	3%	2%	2%	3%	2%	2%	3%	3%	3%	3%	3%
NO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAH	11%	10%	8%	6%	10%	9%	7%	8%	7%	7%	12%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toluene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Xylene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2-Butanone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Scenario 1A											
ICR	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	48%	53%	52%	53%	51%	51%	51%	52%	51%	48%	43%
Acetaldehyde	12%	9%	9%	7%	9%	9%	7%	7%	7%	6%	8%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	7%	11%	11%	13%	11%	11%	14%	13%	14%	14%	12%
Benzene	3%	3%	3%	2%	3%	3%	2%	2%	2%	2%	2%
Cadmium	2%	3%	3%	4%	3%	3%	4%	4%	4%	4%	3%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	16%	13%	13%	13%	13%	13%	14%	14%	15%	19%	21%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	2%	2%	2%	3%	2%	2%	3%	3%	3%	3%	3%
NO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAH	12%	7%	8%	5%	7%	8%	5%	5%	5%	4%	9%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toluene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Xylene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2-Butanone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Scenario 1B											
ICR	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	43%	45%	43%	43%	43%	42%	42%	42%	42%	40%	38%
Acetaldehyde	22%	16%	16%	12%	16%	17%	12%	13%	12%	11%	14%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	14%	19%	19%	24%	20%	20%	24%	24%	25%	25%	22%
Benzene	6%	5%	6%	4%	5%	6%	4%	4%	4%	3%	4%
Cadmium	3%	5%	5%	7%	6%	6%	7%	7%	7%	7%	6%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	9%	7%	7%	7%	7%	7%	8%	7%	8%	10%	12%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	2%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%
NO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAH	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toluene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Xylene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2-Butanone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Scenario 2											
ICR	**Receptor**										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	43%	50%	53%	52%	47%	46%	49%	48%	49%	47%	42%
Acetaldehyde	25%	17%	17%	13%	18%	19%	13%	14%	13%	13%	18%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	11%	12%	11%	13%	12%	12%	14%	14%	14%	16%	15%
Benzene	11%	8%	8%	6%	9%	9%	7%	7%	6%	6%	10%
Cadmium	5%	8%	7%	11%	9%	9%	11%	11%	11%	12%	9%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	<1%	<1%	<1%	1%	<1%	<1%	1%	1%	1%	1%	1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	3%	3%	3%	4%	4%	4%	5%	4%	5%	5%	4%
NO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAH	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toluene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Xylene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2-Butanone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Scenario 3

ICR	Receptor										
	2	3	4	5	6	7	8	9	10	11	12
Formaldehyde	41%	50%	54%	52%	47%	46%	49%	49%	49%	48%	42%
Acetaldehyde	26%	17%	16%	12%	18%	19%	13%	14%	13%	12%	17%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	12%	13%	11%	13%	12%	12%	14%	14%	14%	16%	15%
Benzene	11%	7%	8%	6%	9%	9%	6%	7%	6%	6%	10%
Cadmium	5%	8%	7%	11%	9%	9%	11%	11%	11%	12%	10%
Carbon Monoxide	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Chromium (VI)	<1%	<1%	<1%	1%	<1%	<1%	1%	1%	1%	1%	1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mercury	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Manganese	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
NH_3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nickel	3%	4%	3%	4%	4%	4%	4%	4%	5%	5%	4%
NO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAH	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Selenium	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SO_2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Toluene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Xylene	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
2-Butanone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

5.5 Irritancy

For the purposes of this screening assessment irritancy refers to a direct physiological response arising from short-term exposure to a compound that may result in mild, transient adverse health effects that are reversible upon cessation of exposure. Sub-irritancy threshold concentrations of malodorous substances may also result in psychological impacts, such as anxiety.

The likelihood that exposure to a compound will result in sensory irritation can be assessed by comparison of the exposure concentration to the irritancy threshold. Acute health protective guidelines are designed to be more stringent (i.e. health protective) than irritancy thresholds, therefore exposure concentrations that are below the acute health protective guidelines implicitly are also below the irritancy thresholds and hence do not represent a cause for concern with respect to irritancy. As the acute HI for the proposed scenarios 2 and 3 are predicted to be less than one at all of the receptor locations, it can be concluded that the potential for emissions from the Refinery to cause irritation is very low.

5.6 Uncertainties Associated with Calculated Risks

The risk assessment process relies on a set of assumptions and estimates with varying degrees of certainty and variability. Major sources of uncertainty in risk assessment include

- natural variability (e.g. differences in body weight in a population);
- lack of knowledge about basic physical, chemical, and biological properties and processes;
- assumptions in the models used to estimate key inputs (e.g. air dispersion modelling, dose response models); and
- measurement error (e.g. in characterising emissions).

Perhaps the greatest single source of uncertainty in risk assessment is in the dose-response relationships for chemicals, particularly in relation to carcinogenic unit risks.

For this screening assessment, uniformly conservative assumptions have been used to ensure that potential exposures and associated health risks are over- rather than under-estimated. As a result of the compounding of conservatism, the quantitative risk indicators are considered to be upper-bound estimates, with the actual risk likely to be lower.

5.6.1 Emissions Characterisation and Quantification Uncertainty

There is uncertainty associated with the identification and quantification of atmospheric emissions from the Refinery. The emission estimates were based on emissions testing results obtained by independent NATA accredited sampling contractors and analytical laboratories using appropriate techniques including quality control and quality assurance procedures. This results in lower inherent statistical uncertainty for several emissions sources – in particular the regularly monitored combustion sources.

5.6.2 Estimation of Exposure Concentration Uncertainty

The air dispersion modelling was completed by GHD. The assumptions used in the modelling are discussed in GHD (2021) and have not been reviewed as part of this screening assessment.

The maximum and 9th highest acute HIs were calculated based on 1-hour and 24-hour average, predicted GLCs. The maximum acute HI is predicted to occur once per year under the "worst-case" meteorological conditions and therefore provides the most conservative estimate of exposure concentrations. The 9th highest acute HI is predicted to occur for only 0.1% of the time at any given receptor location. Therefore, for the vast majority of the year, the potential acute health effects are expected to be less significant than the calculated acute HIs suggest.

5.6.3 Exposure Assumptions Uncertainty

To calculate the ICR, it has been assumed that residences located at the key receptor locations spend every hour of every day outdoors at that location for 70 years. Clearly, these exposure conditions are unlikely to be realised, because the actual exposure concentrations (of substances originating at the refinery) in the indoor environment are reasonably expected to be lower than experienced in the outdoor air, and the exposure frequency (i.e. days per year) and exposure duration (years) likely to be considerably lower as people move about.

The screening assessment has been confined to exposure via the inhalation pathway, raising the possibility that the total exposure to specific compounds may have been underestimated. Notwithstanding, inhalation is expected to represent the most significant exposure route (refer to Section 3.1.3).

5.6.4 Toxicity Assessment Uncertainty

The primary uncertainties associated with the toxicity assessment are related to the derivation of the health protective guidelines. Health protective guidelines published by reputable authorities have been applied for this assessment, and these have been derived by applying various conservative (i.e. health protective) assumptions. The extrapolation of animal bioassay results or occupational exposure studies to human risk at much lower levels of exposure involves a number of assumptions regarding effect threshold, interspecies extrapolation, high- to low-dose extrapolation, and route-to-route extrapolation. The scientific validity of these assumptions is uncertain; because each of the individual extrapolations are intended to prevent underestimation of risk, in concert they result in unquantifiable but potentially very significant overestimation of risk.

5.6.5 Risk Characterisation Uncertainty

It should be noted that the summing of the quantitative risk indicators for individual compounds to calculate the overall risk from exposure to multiple compounds does not take into account that different compounds can target different organs and therefore the potential health risk arising from exposure to multiple compounds is not necessarily additive, nor does it account for potential antagonistic or synergistic effects. However, the additive approach is considered to be appropriate for screening assessment purposes and is considered to be conservative (i.e. health protective) in most circumstances.

5.6.6 Multi-Exposure Pathway

It has been shown in Section 3.1.3 that the intake of compounds via inhalation forms the predominant exposure pathway for the sensitive receptors modelled in this HRA. Chronic or long-term exposure are considered to be more relevant for secondary exposure conditions that may arise from atmospheric deposition as a result of site emissions. Table 5-7 shows the maximum calculated chronic/long-term risks from Scenario 3 and the percent increase in intake of compounds required from secondary exposure pathways to reach target risk.

Note that risks are potentially unacceptable only when target risk is exceeded. It can be seen from the Table 5-7 that a large increase in compounds intake is required to cause any significant change in risk conclusions determined from inhalation exposure pathway. Given that inhalation exposure is the predominant compounds intake pathway, secondary exposure intakes is therefore only expected to make minor contributions towards total intake if considering multi-exposure pathway for sensitive receptors. As such, assessment of inhalation exposure pathway is the most appropriate pathway to consider for any potential risks from site emissions.

Table 5-7 further shows that if any emitted compounds or transformation products are not accounted for in the HRA, it is not likely to cause any unacceptable exposure conditions at receptor points. However, given the comprehensive reviews of emissions conducted over the years (eg. Toxikos, 2003; ENVIRON 2003; ENVIRON 2014) it is highly unlikely that any significant compounds are unaccounted.

Table 5-7: Contribution from secondary exposure pathways required to reach risk targets.

Toxicity	Maximum Calculated Risk	Receptor Location	Risk Target	Contribution to reach target Risk
Chronic non-carcinogenic	0.19	12	1	500% more than the modelled concentration at receptor with highest HI
Carcinogenic	4.63×10^{-7}	12	1×10^{-5}	2100% more than the modelled concentration at receptor with highest ICR

6. SUMMARY

Ramboll has revised the screening assessment of the potential health risks arising from atmospheric emissions from the Refinery, to determine the potential risks associated with the proposed incremental increase in alumina production capacity to 5.25 Mtpa.

The approach used to conduct the health risk screening assessment is broadly consistent with the approach used for the previous screening assessment (ENVIRON, 2014). Changes to the health protective guidelines that have occurred since 2014 have been identified and incorporated into the screening assessment, to ensure the most current guideline values are applied.

The assessment has updated emission estimates derived for Refinery point sources, fugitive sources including the RSA and bauxite stockpiles for a number of different scenarios (Table 3-4) that represent the currently approved alumina production capacity of 5 Mtpa, and the proposed incremental increase in the alumina production capacity up to 5.25 Mtpa.

Quantitative health risk indicators were calculated for exposure via the inhalation pathway to atmospheric emissions from the Refinery in isolation, and therefore did not take into account the alternative exposure pathways (e.g. ingestion, dermal absorption), nor other sources of atmospheric emissions of these compounds. The quantitative health risk indicators that were calculated for discrete receptors located in the vicinity of the Refinery include:

- Acute HI: for the assessment of potential acute (short-term) non-carcinogenic health effects;
- Chronic HI: for the assessment of potential chronic (long-term) non-carcinogenic health effects; and
- ICR: for the assessment of potential incremental carcinogenic risk.

Based upon the results of the screening assessment it can be concluded that, in relation to the proposed increase in the alumina production of the Refinery to 5.25 Mtpa, the potential for emissions to cause acute or chronic non-carcinogenic health effects is low and acceptable. The results of the screening assessment indicate that the potential for emissions to contribute to the incidence of cancer in the exposed population is so low as to be almost negligible.

In general, production at the higher alumina production rate of 5.25 Mtpa at the Refinery is expected to result in a small increase in the quantitative health risk indicators at some of the receptor locations and a decrease at other locations (due to changes in the RSA). The increases are not considered significant as they are in alignment with the outcomes of the previous assessment (ENVIRON, 2014) in terms of risk of potential health effects.

The acute HI is mainly attributable to emissions of NO_2, PM_{10}, nickel and mercury. Although the relative contribution of these compounds varies for the different scenarios and receptor locations considered in the assessment, the maximum acute HI is attributable largely to a combination of NO_2 and PM_{10} across the receptors, with nickel and mercury making a lesser contribution.

The chronic HI is mainly attributable to emissions of NO_2, mercury and PM_{10} and to a lesser extent cadmium, acetaldehyde and formaldehyde. PM_{10} emissions account for over half of the chronic HI at many of the receptor locations.

The ICR is mainly attributable to emissions of formaldehyde, acetaldehyde, arsenic, PAHs and chromium (VI). Formaldehyde and acetaldehyde have the most significant contribution to the ICR. It is recommended that Alcoa consider whether any further actions be added to their Air Quality Management Plan (AQMP) to address the prominent role that formaldehyde and acetaldehyde play in contributing to ICR values.

As with any risk evaluation, there are areas of uncertainty in this screening assessment. To ensure that potential risks are not underestimated, uniformly conservative assumptions have been used to characterise exposure and toxicity. Due to the inherent conservatism in the methodology, it is reasonable to assume that the actual risk to exposed populations is lower than that presented in the screening HRA.

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8. LIMITATIONS

Ramboll Australia prepared this report in accordance with the scope of work as outlined in our proposal to GHD dated 29 May 2021 and in accordance with our understanding and interpretation of current regulatory standards.

The conclusions presented in this report represent Ramboll's professional judgment based on information made available during the course of this assignment and are true and correct to the best of Ramboll's knowledge as at the date of the assessment.

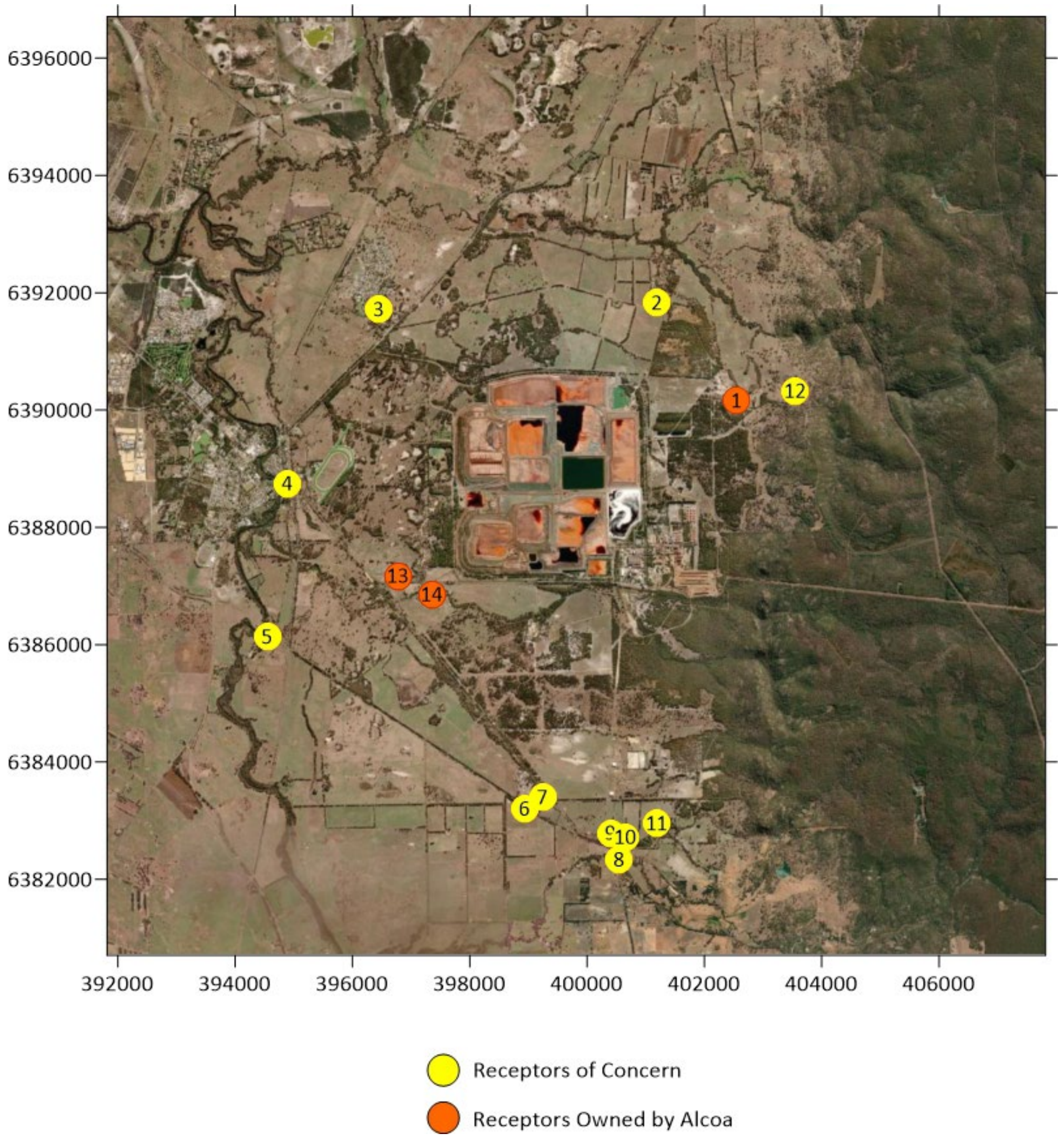
Ramboll did not independently verify all of the written or oral information provided to Ramboll during the course of this investigation. While Ramboll has no reason to doubt the accuracy of the information provided to it, the report is complete and accurate only to the extent that the information provided to Ramboll was itself complete and accurate.

This report does not purport to give legal advice. This advice can only be given by qualified legal advisors.

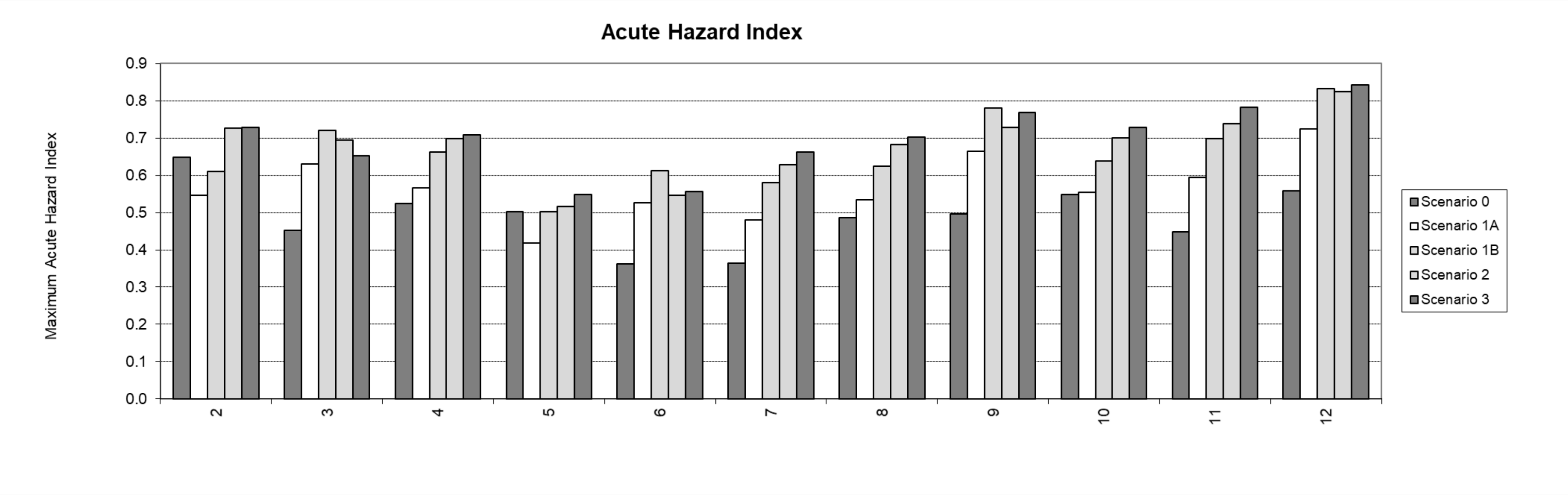
8.1 User Reliance

This report has been prepared exclusively for GHD and may not be relied upon by any other person or entity without Ramboll's express written permission.

FIGURES



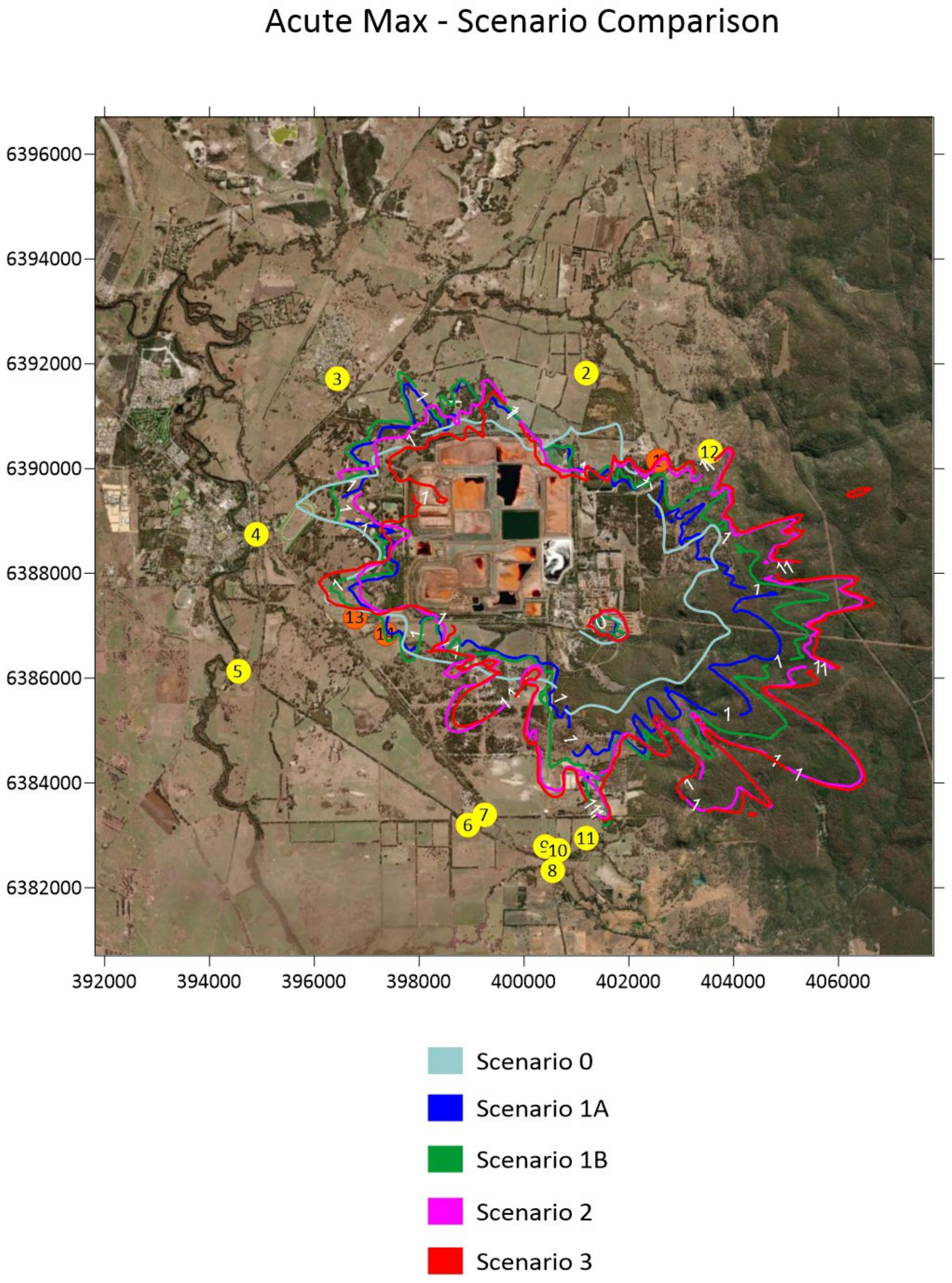
Revision of Pinjarra Refinery Health Risk Screening Assessment	**Figure 1 - Location of Receptors in Relation to the Pinjarra Refinery**
RAMBOLL JOB NO: 318001068	DATE: August 2021



Revision of Pinjarra Refinery Health Risk Screening Assessment

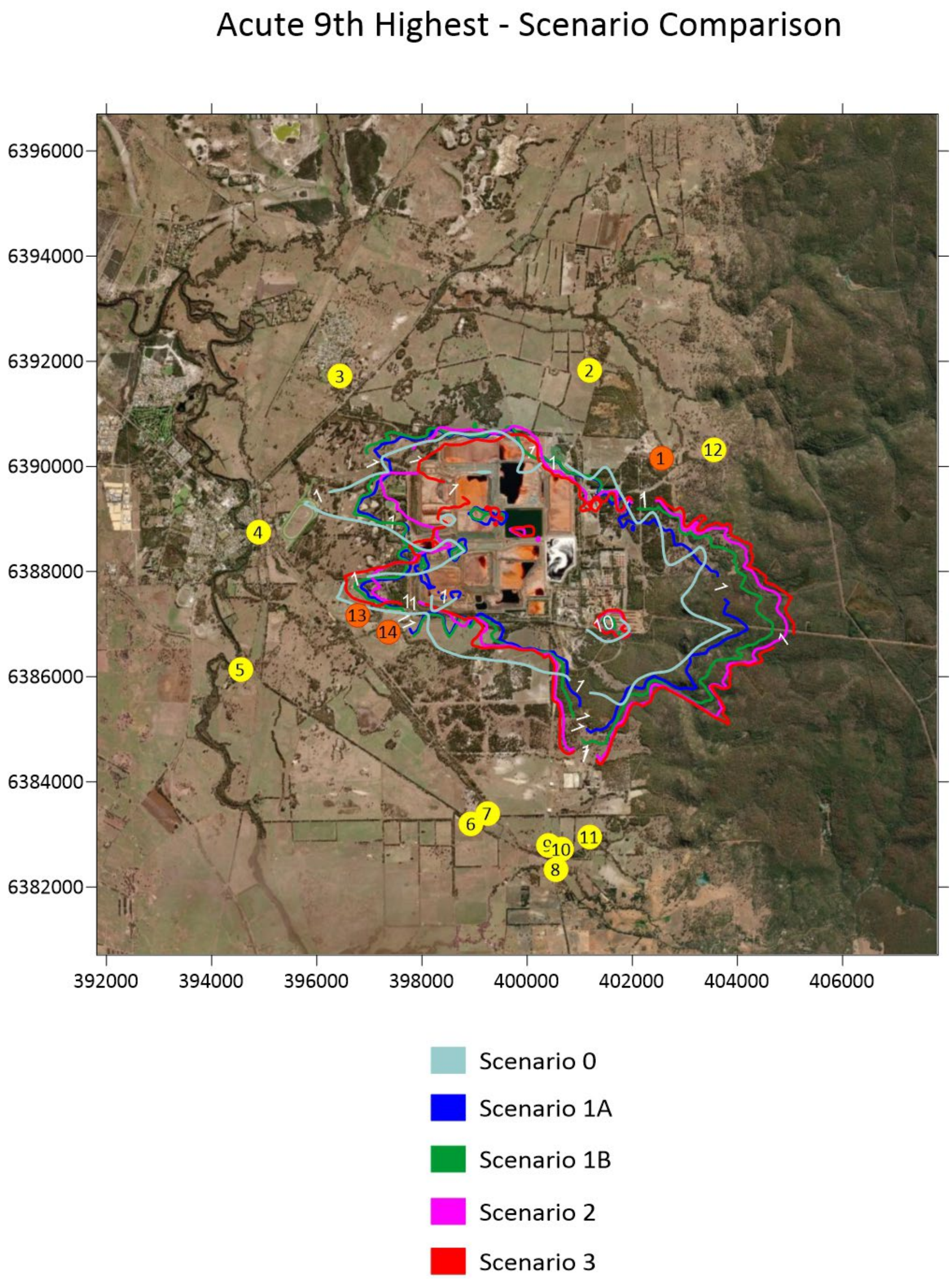
Figure 2 - Maximum Acute Hazard Index for Scenarios 0 - 3

RAMBOLL JOB NO: 318001068 DATE: August 2021



Revision of Pinjarra Refinery Health Risk Screening Assessment	**Figure 3 - Contours of the Maximum Acute Hazard Index for Scenarios 0 - 3**

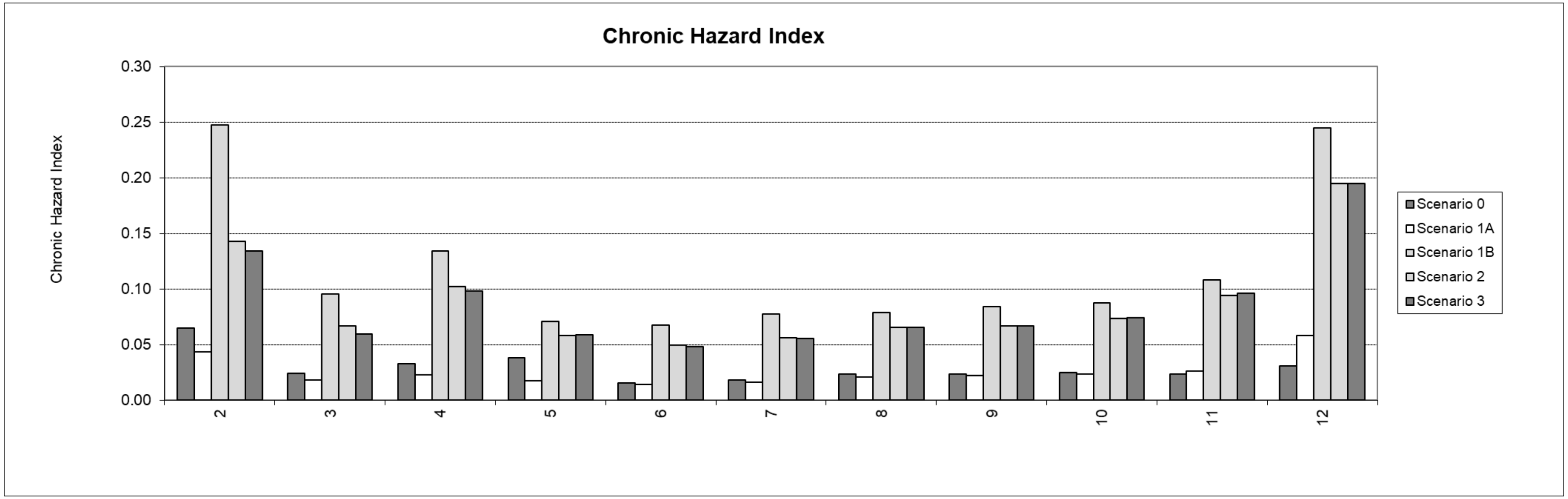
RAMBOLL JOB NO: 318001068 DATE: August 2021



Revision of Pinjarra Refinery Health Risk Screening Assessment

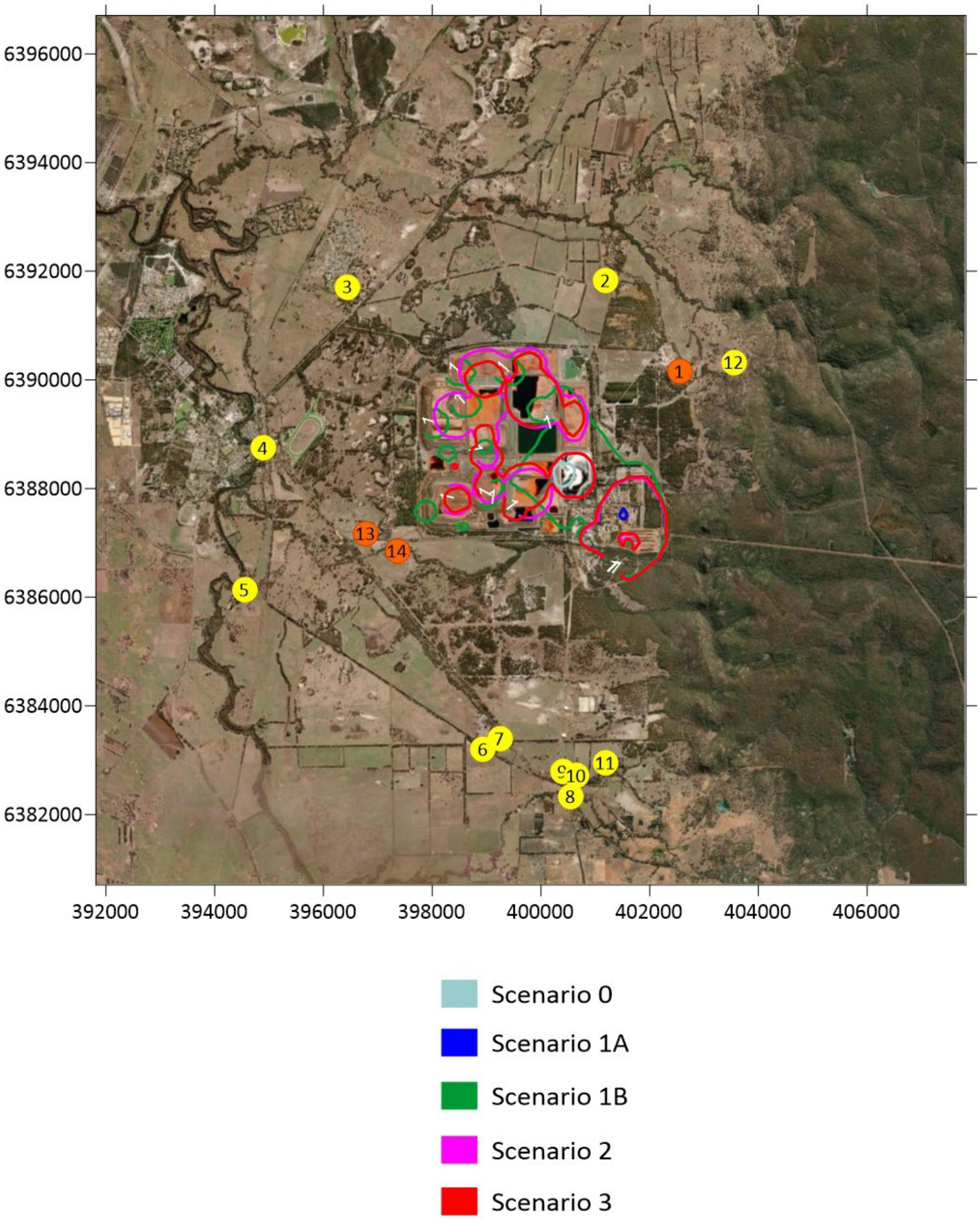
Figure 4 - Contours of the 9th Highest Acute Hazard Index for Scenarios 0 - 3

RAMBOLL JOB NO: 318001068 DATE: August 2021

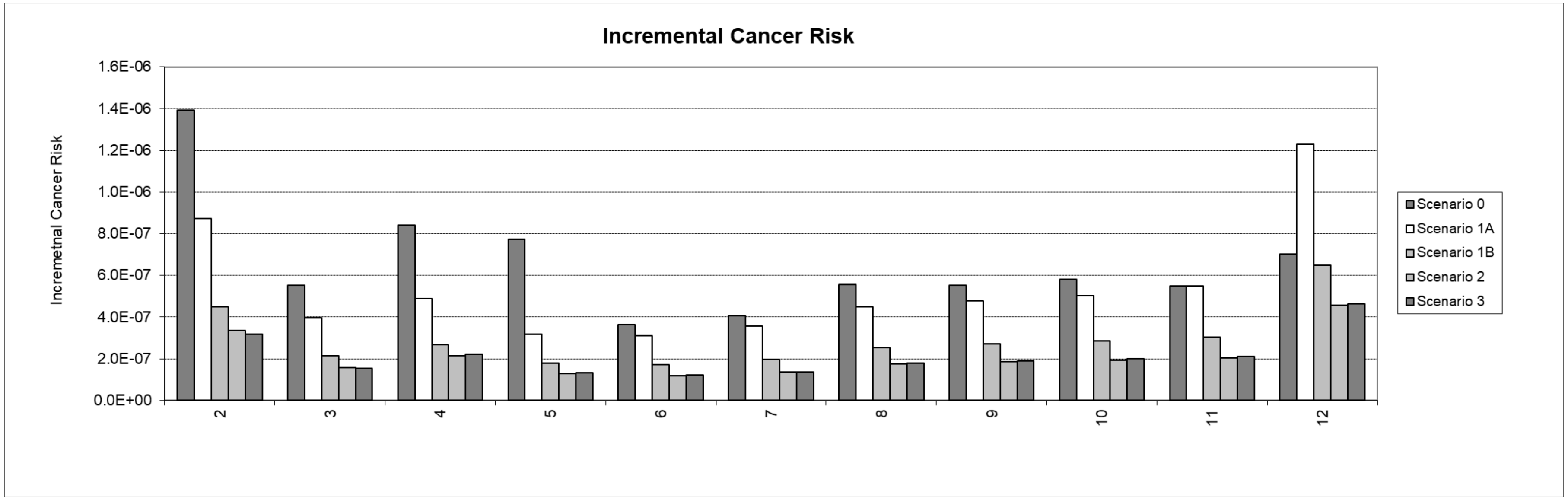


Revision of Pinjarra Refinery Health Risk Screening Assessment	**Figure 5 - Chronic Hazard Index for Scenarios 0 - 3**
RAMBOLL JOB NO: 318001068	DATE: August 2021

Chronic - Scenario Comparison



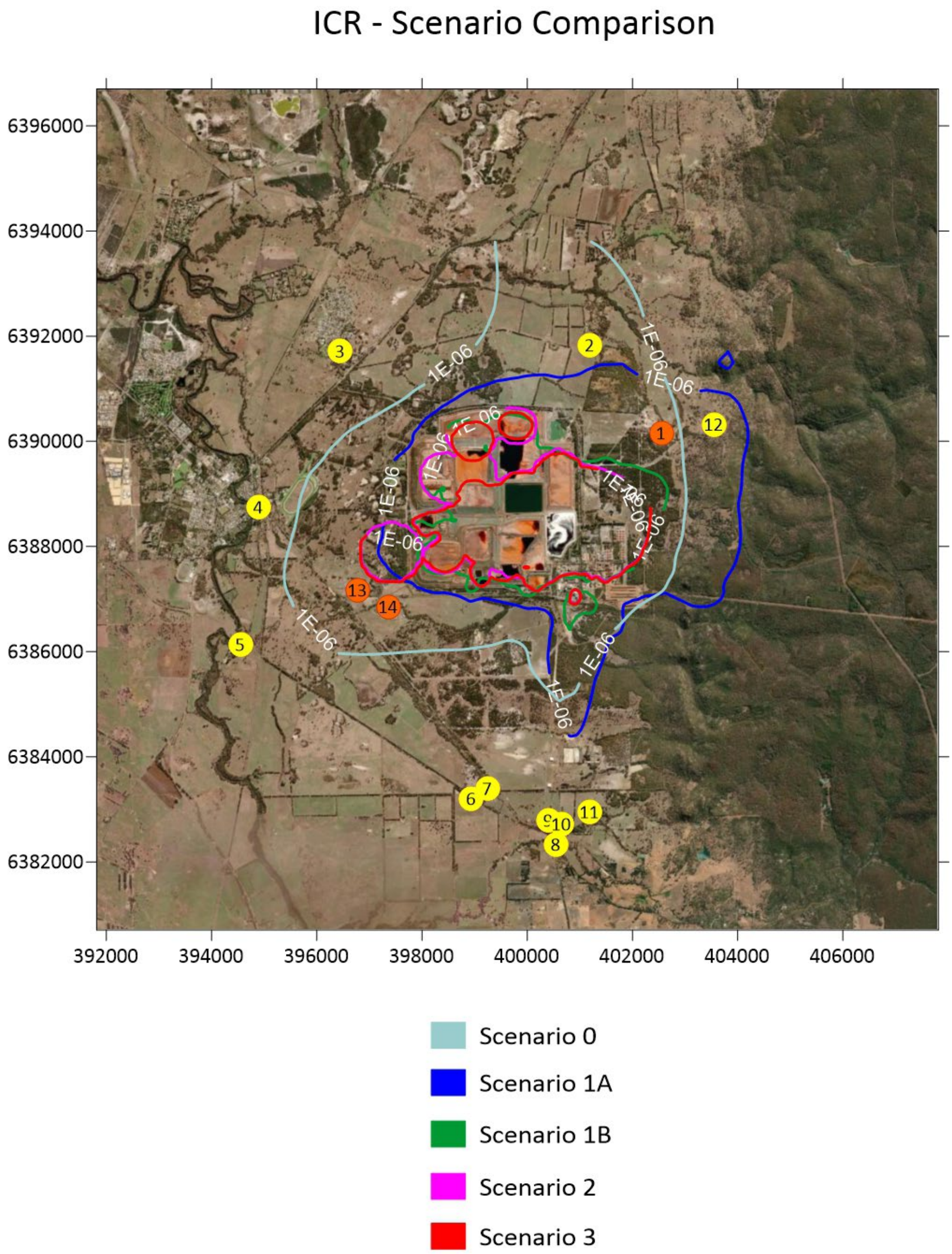
Revision of Pinjarra Refinery Health Risk Screening Assessment	**Figure 6 - Contours of the Chronic Hazard Index for Scenarios 0 - 3**
RAMBOLL JOB NO: 318001068	DATE: August 2021



Revision of Pinjarra Refinery Health Risk Screening Assessment

Figure 7 - Incremental Carcinogenic Risk for Scenarios 0 - 3

DATE: August 2021



Revision of Pinjarra Refinery Health Risk Screening Assessment	**Figure 8 - Contours of Incremental Carcinogenic Risk for Scenarios 0 - 3**

RAMBOLL JOB NO: 318001068 DATE: August 2021

APPENDICES
APPENDIX A

Tabulated Data and Results

Table A-1: Compound List and Total Mass Emission Estimates (g/s) (1)

Compound Name	Scenario 0		Scenario 1A and 1B		Scenario 2		Scenario 3	
	Average Case	Peak Case	Average Case	Peak Case	Average Case	Peak Case	Average Case	Peak Case
NO_X	5.86E+01	8.82E+01	6.30E+01	1.20E+02	5.88E+01	8.79E+01	5.79E+01	9.09E+01
CO	2.20E+02	7.52E+02	3.52E+01	1.53E+02	2.63E+01	1.17E+02	3.20E+01	1.27E+02
SO_2	1.10E+00	4.26E+00	1.31E+00	7.39E+00	9.64E-01	3.66E+00	1.10E+00	4.27E+00
PM_{10}	2.49E+01	2.85E+01	2.58E+01	3.22E+01	2.68E+01	3.02E+01	2.49E+01	3.09E+01
Arsenic	2.34E-03	6.44E-03	1.90E-03	5.36E-03	2.10E-03	5.83E-03	2.34E-03	6.44E-03
Selenium	4.05E-04	7.46E-04	3.75E-04	6.84E-04	3.92E-04	7.35E-04	4.05E-04	7.46E-04
Manganese	4.47E-03	1.43E-02	3.50E-03	1.15E-02	3.94E-03	1.29E-02	4.47E-03	1.43E-02
Cadmium	5.72E-04	1.52E-03	4.42E-04	1.19E-03	4.97E-04	1.40E-03	5.72E-04	1.52E-03
Chromium (VI)	7.40E-05	2.82E-04	8.11E-05	2.87E-04	7.91E-05	2.87E-04	7.40E-05	2.82E-04
Nickel	1.69E-03	5.04E-03	1.43E-03	4.57E-03	1.54E-03	4.83E-03	1.69E-03	5.04E-03
Mercury	1.73E-02	2.32E-02	1.36E-02	1.89E-02	1.53E-02	2.12E-02	1.73E-02	2.32E-02
NH_3	6.46E-01	1.03E+00	6.47E-01	1.03E+00	7.07E-01	1.03E+00	7.08E-01	1.03E+00
PAH	8.65E-06	1.27E-05	4.37E-06	8.68E-06	9.14E-06	1.31E-05	7.82E-06	1.27E-05
Acetone	1.60E+00	5.96E+00	1.87E+00	5.13E+00	1.63E+00	5.68E+00	1.60E+00	5.95E+00
Acetaldehyde	1.38E+00	2.98E+00	1.52E+00	2.45E+00	1.38E+00	2.83E+00	1.38E+00	2.98E+00
Formaldehyde	1.02E+00	3.18E+00	9.59E-01	2.51E+00	1.01E+00	2.91E+00	1.02E+00	3.17E+00
2-Butanone	1.97E-01	4.58E-01	1.90E-01	3.11E-01	2.01E-01	4.51E-01	1.97E-01	4.58E-01
Benzene	8.36E-02	2.29E-01	5.26E-02	1.63E-01	8.65E-02	2.16E-01	8.36E-02	2.29E-01
Toluene	6.11E-02	1.46E-01	4.31E-02	1.13E-01	6.23E-02	1.41E-01	6.10E-02	1.46E-01
Xylenes	8.85E-03	1.79E-02	7.45E-03	1.68E-02	9.01E-03	1.78E-02	8.85E-03	1.79E-02
H_2S	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-03	1.60E-03	1.30E-03	1.60E-03

Notes

1. PAHs reported as Benzo[a]pyrene (BaP) Equivalents

Table A-2 -Pinjarra Refinery air emissions – Scenario 0 Average emissions (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Seleni-um	Manga-nese	Cadmium	Chrom-ium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetal-dehyde	Formal-dehyde	2-Butanone	Benze-ne	Toluene	Xylene
Ox Kiln	2.18E-01	1.83E-01	1.07E-02	1.05E-02	1.63E-04	6.86E-05			8.23E-06	4.01E-05	8.95E-04				2.64E-03				1.39E-04	1.22E-04	
30 RTO	5.93E-01	3.25E-02	7.26E-02		2.39E-05	3.71E-05	6.37E-05	1.20E-05	4.85E-05	3.61E-04	4.06E-03	3.43E-02			2.87E-03	1.19E-03				4.71E-04	
30 RTO in Bypass															9.73E-03	3.52E-03		1.40E-03	8.03E-05	1.06E-03	2.60E-04
Calciner 1&2	1.73E+00	6.66E+00	3.69E-01	8.98E-01	6.98E-04	4.71E-05	1.20E-03	1.05E-04		3.30E-04	8.31E-04			2.14E-07	7.22E-02	1.68E-01	2.15E-01	6.91E-03	1.15E-02	3.92E-03	6.37E-04
Calciner 3&4	2.78E+00	5.72E+00	1.69E-01	3.65E-01	6.11E-04	4.12E-05	1.05E-03	9.19E-05		2.89E-04	7.27E-04			2.04E-07	6.89E-02	1.60E-01	2.05E-01	6.59E-03	1.10E-02	3.74E-03	6.07E-04
Calciner 5&6	3.57E+00	6.36E+00	2.61E-01	4.22E-01	6.08E-04	4.10E-05	1.05E-03	9.14E-05		2.87E-04	7.23E-04			2.10E-07	7.07E-02	1.64E-01	2.10E-01	6.77E-03	1.13E-02	3.84E-03	6.24E-04
Calciner 7	3.35E+00	6.28E+00	1.34E-01	3.66E-01	8.71E-05	9.75E-05	8.47E-04	2.68E-04		2.96E-04	1.57E-03			1.99E-07	6.70E-02	1.56E-01	1.99E-01	6.41E-03	1.07E-02	3.64E-03	5.91E-04
Boiler 2	2.79E+00	8.60E-02	6.69E-03				2.86E-09	1.50E-09	6.94E-10	8.17E-10	5.79E-10				6.85E-03		7.15E-03		4.63E-05	4.34E-05	
Boiler 3&4	3.17E+00	3.05E-01	6.52E-03				2.66E-09	1.40E-09	6.46E-10	7.61E-10	5.39E-10				1.72E-02		1.41E-02	6.27E-04	4.31E-05	4.05E-05	
Boiler 5,6&7	6.84E+00	1.37E+00	1.59E-02				7.19E-09	3.79E-09	1.75E-09	2.06E-09	1.46E-09				2.23E-02		2.15E-02	2.95E-04	1.17E-04	1.09E-04	
Cogen 1	1.62E+01	9.86E+01	2.46E-02				1.63E-08	8.57E-09	2.52E-08	4.65E-09	3.30E-09										
Cogen 2	1.74E+01	9.44E+01	2.49E-02				1.64E-08	8.64E-09	2.54E-08	4.69E-09	3.32E-09										
OBF Vac Pump Stack						3.21E-06									4.52E-02	2.45E-03		2.43E-03			3.03E-04
Calciner Vac Pump Stack 44															1.99E-01	7.83E-02	1.31E-04	2.90E-02		3.35E-04	3.05E-04
45T Cooling Tower											6.74E-05										
Bldg 44 Vac Pump Stack															7.84E-02	1.47E-02	5.59E-03	1.51E-02		3.16E-03	
Powerhouse Dearator											1.41E-05			1.63E-09	3.42E-03	4.06E-03		1.47E-03	7.00E-05	1.20E-05	6.18E-06
Mills Product Hopper												3.36E-01			1.61E-01	1.12E-01		1.17E-02			
25A/C Vapour Droppers															2.31E-02	1.26E-02		3.36E-03		6.94E-04	
x10xcess BO, PRT & CT Vents					2.14E-07	3.93E-07	2.56E-06				2.28E-04	2.76E-01			1.69E-02	7.17E-03		2.62E-03	5.33E-05	5.33E-04	5.33E-05
B34 A-Rake Vents															5.80E-02	2.47E-03		9.01E-04			
35F Tank Vents														2.94E-07	2.95E-02	9.01E-03	1.69E-04	5.10E-03	1.08E-04	1.42E-03	9.36E-04
35D Tank Vents														1.67E-06	3.10E-02	1.86E-02	4.04E-05	7.84E-03	6.70E-05	3.27E-03	1.43E-03
35A Tank Vents														7.03E-07	2.86E-02	2.43E-02		7.96E-03		4.54E-03	6.42E-04
35R, 35S & 35V Tank Vents															8.68E-03	3.33E-03		9.84E-04		5.35E-05	5.99E-05
35J Tank Vents															9.34E-03	9.17E-03	2.06E-05	1.40E-03			
35C Tank Vents - Banks 1&2														2.51E-08	2.95E-03	1.26E-03	9.77E-06	3.18E-04		8.72E-05	1.54E-05
35C Tank Vents - Banks 3-5 & 35H														3.29E-07	4.07E-02	1.01E-02	2.93E-05	6.74E-03		1.20E-03	3.84E-04
Bauxite Stockpiles				1.20E+01	1.20E-05	5.99E-06	7.19E-05	9.58E-07		2.88E-05	1.08E-06										
Residue Areas (all)				1.08E+01	1.39E-04	6.27E-05	1.84E-04	2.27E-06	1.73E-05	6.05E-05	8.22E-03			4.80E-06	5.72E-01	4.15E-01	1.42E-01	7.09E-02	3.84E-02	2.88E-02	2.00E-03

Table A-3 - Pinjarra Refinery air emissions – Scenario 0 Peak emissions (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Seleni-um	Manga-nese	Cadmium	Chrom-ium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetal-dehyde	Formal-dehyde	2-Butanone	Benze-ne	Toluene	Xylene
Ox Kiln	4.62E-01	6.15E-01	4.94E-02	3.56E-02	4.12E-04	2.08E-04	0.00E+00	0.00E+00	2.17E-05	1.17E-04	1.40E-03	0.00E+00			9.30E-03		3.16E-03		1.31E-04	7.75E-05	
30 RTO	1.32E+00	1.77E-01	2.72E-01		8.88E-05	1.17E-04	2.62E-04	7.52E-05	2.43E-04	2.53E-03	7.49E-03	5.42E-02									
30 RTO in Bypass															1.59E-01	5.44E-02		2.36E-02	2.58E-03	2.16E-02	5.66E-03
Calciner 1&2	4.31E+00	2.15E+01	1.28E+00	2.30E+00	1.93E-03	5.15E-05	3.60E-03	2.32E-04		5.58E-04	9.87E-04			2.88E-07	9.56E-01	4.84E-01	7.72E-01	3.86E-02	4.93E-02	1.84E-02	8.57E-04
Calciner 3&4	6.11E+00	2.28E+01	6.72E-01	8.66E-01	1.89E-03	5.04E-05	3.53E-03	2.27E-04		5.46E-04	9.66E-04			2.82E-07	9.36E-01	4.74E-01	7.55E-01	3.78E-02	4.82E-02	1.80E-02	8.39E-04
Calciner 5&6	6.77E+00	2.28E+01	9.48E-01	1.24E+00	1.73E-03	4.62E-05	3.23E-03	2.08E-04		5.00E-04	8.85E-04			2.61E-07	8.67E-01	4.39E-01	7.00E-01	3.50E-02	4.47E-02	1.67E-02	7.78E-04
Calciner 7	7.67E+00	3.00E+01	9.54E-01	1.23E+00	2.34E-04	1.95E-04	3.39E-03	7.80E-04		7.02E-04	2.96E-03			2.62E-07	8.69E-01	4.40E-01	7.01E-01	3.51E-02	4.48E-02	1.68E-02	7.79E-04
Boiler 2	4.31E+00	1.08E+00	8.04E-03				1.47E-08	3.26E-09	1.80E-09	3.05E-09					2.00E-02	1.50E-02	1.43E-02		5.55E-05	5.21E-05	
Boiler 3&4	5.18E+00	6.43E+00	7.84E-03				1.37E-08	3.04E-09	1.68E-09	2.85E-09					3.89E-02		3.16E-02	7.51E-04	5.17E-05	4.85E-05	
Boiler 5,6&7	1.17E+01	1.64E+01	1.91E-02				3.69E-08	8.20E-09	4.54E-09	7.69E-09					5.99E-02	3.12E-02	4.46E-02	3.54E-04	1.40E-04	1.31E-04	
Cogen 1	2.01E+01	3.36E+02	2.50E-02				7.09E-08	1.58E-08	2.57E-08	1.48E-08											
Cogen 2	2.02E+01	2.94E+02	2.48E-02				7.00E-08	1.56E-08	2.53E-08	1.46E-08											
OBF Vac Pump Stack						8.89E-06									7.40E-02	3.58E-03		3.58E-03			7.16E-04
Calciner Vac Pump Stack 44															4.73E-01	1.76E-01	1.36E-03	6.42E-02		1.45E-03	9.68E-04
45T Cooling Tower											6.74E-05										
Bldg 44 Vac Pump Stack															2.60E-01	5.04E-02	1.76E-02	6.30E-02		4.20E-03	
Powerhouse Dearator											1.41E-05			1.87E-09	3.42E-03	5.73E-03		1.91E-03	7.93E-05	6.06E-05	6.30E-06
Mills Product Hopper												4.34E-01			3.23E-01	2.21E-01		2.04E-02			
25A/C Vapour Droppers															3.21E-02	1.31E-02		3.39E-03		7.77E-04	
x10xcess BO, PRT & CT Vents					5.03E-07	1.04E-06	6.94E-06				2.28E-04	5.38E-01			3.90E-02	1.40E-02		7.11E-03	1.73E-04	1.91E-03	1.73E-04
B34 A-Rake Vents															6.87E-03	2.47E-03		1.25E-03			
35F Tank Vents														9.56E-07	6.11E-02	1.50E-02	3.22E-04	1.05E-02	1.91E-04	2.60E-03	1.47E-03
35D Tank Vents														3.68E-06	7.18E-02	5.05E-02	8.84E-05	1.44E-02	7.87E-05	5.54E-03	1.97E-03
35A Tank Vents														1.57E-06	4.66E-02	4.21E-02		1.46E-02		6.93E-03	1.17E-03
35R, 35S & 35V Tank Vents															1.46E-02	5.24E-03		1.43E-03		1.22E-04	1.24E-04
35J Tank Vents															1.12E-02	1.31E-02	2.08E-05	1.77E-03			
35C Tank Vents - Banks 1&2														6.51E-08	4.65E-03	2.17E-03	2.06E-05	5.35E-04		1.56E-04	1.77E-05
35C Tank Vents - Banks 3-5 & 35H														5.72E-07	4.92E-02	1.30E-02	6.17E-05	7.58E-03		1.44E-03	4.17E-04
Bauxite Stockpiles				1.20E+01	1.20E-05	5.99E-06	7.19E-05	9.58E-07		2.88E-05	1.08E-06										
Residue Areas (all)				1.08E+01	1.39E-04	6.27E-05	1.84E-04	2.27E-06	1.73E-05	6.05E-05	8.22E-03			4.80E-06	5.72E-01	4.15E-01	1.42E-01	7.09E-02	3.84E-02	2.88E-02	2.00E-03

Table A-4 - Pinjarra Refinery Air Emissions – Scenario 1A & 1B Average Emissions (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Seleni-um	Manga-nese	Cadmium	Chrom-ium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetal-dehyde	Formal-dehyde	2-Butanone	Benze-ne	Toluene	Xylene
Ox Kiln	2.20E-01	1.80E-01	1.00E-02	1.00E-02	1.60E-04	6.90E-05			8.20E-06	4.00E-05	9.00E-04				2.60E-03				1.40E-04		
30 RTO	5.90E-01	3.00E-02	7.00E-02		2.40E-05	3.70E-05	6.40E-05	1.20E-05	4.90E-05	3.60E-04	4.10E-03	3.40E-02			2.90E-03	1.20E-03				4.70E-04	
30 RTO in Bypass															9.70E-03	3.50E-03		1.40E-03	8.00E-05	1.10E-03	2.60E-04
Calciner 1&2	1.70E+00	6.70E+00	3.70E-01	9.00E-01	7.00E-04	4.70E-05	1.20E-03	1.10E-04		3.30E-04	8.30E-04				7.20E-02	1.70E-01	2.20E-01	6.90E-03	1.20E-02	3.90E-03	6.40E-04
Calciner 3&4	2.80E+00	5.70E+00	1.70E-01	3.60E-01	6.10E-04	4.10E-05	1.10E-03	9.20E-05		2.90E-04	7.30E-04				6.90E-02	1.60E-01	2.10E-01	6.60E-03	1.10E-02	3.70E-03	6.10E-04
Calciner 5&6	3.60E+00	6.40E+00	2.60E-01	4.20E-01	6.10E-04	4.10E-05	1.10E-03	9.10E-05		2.90E-04	7.20E-04				7.10E-02	1.60E-01	2.10E-01	6.80E-03	1.10E-02	3.80E-03	6.20E-04
Calciner 7	3.40E+00	6.30E+00	1.30E-01	3.70E-01	8.70E-05	9.80E-05	8.50E-04	2.70E-04		3.00E-04	1.60E-03				6.70E-02	1.60E-01	2.00E-01	6.40E-03	1.10E-02	3.60E-03	5.90E-04
Boiler 2	2.90E+00	9.00E-02	1.00E-02				2.90E-09	1.60E-09	7.10E-10	8.40E-10	6.00E-10				7.00E-03		7.40E-03		4.80E-05	4.50E-05	
Boiler 3&4	3.30E+00	3.10E-01	1.00E-02				2.70E-09	1.40E-09	6.70E-10	7.80E-10	5.50E-10				1.80E-02		1.50E-02	6.40E-04	4.40E-05	4.20E-05	
Boiler 5,6&7	7.10E+00	1.40E+00	2.00E-02				7.40E-09	3.90E-09	1.80E-09	2.10E-09	1.50E-09				2.30E-02		2.20E-02	3.00E-04	1.20E-04	1.10E-04	
Cogen 1	1.70E+01	3.00E+00	2.00E-02				1.60E-08	8.60E-09	2.50E-08	4.70E-09	3.30E-09										
Cogen 2	1.60E+01	2.00E+00	2.00E-02				1.60E-08	8.60E-09	2.50E-08	4.70E-09	3.30E-09										
OBF Vac Pump Stack						3.20E-06									4.50E-02	2.50E-03		2.40E-03			3.00E-04
Calciner Vac Pump Stack 44															2.00E-01	7.80E-02	1.30E-04	2.90E-02		3.40E-04	3.10E-04
45T Cooling Tower											6.70E-05										
Bldg 44 Vac Pump Stack															7.80E-02	1.50E-02	5.60E-03	1.50E-02		3.20E-03	
Powerhouse Dearator											1.40E-05			1.60E-09	3.40E-03	4.10E-03		1.50E-03	7.00E-05	1.20E-05	6.20E-06
Mills Product Hopper															1.60E-01	1.10E-01		1.20E-02			
25A/C Vapour Droppers															2.30E-02	1.30E-02		3.40E-03		6.90E-04	
x10xcess BO, PRT & CT Vents					2.10E-07	3.90E-07	2.60E-06				2.30E-04	2.80E-01			1.70E-02	7.20E-03		2.60E-03	5.30E-05	5.30E-04	5.30E-05
B34 A-Rake Vents															5.80E-02	2.50E-03		9.00E-04			
35F Tank Vents														2.90E-07	3.00E-02	9.00E-03	1.70E-04	5.10E-03	1.10E-04	1.40E-03	9.40E-04
35D Tank Vents														1.70E-07	3.10E-02	1.90E-02	4.00E-05	7.80E-03	6.70E-05	3.30E-03	1.40E-03
35A Tank Vents														7.00E-07	2.90E-02	2.40E-02		8.00E-03		4.50E-03	6.40E-04
35R, 35S & 35V Tank Vents															8.70E-03	3.30E-03		9.80E-04		5.40E-05	6.00E-05
35J Tank Vents															9.30E-03	9.20E-03	2.10E-05	1.40E-03			
35C Tank Vents - Banks 1&2														2.50E-08	3.00E-03	1.30E-03	9.80E-06	3.20E-04		8.70E-05	1.50E-05
35C Tank Vents - Banks 3-5 & 35H														3.30E-07	4.10E-02	1.00E-02	2.90E-05	6.70E-03		1.20E-03	3.80E-04

Table A-5 - Pinjarra Refinery Air Emissions – Scenario 1A & 1B Peak Emission (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Selenium	Manganese	Cadmium	Chromium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetaldehyde	Formaldehyde	2-Butanone	Benzene	Toluene	Xylene
Ox Kiln	4.60E-01	6.20E-01	5.00E-02	4.00E-02	4.10E-04	2.10E-04	0.00E+00	0.00E+00	2.20E-05	1.20E-04	1.40E-03			0.00E+00	9.30E-03		3.20E-03		1.30E-04	7.80E-05	
30 RTO	1.30E+00	1.80E-01	2.70E-01		8.90E-05	1.20E-04	2.60E-04	7.50E-05	2.40E-04	2.50E-03	7.50E-03	5.40E-02									
30 RTO in Bypass															1.60E-01	5.40E-02		2.40E-02	2.60E-03	2.20E-02	5.70E-03
Calciner 1&2	4.30E+00	2.20E+01	1.30E+00	2.30E+00	1.90E-03	5.20E-05	3.60E-03	2.30E-04		5.60E-04	9.90E-04			2.90E-07	9.60E-01	4.80E-01	7.70E-01	3.90E-02	4.90E-02	1.80E-02	8.60E-04
Calciner 3&4	6.10E+00	2.30E+01	6.70E-01	8.70E-01	1.90E-03	5.00E-05	3.50E-03	2.30E-04		5.50E-04	9.70E-04			2.80E-07	9.40E-01	4.70E-01	7.60E-01	3.80E-02	4.80E-02	1.80E-02	8.40E-04
Calciner 5&6	6.80E+00	2.30E+01	9.50E-01	8.70E-01	1.70E-03	4.60E-05	3.20E-03	2.10E-04		5.00E-04	8.90E-04			2.60E-07	8.70E-01	4.40E-01	7.00E-01	3.50E-02	4.50E-02	1.70E-02	7.80E-04
Calciner 7	7.70E+00	3.0E+00	9.50E-01	1.20E+00	2.30E-04	2.00E-04	3.40E-03	7.80E-04		7.00E-04	3.00E-03			2.60E-07	8.70E-01	4.40E-01	7.00E-01	3.50E-02	4.50E-02	1.70E-02	7.80E-04
Boiler 2	3.90E+00	9.70E-01	1.00E-02	1.20E+00			1.30E-08	2.90E-09	1.60E-09	2.70E-09	3.10E-09				1.80E-02	1.30E-02	1.30E-02		5.00E-05	4.70E-05	
Boiler 3&4	4.60E+00	5.70E+00	1.00E-02				1.20E-08	2.70E-09	1.50E-09	2.50E-09	2.90E-09				3.50E-02		2.80E-02	6.70E-04	4.60E-05	4.30E-05	
Boiler 5,6&7	1.10E+01	1.50E+01	2.00E-02				3.30E-08	7.30E-09	4.10E-09	6.90E-09	7.70E-09				5.40E-02	2.80E-02	4.00E-02	3.20E-04	1.30E-04	1.20E-04	
Cogen 1	2.20E+01	4.90E+00	3.00E-02				8.50E-08	1.90E-08	3.10E-08	1.80E-08	1.50E-08										
Cogen 2	2.40E+01	3.30E+00	3.00E-02				8.40E-08	1.90E-08	3.10E-08	1.80E-08	1.50E-08										
OBF Vac Pump Stack	6.00E+01		8.90E-06								7.40E-02	3.60E-03			3.60E-03			7.20E-04			
Calciner Vac Pump Stack	5.90E+01										4.70E-01	1.80E-01		1.40E-03	6.40E-02		1.50E-03	9.70E-04			
45T Cooling Tower	3.00E+01							6.70E-05													
Bldg 44 Vac Pump Stack	5.20E+01										2.60E-01	5.00E-02		1.80E-02	6.30E-02		4.20E-03				
Powerhouse Dearator	1.30E+02							1.40E-05		1.90E-09	3.40E-03	5.70E-03			1.90E-03	7.90E-05	6.10E-05	6.30E-06			
Mills Product Hopper												4.30E-01			3.20E-01	2.20E-01		2.00E-02			
25A/C Vapour Droppers															3.20E-02	1.30E-02		3.40E-03		7.80E-04	
x10xcess BO, PRT & CT Vents					5.00E-07	1.00E-06	6.90E-06				2.30E-04	5.40E-01			3.90E-02	1.40E-02		7.10E-03	1.70E-04	1.90E-03	1.70E-04
B34 A-Rake Vents															6.90E-03	2.50E-03		1.30E-03			
35F Tank Vents														9.60E-07	6.10E-02	1.50E-02	3.20E-04	1.10E-02	1.90E-04	2.60E-03	1.50E-03
35D Tank Vents														3.70E-06	7.20E-02	5.10E-02	8.80E-05	1.40E-02	7.90E-05	5.50E-03	2.00E-03
35A Tank Vents														1.60E-06	4.70E-02	4.20E-02		1.50E-02		6.90E-03	1.20E-03
35R, 35S & 35V Tank Vents															1.50E-02	5.20E-03		1.40E-03		1.20E-04	1.20E-04
35J Tank Vents															1.10E-02	1.30E-02	2.10E-05	1.80E-03			
35C Tank Vents – Banks 1&2														6.50E-08	4.70E-03	2.20E-03	2.10E-05	5.40E-04		1.60E-04	1.80E-05
35C Tank Vents – Banks 3-5 & 35H														5.70E-07	4.90E-02	1.30E-02	6.20E-05	7.60E-03		1.40E-03	4.20E-04

Table A-6 - Pinjarra Refinery Air Emissions – Scenario 2 Average Emissions (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Seleni-um	Manga-nese	Cadmium	Chrom-ium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetal-dehyde	Formal-dehyde	2-Butanone	Benze-ne	Toluene	Xylene
Ox Kiln	2.12E-01	1.42E-01	9.88E-03	1.54E-02	1.65E-04	1.75E-04	5.56E-06	1.21E-05	1.49E-07	2.37E-05	6.20E-04				8.03E-04		5.62E-04		2.33E-04	2.50E-04	
30 RTO	4.78E-01	3.81E-02	3.34E-02		2.18E-05	3.26E-05	4.12E-05	8.43E-06	9.94E-07	2.31E-04	9.13E-04	2.88E-02			2.52E-03	1.40E-03	1.56E-04	2.91E-05		6.33E-04	
30 RTO in Bypass	3.78E-02	3.01E-03	2.64E-03		1.72E-06	2.58E-06	3.26E-06	6.66E-07	7.85E-08	1.82E-05	7.21E-05	2.28E-03			1.99E-04	1.11E-04	1.23E-05	2.30E-06		5.01E-05	
Calciner 1&2	2.16E+00	6.40E+00	1.73E-01	1.53E+00	2.53E-04	1.79E-04	2.03E-03	1.53E-04	1.21E-06	4.09E-04	1.44E-03			1.58E-06	9.58E-02	1.67E-01	1.97E-01	8.20E-03	5.14E-03	2.02E-03	3.66E-04
Calciner 3&4	2.92E+00	5.26E+00	1.44E-01	6.71E-01	2.40E-04	1.69E-04	1.92E-03	1.45E-04	1.14E-06	3.87E-04	1.36E-03			1.49E-06	8.62E-02	1.41E-01	2.45E-01	7.36E-03	5.40E-03	2.65E-03	
Calciner 5&6	3.66E+00	4.84E+00	1.57E-01	7.39E-01	4.25E-05	8.71E-05	2.07E-03	1.40E-04	2.02E-06	2.11E-04	7.44E-04			7.20E-07	1.43E-01	1.70E-01	1.71E-01	7.66E-03	1.06E-02	3.04E-03	
Calciner 7	2.99E+00	9.46E+00	1.53E-01	6.04E-01	4.26E-05	8.74E-05	2.08E-03	1.41E-04	2.03E-06	2.12E-04	7.46E-04			1.64E-06	1.91E-04	1.28E-02	4.11E-02	1.91E-04	1.93E-02	6.03E-03	
Boiler 2	2.91E+00	5.45E-01	3.44E-03				6.77E-06	1.70E-06	7.74E-08	1.91E-06							6.42E-04		1.02E-04		
Boiler 3&4	3.71E+00	3.22E-01	2.81E-03				5.54E-06	1.39E-06	6.33E-08	1.56E-06							5.25E-04		8.34E-05		
Boiler 6&7	5.35E+00	1.03E+00	6.88E-03				1.35E-05	3.41E-06	1.55E-07	3.82E-06							5.84E-04		1.21E-04		
Cogen 1	2.15E+01	3.74E+01	3.18E-02				2.14E-05	5.39E-06	2.45E-07	6.05E-06							1.17E-01				
Cogen 2	2.06E+00	7.20E+01	2.83E-02				1.90E-05	4.79E-06	2.18E-07	5.38E-06							1.04E-01				
OBF Vac Pump Stack					1.76E-05	1.38E-05	1.70E-05			8.56E-06	9.96E-06				5.91E-02	9.64E-03		3.58E-03	1.96E-05	1.76E-04	1.56E-05
Calciner Filter Vac Pumps															3.15E-02	2.67E-02		1.67E-02		4.44E-04	
44 Seed Filtration															8.31E-02	1.58E-02		1.66E-02		2.21E-03	
110 Deaerator					4.25E-06	1.89E-05	4.08E-05			7.80E-06	3.33E-05	3.09E-03		4.20E-09	2.49E-02				2.34E-04	1.59E-04	1.32E-04
Mills Product Hopper															6.02E-03	8.42E-03	1.00E-04	2.69E-03	2.90E-04	2.83E-04	8.98E-05
25A/C Droppers															1.25E-02	6.83E-03		1.82E-03		3.75E-04	3.60E-05
x10xcess BO, PRT & CT Vents					3.21E-07	5.47E-07	3.50E-06		9.48E-08						2.77E-02	1.18E-02		4.30E-03	9.11E-05	8.79E-04	9.11E-05
B34 A-Rake Stacks												1.20E-02			6.04E-05	1.05E-04			7.40E-06	2.20E-05	
Biox												2.45E-07	1.30E-03						1.36E-05	2.19E-03	2.19E-03
B42					5.10E-07	1.08E-05	4.95E-06			8.29E-07	1.04E-05	2.19E-01			9.78E-02	3.72E-02		1.36E-02	2.38E-04	2.55E-03	7.01E-04
35F Thickeners														2.49E-07	2.23E-02	6.95E-03		4.09E-03	1.01E-04	1.30E-03	6.44E-04
35D Filter Feed Tanks														1.97E-06	4.13E-02	1.63E-02	3.63E-05	9.31E-03	5.42E-05	3.28E-03	1.05E-03
35A Filter x10xit Tanks														6.71E-07	2.78E-02	2.35E-02		7.77E-03		4.14E-03	5.92E-04
35R, 35S, 35V Oxalate seed															1.36E-02	3.83E-03		1.03E-03	1.02E-05	3.40E-05	3.86E-05
35 J J101-102 Central causticizer															4.85E-02	2.14E-02		9.84E-03			
35C Bank 1,3 & 35H														2.22E-08	1.77E-02	4.51E-03	8.12E-06	2.88E-03	2.47E-03	2.56E-03	2.48E-03

Table A-7 - Pinjarra Refinery Air Emissions – Scenario 2 Peak Emissions (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Seleni-um	Manga-nese	Cadmium	Chrom-ium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetal-dehyde	Formal-dehyde	2-Butanone	Benze-ne	Toluene	Xylene
Ox Kiln	5.30E-01	6.00E-01	3.10E-02	6.60E-02	4.20E-04	5.50E-04	1.10E-05	2.70E-05	4.30E-07	1.20E-04	2.00E-03				1.20E-03		1.20E-03		4.10E-04	3.60E-04	
30 RTO																					
30 RTO in Bypass	1.50E+00	2.70E-01	1.20E-01		1.00E-04	1.40E-04	3.00E-04	8.70E-05	5.70E-06	2.90E-03	2.00E-03	3.70E-02			6.20E-03	3.30E-03	1.10E-03	8.20E-05		2.30E-03	
Calciner 1&2	4.70E+00	1.70E+01	7.50E-01	5.60E+00	1.90E-03	1.30E-03	2.00E-02	9.80E-04	7.30E-06	2.10E-03	7.30E-03			2.40E-06	5.30E-01	3.00E-01	2.30E-01	1.60E-02	8.30E-03	3.50E-03	5.70E-04
Calciner 3&4	5.80E+00	2.00E+01	6.00E-01	2.40E+00	1.80E-03	1.30E-03	1.90E-02	9.30E-04	6.90E-06	2.00E-03	6.90E-03			2.30E-06	4.70E-01	3.00E-01	1.00E-01	1.80E-02	1.60E-02	7.90E-03	
Calciner 5&6	6.60E+00	1.50E+01	7.10E-01	2.80E+00	2.30E-04	1.90E-04	8.00E-03	7.60E-04	5.30E-06	6.90E-04	2.90E-03			2.20E-06	8.70E-01	3.50E-01	3.00E-01	2.90E-02	3.30E-02	1.20E-02	
Calciner 7	5.80E+00	3.00E+01	7.30E-01	1.70E+00	2.30E-04	1.90E-04	8.00E-03	7.60E-04	5.30E-06	6.90E-04	2.90E-03			2.20E-06	2.10E-04	2.30E-02	9.20E-02	2.10E-04	3.20E-02	1.10E-02	
Boiler 2	5.10E+00	5.10E+00	4.10E-03				2.90E-05	6.60E-06	3.30E-07	6.10E-06							1.10E-03		1.80E-04		
Boiler 3&4	3.80E+00	3.90E+00	1.60E-03				1.10E-05	2.50E-06	1.30E-07	2.40E-06							4.20E-04		6.90E-05		
Boiler 6&7	9.90E+00	9.60E+00	8.10E-03				5.90E-05	1.30E-05	6.60E-07	1.20E-05							9.80E-04		1.50E-04		
Cogen 1	2.90E+01	4.40E+02	3.50E-02				8.60E-05	1.90E-05	9.60E-07	1.80E-05							1.90E-01				
Cogen 2	4.00E+01	3.60E+02	3.50E-02				8.60E-05	1.90E-05	9.60E-07	1.80E-05							1.90E-01				
OBF Vac Pump Stack					2.60E-05	1.90E-05	2.40E-05			9.30E-06	1.30E-05				5.90E-02	9.60E-03		3.40E-03	2.40E-05	2.00E-04	1.60E-05
Calciner Filter Vac Pumps															3.80E-02	3.00E-02		1.90E-02		5.00E-04	
44 Seed Filtration															3.00E-01	6.00E-02		7.10E-02		3.40E-03	
110 Deaerator					1.60E-05	7.10E-05	9.20E-05			1.60E-05	6.80E-05	6.20E-03		9.00E-09	5.30E-02	2.30E-02	5.50E-04	7.20E-03	4.70E-04	3.40E-04	2.60E-04
Mills Product Hopper															9.90E-03	1.50E-02	2.30E-04	4.90E-03	4.30E-04	4.80E-04	1.70E-04
25A/C Droppers															2.40E-02	9.80E-03		2.50E-03		5.80E-04	5.00E-05
x10xcess BO, PRT &					8.50E-07	1.80E-06	1.20E-05		3.60E-07						6.60E-02	2.90E-02		1.20E-02	2.90E-04	3.20E-03	2.90E-04
B34 A-Rake Stacks												1.20E-02			8.40E-05	1.30E-04			3.10E-05	3.00E-05	
Biox												3.40E-07	1.60E-03						2.00E-05	2.20E-03	2.20E-03
B42					6.90E-07	1.50E-05	6.00E-06			8.60E-07	1.10E-05	2.30E-01			9.90E-02	3.80E-02		1.40E-02	3.00E-04	4.00E-03	8.20E-04
35F Thickeners														8.50E-07	5.40E-02	1.30E-02		9.30E-03	1.70E-04	2.30E-03	1.30E-03
35D Filter Feed Tanks														3.70E-06	1.10E-01	5.10E-02	8.60E-05	2.30E-02	8.00E-05	5.60E-03	2.00E-03
35A Filter x10xit Tanks														1.60E-06	4.70E-02	4.20E-02		1.50E-02		9.80E-03	1.20E-03
35R, 35S, 35V Oxalate seed															3.60E-02	6.90E-03		3.60E-03	2.00E-05	1.70E-04	5.90E-05
35 J J101-102 Central causticizer															1.30E-01	4.10E-02		2.80E-02			
35C Bank 1,3 & 35H														6.50E-08	2.70E-02	8.20E-03	2.10E-05	4.50E-03	3.50E-03	4.30E-03	3.50E-03

Table A-8 - Pinjarra Refinery Air Emissions – Scenario 3 Average Emissions (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Seleni-um	Manga-nese	Cadmium	Chrom-ium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetal-dehyde	Formal-dehyde	2-Butanone	Benze-ne	Toluene	Xylene
Ox Kiln	2.10E-01	1.40E-01	9.90E-03	1.50E-02	1.70E-04	1.80E-04	5.60E-06	1.20E-05	1.50E-07	2.40E-05	6.20E-04				8.00E-04		5.60E-04		2.30E-04	2.50E-04	
30 RTO	4.80E-01	3.80E-02	3.30E-02		2.20E-05	3.30E-05	4.10E-05	8.40E-06	9.90E-07	2.30E-04	9.10E-04	2.90E-02			2.50E-03	1.40E-03	1.60E-04	2.90E-05		6.30E-04	
30 RTO in Bypass	3.80E-02	3.00E-03	2.60E-03		1.70E-06	2.60E-06	3.30E-06	6.70E-07	7.90E-08	1.80E-05	7.20E-05	2.30E-03			2.00E-04	1.10E-04	1.20E-05	2.30E-06		5.00E-05	
Calciner 1&2	2.20E+00	6.40E+00	1.70E-01	1.50E+00	2.60E-04	1.80E-04	2.00E-03	1.50E-04	1.20E-06	4.10E-04	1.40E-03			1.60E-06	9.70E-02	1.70E-01	2.00E-01	8.30E-03	5.20E-03	2.00E-03	3.70E-04
Calciner 3&4	3.10E+00	5.70E+00	1.50E-01	7.00E-01	2.60E-04	1.80E-04	2.00E-03	1.50E-04	1.20E-06	4.10E-04	1.40E-03			1.50E-06	9.20E-02	1.50E-01	2.70E-01	7.80E-03	5.70E-03	2.80E-03	
Calciner 5&6	4.10E+00	5.50E+00	1.80E-01	8.40E-01	4.80E-05	9.80E-05	2.30E-03	1.60E-04	2.30E-06	2.40E-04	8.40E-04			8.10E-07	1.60E-01	1.90E-01	1.90E-01	8.70E-03	1.20E-02	3.40E-03	
Calciner 7	3.00E+00	9.50E+00	1.50E-01	6.10E-01	4.30E-05	8.80E-05	2.10E-03	1.40E-04	2.00E-06	2.10E-04	7.50E-04			1.60E-06	1.90E-04	1.30E-02	4.10E-02	1.90E-04	1.90E-02	6.00E-03	
Boiler 2	3.00E+00	5.60E-01	3.50E-03				7.00E-06	1.80E-06	8.00E-08	2.00E-06							6.60E-04		1.10E-04		
Boiler 3&4	4.30E+00	3.90E-01	3.30E-03				6.60E-06	1.70E-06	7.50E-08	1.90E-06							6.20E-04		9.90E-05		
Boiler 6&7	5.40E+00	1.00E+00	7.00E-03				1.40E-05	3.50E-06	1.60E-07	3.90E-06					2.10E-02		5.90E-04		1.20E-04		
Cogen 1	2.20E+01	3.70E+01	3.20E-02				2.10E-05	5.40E-06	2.40E-07	6.00E-06							1.20E-01				
Cogen 2	2.10E+01	7.20E+01	2.80E-02				1.90E-05	4.80E-06	2.20E-07	5.40E-06							1.00E-01				
OBF Vac Pump Stack					1.80E-05	1.40E-05	1.70E-05			8.60E-06	1.00E-05				5.90E-02	9.60E-03		3.40E-03	2.00E-05	1.80E-04	1.60E-05
Calciner Filter Vac Pumps															3.10E-02	2.70E-02		1.70E-02		4.40E-04	
44 Seed Filtration															1.00E-01	2.00E-02		2.10E-02		2.80E-03	
110 Deaerator					4.20E-06	1.90E-05	4.10E-05			7.80E-06	3.30E-05	3.10E-03		4.20E-09	2.50E-02				2.30E-04	1.60E-04	1.30E-04
Mills Product Hopper															6.30E-03	8.80E-03	1.00E-04	2.80E-03	3.00E-04	3.00E-04	9.40E-05
25A/C Droppers															1.20E-02	6.80E-03		1.80E-03		3.80E-04	3.60E-05
x10xcess BO, PRT & CT Vents					3.80E-07	6.40E-07	4.10E-06		1.10E-07						3.20E-02	1.40E-02		5.00E-03	1.10E-04	1.00E-03	1.10E-04
B34 A-Rake Stacks												1.20E-02			6.00E-05	1.10E-04			7.40E-06	2.20E-05	
Biox												2.50E-07	1.30E-03						1.40E-05	2.20E-03	2.20E-03
B42					5.10E-07	1.10E-05	5.00E-06			8.30E-07	1.00E-05	2.20E-01			9.80E-02	3.70E-02		1.40E-02	2.40E-04	2.60E-03	7.00E-04
35F Thickeners														2.50E-07	2.20E-02	6.90E-03		4.10E-03	1.00E-04	1.30E-03	6.40E-04
35D Filter Feed tanks														2.00E-06	4.10E-02	1.60E-02	3.60E-05	9.30E-03	5.40E-05	3.30E-03	1.00E-03
35A Filter x10xit Tanks														6.70E-07	2.80E-02	2.40E-02		7.80E-03		4.10E-03	5.90E-04
35R, 35S, 35V Oxalate seed															1.40E-02	3.80E-03		1.00E-03	1.00E-05	3.40E-05	3.90E-05

Table A-9 - Pinjarra Refinery Air Emissions – Scenario 3 Peak Emissions (g/s)

Source	NOx	CO	SO_2	PM_{10}	Arsenic	Selenium	Manganese	Cadmium	Chromium (VI)	Nickel	Mercury	NH_3	H_2S	PAH	Acetone	Acetaldehyde	Formaldehyde	2-Butanone	Benzene	Toluene	Xylene
Ox Kiln	5.30E-01	6.00E-01	3.10E-02	6.60E-02	4.20E-04	5.50E-04	1.10E-05	2.70E-05	4.30E-07	1.20E-04	2.00E-03				1.20E-03		1.20E-03		4.10E-04	3.60E-04	
30 RTO																					
30 RTO in Bypass	1.50E+00	2.70E-01	1.20E-01		1.00E-04	1.40E-04	3.00E-04	8.70E-05	5.70E-06	2.90E-03	2.00E-03				6.20E-03	3.30E-03	1.10E-03	8.20E-05		2.30E-03	
Calciner 1&2	4.70E+00	1.70E+01	7.60E-01	5.70E+00	1.90E-03	1.30E-03	2.00E-02	9.90E-04	7.40E-06	2.10E-03	7.30E-03			2.50E-06	5.30E-01	3.10E-01	4.00E-01	1.70E-02	8.40E-03	3.60E-03	5.70E-04
Calciner 3&4	6.00E+00	2.20E+01	6.40E-01	2.60E+00	1.90E-03	1.30E-03	2.00E-02	9.90E-04	7.40E-06	2.10E-03	7.30E-03			2.50E-06	5.00E-01	3.20E-01	4.90E-01	1.90E-02	1.70E-02	8.20E-03	
Calciner 5&6	7.40E+00	1.60E+01	8.00E-01	3.20E+00	2.60E-04	2.20E-04	9.00E-03	8.60E-04	6.00E-06	7.70E-04	3.30E-03			2.50E-06	9.80E-01	4.00E-01	5.20E-01	3.20E-02	3.70E-02	1.40E-02	
Calciner 7	5.80E+00	3.00E+01	7.30E-01	1.70E+00	2.30E-04	1.90E-04	8.00E-03	7.70E-04	5.40E-06	6.90E-04	2.90E-03			2.20E-06	2.10E-04	2.30E-02	9.20E-02	2.10E-04	3.30E-02	1.10E-02	
Boiler 2	5.50E+00	5.50E+00	4.40E-03				3.20E-05	7.10E-06	3.50E-07	6.60E-06							1.20E-03		1.90E-04		
Boiler 3&4	5.10E+00	5.20E+00	2.10E-03				1.50E-05	3.40E-06	1.70E-07	3.10E-06							5.60E-04		9.20E-05		
Boiler 6&7	1.00E+01	9.90E+00	8.30E-03				6.00E-05	1.30E-05	6.70E-07	1.30E-05							1.00E-03		1.60E-04		
Cogen 1	2.90E+01	4.40E+02	3.50E-02				8.60E-05	1.90E-05	9.60E-07	1.80E-05							1.90E-01				
Cogen 2	4.00E+01	3.60E+02	3.50E-02				8.60E-05	1.90E-05	9.60E-07	1.80E-05							1.90E-01				
OBF Vac Pump Stack					2.60E-04	1.90E-05	2.40E-05			9.30E-06	1.30E-05				5.90E-02	9.60E-03		3.40E-03	2.40E-05	2.00E-04	1.60E-05
Calciner Filter Vac Pumps															3.80E-02	3.00E-02		1.90E-02		5.00E-04	
44 Seed Filtration															3.90E-01	7.70E-02		9.10E-02		4.40E-03	
110 Deaerator					1.60E-05	7.10E-05	9.20E-05			1.60E-05	6.80E-05			9.00E-09	5.30E-02	2.30E-02	5.50E-04	7.20E-03	4.70E-04	3.40E-04	2.60E-04
Mills Product Hopper															9.90E-03	1.50E-02	2.30E-04	4.90E-03	4.30E-04	4.80E-04	1.70E-04
25A/C Droppers															2.40E-02	9.80E-03		2.50E-03		5.80E-04	5.00E-05
x10xcess BO, PRT & CT Vents					9.20E-07	1.90E-06	1.30E-05		3.90E-07						7.10E-02	3.20E-02		1.30E-02	3.20E-04	3.50E-03	3.20E-04
B34 A-Rake Stacks															8.40E-05	1.30E-04			3.10E-05	3.00E-05	
Biox												3.40E-07	1.60E-03						2.00E-05	2.20E-03	2.20E-03
B42					6.90E-07	1.50E-05	6.00E-06			8.60E-07	1.10E-05	2.30E-01			9.90E-02	3.80E-02		1.40E-02	3.00E-04	4.00E-03	8.20E-04
35F Thickeners														8.50E-07	5.40E-02	1.30E-02		9.30E-03	1.70E-04	2.30E-03	1.30E-03
35D Filter Feed tanks														3.70E-06	1.10E-01	5.10E-02	8.60E-05	2.30E-02	8.00E-05	5.60E-03	2.00E-03
35A Filter x10xit Tanks														1.60E-06	4.70E-02	4.20E-02		1.50E-02		9.80E-03	1.20E-03
35R, 35S, 35V Oxalate seed															3.60E-02	6.90E-03		3.60E-03	2.00E-05	1.70E-04	5.90E-05

Table A-10 - Estimated Annual Emissions Of Fugitive Gaseous Emissions (kg/year)

VOC	Scenario	Super Thickener	New Cooling Pond	Cooling Pond Breach	Old Cooling Pond	ROWS	ROP	FWS	Storm Water Lake	Oxalate Ponds	Wet Sands	RSA	Total
BaP-equivalents	Sc 1A	1.9E-03	1.1E-01	1.3E-03							2.1E-05	4.2E-02	1.5E-01
	Sc 1B	1.7E-03	9.5E-02	1.1E-03							1.9E-04	3.7E-02	1.4E-01
	Sc 2											3.8E-02	3.8E-02
	Sc 3											2.8E-02	2.8E-02
Acetone	Sc 1A	1.05E+03	1.01E+04	1.60E+02	1.83E+02	2.98E+02	2.10E+01	2.23E+02	2.90E+01	1.70E+01	3.00E+00	5.97E+03	1.81E+04
	Sc 1B	9.38E+02	9.03E+03	1.43E+02	1.64E+02	2.66E+02	1.90E+01	1.99E+02	2.60E+01	1.50E+01	2.40E+01	5.60E+03	1.64E+04
	Sc 2						1.40E+01			2.37E+01		5.82E+03	5.85E+03
	Sc 3					7.60E+01	1.40E+01			2.37E+01		4.28E+03	4.39E+03
Acetaldehyde	Sc 1A	7.70E+02	6.79E+03	5.10E+01	5.10E+01	8.30E+01	6.00E+00	2.50E+03	8.00E+00	5.00E+00	1.00E+00	2.82E+03	1.31E+04
	Sc 1B	6.88E+02	6.07E+03	4.50E+01	4.60E+01	7.50E+01	5.00E+00	2.23E+03	7.00E+00	4.00E+00	8.00E+00	2.65E+03	1.18E+04
	Sc 2						4.00E+00			7.00E+00		2.75E+03	2.76E+03
	Sc 3					2.10E+01	4.00E+00			7.00E+00		2.02E+03	2.05E+03
Formaldehyde	Sc 1A	1.10E+01	1.15E+03	2.50E+01	4.03E+02	6.55E+02	4.70E+01		6.40E+01	3.70E+01	4.2E-01	2.09E+03	4.48E+03
	Sc 1B	9.00E+00	1.02E+03	2.30E+01	3.60E+02	5.85E+02	4.20E+01		5.70E+01	3.30E+01	3.80E+00	1.72E+03	3.86E+03
	Sc 2						3.10E+01			5.20E+01		1.79E+03	1.87E+03
	Sc 3					1.67E+02	3.10E+01			5.20E+01		1.31E+03	1.56E+03
2-Butanone	Sc 1A	1.03E+02	1.50E+03	1.80E+01							3.0E-01	6.11E+02	2.24E+03
	Sc 1B	9.20E+01	1.34E+03	1.60E+01							2.70E+00	5.18E+02	1.97E+03
	Sc 2											5.38E+02	5.38E+02
	Sc 3											3.96E+02	3.96E+02
Benzene	Sc 1A	1.50E+01	9.46E+02	6.00E+00							9.5E-02	2.43E+02	1.21E+03
	Sc 1B	1.30E+01	8.45E+02	5.00E+00							8.5E-01	2.08E+02	1.07E+03
	Sc 2											2.16E+02	2.16E+02
	Sc 3											1.59E+02	1.59E+02
Toluene	Sc 1A	6.10E+01	2.98E+02	1.10E+01							1.9E-01	5.38E+02	9.08E+02
	Sc 1B	5.50E+01	6.14E+02	1.00E+01							1.70E+00	4.53E+02	1.13E+03
	Sc 2											4.70E+02	4.70E+02
	Sc 3											3.46E+02	3.46E+02
Xylene	Sc 1A	1.00E+01	5.30E+01										6.30E+01
	Sc 1B	9.00E+00	4.80E+01										5.60E+01
	Sc 2												
	Sc 3												
Mercury	Sc 1A		2.59E+02										2.59E+02
	Sc 1B		2.59E+02										2.59E+02
	Sc 2												
	Sc 3												

Table A-11: Health Protective Guidelines

	Acute Health Effects							
	Scenarios 0 and 1A				Scenarios 1B, 2, 3			
Compound Name	Guideline	Units	Averaging Period	Reference	Guideline	Units	Averaging Period	Reference
NO_X	2.25E+02	µg/m^3	1	NEPC	1.50E+02	µg/m^3	1	NEPC
CO	1.03E+04	µg/m^3	8	NEPC	1.03E+04	µg/m^3	8	NEPC
SO_2	5.23E+02	µg/m^3	1	NEPC	5.20E+01	µg/m^3	24	NEPC (2019)
PM_{10}	5.00E+01	µg/m^3	24	NEPC	5.00E+01	µg/m^3	24	NEPC
Arsenic	2.00E-01	µg/m^3	1	OEHHA	2.00E-01	µg/m^3	1	OEHHA
Selenium								
Manganese								
Cadmium	3.00E-02	µg/m^3	24	ATSDR	3.00E-02	µg/m^3	24	ATSDR
Chromium (VI)								
Nickel	2.00E-01	µg/m^3	1	OEHHA	2.00E-01	µg/m^3	1	OEHHA
Mercury	6.00E-01	µg/m^3	1	OEHHA	6.00E-01	µg/m^3	1	OEHHA
NH_3	1.18E+03	µg/m^3	1	OEHHA	1.18E+03	µg/m^3	24	ATSDR
PAHs								
Acetone	6.18E+04	µg/m^3	24	ATSDR	6.18E+04	µg/m^3	24	ATSDR
Acetaldehyde	2.00E+03	µg/m^3	24	WHOa	4.70E+02	µg/m^3	24	WHO (1995)
Formaldehyde	4.90E+01	µg/m^3	24	NEPC (AT)	4.90E+01	µg/m^3	24	NEPC (AT)
2-Butanone	1.30E+04	µg/m^3	1	OEHHA	1.30E+04	µg/m^3	1	OEHHA
Benzene	2.70E+01	µg/m^3	6	OEHHA	2.70E+01	µg/m^3	1	OEHHA
Toluene	3.77E+03	µg/m^3	24	NEPC (AT)	3.77E+03	µg/m^3	24	NEPC (AT)
Xylenes	1.08E+03	µg/m^3	24	NEPC (AT)	1.09E+03	µg/m^3	24	NEPC (AT)
H_2S					4.20E+01	µg/m^3	1	OEHHA

	Chronic Health Effects							
	Scenarios 0 and 1A				Scenarios 1B, 2, 3			
Compound Name	Guideline	Units	Averaging Period	Reference	Guideline	Units	Averaging Period	Reference
NO_X	5.70E+01	µg/m^3	Annual	NEPC	2.80E+01	µg/m^3	Annual	NEPC
CO								
SO_2	5.20E+01	µg/m^3	Annual	NEPC	5.20E+01	µg/m^3	Annual	NEPC (2016)
PM_{10}					2.50E+01	µg/m^3	Annual	NEPC
Arsenic	1.00E+00	µg/m^3	Annual	RIVM	1.50E-02	µg/m^3	Annual	OEHHA
Selenium	2.00E+01	µg/m^3	Annual	OEHHA	2.00E+01	µg/m^3	Annual	OEHHA
Manganese	1.50E-01	µg/m^3	Annual	WHO	5.00E-02	µg/m^3	Annual	IRIS 2019
Cadmium	5.00E-03	µg/m^3	Annual	WHO	5.00E-03	µg/m^3	Annual	ATSDR 2019
Chromium (VI)	1.00E-01	µg/m^3	Annual	IRIS	5.00E-03	µg/m^3	Annual	ATSDR 2019
Nickel	9.00E-02	µg/m^3	Annual	ATSDR	1.40E-02	µg/m^3	Annual	OEHHA
Mercury	2.00E-01	µg/m^3	Annual	WHO	3.00E-02	µg/m3	Annual	OEHHA
NH_3	1.00E+02	µg/m^3	Annual	IRIS	7.60E+01	µg/m^3	Annual	ATSDR 2019
PAHs					2.74E-04	µg/m^3	Annual	NEPC (2004)
Acetone	3.37E+04	µg/m^3	Annual	ATSDR				
Acetaldehyde	5.00E+01	µg/m^3	Annual	WHO	9.00E+00	µg/m^3	Annual	IRIS 2019
Formaldehyde	1.10E+01	µg/m^3	Annual	ATSDR	9.00E+00	µg/m^3	Annual	OEHHA 2019
2-Butanone	5.00E+03	µg/m^3	Annual	IRIS	5.00E+03	µg/m^3	Annual	IRIS
Benzene	3.00E+00	µg/m^3	Annual	OEHHA	1.00E+01	µg/m^3	Annual	ATSDR 2019
Toluene	3.77E+02	µg/m^3	Annual	NEPC (AT)	3.77E+02	µg/m^3	Annual	NEPC (AT)
Xylenes	8.67E+02	µg/m^3	Annual	NEPC (AT)	8.68E+02	µg/m^3	Annual	NEPC (2004)
H_2S					2.00E+00	µg/m^3	Annual	IRIS

	Carcinogenic Health Effects					
	Scenarios 0 and 1A			Scenarios 1B, 2, 3		
Compound Name	Guideline	Units	Reference			
NO_X						
CO						
SO_2						
PM_{10}						
Arsenic	1.50E-03	per µg/m^3	WHO	1.50E-03	per µg/m^3	WHO
Selenium						
Manganese						
Cadmium	1.80E-03	per µg/m^3	IRIS	1.80E-03	per µg/m^3	IRIS 2019
Chromium (VI)	4.00E-02	per µg/m^3	WHO	1.20E-02	per µg/m^3	IRIS 2019
Nickel	3.80E-04	per µg/m^3	WHO	2.60E-04	per µg/m^3	OEHHA 2019
Mercury						
NH_3						
PAHs	8.70E-02	per µg/m^3	WHO	6.00E-04	per µg/m^3	NEPM
Acetone						
Acetaldehyde	9.00E-07	per µg/m^3	WHO	9.00E-07	per µg/m^3	WHO 2000
Formaldehyde	1.30E-05	per µg/m^3	IRIS	6.00E-06	per µg/m^3	OEHHA 2019
2-Butanone						
Benzene	6.00E-06	per µg/m^3	WHO	6.00E-06	per µg/m^3	WHO 2000
Toluene						
Xylenes						

Notes

1. Referenced to 25ºC, and 101.3 kPa
2. Blanks in the table indicate that no applicable guideline was able to be identified.
3. NEPC: National Environment Protection (Ambient Air Quality) Measure (NEPC, 2003, 2021)
4. NEPC (AT): National Environment Protection (Air Toxics) Measure, (NEPC, 2004)
5. WHO: World Health Organisation (WHO) Air Quality Guidelines for Europe Second Edition (2000)
6. WHO (1995): EHC 167 Environmental Health Criteria 167 Acetaldehyde, International Programme on Chemical Safety

7. WHO (2003): CICAD 50 Elemental Mercury and Inorganic Mercury Compounds: Human Health Aspects
8. OEHHA: California Office of Environmental Health Hazard Assessment's (OEHHA) Toxicity Criteria Database
9. ATSDR: U.S. Agency for Toxic Substances and Disease Registry's (ATSDR) Minimal Risk Levels (MRLs) for Hazardous Substances
10. IRIS: U.S. Environment Protection Agency's (US EPA) Integrated Risk Information System (IRIS)
11. RIVM: Dutch National Institute of Public Health and the Environment (RIVM) human-toxicological Maximum Permissible Risk Levels (2001)

Table A-12: Quantitative Health Risk Indicators - Acute

	Scenario 0 - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**
NO_2	1.76E-01	1.74E-01	3.86E-02	1.78E-01	0.00E+00	0.00E+00	1.74E-01	1.53E-01	1.66E-01	1.62E-01	1.97E-01	1.01E-01	1.52E-01	1.53E-01	1.63E-01	1.68E-01	1.66E-01	1.79E-01	1.47E-01	1.82E-01	9.79E-02	1.83E-01
CO	2.43E-03	8.07E-03	2.93E-04	4.09E-03	4.50E-07	4.67E-07	1.17E-02	2.40E-03	6.35E-03	2.05E-03	5.92E-03	6.57E-03	2.19E-03	8.02E-03	2.42E-03	4.13E-03	2.43E-03	4.84E-03	2.98E-03	2.02E-03	5.66E-03	2.32E-03
SO_2	4.48E-03	1.92E-03	1.49E-03	5.27E-03	0.00E+00	0.00E+00	6.40E-03	4.72E-03	8.20E-03	7.57E-03	9.07E-03	4.64E-03	4.13E-03	6.57E-03	4.59E-03	6.39E-03	4.51E-03	6.70E-03	2.70E-03	7.42E-03	5.62E-03	1.06E-02
PM_{10}	6.99E-02	1.10E-01	1.14E-01	5.03E-02	4.74E-01	4.69E-01	2.16E-01	1.71E-01	6.56E-02	1.98E-02	1.65E-02	1.28E-01	8.64E-02	1.19E-01	7.27E-02	7.73E-02	9.77E-02	6.30E-02	1.22E-01	8.19E-02	7.80E-02	8.32E-02
Arsenic	1.87E-02	8.76E-03	7.14E-03	2.23E-02	2.09E-04	1.28E-04	2.83E-02	1.98E-02	3.85E-02	3.49E-02	4.08E-02	2.10E-02	1.83E-02	2.80E-02	1.98E-02	2.85E-02	1.96E-02	2.99E-02	1.14E-02	3.36E-02	1.61E-02	4.86E-02
Cadmium	3.11E-03	5.90E-03	1.12E-03	3.84E-03	3.62E-04	1.31E-03	1.02E-02	7.86E-03	6.73E-03	3.21E-03	4.03E-03	1.31E-02	2.76E-03	8.66E-03	3.24E-03	6.08E-03	2.96E-03	1.07E-02	1.99E-03	3.30E-03	6.72E-03	3.58E-03
Nickel	1.01E-01	2.75E-02	3.53E-02	1.61E-02	9.04E-05	5.56E-05	1.67E-02	2.42E-02	2.71E-02	2.63E-02	3.31E-02	1.81E-02	4.02E-02	2.02E-02	4.20E-02	3.14E-02	4.50E-02	3.59E-02	2.68E-02	3.21E-02	1.36E-01	2.83E-02
Mercury	2.67E-01	1.86E-01	2.49E-01	2.76E-02	4.84E-02	2.37E-04	2.02E-02	2.67E-02	2.68E-02	2.62E-02	4.36E-02	2.01E-02	1.72E-01	2.13E-02	1.81E-01	3.28E-02	2.03E-01	3.84E-02	1.28E-01	3.36E-02	2.02E-01	5.44E-02
NH_3	5.06E-04	4.97E-04	3.73E-04	1.20E-04	4.95E-05	4.96E-05	1.62E-04	1.50E-04	2.50E-04	1.13E-04	1.28E-04	5.91E-04	4.99E-04	2.58E-04	5.11E-04	2.46E-04	5.27E-04	3.34E-04	3.54E-04	3.12E-04	6.52E-04	1.95E-04
Acetone	1.97E-05	2.35E-05	1.40E-05	8.82E-06	5.83E-06	6.62E-06	1.76E-05	1.36E-05	1.78E-05	8.88E-06	8.53E-06	3.56E-05	1.75E-05	1.53E-05	1.85E-05	9.83E-06	1.86E-05	2.19E-05	1.49E-05	1.25E-05	2.36E-05	1.09E-05
Acetaldehyde	3.04E-04	3.49E-04	2.23E-04	1.51E-04	1.39E-04	1.51E-04	2.94E-04	2.22E-04	2.84E-04	1.50E-04	1.37E-04	5.71E-04	2.65E-04	2.49E-04	2.85E-04	1.59E-04	2.84E-04	3.47E-04	2.22E-04	2.05E-04	3.86E-04	1.72E-04
Formaldehyde	2.79E-03	6.76E-03	1.15E-03	4.55E-03	1.13E-03	2.14E-03	1.19E-02	8.78E-03	7.92E-03	4.30E-03	4.33E-03	1.60E-02	2.56E-03	9.70E-03	2.95E-03	6.87E-03	2.78E-03	1.18E-02	1.91E-03	3.91E-03	6.11E-03	3.98E-03
2-Butanone	1.23E-04	8.99E-05	1.09E-04	2.41E-05	3.72E-06	1.04E-06	1.77E-05	3.02E-05	3.64E-05	3.19E-05	3.84E-05	2.42E-05	1.03E-04	2.83E-05	1.06E-04	2.15E-05	1.09E-04	2.16E-05	7.89E-05	3.50E-05	1.19E-04	6.19E-05
Benzene	2.25E-03	3.21E-03	2.44E-03	5.51E-03	7.84E-04	2.02E-04	6.48E-03	4.28E-03	8.10E-03	7.35E-03	8.89E-03	4.67E-03	4.12E-03	6.66E-03	4.67E-03	5.76E-03	4.52E-03	6.08E-03	2.79E-03	6.90E-03	1.50E-03	1.07E-02
Toluene	8.37E-06	1.02E-05	6.56E-06	4.17E-06	4.35E-06	4.44E-06	6.57E-06	4.97E-06	7.50E-06	3.67E-06	3.34E-06	1.29E-05	7.71E-06	6.79E-06	7.71E-06	5.17E-06	8.24E-06	9.46E-06	7.50E-06	5.27E-06	1.15E-05	4.97E-06
Xylenes	7.10E-06	7.43E-06	5.24E-06	1.97E-06	1.47E-06	1.46E-06	2.78E-06	2.32E-06	4.84E-06	1.94E-06	2.10E-06	8.33E-06	6.81E-06	3.92E-06	6.60E-06	3.06E-06	7.27E-06	5.63E-06	6.81E-06	4.21E-06	9.45E-06	3.88E-06
H_2S	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	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
Total	***6.49E-01***	***5.33E-01***	***4.51E-01***	***3.17E-01***	***5.25E-01***	***4.74E-01***	***5.03E-01***	***4.23E-01***	***3.62E-01***	***2.94E-01***	***3.64E-01***	***3.35E-01***	***4.85E-01***	***3.82E-01***	***4.97E-01***	***3.67E-01***	***5.49E-01***	***3.87E-01***	***4.48E-01***	***3.87E-01***	***5.58E-01***	***4.29E-01***

	Scenario 1A - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**
NO_2	6.76E-02	4.98E-02	2.02E-01	1.22E-01	2.02E-01	0.00E+00	1.62E-01	2.14E-02	1.61E-01	1.16E-01	1.90E-01	1.23E-01	1.32E-01	1.66E-01	1.91E-01	1.91E-01	8.89E-02	1.78E-01	2.05E-01	1.86E-01	2.22E-01	2.06E-01
CO	8.66E-04	9.78E-04	1.62E-02	3.41E-03	6.75E-03	0.00E+00	8.47E-03	2.83E-04	4.94E-03	6.57E-03	1.26E-02	6.42E-03	2.22E-03	9.91E-03	3.18E-03	8.18E-03	9.68E-04	1.03E-02	1.18E-02	7.18E-03	9.27E-03	8.30E-03
SO_2	4.37E-03	1.38E-03	1.24E-02	3.24E-03	4.21E-03	0.00E+00	6.47E-03	1.54E-03	5.24E-03	5.06E-03	8.96E-03	5.00E-03	4.22E-03	7.20E-03	4.86E-03	5.78E-03	5.34E-03	7.47E-03	8.68E-03	5.37E-03	8.34E-03	6.21E-03
PM_{10}	2.06E-01	1.60E-01	2.57E-01	2.04E-01	3.05E-01	2.97E-01	1.33E-01	1.32E-01	1.72E-01	1.37E-01	1.64E-01	1.55E-01	1.57E-01	1.44E-01	1.80E-01	1.67E-01	1.69E-01	1.63E-01	2.41E-01	2.13E-01	2.12E-01	1.65E-01
Arsenic	1.91E-02	5.38E-03	5.05E-02	1.30E-02	1.91E-02	2.38E-05	1.89E-02	9.18E-03	1.58E-02	1.98E-02	3.47E-02	2.00E-02	1.70E-02	2.82E-02	2.06E-02	2.48E-02	1.38E-02	2.97E-02	3.50E-02	2.16E-02	2.30E-02	2.13E-02
Cadmium	9.31E-04	9.60E-04	0.00E+00	4.82E-04	2.12E-04	4.69E-04	6.21E-03	4.45E-03	5.93E-04	9.21E-03	8.37E-03	8.99E-03	8.89E-03	7.37E-03	1.33E-02	1.02E-02	7.72E-03	7.97E-03	4.99E-03	5.78E-03	2.80E-03	3.43E-03
Nickel	9.30E-02	2.93E-02	4.20E-02	3.52E-02	8.11E-03	0.00E+00	3.07E-02	3.07E-02	7.85E-02	2.14E-02	1.54E-02	2.56E-02	8.98E-02	1.69E-02	1.02E-01	1.65E-02	1.22E-01	1.96E-02	3.32E-02	2.59E-02	8.95E-02	5.17E-02
Mercury	1.49E-01	1.62E-01	3.92E-02	3.80E-02	1.31E-02	1.49E-01	3.00E-02	7.76E-02	8.35E-02	2.29E-02	1.53E-02	2.76E-02	1.01E-01	1.67E-02	1.15E-01	1.67E-02	1.28E-01	1.96E-02	3.51E-02	2.70E-02	1.42E-01	7.41E-02
NH_3	1.11E-04	6.55E-05	4.74E-05	8.93E-06	3.80E-05	2.82E-05	1.15E-04	1.25E-04	4.66E-06	2.36E-04	2.41E-04	2.45E-04	3.40E-04	1.02E-03	5.45E-04	2.97E-04	3.43E-04	1.21E-03	2.36E-04	2.58E-04	1.97E-03	7.23E-04
Acetone	6.68E-06	1.08E-05	2.26E-06	1.84E-06	3.94E-06	2.97E-06	1.25E-05	1.16E-05	2.36E-06	1.87E-05	1.94E-05	1.81E-05	1.80E-05	2.39E-05	2.83E-05	2.00E-05	1.64E-05	2.73E-05	1.08E-05	1.14E-05	1.88E-05	1.20E-05
Acetaldehyde	1.32E-04	1.44E-04	4.17E-05	2.95E-05	8.11E-05	5.43E-05	1.90E-04	1.76E-04	4.80E-05	2.85E-04	2.92E-04	2.80E-04	2.68E-04	3.68E-04	4.24E-04	3.07E-04	2.43E-04	4.24E-04	1.62E-04	1.72E-04	2.98E-04	1.78E-04
Formaldehyde	3.98E-03	4.82E-03	1.18E-03	2.67E-03	3.24E-03	2.08E-03	1.61E-02	1.14E-02	2.14E-03	2.27E-02	2.04E-02	2.28E-02	2.17E-02	1.70E-02	3.33E-02	2.54E-02	1.88E-02	1.85E-02	1.22E-02	1.35E-02	5.75E-03	7.98E-03
2-Butanone	4.09E-05	5.88E-05	2.11E-05	2.91E-05	2.57E-05	1.37E-05	1.41E-05	2.22E-06	5.60E-06	2.43E-05	2.12E-05	2.74E-05	4.32E-06	2.60E-05	5.16E-06	2.74E-05	4.42E-06	2.52E-05	2.26E-05	1.74E-05	4.53E-05	3.39E-05
Benzene	4.63E-04	1.28E-03	1.08E-02	1.82E-03	3.67E-03	2.90E-04	5.09E-03	4.57E-04	1.82E-03	4.31E-03	8.34E-03	4.07E-03	6.13E-05	6.54E-03	6.98E-05	5.12E-03	5.02E-05	6.76E-03	7.85E-03	4.45E-03	6.64E-03	5.07E-03
Toluene	4.36E-06	4.93E-06	1.89E-06	1.56E-06	3.95E-06	2.45E-06	5.43E-06	5.65E-06	1.77E-06	8.14E-06	8.33E-06	8.16E-06	8.46E-06	1.17E-05	1.19E-05	9.02E-06	8.06E-06	1.29E-05	5.60E-06	5.74E-06	1.10E-05	6.38E-06
Xylenes	2.11E-06	1.67E-06	5.19E-07	2.67E-07	9.86E-07	7.02E-07	2.27E-06	2.57E-06	2.80E-07	3.72E-06	3.89E-06	3.82E-06	5.51E-06	9.13E-06	7.42E-06	4.80E-06	5.49E-06	1.02E-05	3.45E-06	3.73E-06	9.33E-06	5.00E-06
H_2S	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	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
Total	***5.45E-01***	***4.17E-01***	***6.31E-01***	***4.24E-01***	***5.65E-01***	***4.49E-01***	***4.17E-01***	***2.90E-01***	***5.26E-01***	***3.66E-01***	***4.79E-01***	***3.99E-01***	***5.34E-01***	***4.21E-01***	***6.64E-01***	***4.72E-01***	***5.55E-01***	***4.62E-01***	***5.95E-01***	***5.11E-01***	***7.24E-01***	***5.50E-01***

	Scenario 1B - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**
NO_2	3.29E-01	2.16E-01	3.03E-01	1.83E-01	3.03E-01	1.45E-01	2.44E-01	1.29E-01	2.42E-01	1.74E-01	2.86E-01	1.92E-01	3.16E-01	2.49E-01	2.87E-01	2.61E-01	3.17E-01	2.67E-01	3.08E-01	2.67E-01	3.33E-01	3.10E-01
CO	8.72E-03	5.89E-03	1.62E-02	3.41E-03	6.75E-03	4.27E-03	8.47E-03	5.56E-03	4.95E-03	6.57E-03	1.26E-02	7.11E-03	1.23E-02	9.92E-03	3.19E-03	1.18E-02	1.19E-02	1.03E-02	1.18E-02	4.86E-03	9.27E-03	8.30E-03
SO_2	1.89E-03	2.32E-03	0.00E+00	6.65E-04	4.43E-04	7.46E-04	9.96E-03	7.14E-03	1.46E-02	7.92E-04	1.26E-02	1.48E-02	1.55E-02	2.44E-02	2.28E-02	1.74E-02	1.38E-02	1.33E-02	8.63E-03	2.02E-02	4.73E-03	2.20E-02
PM_{10}	2.06E-01	1.60E-01	2.57E-01	2.04E-01	3.05E-01	2.97E-01	1.33E-01	1.32E-01	1.37E-01	1.72E-01	1.64E-01	1.55E-01	1.57E-01	1.11E-01	1.80E-01	1.67E-01	1.69E-01	1.63E-01	2.41E-01	1.88E-01	2.12E-01	1.19E-01
Arsenic	2.31E-02	1.52E-02	5.05E-02	1.30E-02	1.91E-02	1.22E-02	1.89E-02	1.66E-02	1.58E-02	1.98E-02	3.47E-02	2.18E-02	3.49E-02	2.82E-02	2.06E-02	3.49E-02	3.51E-02	2.97E-02	3.50E-02	9.28E-03	2.30E-02	2.13E-02
Cadmium	9.31E-04	9.60E-04	0.00E+00	4.82E-04	2.12E-04	4.69E-04	6.21E-03	4.45E-03	9.21E-03	5.93E-04	8.37E-03	8.99E-03	8.89E-03	1.54E-02	1.33E-02	1.02E-02	7.72E-03	7.97E-03	4.99E-03	1.23E-02	2.80E-03	1.23E-02
Nickel	1.26E-02	9.22E-03	4.20E-02	3.52E-02	8.11E-03	5.72E-03	3.07E-02	1.27E-02	7.85E-02	2.14E-02	1.54E-02	2.19E-02	2.38E-02	1.69E-02	1.02E-01	1.98E-02	2.71E-02	1.96E-02	3.32E-02	2.92E-02	8.95E-02	5.17E-02
Mercury	1.69E-02	2.24E-02	3.92E-02	3.80E-02	1.31E-02	5.16E-03	3.00E-02	1.17E-02	8.35E-02	2.29E-02	1.53E-02	2.28E-02	2.41E-02	1.67E-02	1.15E-01	1.97E-02	2.78E-02	1.96E-02	3.51E-02	5.50E-02	1.42E-01	7.41E-02
NH_3	1.11E-04	6.57E-05	4.75E-05	8.95E-06	3.80E-05	2.82E-05	1.15E-04	1.25E-04	2.36E-04	4.67E-06	2.42E-04	2.46E-04	3.40E-04	3.56E-04	5.46E-04	2.98E-04	3.43E-04	1.21E-03	2.37E-04	4.60E-04	1.98E-03	1.11E-03
Acetone	6.68E-06	1.08E-05	2.26E-06	1.84E-06	3.94E-06	2.97E-06	1.25E-05	1.16E-05	1.87E-05	2.36E-06	1.94E-05	1.81E-05	1.80E-05	2.73E-05	2.83E-05	2.00E-05	1.64E-05	2.73E-05	1.08E-05	2.36E-05	1.88E-05	4.27E-05
Acetaldehyde	5.60E-04	6.13E-04	1.78E-04	1.25E-04	3.45E-04	2.31E-04	8.10E-04	7.49E-04	1.21E-03	2.04E-04	1.24E-03	1.19E-03	1.14E-03	1.76E-03	1.80E-03	1.31E-03	1.04E-03	1.81E-03	6.91E-04	1.50E-03	1.27E-03	2.57E-03
Formaldehyde	3.98E-03	4.82E-03	1.18E-03	2.67E-03	3.24E-03	2.08E-03	1.61E-02	1.14E-02	2.27E-02	2.14E-03	2.04E-02	2.28E-02	2.17E-02	3.79E-02	3.33E-02	2.54E-02	1.88E-02	1.85E-02	1.22E-02	2.93E-02	5.75E-03	2.90E-02
2-Butanone	1.26E-05	1.60E-05	2.11E-05	2.91E-05	2.57E-05	7.76E-06	1.41E-05	6.29E-06	5.60E-06	2.43E-05	2.12E-05	2.23E-05	3.10E-05	2.60E-05	5.16E-06	3.39E-05	3.02E-05	2.52E-05	2.26E-05	6.19E-05	4.53E-05	3.39E-05
Benzene	5.29E-03	3.77E-03	1.08E-02	1.82E-03	3.67E-03	2.82E-03	5.09E-03	3.85E-03	1.82E-03	4.31E-03	8.34E-03	4.64E-03	8.10E-03	6.54E-03	6.98E-05	8.16E-03	7.77E-03	6.76E-03	7.85E-03	9.58E-04	6.64E-03	5.07E-03
Toluene	4.36E-06	4.93E-06	1.89E-06	1.56E-06	3.95E-06	2.45E-06	5.44E-06	5.65E-06	8.15E-06	1.77E-06	8.34E-06	8.16E-06	8.46E-06	1.07E-05	1.19E-05	9.02E-06	8.07E-06	1.29E-05	5.60E-06	1.02E-05	1.10E-05	2.12E-05
Xylenes	2.11E-06	1.66E-06	5.18E-07	2.66E-07	9.85E-07	7.01E-07	2.27E-06	2.57E-06	3.72E-06	2.80E-07	3.89E-06	3.82E-06	5.50E-06	5.19E-06	7.40E-06	4.80E-06	5.48E-06	1.02E-05	3.45E-06	6.00E-06	9.31E-06	1.86E-05
H_2S	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	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
Total	***6.09E-01***	***4.42E-01***	***7.20E-01***	***4.82E-01***	***6.63E-01***	***4.76E-01***	***5.03E-01***	***3.36E-01***	***6.11E-01***	***4.25E-01***	***5.79E-01***	***4.73E-01***	***6.24E-01***	***5.18E-01***	***7.79E-01***	***5.78E-01***	***6.37E-01***	***5.59E-01***	***6.98E-01***	***6.18E-01***	***8.32E-01***	***6.57E-01***

	Scenario 2 - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**
NO_2	3.74E-01	2.04E-01	2.96E-01	1.66E-01	3.17E-01	1.60E-01	2.39E-01	1.79E-01	2.24E-01	1.55E-01	2.69E-01	1.68E-01	3.17E-01	2.31E-01	2.88E-01	2.55E-01	3.18E-01	2.39E-01	3.06E-01	2.44E-01	4.38E-01	2.86E-01
CO	3.88E-02	2.26E-02	1.39E-02	7.43E-03	6.20E-02	1.95E-02	1.45E-02	2.23E-02	1.09E-02	6.58E-03	1.12E-02	7.78E-03	1.76E-02	7.16E-03	1.03E-02	1.88E-02	1.74E-02	8.19E-03	1.36E-02	9.22E-03	5.46E-02	7.25E-03
SO_2	1.08E-03	3.67E-03	0.00E+00	3.63E-04	1.44E-03	4.23E-03	6.93E-03	4.81E-03	1.01E-02	5.75E-04	1.02E-02	8.80E-03	1.06E-02	1.72E-02	1.57E-02	1.18E-02	9.04E-03	1.68E-02	1.39E-02	5.76E-03	3.00E-03	1.14E-02
PM_{10}	2.39E-01	1.84E-01	2.14E-01	2.00E-01	2.52E-01	2.37E-01	1.51E-01	1.36E-01	1.76E-01	2.03E-01	2.01E-01	1.92E-01	1.86E-01	1.56E-01	2.26E-01	2.12E-01	2.02E-01	1.71E-01	2.42E-01	2.63E-01	2.37E-01	1.68E-01
Arsenic	1.66E-02	6.66E-03	3.58E-02	2.46E-02	1.43E-02	7.11E-03	2.03E-02	5.92E-03	2.10E-02	1.70E-02	2.59E-02	1.87E-02	2.53E-02	2.41E-02	3.08E-02	1.18E-02	2.66E-02	1.92E-02	2.22E-02	2.14E-02	1.76E-02	2.28E-02
Cadmium	2.28E-03	7.46E-03	0.00E+00	7.25E-04	2.90E-03	8.97E-03	1.46E-02	1.01E-02	2.11E-02	1.19E-03	2.13E-02	1.81E-02	2.18E-02	3.63E-02	3.27E-02	2.47E-02	1.83E-02	3.57E-02	2.88E-02	1.17E-02	5.74E-03	2.42E-02
Nickel	2.33E-02	1.23E-02	6.60E-02	2.95E-02	1.89E-02	9.27E-03	2.96E-02	7.70E-03	3.96E-02	3.37E-02	3.82E-02	3.46E-02	4.81E-02	5.05E-02	5.98E-02	2.94E-02	5.32E-02	4.40E-02	5.96E-02	4.29E-02	3.26E-02	9.62E-02
Mercury	2.67E-02	1.12E-02	6.16E-02	3.53E-02	2.39E-02	1.09E-02	3.21E-02	9.30E-03	3.45E-02	2.93E-02	4.17E-02	3.20E-02	4.36E-02	3.93E-02	5.07E-02	2.00E-02	4.51E-02	3.61E-02	4.01E-02	3.73E-02	2.95E-02	4.74E-02
NH_3	2.96E-05	9.22E-05	2.01E-05	2.14E-06	2.23E-05	3.28E-05	3.25E-05	3.58E-05	6.16E-05	1.75E-06	6.09E-05	6.78E-05	1.02E-04	9.39E-05	1.30E-04	7.15E-05	2.65E-04	9.80E-05	1.08E-04	5.00E-05	8.86E-05	2.72E-04
Acetone	5.23E-06	1.44E-05	2.15E-06	1.42E-06	6.12E-06	6.62E-06	7.31E-06	6.98E-06	1.09E-05	1.73E-06	1.09E-05	1.13E-05	1.18E-05	1.55E-05	1.72E-05	1.24E-05	2.03E-05	1.56E-05	1.44E-05	7.15E-06	2.73E-05	2.27E-05
Acetaldehyde	4.47E-04	9.07E-04	2.04E-04	1.12E-04	4.66E-04	4.44E-04	4.68E-04	4.54E-04	7.02E-04	1.62E-04	7.14E-04	7.27E-04	6.93E-04	9.74E-04	1.03E-03	7.81E-04	1.12E-03	9.80E-04	8.76E-04	4.35E-04	1.37E-03	1.36E-03
Formaldehyde	1.11E-03	3.16E-03	7.56E-04	1.47E-03	2.86E-03	4.16E-03	5.01E-03	3.04E-03	6.14E-03	7.57E-04	6.18E-03	5.67E-03	6.87E-03	9.52E-03	9.52E-03	6.62E-03	4.58E-03	9.31E-03	7.84E-03	3.61E-03	2.23E-03	7.69E-03
2-Butanone	8.17E-06	7.62E-06	3.53E-05	5.75E-06	2.21E-05	2.12E-06	1.02E-05	1.44E-06	2.37E-05	1.29E-05	1.23E-05	1.96E-05	2.38E-05	2.07E-05	2.71E-05	2.04E-05	2.43E-05	8.18E-06	2.58E-05	2.37E-05	1.62E-05	4.35E-05
Benzene	2.69E-03	1.31E-03	5.45E-03	2.68E-03	2.02E-03	1.01E-03	3.46E-03	9.15E-04	2.85E-03	2.76E-03	4.15E-03	3.37E-03	4.40E-03	2.96E-03	4.23E-03	1.51E-03	4.09E-03	3.43E-03	3.37E-03	4.28E-03	3.10E-03	3.79E-03
Toluene	3.94E-06	1.06E-05	2.43E-06	1.60E-06	5.53E-06	4.33E-06	4.09E-06	4.65E-06	6.37E-06	1.61E-06	6.37E-06	6.95E-06	7.20E-06	7.84E-06	1.00E-05	7.07E-06	1.57E-05	8.09E-06	8.24E-06	4.77E-06	1.99E-05	1.75E-05
Xylenes	2.39E-06	8.71E-06	1.20E-06	8.52E-07	2.99E-06	1.98E-06	2.58E-06	3.25E-06	4.25E-06	2.25E-07	4.64E-06	4.14E-06	8.87E-06	5.96E-06	1.08E-05	7.28E-06	2.16E-05	6.72E-06	7.27E-06	5.22E-06	3.51E-05	2.14E-05
H_2S	1.53E-05	7.84E-06	0.00E+00	0.00E+00	1.33E-06	0.00E+00	6.65E-06	0.00E+00	3.75E-05	2.54E-05	9.30E-06	2.67E-05	3.50E-05	6.85E-05	5.61E-05	5.56E-05	4.45E-05	2.41E-05	8.28E-05	6.86E-05	3.83E-05	1.47E-04
Total	***7.27E-01***	***4.57E-01***	***6.94E-01***	***4.69E-01***	***6.97E-01***	***4.63E-01***	***5.17E-01***	***3.79E-01***	***5.46E-01***	***4.49E-01***	***6.29E-01***	***4.90E-01***	***6.82E-01***	***5.76E-01***	***7.29E-01***	***5.93E-01***	***7.01E-01***	***5.84E-01***	***7.38E-01***	***6.43E-01***	***8.25E-01***	***6.77E-01***

	Scenario 3 - Acute																					
	Receptor 2		**Receptor 3**		**Receptor 4**		**Receptor 5**		**Receptor 6**		**Receptor 7**		**Receptor 8**		**Receptor 9**		**Receptor 10**		**Receptor 11**		**Receptor 12**	
Compound Name	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**	**Max**	**9th Highest**
NO_2	3.86E-01	2.10E-01	2.97E-01	2.35E-01	3.18E-01	1.64E-01	2.57E-01	1.72E-01	2.34E-01	1.64E-01	2.95E-01	1.80E-01	3.10E-01	2.74E-01	3.04E-01	2.67E-01	3.22E-01	2.49E-01	3.30E-01	2.47E-01	4.41E-01	3.39E-01
CO	3.92E-02	2.28E-02	1.42E-02	3.18E-03	6.22E-02	1.96E-02	1.51E-02	8.77E-03	1.13E-02	6.86E-03	1.18E-02	7.55E-03	1.09E-02	2.63E-02	1.08E-02	1.90E-02	1.81E-02	9.75E-03	1.12E-02	9.44E-03	5.51E-02	2.09E-02
SO_2	1.06E-03	3.74E-03	0.00E+00	3.25E-04	1.48E-03	4.33E-03	7.15E-03	4.76E-03	1.04E-02	5.90E-03	1.06E-02	1.33E-02	1.11E-02	1.80E-02	1.63E-02	1.24E-02	1.78E-02	9.37E-03	1.43E-02	6.03E-03	3.11E-03	1.28E-02
PM_{10}	2.27E-01	1.66E-01	1.68E-01	1.47E-01	2.60E-01	2.39E-01	1.55E-01	1.38E-01	1.66E-01	1.67E-01	1.97E-01	1.78E-01	1.93E-01	1.62E-01	2.34E-01	2.12E-01	1.79E-01	2.10E-01	2.51E-01	2.68E-01	2.46E-01	1.73E-01
Arsenic	1.70E-02	6.86E-03	3.67E-02	2.81E-03	1.42E-02	7.35E-03	2.11E-02	8.57E-03	2.16E-02	1.75E-02	2.64E-02	1.90E-02	2.87E-02	1.73E-02	3.17E-02	1.20E-02	2.75E-02	2.26E-02	2.34E-02	2.20E-02	1.81E-02	2.75E-02
Cadmium	2.24E-03	7.64E-03	0.00E+00	6.53E-04	3.00E-03	9.21E-03	1.51E-02	1.00E-02	2.17E-02	1.22E-02	2.21E-02	2.78E-02	2.28E-02	3.79E-02	3.40E-02	2.60E-02	3.77E-02	1.90E-02	2.98E-02	1.23E-02	5.98E-03	2.70E-02
Nickel	2.39E-02	1.26E-02	6.71E-02	3.41E-02	1.90E-02	9.55E-03	3.09E-02	2.88E-02	4.03E-02	3.44E-02	3.93E-02	3.69E-02	5.88E-02	2.42E-02	6.11E-02	2.97E-02	5.46E-02	4.33E-02	5.59E-02	4.37E-02	3.34E-02	3.92E-02
Mercury	2.74E-02	1.16E-02	6.30E-02	9.99E-03	2.41E-02	1.12E-02	3.38E-02	2.02E-02	3.55E-02	3.01E-02	4.30E-02	3.22E-02	4.94E-02	2.86E-02	5.23E-02	2.03E-02	4.69E-02	3.83E-02	4.47E-02	3.84E-02	3.05E-02	4.41E-02
NH_3	2.96E-05	9.22E-05	2.01E-05	2.14E-06	2.23E-05	3.28E-05	3.25E-05	3.58E-05	6.16E-05	1.01E-04	6.09E-05	8.49E-05	1.02E-04	9.39E-05	1.30E-04	7.15E-05	9.80E-05	2.65E-04	1.08E-04	5.00E-05	8.86E-05	2.72E-04
Acetone	5.31E-06	1.48E-05	1.93E-06	1.17E-06	6.19E-06	6.81E-06	7.71E-06	7.15E-06	1.12E-05	1.38E-05	1.13E-05	1.36E-05	1.24E-05	1.65E-05	1.81E-05	1.31E-05	1.67E-05	2.09E-05	1.50E-05	7.50E-06	2.78E-05	2.43E-05
Acetaldehyde	4.43E-04	9.14E-04	1.91E-04	9.72E-05	4.67E-04	4.48E-04	4.87E-04	4.58E-04	7.19E-04	7.56E-04	7.36E-04	8.28E-04	7.27E-04	1.02E-03	1.07E-03	8.19E-04	1.04E-03	1.15E-03	9.11E-04	4.52E-04	1.40E-03	1.45E-03
Formaldehyde	1.58E-03	4.73E-03	5.55E-04	1.17E-03	3.49E-03	6.49E-03	8.70E-03	5.29E-03	1.12E-02	6.73E-03	1.16E-02	1.39E-02	1.24E-02	1.91E-02	1.79E-02	1.32E-02	1.91E-02	8.95E-03	1.50E-02	6.58E-03	3.42E-03	1.53E-02
2-Butanone	8.63E-06	8.30E-06	4.05E-05	1.78E-05	2.58E-05	2.21E-06	1.09E-05	1.44E-05	2.53E-05	1.34E-05	1.34E-05	1.36E-05	2.24E-05	1.90E-05	2.79E-05	2.10E-05	2.52E-05	2.21E-05	1.82E-05	2.45E-05	1.70E-05	2.64E-05
Benzene	2.78E-03	1.36E-03	5.59E-03	7.79E-05	2.13E-03	1.03E-03	3.72E-03	1.96E-03	2.95E-03	2.88E-03	4.41E-03	2.98E-03	4.68E-03	3.27E-03	4.44E-03	1.53E-03	4.36E-03	3.87E-03	5.02E-03	4.41E-03	3.24E-03	4.75E-03
Toluene	3.80E-06	1.04E-05	2.10E-06	1.26E-06	5.44E-06	4.22E-06	4.17E-06	4.66E-06	6.30E-06	7.86E-06	6.36E-06	7.03E-06	7.35E-06	7.99E-06	1.02E-05	7.19E-06	8.28E-06	1.59E-05	8.40E-06	4.82E-06	2.02E-05	1.78E-05
Xylenes	2.40E-06	8.72E-06	1.20E-06	8.52E-07	2.99E-06	1.98E-06	2.59E-06	3.25E-06	4.26E-06	7.86E-06	4.65E-06	5.98E-06	8.88E-06	5.97E-06	1.08E-05	7.29E-06	6.73E-06	2.17E-05	7.28E-06	5.23E-06	3.52E-05	2.14E-05
H_2S	1.53E-05	7.84E-06	0.00E+00	0.00E+00	1.56E-06	0.00E+00	6.66E-06	4.93E-06	3.80E-05	2.54E-05	9.67E-06	2.76E-05	6.68E-05	5.69E-06	5.60E-05	5.54E-05	4.44E-05	5.79E-05	5.18E-05	6.83E-05	3.83E-05	7.81E-05
Total	***7.29E-01***	***4.48E-01***	***6.52E-01***	***4.35E-01***	***7.08E-01***	***4.72E-01***	***5.48E-01***	***3.99E-01***	***5.56E-01***	***4.49E-01***	***6.62E-01***	***5.13E-01***	***7.02E-01***	***6.11E-01***	***7.69E-01***	***6.14E-01***	***7.28E-01***	***6.15E-01***	***7.82E-01***	***6.58E-01***	***8.42E-01***	***7.06E-01***

Table A-13: Quantitative Health Risk Indicators - Chronic

	Scenario 0 - Chronic										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	2.36E-02	8.19E-03	1.38E-02	2.03E-02	5.61E-03	6.49E-03	1.12E-02	1.04E-02	1.14E-02	1.18E-02	1.40E-02
SO_2	6.60E-04	2.44E-04	3.97E-04	5.41E-04	2.03E-04	2.35E-04	3.92E-04	3.75E-04	4.04E-04	3.86E-04	3.90E-04
PM_{10}	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
Arsenic	8.89E-05	3.89E-05	6.98E-05	6.76E-05	2.65E-05	3.03E-05	4.78E-05	4.60E-05	4.94E-05	4.70E-05	4.86E-05
Selenium	1.39E-06	5.80E-07	9.93E-07	6.83E-07	2.68E-07	3.00E-07	4.71E-07	4.48E-07	4.89E-07	4.82E-07	6.23E-07
Manganese	8.61E-04	3.92E-04	7.62E-04	8.33E-04	3.16E-04	3.65E-04	5.94E-04	5.82E-04	6.15E-04	5.66E-04	5.50E-04
Cadmium	3.20E-03	1.31E-03	2.34E-03	3.17E-03	1.17E-03	1.36E-03	2.39E-03	2.36E-03	2.47E-03	2.20E-03	2.11E-03
Chromium (VI)	9.19E-05	3.01E-05	4.15E-05	3.11E-05	1.27E-05	1.39E-05	2.19E-05	1.94E-05	2.26E-05	2.55E-05	3.74E-05
Nickel	1.08E-03	3.79E-04	5.79E-04	6.24E-04	2.42E-04	2.76E-04	4.51E-04	4.26E-04	4.66E-04	4.64E-04	5.44E-04
Mercury	2.50E-02	9.03E-03	8.95E-03	6.95E-03	4.96E-03	5.61E-03	4.45E-03	4.88E-03	4.80E-03	4.24E-03	8.01E-03
NH_3	1.87E-03	5.32E-04	5.25E-04	5.54E-04	3.29E-04	3.58E-04	5.14E-04	5.40E-04	5.62E-04	5.59E-04	9.06E-04
Acetone	8.50E-06	3.13E-06	3.65E-06	2.93E-06	1.98E-06	2.10E-06	2.35E-06	2.62E-06	2.56E-06	2.26E-06	4.08E-06
Acetaldehyde	3.22E-03	1.24E-03	1.60E-03	1.31E-03	8.43E-04	9.05E-04	1.02E-03	1.11E-03	1.10E-03	9.67E-04	1.59E-03
Formaldehyde	3.58E-03	1.61E-03	2.65E-03	2.68E-03	1.22E-03	1.38E-03	1.90E-03	1.91E-03	1.98E-03	1.77E-03	1.93E-03
2-Butanone	7.87E-06	2.77E-06	3.14E-06	2.62E-06	1.82E-06	1.95E-06	2.16E-06	2.41E-06	2.35E-06	2.06E-06	3.90E-06
Benzene	1.82E-03	8.17E-04	1.32E-03	9.71E-04	6.20E-04	6.89E-04	6.79E-04	7.39E-04	7.20E-04	6.08E-04	9.10E-04
Toluene	2.17E-05	9.46E-06	1.19E-05	7.70E-06	5.35E-06	5.59E-06	5.67E-06	6.17E-06	6.12E-06	5.55E-06	1.10E-05
Xylenes	1.96E-06	6.11E-07	6.58E-07	5.88E-07	4.19E-07	4.51E-07	5.37E-07	5.76E-07	5.83E-07	5.49E-07	1.16E-06
H_2S	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
PAHs	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
Total	***6.50E-02***	***2.40E-02***	***3.30E-02***	***3.80E-02***	***1.60E-02***	***1.80E-02***	***2.40E-02***	***2.30E-02***	***2.50E-02***	***2.40E-02***	***3.10E-02***

Scenario 1A - Chronic											
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	1.21E-02	6.65E-03	9.78E-03	8.87E-03	5.14E-03	5.85E-03	9.84E-03	9.92E-03	1.10E-02	1.32E-02	2.79E-02
SO_2	3.71E-04	2.44E-04	3.06E-04	2.64E-04	2.03E-04	2.31E-04	3.75E-04	3.89E-04	4.24E-04	4.66E-04	8.75E-04
PM_{10}	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
Arsenic	4.11E-05	2.80E-05	3.44E-05	2.84E-05	2.26E-05	2.56E-05	4.13E-05	4.29E-05	4.65E-05	5.07E-05	9.45E-05
Selenium	5.33E-07	2.68E-07	3.22E-07	2.45E-07	2.14E-07	2.42E-07	3.58E-07	3.70E-07	4.03E-07	4.80E-07	1.07E-06
Manganese	4.11E-04	3.21E-04	3.99E-04	3.54E-04	2.70E-04	3.07E-04	5.06E-04	5.29E-04	5.70E-04	6.00E-04	1.07E-03
Cadmium	1.61E-03	1.26E-03	1.56E-03	1.44E-03	1.09E-03	1.24E-03	2.02E-03	2.12E-03	2.27E-03	2.39E-03	4.46E-03
Chromium (VI)	3.39E-05	1.28E-05	1.58E-05	1.05E-05	1.05E-05	1.17E-05	1.61E-05	1.62E-05	1.87E-05	2.62E-05	6.42E-05
Nickel	4.47E-04	2.49E-04	3.08E-04	2.49E-04	2.08E-04	2.35E-04	3.64E-04	3.75E-04	4.14E-04	4.85E-04	9.97E-04
Mercury	1.75E-02	4.47E-03	4.67E-03	2.39E-03	3.27E-03	3.87E-03	2.80E-03	3.32E-03	2.98E-03	3.08E-03	9.80E-03
NH_3	1.49E-03	3.91E-04	3.75E-04	2.46E-04	2.92E-04	3.43E-04	3.71E-04	3.90E-04	4.23E-04	4.67E-04	1.61E-03
Acetone	5.66E-06	1.80E-06	2.10E-06	1.01E-06	1.41E-06	1.65E-06	1.41E-06	1.65E-06	1.53E-06	1.50E-06	4.94E-06
Acetaldehyde	2.24E-03	7.64E-04	9.64E-04	4.74E-04	6.22E-04	7.23E-04	6.71E-04	7.63E-04	7.30E-04	7.19E-04	2.08E-03
Formaldehyde	5.89E-03	2.95E-03	3.58E-03	2.39E-03	2.25E-03	2.56E-03	3.29E-03	3.52E-03	3.65E-03	3.75E-03	7.54E-03
2-Butanone	5.01E-06	1.52E-06	1.80E-06	8.96E-07	1.25E-06	1.48E-06	1.25E-06	1.47E-06	1.35E-06	1.32E-06	4.54E-06
Benzene	1.56E-03	5.80E-04	9.08E-04	3.87E-04	5.12E-04	6.14E-04	5.41E-04	6.34E-04	5.70E-04	5.16E-04	1.48E-03
Toluene	2.09E-05	6.97E-06	9.08E-06	3.43E-06	5.13E-06	5.95E-06	4.70E-06	5.42E-06	5.03E-06	4.92E-06	1.74E-05
Xylenes	1.27E-06	3.56E-07	4.54E-07	2.33E-07	2.96E-07	3.49E-07	3.38E-07	3.66E-07	3.78E-07	4.24E-07	1.60E-06
H_2S	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
PAHs	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
Total	***4.37E-02***	***1.79E-02***	***2.29E-02***	***1.71E-02***	***1.39E-02***	***1.60E-02***	***2.08E-02***	***2.20E-02***	***2.31E-02***	***2.58E-02***	***5.80E-02***

Scenario 1B - Chronic											
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	2.44E-02	1.35E-02	1.98E-02	1.80E-02	1.04E-02	1.19E-02	2.00E-02	2.01E-02	2.24E-02	2.68E-02	5.65E-02
SO_2	3.71E-04	2.44E-04	3.06E-04	2.64E-04	2.03E-04	2.31E-04	3.75E-04	3.89E-04	4.24E-04	4.66E-04	8.75E-04
PM_{10}	7.11E-02	3.64E-02	6.33E-02	2.39E-02	2.24E-02	2.51E-02	2.19E-02	2.21E-02	2.47E-02	3.86E-02	7.33E-02
Arsenic	2.74E-03	1.87E-03	2.29E-03	1.89E-03	1.51E-03	1.71E-03	2.75E-03	2.86E-03	3.10E-03	3.38E-03	6.30E-03
Selenium	5.33E-07	2.68E-07	3.22E-07	2.45E-07	2.14E-07	2.42E-07	3.58E-07	3.70E-07	4.03E-07	4.80E-07	1.07E-06
Manganese	1.23E-03	9.63E-04	1.20E-03	1.06E-03	8.10E-04	9.22E-04	1.52E-03	1.59E-03	1.71E-03	1.80E-03	3.22E-03
Cadmium	1.61E-03	1.26E-03	1.56E-03	1.44E-03	1.09E-03	1.24E-03	2.02E-03	2.12E-03	2.27E-03	2.39E-03	4.46E-03
Chromium (VI)	6.79E-04	2.57E-04	3.16E-04	2.09E-04	2.09E-04	2.34E-04	3.22E-04	3.24E-04	3.74E-04	5.25E-04	1.28E-03
Nickel	2.87E-03	1.60E-03	1.98E-03	1.60E-03	1.34E-03	1.51E-03	2.34E-03	2.41E-03	2.66E-03	3.12E-03	6.41E-03
Mercury	1.17E-01	2.98E-02	3.11E-02	1.59E-02	2.18E-02	2.58E-02	1.87E-02	2.21E-02	1.99E-02	2.05E-02	6.53E-02
NH_3	1.96E-03	5.15E-04	4.93E-04	3.24E-04	3.84E-04	4.51E-04	4.88E-04	5.14E-04	5.57E-04	6.14E-04	2.12E-03
Acetone	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
Acetaldehyde	1.24E-02	4.25E-03	5.35E-03	2.63E-03	3.46E-03	4.02E-03	3.72E-03	4.24E-03	4.06E-03	4.00E-03	1.15E-02
Formaldehyde	7.02E-03	3.51E-03	4.27E-03	2.85E-03	2.68E-03	3.05E-03	3.92E-03	4.19E-03	4.35E-03	4.46E-03	8.98E-03
2-Butanone	5.01E-06	1.52E-06	1.80E-06	8.96E-07	1.25E-06	1.48E-06	1.25E-06	1.47E-06	1.35E-06	1.32E-06	4.54E-06
Benzene	4.67E-04	1.74E-04	2.72E-04	1.16E-04	1.54E-04	1.84E-04	1.62E-04	1.90E-04	1.71E-04	1.55E-04	4.44E-04
Toluene	2.09E-05	6.97E-06	9.08E-06	3.43E-06	5.13E-06	5.95E-06	4.70E-06	5.41E-06	5.03E-06	4.92E-06	1.74E-05
Xylenes	1.27E-06	3.55E-07	4.53E-07	2.33E-07	2.96E-07	3.49E-07	3.38E-07	3.65E-07	3.77E-07	4.23E-07	1.60E-06
H_2S	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
PAHs	4.25E-03	1.19E-03	1.57E-03	6.19E-04	9.56E-04	1.13E-03	8.88E-04	1.00E-03	9.64E-04	1.01E-03	4.41E-03
Total	***2.48E-01***	***9.55E-02***	***1.34E-01***	***7.09E-02***	***6.74E-02***	***7.75E-02***	***7.91E-02***	***8.42E-02***	***8.76E-02***	***1.08E-01***	***2.45E-01***

Scenario 2 - Chronic											
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	2.43E-02	1.38E-02	2.09E-02	1.91E-02	1.06E-02	1.19E-02	2.03E-02	2.04E-02	2.27E-02	2.72E-02	5.64E-02
SO_2	2.30E-04	1.59E-04	1.99E-04	1.75E-04	1.33E-04	1.52E-04	2.45E-04	2.54E-04	2.76E-04	3.00E-04	5.64E-04
PM_{10}	8.22E-02	3.61E-02	5.93E-02	2.48E-02	2.54E-02	2.88E-02	2.44E-02	2.47E-02	2.75E-02	4.23E-02	8.29E-02
Arsenic	1.70E-03	8.53E-04	1.03E-03	7.47E-04	6.57E-04	7.43E-04	1.10E-03	1.14E-03	1.24E-03	1.43E-03	3.07E-03
Selenium	1.49E-06	6.91E-07	8.06E-07	5.85E-07	5.35E-07	6.07E-07	8.61E-07	9.01E-07	9.64E-07	1.11E-06	2.45E-06
Manganese	2.51E-03	1.89E-03	2.31E-03	2.10E-03	1.60E-03	1.83E-03	2.96E-03	3.09E-03	3.33E-03	3.47E-03	6.25E-03
Cadmium	1.89E-03	1.41E-03	1.74E-03	1.55E-03	1.18E-03	1.34E-03	2.19E-03	2.27E-03	2.47E-03	2.63E-03	4.81E-03
Chromium (VI)	3.88E-05	2.17E-05	2.67E-05	2.27E-05	1.83E-05	2.09E-05	3.20E-05	3.31E-05	3.64E-05	4.12E-05	8.55E-05
Nickel	2.68E-03	1.50E-03	1.85E-03	1.49E-03	1.24E-03	1.41E-03	2.16E-03	2.24E-03	2.47E-03	2.79E-03	5.59E-03
Mercury	5.80E-03	3.02E-03	3.68E-03	2.82E-03	2.43E-03	2.76E-03	4.13E-03	4.27E-03	4.71E-03	5.49E-03	1.15E-02
NH_3	5.93E-04	1.71E-04	1.73E-04	1.02E-04	1.16E-04	1.40E-04	1.59E-04	1.68E-04	1.81E-04	2.01E-04	4.98E-04
Acetone	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
Acetaldehyde	1.03E-02	3.37E-03	4.45E-03	1.97E-03	2.72E-03	3.15E-03	2.89E-03	3.27E-03	3.15E-03	3.15E-03	9.86E-03
Formaldehyde	5.27E-03	2.91E-03	4.18E-03	2.42E-03	2.03E-03	2.28E-03	3.11E-03	3.30E-03	3.46E-03	3.54E-03	7.02E-03
2-Butanone	5.18E-06	1.50E-06	1.79E-06	8.70E-07	1.22E-06	1.44E-06	1.27E-06	1.46E-06	1.38E-06	1.43E-06	5.26E-06
Benzene	6.34E-04	2.03E-04	2.91E-04	1.30E-04	1.76E-04	2.06E-04	1.91E-04	2.21E-04	2.06E-04	2.06E-04	7.67E-04
Toluene	2.61E-05	7.70E-06	9.64E-06	3.94E-06	5.86E-06	6.77E-06	5.71E-06	6.46E-06	6.24E-06	6.64E-06	2.61E-05
Xylenes	3.30E-06	7.95E-07	9.12E-07	4.77E-07	6.36E-07	7.51E-07	6.80E-07	7.09E-07	7.79E-07	1.07E-06	4.88E-06
H_2S	1.32E-04	2.59E-05	3.05E-05	1.57E-05	1.94E-05	2.31E-05	2.23E-05	2.20E-05	2.59E-05	3.70E-05	1.17E-04
PAHs	4.49E-03	1.36E-03	1.75E-03	8.30E-04	1.10E-03	1.28E-03	1.24E-03	1.38E-03	1.37E-03	1.41E-03	5.13E-03
Total	***1.43E-01***	***6.68E-02***	***1.02E-01***	***5.82E-02***	***4.94E-02***	***5.61E-02***	***6.52E-02***	***6.68E-02***	***7.31E-02***	***9.42E-02***	***1.95E-01***

Scenario 3 - Chronic											
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	2.52E-02	1.41E-02	2.12E-02	1.94E-02	1.07E-02	1.21E-02	2.06E-02	2.06E-02	2.30E-02	2.78E-02	5.67E-02
SO_2	2.34E-04	1.62E-04	2.04E-04	1.80E-04	1.35E-04	1.54E-04	2.51E-04	2.60E-04	2.84E-04	3.11E-04	5.74E-04
PM_{10}	7.31E-02	2.88E-02	5.51E-02	2.46E-02	2.38E-02	2.75E-02	2.41E-02	2.42E-02	2.74E-02	4.29E-02	8.20E-02
Arsenic	1.71E-03	8.66E-04	1.05E-03	7.63E-04	6.67E-04	7.54E-04	1.12E-03	1.16E-03	1.26E-03	1.47E-03	3.11E-03
Selenium	1.51E-06	7.01E-07	8.22E-07	5.98E-07	5.43E-07	6.16E-07	8.76E-07	9.17E-07	9.82E-07	1.13E-06	2.48E-06
Manganese	2.57E-03	1.94E-03	2.39E-03	2.17E-03	1.63E-03	1.87E-03	3.05E-03	3.19E-03	3.43E-03	3.64E-03	6.40E-03
Cadmium	1.93E-03	1.44E-03	1.79E-03	1.60E-03	1.20E-03	1.37E-03	2.26E-03	2.34E-03	2.54E-03	2.74E-03	4.91E-03
Chromium (VI)	4.01E-05	2.23E-05	2.75E-05	2.35E-05	1.87E-05	2.14E-05	3.30E-05	3.41E-05	3.75E-05	4.29E-05	8.76E-05
Nickel	2.71E-03	1.52E-03	1.89E-03	1.53E-03	1.26E-03	1.43E-03	2.21E-03	2.29E-03	2.53E-03	2.87E-03	5.67E-03
Mercury	5.86E-03	3.06E-03	3.75E-03	2.89E-03	2.47E-03	2.80E-03	4.22E-03	4.36E-03	4.80E-03	5.63E-03	1.17E-02
NH_3	6.20E-04	1.81E-04	1.90E-04	1.12E-04	1.27E-04	1.49E-04	1.60E-04	1.71E-04	1.86E-04	2.00E-04	5.34E-04
Acetone	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
Acetaldehyde	1.01E-02	3.23E-03	4.43E-03	2.02E-03	2.72E-03	3.16E-03	2.94E-03	3.32E-03	3.21E-03	3.24E-03	9.99E-03
Formaldehyde	4.76E-03	2.80E-03	4.34E-03	2.53E-03	2.07E-03	2.32E-03	3.24E-03	3.42E-03	3.60E-03	3.75E-03	7.16E-03
2-Butanone	5.22E-06	1.49E-06	1.82E-06	9.04E-07	1.26E-06	1.48E-06	1.30E-06	1.51E-06	1.42E-06	1.47E-06	5.38E-06
Benzene	6.03E-04	1.89E-04	2.84E-04	1.30E-04	1.72E-04	2.03E-04	1.91E-04	2.20E-04	2.06E-04	2.08E-04	7.63E-04
Toluene	2.46E-05	6.97E-06	9.30E-06	3.95E-06	5.75E-06	6.66E-06	5.70E-06	6.45E-06	6.25E-06	6.67E-06	2.61E-05
Xylenes	3.28E-06	7.98E-07	9.14E-07	4.80E-07	6.37E-07	7.48E-07	6.81E-07	7.11E-07	7.82E-07	1.07E-06	4.88E-06
H_2S	1.22E-04	2.54E-05	2.94E-05	1.55E-05	1.84E-05	2.13E-05	2.20E-05	2.18E-05	2.57E-05	3.63E-05	1.11E-04
PAHs	4.28E-03	1.27E-03	1.70E-03	8.23E-04	1.08E-03	1.26E-03	1.23E-03	1.36E-03	1.36E-03	1.41E-03	5.08E-03
Total	***1.34E-01***	***5.96E-02***	***9.84E-02***	***5.88E-02***	***4.81E-02***	***5.51E-02***	***6.57E-02***	***6.70E-02***	***7.39E-02***	***9.62E-02***	***1.95E-01***

Table A-14: Quantitative Health Risk Indicators - ICR

	Scenario 0 - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	1.33E-07	5.83E-08	1.05E-07	1.01E-07	3.97E-08	4.55E-08	7.18E-08	6.90E-08	7.41E-08	7.05E-08	7.28E-08
Cadmium	2.88E-08	1.18E-08	2.10E-08	2.85E-08	1.06E-08	1.23E-08	2.15E-08	2.12E-08	2.23E-08	1.98E-08	1.90E-08
Chromium (VI)	3.68E-07	1.20E-07	1.66E-07	1.25E-07	5.07E-08	5.56E-08	8.75E-08	7.75E-08	9.04E-08	1.02E-07	1.50E-07
Nickel	3.69E-08	1.29E-08	1.98E-08	2.13E-08	8.29E-09	9.44E-09	1.54E-08	1.46E-08	1.59E-08	1.59E-08	1.86E-08
Acetaldehyde	1.45E-07	5.57E-08	7.18E-08	5.91E-08	3.79E-08	4.07E-08	4.59E-08	5.00E-08	4.94E-08	4.35E-08	7.17E-08
Formaldehyde	4.99E-07	2.25E-07	3.69E-07	3.74E-07	1.71E-07	1.92E-07	2.65E-07	2.67E-07	2.75E-07	2.47E-07	2.69E-07
Benzene	3.28E-08	1.47E-08	2.37E-08	1.75E-08	1.12E-08	1.24E-08	1.22E-08	1.33E-08	1.30E-08	1.09E-08	1.64E-08
PAHs	1.50E-07	5.37E-08	6.31E-08	4.50E-08	3.54E-08	3.79E-08	3.84E-08	4.22E-08	4.18E-08	3.84E-08	8.63E-08
Total	***1.39E-06***	***5.52E-07***	***8.39E-07***	***7.72E-07***	***3.64E-07***	***4.06E-07***	***5.58E-07***	***5.54E-07***	***5.82E-07***	***5.48E-07***	***7.03E-07***

	Scenario 1A - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	6.17E-08	4.20E-08	5.16E-08	4.26E-08	3.39E-08	3.84E-08	6.19E-08	6.43E-08	6.97E-08	7.61E-08	1.42E-07
Cadmium	1.45E-08	1.14E-08	1.40E-08	1.30E-08	9.80E-09	1.12E-08	1.82E-08	1.91E-08	2.04E-08	2.15E-08	4.01E-08
Chromium (VI)	1.36E-07	5.14E-08	6.32E-08	4.19E-08	4.18E-08	4.69E-08	6.45E-08	6.48E-08	7.49E-08	1.05E-07	2.57E-07
Nickel	1.53E-08	8.51E-09	1.05E-08	8.52E-09	7.11E-09	8.04E-09	1.24E-08	1.28E-08	1.42E-08	1.66E-08	3.41E-08
Acetaldehyde	1.01E-07	3.44E-08	4.34E-08	2.13E-08	2.80E-08	3.26E-08	3.02E-08	3.43E-08	3.29E-08	3.24E-08	9.35E-08
Formaldehyde	4.15E-07	2.09E-07	2.52E-07	1.69E-07	1.58E-07	1.80E-07	2.31E-07	2.47E-07	2.57E-07	2.63E-07	5.30E-07
Benzene	2.80E-08	1.04E-08	1.63E-08	6.97E-09	9.22E-09	1.11E-08	9.74E-09	1.14E-08	1.03E-08	9.29E-09	2.66E-08
PAHs	1.02E-07	2.85E-08	3.75E-08	1.48E-08	2.28E-08	2.70E-08	2.12E-08	2.39E-08	2.31E-08	2.42E-08	1.05E-07
Total	***8.73E-07***	***3.95E-07***	***4.89E-07***	***3.18E-07***	***3.11E-07***	***3.55E-07***	***4.49E-07***	***4.78E-07***	***5.02E-07***	***5.48E-07***	***1.23E-06***

	Scenario 1B - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	6.17E-08	4.20E-08	5.16E-08	4.26E-08	3.39E-08	3.84E-08	6.19E-08	6.43E-08	6.97E-08	7.61E-08	1.42E-07
Cadmium	1.45E-08	1.14E-08	1.40E-08	1.30E-08	9.80E-09	1.12E-08	1.82E-08	1.91E-08	2.04E-08	2.15E-08	4.01E-08
Chromium (VI)	4.07E-08	1.54E-08	1.90E-08	1.26E-08	1.25E-08	1.41E-08	1.93E-08	1.94E-08	2.25E-08	3.15E-08	7.70E-08
Nickel	1.05E-08	5.82E-09	7.21E-09	5.83E-09	4.86E-09	5.50E-09	8.51E-09	8.78E-09	9.69E-09	1.13E-08	2.33E-08
Acetaldehyde	1.01E-07	3.44E-08	4.34E-08	2.13E-08	2.80E-08	3.26E-08	3.02E-08	3.43E-08	3.29E-08	3.24E-08	9.35E-08
Formaldehyde	1.92E-07	9.64E-08	1.17E-07	7.80E-08	7.31E-08	8.31E-08	1.07E-07	1.14E-07	1.18E-07	1.22E-07	2.45E-07
Benzene	2.80E-08	1.04E-08	1.63E-08	6.97E-09	9.22E-09	1.11E-08	9.74E-09	1.14E-08	1.03E-08	9.29E-09	2.66E-08
PAHs	7.01E-10	1.97E-10	2.58E-10	1.02E-10	1.58E-10	1.86E-10	1.46E-10	1.65E-10	1.59E-10	1.67E-10	7.27E-10
Total	**4.48E-07**	**2.16E-07**	**2.68E-07**	**1.80E-07**	**1.72E-07**	**1.96E-07**	**2.55E-07**	**2.72E-07**	**2.84E-07**	**3.04E-07**	**6.48E-07**

	Scenario 2 - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	3.82E-08	1.92E-08	2.31E-08	1.68E-08	1.48E-08	1.67E-08	2.48E-08	2.56E-08	2.79E-08	3.23E-08	6.91E-08
Cadmium	1.70E-08	1.27E-08	1.57E-08	1.39E-08	1.06E-08	1.21E-08	1.97E-08	2.05E-08	2.22E-08	2.36E-08	4.33E-08
Chromium (VI)	2.33E-09	1.30E-09	1.60E-09	1.36E-09	1.10E-09	1.25E-09	1.92E-09	1.99E-09	2.19E-09	2.47E-09	5.13E-09
Nickel	9.75E-09	5.44E-09	6.74E-09	5.44E-09	4.50E-09	5.13E-09	7.87E-09	8.16E-09	8.99E-09	1.02E-08	2.03E-08
Acetaldehyde	8.38E-08	2.73E-08	3.60E-08	1.60E-08	2.20E-08	2.55E-08	2.34E-08	2.65E-08	2.55E-08	2.55E-08	7.98E-08
Formaldehyde	1.44E-07	7.97E-08	1.14E-07	6.61E-08	5.54E-08	6.22E-08	8.48E-08	8.99E-08	9.43E-08	9.65E-08	1.91E-07
Benzene	3.81E-08	1.22E-08	1.75E-08	7.78E-09	1.05E-08	1.24E-08	1.14E-08	1.32E-08	1.23E-08	1.23E-08	4.60E-08
PAHs	7.41E-10	2.25E-10	2.88E-10	1.37E-10	1.82E-10	2.11E-10	2.05E-10	2.27E-10	2.26E-10	2.33E-10	8.45E-10
Total	***3.34E-07***	***1.58E-07***	***2.15E-07***	***1.28E-07***	***1.19E-07***	***1.35E-07***	***1.74E-07***	***1.86E-07***	***1.94E-07***	***2.03E-07***	***4.56E-07***

	Scenario 3 - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	3.86E-08	1.95E-08	2.35E-08	1.72E-08	1.50E-08	1.70E-08	2.53E-08	2.61E-08	2.85E-08	3.30E-08	6.99E-08
Cadmium	1.74E-08	1.30E-08	1.61E-08	1.44E-08	1.08E-08	1.24E-08	2.03E-08	2.11E-08	2.29E-08	2.47E-08	4.42E-08
Chromium (VI)	2.41E-09	1.34E-09	1.65E-09	1.41E-09	1.12E-09	1.28E-09	1.98E-09	2.04E-09	2.25E-09	2.57E-09	5.25E-09
Nickel	9.86E-09	5.54E-09	6.89E-09	5.58E-09	4.57E-09	5.21E-09	8.06E-09	8.35E-09	9.19E-09	1.05E-08	2.06E-08
Acetaldehyde	8.17E-08	2.62E-08	3.59E-08	1.64E-08	2.21E-08	2.56E-08	2.38E-08	2.69E-08	2.60E-08	2.63E-08	8.09E-08
Formaldehyde	1.30E-07	7.67E-08	1.18E-07	6.91E-08	5.64E-08	6.33E-08	8.82E-08	9.32E-08	9.81E-08	1.02E-07	1.95E-07
Benzene	3.62E-08	1.14E-08	1.71E-08	7.78E-09	1.03E-08	1.22E-08	1.14E-08	1.32E-08	1.23E-08	1.25E-08	4.58E-08
PAHs	7.06E-10	2.09E-10	2.80E-10	1.36E-10	1.77E-10	2.07E-10	2.03E-10	2.25E-10	2.25E-10	2.32E-10	8.38E-10
Total	***3.17E-07***	***1.54E-07***	***2.20E-07***	***1.32E-07***	***1.21E-07***	***1.37E-07***	***1.79E-07***	***1.91E-07***	***1.99E-07***	***2.12E-07***	***4.63E-07***

Table A-15: Percentage Contributions - Acute

	Scenario 0 - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest
NO_2	27%	33%	9%	56%	0%	0%	35%	36%	46%	55%	54%	30%	31%	40%	33%	46%	30%	46%	33%	47%	18%	43%
CO	<1%	2%	<1%	1%	<1%	<1%	2%	<1%	2%	<1%	2%	2%	<1%	2%	<1%	1%	<1%	1%	<1%	<1%	1%	<1%
SO_2	<1%	<1%	<1%	2%	0%	0%	1%	1%	2%	3%	3%	1%	<1%	2%	<1%	2%	<1%	2%	<1%	2%	1%	3%
PM_{10}	11%	21%	25%	16%	90%	99%	43%	40%	18%	7%	5%	38%	18%	31%	15%	21%	18%	16%	27%	21%	14%	19%
Arsenic	3%	2%	2%	7%	<1%	<1%	6%	5%	11%	12%	11%	6%	4%	7%	4%	8%	4%	8%	3%	9%	3%	11%
Cadmium	<1%	1%	<1%	1%	<1%	<1%	2%	2%	2%	1%	1%	4%	<1%	2%	<1%	2%	<1%	3%	<1%	<1%	1%	<1%
Nickel	16%	5%	8%	5%	<1%	<1%	3%	6%	7%	9%	9%	5%	8%	5%	8%	9%	8%	9%	6%	8%	24%	7%
Mercury	41%	35%	55%	9%	9%	<1%	4%	6%	7%	9%	12%	6%	36%	6%	36%	9%	37%	10%	29%	9%	36%	13%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Formaldehyde	<1%	1%	<1%	1%	<1%	<1%	2%	2%	2%	2%	1%	5%	<1%	3%	<1%	2%	<1%	3%	<1%	1%	1%	<1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	<1%	2%	<1%	<1%	1%	1%	2%	3%	2%	1%	<1%	2%	<1%	2%	<1%	2%	<1%	2%	<1%	2%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 1A - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest
NO_2	12%	12%	32%	29%	36%	0%	39%	7%	31%	32%	40%	31%	25%	39%	29%	40%	16%	38%	34%	36%	31%	37%
CO	<1%	<1%	3%	<1%	1%	0%	2%	<1%	<1%	2%	3%	2%	<1%	2%	<1%	2%	<1%	2%	2%	1%	1%	2%
SO_2	<1%	<1%	2%	<1%	<1%	0%	2%	<1%	<1%	1%	2%	1%	<1%	2%	<1%	1%	<1%	2%	1%	1%	1%	1%
PM_{10}	38%	39%	41%	48%	54%	66%	32%	46%	33%	38%	34%	39%	29%	34%	27%	35%	30%	35%	40%	42%	29%	30%
Arsenic	4%	1%	8%	3%	3%	<1%	5%	3%	3%	5%	7%	5%	3%	7%	3%	5%	2%	6%	6%	4%	3%	4%
Cadmium	<1%	<1%	0%	<1%	<1%	<1%	1%	2%	<1%	3%	2%	2%	2%	2%	2%	2%	1%	2%	<1%	1%	<1%	<1%
Nickel	17%	7%	7%	8%	1%	0%	7%	11%	15%	6%	3%	6%	17%	4%	15%	3%	22%	4%	6%	5%	12%	9%
Mercury	27%	39%	6%	9%	2%	33%	7%	27%	16%	6%	3%	7%	19%	4%	17%	4%	23%	4%	6%	5%	20%	13%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Formaldehyde	<1%	1%	<1%	<1%	<1%	<1%	4%	4%	<1%	6%	4%	6%	4%	4%	5%	5%	3%	4%	2%	3%	<1%	1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	2%	<1%	<1%	<1%	1%	<1%	<1%	1%	2%	1%	<1%	2%	<1%	1%	<1%	1%	1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 1B - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest
NO_2	54%	49%	42%	38%	46%	30%	49%	38%	40%	41%	49%	41%	51%	48%	37%	45%	50%	48%	44%	43%	40%	47%
CO	1%	1%	2%	<1%	1%	<1%	2%	2%	<1%	2%	2%	2%	2%	2%	<1%	2%	2%	2%	2%	<1%	1%	1%
SO_2	<1%	<1%	0%	<1%	<1%	<1%	2%	2%	2%	<1%	2%	3%	2%	5%	3%	3%	2%	2%	1%	3%	<1%	3%
PM_{10}	34%	36%	36%	42%	46%	62%	26%	39%	22%	41%	28%	33%	25%	21%	23%	29%	26%	29%	34%	30%	25%	18%
Arsenic	4%	3%	7%	3%	3%	3%	4%	5%	3%	5%	6%	5%	6%	5%	3%	6%	6%	5%	5%	2%	3%	3%
Cadmium	<1%	<1%	0%	<1%	<1%	<1%	1%	1%	2%	<1%	1%	2%	1%	3%	2%	2%	1%	1%	<1%	2%	<1%	2%
Nickel	2%	2%	6%	7%	1%	1%	6%	4%	13%	5%	3%	5%	4%	3%	13%	3%	4%	4%	5%	5%	11%	8%
Mercury	3%	5%	5%	8%	2%	1%	6%	3%	14%	5%	3%	5%	4%	3%	15%	3%	4%	4%	5%	9%	17%	11%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Formaldehyde	<1%	1%	<1%	<1%	<1%	<1%	3%	3%	4%	<1%	4%	5%	3%	7%	4%	4%	3%	3%	2%	5%	<1%	4%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	1%	<1%	<1%	<1%	1%	1%	<1%	1%	1%	<1%	1%	1%	<1%	1%	1%	1%	1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 2 - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest
NO_2	52%	45%	43%	35%	45%	35%	46%	47%	41%	34%	43%	34%	46%	40%	39%	43%	45%	41%	41%	38%	53%	42%
CO	5%	5%	2%	2%	9%	4%	3%	6%	2%	1%	2%	2%	3%	1%	1%	3%	2%	1%	2%	1%	7%	1%
SO_2	<1%	<1%	0%	<1%	<1%	<1%	1%	1%	2%	<1%	2%	2%	2%	3%	2%	2%	1%	3%	2%	<1%	<1%	2%
PM_{10}	33%	40%	31%	43%	36%	51%	29%	36%	32%	45%	32%	39%	27%	27%	31%	36%	29%	29%	33%	41%	29%	25%
Arsenic	2%	1%	5%	5%	2%	2%	4%	2%	4%	4%	4%	4%	4%	4%	4%	2%	4%	3%	3%	3%	2%	3%
Cadmium	<1%	2%	0%	<1%	<1%	2%	3%	3%	4%	<1%	3%	4%	3%	6%	4%	4%	3%	6%	4%	2%	<1%	4%
Nickel	3%	3%	10%	6%	3%	2%	6%	2%	7%	7%	6%	7%	7%	9%	8%	5%	8%	8%	8%	7%	4%	14%
Mercury	4%	2%	9%	8%	3%	2%	6%	2%	6%	7%	7%	7%	6%	7%	7%	3%	6%	6%	5%	6%	4%	7%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Formaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	1%	<1%	<1%	1%	1%	2%	1%	1%	<1%	2%	1%	<1%	<1%	1%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	<1%	<1%	0%	0%	<1%	0%	<1%	0%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 3 - Acute																					
	Receptor 2		Receptor 3		Receptor 4		Receptor 5		Receptor 6		Receptor 7		Receptor 8		Receptor 9		Receptor 10		Receptor 11		Receptor 12	
Compound Name	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest	Max	9th Highest
NO_2	53%	47%	46%	54%	45%	35%	47%	43%	42%	37%	45%	35%	44%	45%	40%	43%	44%	40%	42%	37%	52%	48%
CO	5%	5%	2%	<1%	9%	4%	3%	2%	2%	2%	2%	1%	2%	4%	1%	3%	2%	2%	1%	1%	7%	3%
SO_2	<1%	<1%	0%	<1%	<1%	<1%	1%	1%	2%	1%	2%	3%	2%	3%	2%	2%	2%	2%	2%	<1%	<1%	2%
PM_{10}	31%	37%	26%	34%	37%	51%	28%	35%	30%	37%	30%	35%	27%	26%	30%	35%	25%	34%	32%	41%	29%	25%
Arsenic	2%	2%	6%	<1%	2%	2%	4%	2%	4%	4%	4%	4%	4%	3%	4%	2%	4%	4%	3%	3%	2%	4%
Cadmium	<1%	2%	0%	<1%	<1%	2%	3%	3%	4%	3%	3%	5%	3%	6%	4%	4%	5%	3%	4%	2%	<1%	4%
Nickel	3%	3%	10%	8%	3%	2%	6%	7%	7%	8%	6%	7%	8%	4%	8%	5%	8%	7%	7%	7%	4%	6%
Mercury	4%	3%	10%	2%	3%	2%	6%	5%	6%	7%	6%	6%	7%	5%	7%	3%	6%	6%	6%	6%	4%	6%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetaldehyde	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Formaldehyde	<1%	1%	<1%	<1%	<1%	1%	2%	1%	2%	2%	2%	3%	2%	3%	2%	2%	3%	1%	2%	<1%	<1%	2%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	<1%	<1%	0%	0%	<1%	0%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

Table A-16 - Percentage Contributions - Chronic

	Scenario 0 - Chronic										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	36%	34%	42%	53%	36%	37%	47%	44%	46%	50%	45%
SO_2	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	1%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Manganese	1%	2%	2%	2%	2%	2%	3%	2%	2%	2%	2%
Cadmium	5%	6%	7%	8%	8%	8%	10%	10%	10%	9%	7%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Mercury	38%	38%	27%	18%	32%	32%	19%	21%	19%	18%	26%
NH_3	3%	2%	2%	1%	2%	2%	2%	2%	2%	2%	3%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetaldehyde	5%	5%	5%	3%	5%	5%	4%	5%	4%	4%	5%
Formaldehyde	6%	7%	8%	7%	8%	8%	8%	8%	8%	7%	6%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	3%	3%	4%	3%	4%	4%	3%	3%	3%	3%	3%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAHs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 1A - Chronic										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	28%	37%	43%	52%	37%	37%	47%	45%	48%	51%	48%
SO_2	<1%	1%	1%	2%	1%	1%	2%	2%	2%	2%	2%
PM_{10}	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Arsenic	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Manganese	<1%	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Cadmium	4%	7%	7%	8%	8%	8%	10%	10%	10%	9%	8%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
Mercury	40%	25%	20%	14%	24%	24%	13%	15%	13%	12%	17%
NH_3	3%	2%	2%	1%	2%	2%	2%	2%	2%	2%	3%
Acetone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetaldehyde	5%	4%	4%	3%	4%	5%	3%	3%	3%	3%	4%
Formaldehyde	13%	16%	16%	14%	16%	16%	16%	16%	16%	15%	13%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	4%	3%	4%	2%	4%	4%	3%	3%	2%	2%	3%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAHs	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 1B - Chronic										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	10%	14%	15%	25%	15%	15%	25%	24%	26%	25%	23%
SO_2	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PM_{10}	29%	38%	47%	34%	33%	32%	28%	26%	28%	36%	30%
Arsenic	1%	2%	2%	3%	2%	2%	3%	3%	4%	3%	3%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Manganese	<1%	1%	<1%	1%	1%	1%	2%	2%	2%	2%	1%
Cadmium	<1%	1%	1%	2%	2%	2%	3%	3%	3%	2%	2%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	1%	2%	1%	2%	2%	2%	3%	3%	3%	3%	3%
Mercury	47%	31%	23%	22%	32%	33%	24%	26%	23%	19%	27%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Acetaldehyde	5%	4%	4%	4%	5%	5%	5%	5%	5%	4%	5%
Formaldehyde	3%	4%	3%	4%	4%	4%	5%	5%	5%	4%	4%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PAHs	2%	1%	1%	<1%	1%	1%	1%	1%	1%	<1%	2%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 2 - Chronic										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	17%	21%	20%	33%	21%	21%	31%	31%	31%	29%	29%
SO_2	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PM_{10}	58%	54%	58%	42%	51%	51%	37%	37%	38%	45%	43%
Arsenic	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Manganese	2%	3%	2%	4%	3%	3%	5%	5%	5%	4%	3%
Cadmium	1%	2%	2%	3%	2%	2%	3%	3%	3%	3%	2%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	2%	2%	2%	3%	2%	3%	3%	3%	3%	3%	3%
Mercury	4%	5%	4%	5%	5%	5%	6%	6%	6%	6%	6%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Acetaldehyde	7%	5%	4%	3%	5%	6%	4%	5%	4%	3%	5%
Formaldehyde	4%	4%	4%	4%	4%	4%	5%	5%	5%	4%	4%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PAHs	3%	2%	2%	1%	2%	2%	2%	2%	2%	1%	3%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 3 - Chronic										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
NO_2	19%	24%	22%	33%	22%	22%	31%	31%	31%	29%	29%
SO_2	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PM_{10}	55%	48%	56%	42%	50%	50%	37%	36%	37%	45%	42%
Arsenic	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%
Selenium	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Manganese	2%	3%	2%	4%	3%	3%	5%	5%	5%	4%	3%
Cadmium	1%	2%	2%	3%	3%	2%	3%	3%	3%	3%	3%
Chromium (VI)	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Nickel	2%	3%	2%	3%	3%	3%	3%	3%	3%	3%	3%
Mercury	4%	5%	4%	5%	5%	5%	6%	6%	6%	6%	6%
NH_3	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Acetone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Acetaldehyde	8%	5%	5%	3%	6%	6%	4%	5%	4%	3%	5%
Formaldehyde	4%	5%	4%	4%	4%	4%	5%	5%	5%	4%	4%
2-Butanone	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Benzene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Toluene	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Xylenes	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
H_2S	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
PAHs	3%	2%	2%	1%	2%	2%	2%	2%	2%	1%	3%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

Table A-17 - Percentage Contributions - ICR

	Scenario 0 - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	10%	11%	13%	13%	11%	11%	13%	12%	13%	13%	10%
Cadmium	2%	2%	3%	4%	3%	3%	4%	4%	4%	4%	3%
Chromium (VI)	26%	22%	20%	16%	14%	14%	16%	14%	16%	19%	21%
Nickel	3%	2%	2%	3%	2%	2%	3%	3%	3%	3%	3%
Acetaldehyde	10%	10%	9%	8%	10%	10%	8%	9%	9%	8%	10%
Formaldehyde	36%	41%	44%	49%	47%	47%	48%	48%	47%	45%	38%
Benzene	2%	3%	3%	2%	3%	3%	2%	2%	2%	2%	2%
PAHs	11%	10%	8%	6%	10%	9%	7%	8%	7%	7%	12%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 1A - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	7%	11%	11%	13%	11%	11%	14%	13%	14%	14%	12%
Cadmium	2%	3%	3%	4%	3%	3%	4%	4%	4%	4%	3%
Chromium (VI)	16%	13%	13%	13%	13%	13%	14%	14%	15%	19%	21%
Nickel	2%	2%	2%	3%	2%	2%	3%	3%	3%	3%	3%
Acetaldehyde	12%	9%	9%	7%	9%	9%	7%	7%	7%	6%	8%
Formaldehyde	48%	53%	52%	53%	51%	51%	51%	52%	51%	48%	43%
Benzene	3%	3%	3%	2%	3%	3%	2%	2%	2%	2%	2%
PAHs	12%	7%	8%	5%	7%	8%	5%	5%	5%	4%	9%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 1B - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	14%	19%	19%	24%	20%	20%	24%	24%	25%	25%	22%
Cadmium	3%	5%	5%	7%	6%	6%	7%	7%	7%	7%	6%
Chromium (VI)	9%	7%	7%	7%	7%	7%	8%	7%	8%	10%	12%
Nickel	2%	3%	3%	3%	3%	3%	3%	3%	3%	4%	4%
Acetaldehyde	22%	16%	16%	12%	16%	17%	12%	13%	12%	11%	14%
Formaldehyde	43%	45%	43%	43%	43%	42%	42%	42%	42%	40%	38%
Benzene	6%	5%	6%	4%	5%	6%	4%	4%	4%	3%	4%
PAHs	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 2 - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	11%	12%	11%	13%	12%	12%	14%	14%	14%	16%	15%
Cadmium	5%	8%	7%	11%	9%	9%	11%	11%	11%	12%	9%
Chromium (VI)	<1%	<1%	<1%	1%	<1%	<1%	1%	1%	1%	1%	1%
Nickel	3%	3%	3%	4%	4%	4%	5%	4%	5%	5%	4%
Acetaldehyde	25%	17%	17%	13%	18%	19%	13%	14%	13%	13%	18%
Formaldehyde	43%	50%	53%	52%	47%	46%	49%	48%	49%	47%	42%
Benzene	11%	8%	8%	6%	9%	9%	7%	7%	6%	6%	10%
PAHs	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

	Scenario 3 - Incremental Carcinogenic Risk										
Compound Name	Receptor 2	Receptor 3	Receptor 4	Receptor 5	Receptor 6	Receptor 7	Receptor 8	Receptor 9	Receptor 10	Receptor 11	Receptor 12
Arsenic	12%	13%	11%	13%	12%	12%	14%	14%	14%	16%	15%
Cadmium	5%	8%	7%	11%	9%	9%	11%	11%	11%	12%	10%
Chromium (VI)	<1%	<1%	<1%	1%	<1%	<1%	1%	1%	1%	1%	1%
Nickel	3%	4%	3%	4%	4%	4%	4%	4%	5%	5%	4%
Acetaldehyde	26%	17%	16%	12%	18%	19%	13%	14%	13%	12%	17%
Formaldehyde	41%	50%	54%	52%	47%	46%	49%	49%	49%	48%	42%
Benzene	11%	7%	8%	6%	9%	9%	6%	7%	6%	6%	10%
PAHs	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Total	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***	***100%***

Table A-18 – Summary of toxicity and transformations for compounds with most contribution towards calculated risks in 2014 HRA (ENVIRON 2014).

Selected Contaminants	Category	Details	Reference
Arsenic	Description	Arsenic is a non-volatile metalloid and may enter the atmosphere associated with dust particles, primarily as inorganic arsenic. Arsenic released from mining operations can be associated with very small particles that travel long distances. Some of these particles can get deposited onto the ground or get washed out of air by rain (wet and dry deposition). As arsenic compounds are water soluble, it has potential to enter surface water and sediments.	ATSDR 2007
	IARC Ranking	Group 1: Carcinogenic to humans	
	Acute Effects	Arsenic is a recognised human poison however its unlikely that fatality would occur via inhalation route of exposure. Inhalation of high arsenic can cause patches of darkened skin condition like warts. Can also cause sore throat and irritated lungs.	
	Chronic effects	Longer term inhalation can also cause skin effects (as above), circulatory and peripheral nervous disorders and respiratory disorders.	
	Carcinogenic effects	Increase risk of lung cancer with potential to cause tumours at other sites including liver, skin and digestive tract.	
	Significant atmospheric transformation	Arsenic released from smelting processes are considered to be mostly trivalent arsenic with minor amounts of volatile methyl arsines. Some of it can oxidise to pentavalent state in the atmosphere, so that trivalent and pentavalent forms co-exist. However, as the total arsenic will remain same after any transformation, it is accounted for in the modelling presented in this report. Hence any arsenic transformation in the atmosphere is not expected to change arsenic related risk conclusions.	
Acetaldehyde	Description	Is a highly volatile organic compound (VOC) and is present in the atmosphere in gaseous form. However, it does not persist due to atmospheric degradation.	USEPA 2000; NICNAS 2019; Health Canada 2000
	IARC Ranking	Group 2B: Possibly carcinogenic to humans	
	Acute Effects	Irritation of eyes, skin and respiratory tract. At higher exposure levels, erythema, coughing, pulmonary edema, and necrosis may also occur	
	Chronic effects	Intoxication effects similar to alcohol, respiratory and renal effects.	
	Carcinogenic effects	Limited evidence of nasal and laryngeal tumours in animal studies.	
	Significant atmospheric transformation	Acetaldehyde in atmosphere undergoes photo-oxidation with hydroxyl radicals, ozone, hydroxyperoxyl radicals and nitrate radicals. However, daytime reaction with hydroxyl radical is most important. Photo-oxidation products can include peroxyacetyl nitrate, formaldehyde, peroxyacetic acid and acetic acid. Given the low concentrations of acetaldehyde being emitted, the photo-oxidation products are also considered to be low. A degradation rate for acetaldehyde was not included in the modelling, therefore the model over-predicts acetaldehyde concentrations at receptor sites. Note that due to the degradation processes	

		affecting acetaldehyde concentrations, its atmospheric half-life is considered to be short (normally <10 hours).	
Formaldehyde	Description	Is a flammable and volatile organic compound (VOC) and is present in the atmosphere in gaseous form. However, it does not persist due to atmospheric degradation during daytime and removal via rain.	ATSDR 1999
	IARC Ranking	Group 2A: Probably carcinogenic to humans	
	Acute Effects	Irritation of the eyes, nose, and throat, along with increased tearing. Can be immediately dangerous to life and health at 20 ppm.	
	Chronic effects	Respiratory and occular effects, with lungs affected at high concentrations.	
	Carcinogenic effects	There is limited evidence in humans and sufficient evidence in laboratory animals that formaldehyde may cause cancer of the nose and throat	
	Significant atmospheric transformation	Direct photolysis and oxidation by photochemically produced hydroxyl radicals are the key removal pathway from the atmosphere during day, while reaction with nitrate radical is important at night-time. Degradation products such as hydrogen gas, carbon monoxide and formic acid may be formed. As the concentration of formaldehyde is low in emissions from the site, these products will also be very low and make insignificant contribution towards any exposure risks. The modelling of emissions allows for degradation of formaldehyde. A decay rate of 5.7% per hour has been used. This decay rate is conservative as formaldehyde half-lives (50% reduction) have been found to range from 1.6 to 19 hours under different environmental conditions.	
Chromium VI	Description	Chromium is a non-volatile metal and may enter the atmosphere associated with dust particles. It can undergo wet and dry deposition. In the environment chromium predominantly exists as chromium III or chromium VI. Chromium VI is considered to be more toxic than chromium III.	ATSDR 2012
	IARC Ranking	Group 1: Carcinogenic to humans	
	Acute Effects	Irritation of the lining of the nose, runny nose, and breathing problems (asthma, cough, shortness of breath, wheezing) including allergies and skin rashes	
	Chronic effects	Upper and lower respiratory tract damage, haematological effects and hepatic effects.	
	Carcinogenic effects	Lung cancer from inhalation	
	Significant atmospheric transformation	No relevant transformations are noted. Although, in presence of vanadium, chromium VI can reduce to chromium III, which is a species of lower toxicity. Notable amounts of vanadium are not present in the emissions and is not accounted for in the modelling.	
PAH	Description	Are a group of compounds usually formed during incomplete combustion processes and in air are usually attached to dust particles. There are more than 100 different compounds of PAHs but usually toxicity due to benzo[a]pyrene is used as a marker for all compounds.	USEPA 2017; ATSDR 1995; NEPC 2003
	IARC Ranking	Benzo[a]pyrene ranked as Group 1: Carcinogenic to humans.	

	Acute Effects	Can potentially harmful effects on skin, body fluids and immune system	
	Chronic effects	Developmental and reproductive toxicity.	
	Carcinogenic effects	Strong animal and human evidence of carcinogenicity of benzo[a]pyrene, causing lung and skin cancer.	
	Significant atmospheric transformation	PAHs can degrade in the atmosphere by photolysis and reaction with NOx, N2O5, OH, ozone, sulfur dioxide, and peroxyacetyl nitrate. While there can be volatile species of PAHs, those associated with particulates tend to have lower reaction rates and favour photolytic degradation. Given the low concentration of PAHs in the emission, degradation products are also expected to be very low and therefore are not included in emission modelling.	
Mercury	Description	Mercury is a metal that can exist in the atmosphere in gaseous state (Hg^0 elemental mercury) and particulate bound. It can undergo wet and dry deposition.	ATSDR 2022
	IARC Ranking	Elemental mercury ranked as Group 3: Not classifiable as to its carcinogenicity to humans	
	Acute Effects	Exposure at fatal and near-fatal levels can cause adverse respiratory effects including lung inflammation, pneumonitis, and respiratory failure due to pulmonary edema	
	Chronic effects	Can cause neurological and renal effects.	
	Carcinogenic effects	No notable effects found	
	Significant atmospheric transformation	Gaseous elemental mercury may get transformed into other forms of mercury including precipitate and particulate bound. The transformation may assist in wet and dry deposition from the atmosphere. As these transformations do not change total mercury concentrations but facilitate increased rate of atmospheric removal, emissions modelling without any mercury transformations is conservative.	
Nickel	Description	Nickel is a metal that can be released into the atmosphere attached to small particles. It can undergo wet and dry deposition.	ATSDR 2005
	IARC Ranking	Group 1: Carcinogenic to humans	
	Acute Effects	Allergic reaction. Including skin rash and dermatitis	
	Chronic effects	Respiratory effects such as chronic bronchitis and reduced lung function	
	Carcinogenic effects	Dust inhalation can cause cancer of the lung and nasal sinus.	
	Significant atmospheric transformation	No significant transformation mechanism identified.	
NO2	Description	Are a mixture of gases released into the atmosphere, composed of nitrogen and oxygen. Two most toxicologically important nitrogen oxides are nitric oxide and nitrogen dioxide. They tend to break down in the atmosphere due to photochemical reaction.	NEPC 2018; ATSDR 2002

	IARC Ranking	Not classified	
	Acute Effects	Can cause irritation of eyes, nose, throat and lungs, shortness of breath, tiredness and nausea. High levels can cause burns to skin and eyes. Can cause respiratory and cardiovascular effects.	
	Chronic effects	Respiratory effects such as asthma and reduced lung function. Increased mortality rates due to respiratory and cardiovascular effects.	
	Carcinogenic effects	No evidence of carcinogenic effects	
	Significant atmospheric transformation	Nitrogen dioxide can be formed from reaction of nitric oxide and ozone. Nitrogen dioxide in the atmosphere can also form nitric acid which forms part of the phenomena known as acid rain. Formation of additional nitrogen dioxide in the atmosphere was included in the modelling of emissions.	
PM10	Description	PM stands for particulate matter which consists of a mixture of solid and liquid droplets in the air. It can include a range of particles such as dust, dirt, soot, or smoke and other small chemical matter such sulfates, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. PM10 refers to particles of ≤10 micrometers, which can be inhaled deep into the lung tissue and even blood stream.	NEPC 2000; ATSDR 2022; USEPA 2003
	IARC Ranking	Not classified	
	Acute Effects	Causes respiratory effects such as aggravating lung disease, cause asthma attacks and acute bronchitis and increase susceptibility to respiratory infections. Can increase incidences of heart attacks and arrhythmias in people with pre-existing issues.	
	Chronic effects	Can cause reduced lung function, development of chronic bronchitis, develop cardiovascular disease and premature death.	
	Carcinogenic effects	Particulate matter from outdoor air pollution causes cancer of the lung. A positive association has been observed between exposure to outdoor air pollution and cancer of the urinary bladder No evidence of carcinogenic effects	
	Significant atmospheric transformation	PM10 particles can occur due to natural and anthropogenic sources. Atmospheric chemical reactions can also produce PM10. PM10 can undergo wet and dry deposition and can take part in atmospheric reactions depending on chemical nature of the particle. No transformation were considered to be significant for consideration in the modelling or that would likely affect the risk outcomes of the report.	

APPENDIX B

Post Processing of Modelling Files

The air dispersion modelling for this health risk screening assessment was conducted by GHD (2021) using the CALPUFF model. The results of the air dispersion modelling were provided to Ramboll as a number of CALPUFF output files for each of the scenarios by GHD for the Refinery. The scenarios are summarised in Table B-1.

Table B-1 - Scenarios

Scenario	Alumina Production Rate	Emissions	Meteorology	Health Protective Guidelines
0	5 Mtpa	previous assessment	2006	previous
1A	5 Mtpa	forecast	2018-19	previous
1B	5 Mtpa	forecast	2018-19	current
2	5 Mtpa	nominal (2014-2021 average)	2018-19	current
3	5.25 Mtpa	predicted	2018-19	current

It should be noted that Scenarios 1A and 1B are based on the same set of emission estimates, but using the health protective guidelines applied for the previous screening assessment (ENVIRON, 2014) and the most current health protective guidelines respectively.

Ramboll read the CALPUFF files provided by GHD and produced individual files that contained the predicted GLCs for each hour of the year for each model grid point for each source.

Predicted GLCs of NO_2 were post processed to account for the oxidation of NO present in NO_x emissions. To derive the NO_2 GLCs, the initial NO_2/NO_X ratio was set for each refinery source based on information provided by Alcoa using a conservative NO_2/NO_x ratio of 13%, derived by Alcoa from monitoring at the site and consistent with previous studies.

For each hour, the predicted GLCs of NO and NO_2 were calculated separately based on the contribution from each source and the initial NO_2/NO_X ratio. When all emission sources for the hour had been process, the predicted NO concentration at each grid point was used in conjunction with the ozone limiting method to calculate the amount of NO_2 that would be formed from the NO in the presence of O_3 as follows:

$$NO_{2photo} = \text{minimum } (NO, O_3)$$

NO_{2photo} = NO_2 concentration (ppb) formed by the oxidation of NO by ozone
O_3 = ambient ozone concentration for that hour (ppb).

The ambient ozone concentrations were varied for each hour of the day and based on ambient monitoring data collected at Wagerup as presented in CSIRO (2005) and presented in Table B-2.

Table B-2 - Ozone Concentration (ppb) for Each Hour of the Day

Hour	Ozone	Hour	Ozone	Hour	Ozone	Hour	Ozone
1	19.7	7	19.0	13	28.1	19	22.0
2	19.5	8	20.8	14	28.0	20	21.0
3	19.0	9	22.5	15	27.8	21	19.8
4	18.5	10	24.5	16	27.0	22	20.0
5	18.2	11	26.0	17	25.0	23	20.0
6	18.1	12	27.0	18	23.2	24	19.9

The total NO_2 concentration was then calculated as the sum of the primary NO_2 concentration (i.e. the GLC associated with the percentage of NO_x emitted as NO_2) and the secondary NO_2 (i.e. NO_{2photo}) for each hour and each grid point and written to the output file.

The files that contained the predicted concentrations for each individual compound for each hour of the year and for each grid point were then analysed to produce the following statistics for each grid point:

- Maximum 1-hour average GLC;
- 9th highest 1-hour average GLC; and
- Annual average GLC.

For pollutants with an acute health protective guideline that does not refer to a 1-hour averaging period, but rather a 24-hour averaging period, the hour-by-hour GLC file for the pollutant was post processed to provide a 24-hour average concentration for each hour at each receptor location.

The health risk screening assessment used the predicted GLC statistics to calculate the individual hazard quotients and the total HI for the acute non-carcinogenic exposures based on the peak emission rate estimates. The predicted annual average GLCs were used to calculate the chronic non-carcinogenic and carcinogenic exposures based on the average emission rate estimates.