Technical report B

Human health risk assessment report

Cleanaway Western Sydney Energy and Resource Recovery Centre: Health Risk Assessment

Prepared for: Cleanaway Pty Ltd

21 September 2020

Document History and Status

Report Reference	CLEAN/20/WSERRC001
Revision	F – Post Adequacy
Date	21 September 2020
Previous Revisions	A – Draft (9 June 2020) B – Draft (25 June 2020) C – Adequacy Final (26 June 2020) D – Post Adequacy (8 September 2020) E – Post Adequacy (10 September 2020)

Limitations

Environmental Risk Sciences has prepared this report for the use of Cleanaway Pty Ltd (and project partners (ARUP Pty Ltd)) in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It is prepared in accordance with the scope of work and for the purpose outlined in the Section 1 of this report.

The methodology adopted, and sources of information used are outlined in this report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports provided for use in this assessment was false.

This report was prepared between May and September 2020 and is based on the information provided and reviewed at that time. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Table of Contents

Appendices

Glossary of Terms and Abbreviations

Term	Definition
ABS	Australian Bureau of Statistics
Acute exposure	Contact with a substance that occurs once or for only a short time (up to 14 days)
Absorption	The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs
Adverse health effect	A change in body function or cell structure that might lead to disease or health problems
ATSDR	Agency for Toxic Substances and Disease Register
AAQ	Ambient air quality
ANZECC	Australia and New Zealand Environment and Conservation Council
Background level	An average or expected amount of a substance or material in a specific environment, or typical amounts of substances that occur naturally in an environment.
Biodegradation	Decomposition or breakdown of a substance through the action of micro-organisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).
Body burden	The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.
Carcinogen	A substance that causes cancer.
CCME	Canadian Council of Ministers of the Environment
Chronic exposure	Contact with a substance or stressor that occurs over a long time (more than one year) [compare with acute exposure and intermediate duration exposure].
CO	Carbon monoxide
DECCW	NSW Department of Environment, Climate Change and Water
DEFRA	Department for Environment, Food & Rural Affairs
DEH	Australian Department of Environment and Heritage
Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An ‘exposure dose’ is how much of a substance is encountered in the environment. An ‘absorbed dose’ is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Also includes contact with a stressor such as noise or vibration. Exposure may be short term [acute exposure], of intermediate duration, or long term [chronic exposure].
Exposure assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Term	Definition
Exposure pathway	The route a substance takes from its source (where it began) to its endpoint (where it ends), and how people can come into contact with (or get exposed) to it. An exposure pathway has five parts: a source of contamination (such as chemical substance leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
Genotoxic carcinogen	These are carcinogens that have the potential to result in genetic (DNA) damage (gene mutation, gene amplification, chromosomal rearrangement). Where this occurs, the damage may be sufficient to result in the initiation of cancer at some time during a lifetime.
Guideline value	Guideline value is a concentration in soil, sediment, water, biota or air (established by relevant regulatory authorities such as the NSW Department of Environment and Conservation (DEC) or institutions such as the National Health and Medical Research Council (NHMRC), Australia and New Zealand Environment and Conservation Council (ANZECC) and World Health Organization (WHO)), that is used to identify conditions below which no adverse effects, nuisance or indirect health effects are expected. The derivation of a guideline value utilises relevant studies on animals or humans and relevant factors to account for inter and intra-species variations and uncertainty factors. Separate guidelines may be identified for protection of human health and the environment. Dependent on the source, guidelines would have different names, such as investigation level, trigger value and ambient guideline.
HI	Hazard Index
IARC	International Agency for Research on Cancer
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see route of exposure].
Intermediate exposure Duration	Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].
LGA	Local Government Area
LOR	Limit of Reporting
Metabolism	The conversion or breakdown of a substance from one form to another by a living organism.
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides
NSW	New South Wales
NSW EPA	NSW Environment Protection Authority
OEH	NSW Office of Environment and Heritage
OEHHA	Office of Environmental Health Hazard Assessment, California Environment Protection Agency (Cal EPA)
PM	Particulate matter
$PM_{2.5}$	Particulate matter of aerodynamic diameter 2.5 µm and less
PM_{10}	Particulate matter of aerodynamic diameter 10 µm and less
Point of exposure	The place where someone can come into contact with a substance present in the environment [see exposure pathway].
Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Term	Definition
Receptor population	People who could come into contact with hazardous substances [see exposure pathway].
Risk	The probability that something would cause injury or harm.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
SEIFA	Socio-Economic Index for Areas
SO_2	Sulfur dioxide
TCEQ	Texas Commission on Environmental Quality
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicity data	Characterisation or quantitative value estimated (by recognised authorities) for each individual chemical substance for relevant exposure pathway (inhalation, oral or dermal), with special emphasis on dose-response characteristics. The data are based on based on available toxicity studies relevant to humans and/or animals and relevant safety factors.
Toxicological profile	An assessment that examines, summarises, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
Toxicology	The study of the harmful effects of substances on humans or animals.
TSP	Total suspended particulates
UK	United Kingdom
US	United States
USEPA	United States Environmental Protection Agency
WHO	World Health Organization
$\mu g/m^3$	Micrograms per cubic metre

Executive Summary

Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Cleanaway and Macquarie Capital to undertake a Human Health Risk Assessment (HHRA) for an energy from waste facility in Western Sydney.

The site for the proposed facility is 339 Wallgrove Road in Eastern Creek, NSW (Lot 1 DP 1059698). The site is in the Wallgrove Precinct of the Western Sydney Parklands (WSP) in the Blacktown Local Government Area (LGA).

The proposal will be designed to thermally treat up to 500,000 tonnes per year of residual municipal solid waste (MSW) and residual commercial and industrial (C&I) waste streams that would otherwise be sent to landfill. This process would generate up to 58 megawatts (MW) of electricity on a gross basis with a proportion of the electricity generated to be used to power the facility itself and the remainder to be exported to the grid.

The waste feedstock received at the facility will include waste that is left over from off-site recycling and resource recovery operations and waste from source separated collections. In the current waste market, it is not environmentally, technically or financially viable to undertake further recycling or resource recovery of the residual waste streams that this proposal is targeting. Without an EfW option, the residual waste that this proposal would process, would be sent to landfill.

Location of receptors and types of exposure

The closest residential location in any direction is at least 1 km away from the proposed facility to the south. Other residential areas are 3 to 3.5 km away from the facility.

The sites surrounding the proposed facility are commercial/industrial. These sites are 200-500 m from the proposed facility. The closest location used as a school, preschool, church or other similar location in any direction is 1 km away from the proposed facility – a child care centre in the Eastern Creek industrial area.

The health risk assessment has evaluated exposure to the air emissions from the facility via:

- Inhalation the air containing the emissions
- Deposition of particles onto soil and
    - direct contact with that soil
    - uptake into and consumption of home grown fruit and vegetables
    - uptake into and consumption of home grown eggs
    - uptake into and consumption of home grown meat
    - uptake into and consumption of home grown milk
- Deposition of particles onto a roof, collection into household rainwater tanks and consumption of tank water for domestic purposes
- Deposition of particles onto the surface of Prospect Reservoir and use of water for drinking (including washoff of deposited particles into the reservoir from the surrounding catchment).

It is noted that the pathways related to consumption of fruit, vegetables, eggs, meat or milk refer to home grown produce. This means the calculations are designed to assess consumption of produce grown on a farm by those living on that farm as this will be the pathway with highest exposure potential (i.e. worst case).

Exposure scenarios evaluated

The following exposure scenarios have been assessed:

- Maximum off-site location – exposures via inhalation and direct contact with soil *(this location varies depending on the chemical but will be just outside the boundary of the facility or on the roads immediately outside the boundary)*.
- Maximum residential location – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and use of a rainwater tank
- Maximum commercial/industrial location – exposure via inhalation and direct contact with soil
- Maximum commercial/industrial location (as residential) – assumes this location changes land use to residential – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and use of a rainwater tank
- Maximum other places location – exposure via inhalation and direct contact with soil
- Maximum other places location (as residential) – assumes this location changes land use to residential – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and use of a rainwater tank
- Maximum farm location – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and, in addition, consumption of home grown milk and meat and use of a rainwater tank
- Maximum on-site location – exposure via inhalation for visitors to the education centre/café/gallery as well as staff working in the café/gallery (i.e. not related to operation of the proposed facility)
- Prospect Reservoir – exposure via consumption of drinking water where particles have deposited onto the water in the reservoir and have washed off into the reservoir from the land surrounding when it rains
- Cumulative with proposed Next Generation facility – in this scenario the annual average ground level concentrations at the maximum off-site location (scenario 1) for this proposed facility was combined with the annual average ground level concentrations at the maximum off-site location for the proposed Next Generation facility to the east. It is noted that it is not possible for these two locations to actually be co-located as they will actually be kilometres apart. Assessing risks based on assuming they are in the same place is a conservative assessment of the potential for impacts if the two facilities were approved and constructed.

Modelling

Emissions from the plant have been modelled by Todoroski Air Sciences in line with NSW EPA requirements. The modelling generated ground level concentrations for assessing both short and long term exposures. The potential for impacts on human health due to short term exposures were assessed using the maximum 1 hour concentration at ground level. The potential for impacts on human health due to Long term exposure scenarios were assessed using two different estimates of annual average ground level concentrations:

- Annual average ground level concentrations using expected / design stack concentrations – Scenario 1
- Annual average ground level concentrations assuming the maximum 1 hour regulatory (licence) stack concentrations were emitted for every hour all year – EPA Limit modelling scenario.

The air quality modelling and the risk calculations have assumed the following mitigation measures will be in place during operation of such a facility:

- proper operation and maintenance of the facility
- detailed monitoring of emissions (including continuous monitoring for relevant pollutants)
- monitoring of the proper operation of pollution control/flue gas equipment using sensors to detect breakage in the baghouse etc
- automated doors that rapidly open and close for each tipping bay
- transport of waste to the site using enclosed trucks or other relevant techniques
- waste always unloaded within the building housing the tipping bays and storage bunker.

Results

Criteria pollutants

Criteria air pollutants are those that are targeted by the National Environment Protection (Ambient Air Quality) Measure (NEPC 2016). They are common air pollutants that need to managed well to maintain acceptable air quality. The pollutants included are sulfur dioxide, nitrogen dioxide, carbon monoxide, particles (PM_{10}, $PM_{2.5}$).

There are many sources of these types of air pollutants including all combustion sources – fires, bushfires, cooking, vehicles, wood fired heaters, open fireplaces, ship engines, power stations etc – and other sources like windblown dust and salt spray.

Air quality modelling was undertaken by Todoroski Air Sciences to estimate the ground level concentrations at all relevant locations around the proposed facility. The results for the maximum off-site location have been listed in **Table ES-1**. All other locations around the facility will have lower concentrations than those listed here.

Table ES-1: Criteria Pollutants (maximum off-site location) (µg/m^3)

Scenario	Sulfur dioxide	Nitrogen dioxide	Carbon monoxide	$PM_{2.5}$	PM_{10}
Guideline	60	62	10000	8	30
Averaging period	Annual average	Annual average	8 hour average	Annual average	Annual average
Contribution from project	0.06	1.47	94	0.02	0.02
% contribution from project (compared to NEPM guideline value)	0.3%	2.3%	0.9%	4.3%	1.2%
Project plus background	1.6	22	1655	8	18
Project plus background and Next Generation facility	1.6	22	1657	8	18

For sulfur dioxide, nitrogen dioxide and carbon monoxide, levels contributed by this facility are low and the cumulative concentrations (those including background and the Next Generation facility) are all well below the relevant national guidelines.

For particles, levels contributed by this facility are low, but the overall cumulative concentrations are similar to the national guidelines. Further evaluation has been undertaken in this assessment which confirms that the small contribution from this facility does not change the number of days per year for which particles might be at or above the national guidelines. In addition, a more detailed assessment of risk due to exposure to this small contribution also confirms the change in health impacts will be negligible.

<u>Other pollutants</u>

<u>Short term exposures</u>

The assessment of short term exposures used the maximum 1 hour average ground level concentration at the worst case location and compared that value to public health based guidelines for exposure over 1 hour. The worst case location is the maximum off-site location. This location varies depending on the chemical (gases versus attached to particles). It will be located just outside the boundary of the facility or on the roads surrounding the facility.

The risk quotient is the ratio between the maximum 1 hour average ground level concentration and the public health based guideline for each chemical that might be present in the emissions. For this assessment, the individual risk quotients were between 5 times and 100000 times lower than the relevant guideline based on short term exposure in air. In addition, if all the risk quotients are summed to get an overall consideration of short term risk, then this risk index was also below 1.

Short term exposures at the most affected location do not pose an unacceptable risk based on guidelines adopted using guidance from Australian health authorities.

<u>Long term exposures</u>

The assessment of long term exposures to emissions has been assessed for the following types of exposures (as noted above):

- Inhalation the air containing the emissions
- Deposition of particles onto soil and
    - direct contact with that soil
    - uptake into and consumption of home grown fruit and vegetables
    - uptake into and consumption of home grown eggs
    - uptake into and consumption of home grown meat
    - uptake into and consumption of home grown milk
- Deposition of particles onto a roof, collection into household rainwater tanks and consumption of tank water for domestic purposes
- Deposition of particles onto the surface of Prospect Reservoir and use of water for drinking (including washoff of deposited particles into the reservoir from the surrounding catchment).

The assessment used the annual average ground level concentrations and the deposition rate for particles for the two long term scenarios modelled in the air quality impact assessment:

- Annual average ground level concentrations using expected / design stack concentrations – Scenario 1
- Annual average ground level concentrations assuming the maximum 1 hour regulatory (licence) stack concentrations were emitted for every hour all year – EPA Limit modelling scenario.

The risk calculations involved determining exposure via:

- inhalation (breathing it in)
- ingestion (eating or drinking it – direct or indirect) or
- dermally (absorbing it through the skin)

for each of the various chemicals that might be present in the emissions.

Ingestion and dermal exposure have been assessed for the chemicals attached to particles that mix into soil where people might come into direct contact with the soil or where the chemicals attached to the particles get mixed into the soil and then taken up into various types of produce like vegetables or eggs that people might grow in their backyards. In addition, the potential for chemicals to be present in rainwater tanks or Prospect Reservoir due to deposition of particles has also been assessed.

Risk estimates (sum of all the chemicals) have been calculated for each exposure scenario and each type of exposure.

Scenario 1 – Expected case:

The findings for the risk calculations for this scenario are provided in **Table ES-2**.

Table ES-2: Calculated Risks – Scenario 1

Scenario	Risk (inhalation)	Risk (deposition)	Risk (rainwater tank)	Risk (total)
Maximum off-site	0.01	0.04	NA	0.05
Maximum residential	0.009	0.007	0.0005	0.02
Maximum commercial	0.003	0.01	0.002	0.02
Maximum other places	0.004	0.003	0.0004	0.007
Maximum farm	0.005	0.02	0.0002	0.03
Maximum on-site	0.002	0.003	NA	0.005
Maximum commercial (as residential)	0.01	0.03	0.002	0.04
Maximum other places (as residential)	0.01	0.003	0.0004	0.01
Prospect Reservoir	NA	0.0008	NA	0.0008
Cumulative with proposed Next Generation facility	0.03	0.06-0.2	NA	0.09-0.2
Guideline	≤1	≤1	≤1	≤1

All threshold risks calculated for the various scenarios evaluated for this facility are at least 20 times below the relevant guideline. The cumulative case for both this facility and the Next Generation facility is at least 5 to 10 times lower than the relevant guideline.

There was one chemical that was also assessed for its potential to cause effects via non-threshold mechanisms – benzene. This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.Exposure via inhalation is the only relevant pathway for these types of chemicals and the risk estimates were 10 to 100 fold lower than the relevant guidelines.

EPA Limit modelling scenario:

The EPA limit modelling scenario describes the situation where the plant operates in a way that generates the maximum 1 hour stack concentrations every hour of the year. It is not possible to operate the plant using these conditions. However, this assessment has been undertaken to demonstrate the absolute worst case.

The findings for the risk calculations for this scenario are provided in **Table ES-3**.

Table ES-3: Calculated Risks – EPA limit modelling scenario

Scenario	Risk (inhalation)	Risk (deposition)	Risk (rainwater tank)	Risk (total)
Maximum off-site	0.09	0.1	NA	0.2
Maximum residential	0.06	0.02	0.001	0.08
Maximum commercial	0.02	0.04	0.004	0.06
Maximum other places	0.02	0.01	0.0009	0.03
Maximum farm	0.07	0.1	0.0005	0.2
Maximum on-site	0.009	0.01	NA	0.02
Maximum commercial (as residential)	0.06	0.1	0.004	0.2
Maximum other places (as residential)	0.06	0.02	0.0009	0.08
Prospect Reservoir	NA	0.003	NA	0.003
Guideline	≤1	≤1	≤1	≤1

All threshold risks calculated for the various scenarios evaluated for this facility using this scenario are at least 5 times below the relevant guideline.

Transport of waste

The waste to be treated at this facility (i.e. residual municipal solid waste (MSW) and residual commercial and industrial (C&I) waste streams) will be primarily sourced from the general area around the facility.

These waste streams currently exist and are transported around the region to locations for sorting. Once sorted the residual materials that cannot be recycled are currently transported to a landfill for final disposal. Existing landfills that receive such waste from various parts of Sydney include locations such as SUEZ Kemps Creek Resource Recovery Park, SUEZ Lucas Heights Resource Recovery Park, Veolia Woodlawn, Summerhill Waste Management Centre (City of Newcastle) and others.

Currently, kerbside waste is collected in the local area and taken to the Cleanaway Erskine Park Landfill where the waste is sorted and the residual is taken to a landfill in Newcastle (Summerhill) or to the ResourceCo facility in Wetherill Park. Commercial/industrial waste is also taken to the Erskine Park Landfill for sorting.

During the operation of this facility the same system would be in place to collect kerbside waste as exists currently so there would be no change in transport emissions from this part of the process. There would also be no change in emissions for waste being delivered to the Erskine Park Landfill from commercial/industrial customers.

Any change in emissions to air from the transportation of waste results from potential changes in travel for trucks handling residual waste from the Erskine Park Landfill. Instead of the material being transported to Newcastle or to Wetherill Park (or other locations outside the immediate area), it would be transported to this facility which is closer to the Erskine Park facility.

Todoroski Air Sciences has undertaken modelling of the change in expected emissions from truck movements within 10 km of this facility.

The changes in emissions from the transportation of materials on public roads ranged from 0.01-0.07% relative to the current situation. This is a negligible change.

Overall Conclusion

The potential for air emissions from this facility to pose a risk to people has been assessed for short and long term exposures and has considered multiple pathways of exposure. The assessment has considered maximum off-site locations for each type of land use being assessed. In addition, potential risks from emissions from the transportation of waste have been considered.

All assessments have found that risks are in compliance with the guidelines developed by government authorities in Australia and are considered low.

1 Introduction

1.1 Background

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Cleanaway and Macquarie Capital to undertake a Human Health Risk Assessment (HHRA) for an energy from waste facility in Western Sydney.

Cleanaway and Macquarie Capital have entered into a joint venture agreement to develop an energy-from-waste (EfW) facility known as the Western Sydney Energy and Resource Recovery Centre (WSERRC) (the proposal).

The site for the proposed facility is 339 Wallgrove Road in Eastern Creek, NSW (Lot 1 DP 1059698). The site is in the Wallgrove Precinct of the Western Sydney Parklands (WSP) in the Blacktown Local Government Area (LGA).

The proposal will be designed to thermally treat up to 500,000 tonnes per year of residual municipal solid waste (MSW) and residual commercial and industrial (C&I) waste streams that would otherwise be sent to landfill. This process would generate up to 58 megawatts (MW) of electricity on a gross basis with a proportion of the electricity generated to be used to power the facility itself and the remainder to be exported to the grid.

The waste feedstock received at the facility will include waste that is left over from off-site recycling and resource recovery operations and waste from source separated collections. In the current waste market, it is not environmentally, technically or financially viable to undertake further recycling or resource recovery of the residual waste streams that this proposal is targeting. Without an EfW option, the residual waste that this proposal would process, would be sent to landfill.

Whilst some residual materials are produced as a result of the EfW process, including bottom ash, boiler ash and flue gas treatment residues (FGTr), the EfW process typically leads to a 95% reduction in the volume of waste that would otherwise go to landfill.

The proposal would also include a process on site for recovering ferrous metals from the bottom ash to be sold to metal recyclers. Non-ferrous metals will also be recovered from the bottom ash, with options for the incorporation of the bottom ash into other construction products being investigated. The location of the site for non-ferrous metals recovery and potential incorporation of bottom ash into construction products is being investigated but does not form part of the scope of this proposal.

As well as diverting waste from landfill, the proposal will enhance energy security for NSW by providing a renewable base load energy source and an alternative to traditional fossil fuel generation. There is also the potential for the proposal to offset and provide a renewable energy source to neighbouring facilities currently using fossil fuel generated energy sources. The proposal will be capable of producing energy for over 65,000 homes in Western Sydney, reducing greenhouse gas emissions by around 450,000 tonnes of CO2-e per year, equivalent to taking approximately 100,000 cars off the road each year.

The proposal will also include a visitor centre to help educate and inform the community on the circular economy, recycling, resource recovery and EfW.

The proposal will use established and proven EfW technology. Moving grate technology has been chosen as the means to thermally treat incoming waste to recover energy and advanced flue gas treatment technology would be implemented to clean the air to stringent emission standards. Moving grate technology has been used globally for over 50 years with hundreds of operational examples. During that time, the technology has developed in response to continuous improvement in the industry. There are approximately 500 similar operational examples across Europe using the same technology being proposed for the WSERRC.

Flue gas treatment technologies has also seen continuous improvements in their ability to achieve ever more stringent emissions standards. The NSW EfW policy states that "To ensure emissions are below levels that may pose a risk of harm to the community, facilities proposing to recover energy from waste will need to meet current international best practice techniques". This proposal has been designed to meet the European Industrial Emissions Directive (IED) (directive 2010/75/EU of the European Parliament)1 and the associated Best Available Techniques Reference2 (BREF) document which sets the European Union environmental standards for waste incineration as published on 3rd December 2019. Additionally, the facility will comply with the technical criteria set out in the NSW Energy from Waste Policy Statement.

A number of additional projects, referred to as related development, are required to support the operation of the WSERRC. These will be assessed and determined through separate approval processes and are not part of the scope of the proposal. The additional projects that comprise related development include:

- Expansion of the Erskine Park Resource Recovery Facility for the pre-processing of waste before delivery to WSERRC.
- Ash storage and secondary metals recovery facility.
- A connection to the Endeavour Energy high voltage electricity network.
- Water and sewer connections
- Site access works.

1.2 Objectives

The objective of the HHRA presented in this report is to address the relevant Secretary's Environmental Assessment Requirements (SEARs), namely:

- A quantitative human health risk assessment in accordance with the 'Environmental Health Risk Assessment: Guidelines for assessing human health risks from environmental hazards' (enHealth, 2012) covering the inhalation of criteria pollutants and exposure (from all pathways, i.e. inhalation, ingestion and dermal) to specific air toxics, including impacts from the transport of waste material.
- Consideration of the impacts on drinking water sources such as Prospect Reservoir and rainwater tanks, including the impacts on water quality and human health.

In addition, it is acknowledged that the specific requirements listed above were developed based on input from government agencies including NSW Health, NSW EPA and others.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075
[2] https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC118637_WI_Bref_2019_published_0.pdf

1.3 Approach and scope of works

The HHRA is proposed to be undertaken in accordance with the following guidance (and associated references as relevant):

- enHealth, 2012. Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards. (enHealth 2012a)
- enHealth 2012. Australian Exposure Factors Guide (enHealth 2012b)

Consideration will also be given to the following guidance documents on the conduct of health risk assessments associated with air emissions from point sources as well as road/rail sources:

- NEPC 2016. National Environment Protection (Ambient Air Quality) Measure (NEPC 2016)
- NEPC 2011. National Environmental Protection (Air Toxics) Measure (NEPC 2011a)
- NSW EPA 2016. Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA 2016).

To address the above scope of works, the HHRA has presented the following:

- Description of the project (**Section 2**)
- Identification of the community of concern – this is the location and characteristics of the population surrounding the site (**Section 3**)
- Description of methodology for assessing health impacts from air emissions (**Section 4**)
- Assessment of health impacts from air emissions – this is a quantitative assessment of potential community health impacts from changes in air quality as a result of the operation of the facility (**Section 5**)
- Uncertainty and sensitivity assessment (**Section 5.4**)
- Discussion – air emissions due to transportation of waste (**Section 6**)
- Conclusions (**Section 7**)

1.4 Definitions

For the conduct of the HHRA the following definitions are relevant and should be considered when reading this report.

Health

The World Health Organisation defines health as "*a (dynamic) state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity*".

Hence the assessment of health should include both the traditional/medical definition that focuses on illness and disease as well as the more broad social definition that includes the general health and wellbeing of a population.

Health Hazard

These are aspects of a Project, or specific activities that present a hazard or source of negative risk to health or well-being.

In relation to the HHRA, these hazards may be associated with specific aspects of the proposed development/construction or operational activities, incidents or circumstances that have the potential to directly affect health. In addition, some activities may have a flow-on effect that results in some effect on health. Hence health hazards may be identified on the basis of the potential for both direct and indirect effects on health.

Health Outcomes

These are the effects of the activity on health. These outcomes can be negative (such as injury, disease or disadvantage), or positive (such as good quality of life, physical and mental wellbeing, reduction in injury, diseases or disadvantage).

It is noted that where health effects are considered these are also associated with a time or duration with some effects being experienced for a short period of time (acute) and other for a long period of time (chronic). The terminology relevant to acute and chronic effects is most often applied to the assessment of negative/adverse effects as these are typically the focus of technical evaluations of various aspects of the project.

Likelihood

This refers to how likely it is that an effect or health outcome will be experienced. It is often referred to as the probability of an impact occurring.

Risk

This is the chance of something happening that will have an impact on objectives. In relation to the proposed project and the conduct of the HHRA, the concept of risk more specifically relates to the chance that some aspect of the project will result in a reduction or improvement in the health and/or well-being of the local community. The assessment of risk has been undertaken on a quantitative basis for air, water and noise emissions and a qualitative basis for all other impacts. This is in line with the methods and levels of evidence currently available to assess risk.

Equity

Equity relates to the potential for the project to lead to impacts that are differentially distributed in the surrounding population. Population groups may be advantaged or disadvantaged based on age, gender, socioeconomic status, geographic location, cultural background, aboriginality, and current health status and existing disability.

1.5 Available information

In relation to the proposed project, the HHRA has been undertaken on the basis of existing information which is available in the following reports:

- Todoroski Air Sciences 2020, DRAFT Air Quality and Odour Impact Assessment (AQIA). Western Sydney Energy and Resource Recovery Centre (WSERRC)
- Project Description Information from ARUP
- Air Quality Modelling Output Spreadsheets
- ARUP 2020, Cleanaway & Macquarie Capital Western Sydney Energy and Resource Recovery Centre Traffic and Transport Technical Report

2 Project description

2.1 Overview

Cleanaway and Macquarie Capital are jointly developing an energy-from-waste (EfW) facility known as the Western Sydney Energy and Resource Recovery Centre (WSERRC) (the proposal).

The proposal will be designed to thermally treat up to 500,000 tonnes per year of residual municipal solid waste (MSW) and residual commercial and industrial (C&I) waste streams that would otherwise be sent to landfill. This process would generate up to 58 megawatts (MW) of base load electricity some of which would be used to power the facility itself with the remaining 55 MW exported to the grid. The proposal involves the building of all onsite infrastructure needed to support the facility including site utilities, internal roads, weighbridges, parking and hardstand areas, storm water infrastructure, fencing and landscaping.

The proposal site is located at 339 Wallgrove Road in Eastern Creek, NSW (Lot 1 DP 1059698) which is in the Blacktown local government area (LGA). The site is in the Wallgrove Precinct of the Western Sydney Parklands (WSP) Plan of Management.

The 8.23 ha site is divided by a small strip of land not part of the proposal site, resulting in a 2.04 ha northern section and a 6.19 ha southern section. This dividing strip is part of the adjacent lot and includes a right of carriageway benefitting the proposal site allowing vehicles to move between the two parts of the site. The proposal area will be fully contained in the 6.19 ha portion of the site. Works to occur on the 2.04 ha northern section of the site include the clearing of weeds and exotic vegetation within the existing overland flow channel which is confined to the eastern section of this parcel of land. The northern section will also be used temporarily to support construction works. It is not currently expected that any other works will occur on the 2.04 ha northern section of the site as part of this proposal.

The facility will use established and proven EfW technology. Moving grate technology has been chosen as the means to thermally treat incoming waste to recover energy and advanced flue gas treatment technology will be installed as the means to clean air emissions. Moving grate technology has been used globally for over 50 years and in that time the technology has been improved continually, responding to regulatory, industry and public demands.

The NSW EfW policy states that *"To ensure emissions are below levels that may pose a risk of harm to the community, facilities proposing to recover energy from waste will need to meet current international best practice techniques"*.

This proposal has been designed to meet the European Industrial Emissions Directive (IED) (directive 2010/75/EU of the European Parliament)[3] and the associated Best Available Techniques (BAT) Reference document for Waste Incineration[4] (BREF) which sets the European Union environmental standards for waste incineration as published on 3 December 2019. The EU Commission Implementing Decision (2019/2010) on the 12 November 2019 states the best available techniques (BAT) conclusions as the main element of the BREF and prescribes them to be adopted by Member States. Additionally, the facility will comply with the technical criteria set out in the NSW EfW policy

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0075

[4] https://eippcb.jrc.ec.europa.eu/sites/default/files/2020-01/JRC118637_WI_Bref_2019_published_0.pdf

2.2 Site description

The proposal site is located at 339 Wallgrove Road in Eastern Creek, NSW (Lot 1 DP 1059698). The site is in the Wallgrove Precinct of the Western Sydney Parklands (WSP) in the Blacktown local government area (LGA). **Figures 1** and **2** provide the regional and local context for the site.

Access to the site is via an unnamed road (also referred to as the Austral Bricks Road) adjacent to the site's southern boundary. The unnamed road connects to Wallgrove Road which in turn connects to the wider road network including the M7 motorway. The existing road network provides for B-double access to the unnamed road.

The existing site includes buildings associated with a disused poultry facility, which will be cleared from the site prior to starting construction.

The site is bounded by the M7 Motorway to the west with the Eastern Creek industrial area located farther west. The now-closed Eastern Creek landfill site (which still has an operational organics recycling facility component) is located to the north and north-east, with the operational Global Renewables waste management facility located immediately to the east (see **Figure 2**). To the south, the site is bounded by the Warragamba Pipeline Corridor with the Austral Bricks facility located farther south.

The nearest residential area is located around 1 km to the south of the site. The Erskine Park residential area is located around 3.5 km to the west with Minchinbury located around 3 km to the north. Horsley Park Public School is located over 2 km south of the site and a childcare centre is located within the Eastern Creek industrial area approximately 1 km to the west of the site.

Salmonella

The proposal site history indicates that the site has been used for mixed-use commercial and industrial activities, including a poultry factory farm since the 1970s. A Biosecurity Direction from the Department of Primary Industries (DPI) was issued to the previous site owner dated 24 January 2019 concerning the presence of Salmonella on-site. The current site owners worked with DPI to address the Salmonella issue in accordance with established procedures. The applicant has since received a letter from DPI dated 26 May 2020 which confirmed the site is now considered a "resolved premise" and, therefore, the Biosecurity Direction has been revoked.

Site layout

Key features of the site layout are shown in **Figure 3.**

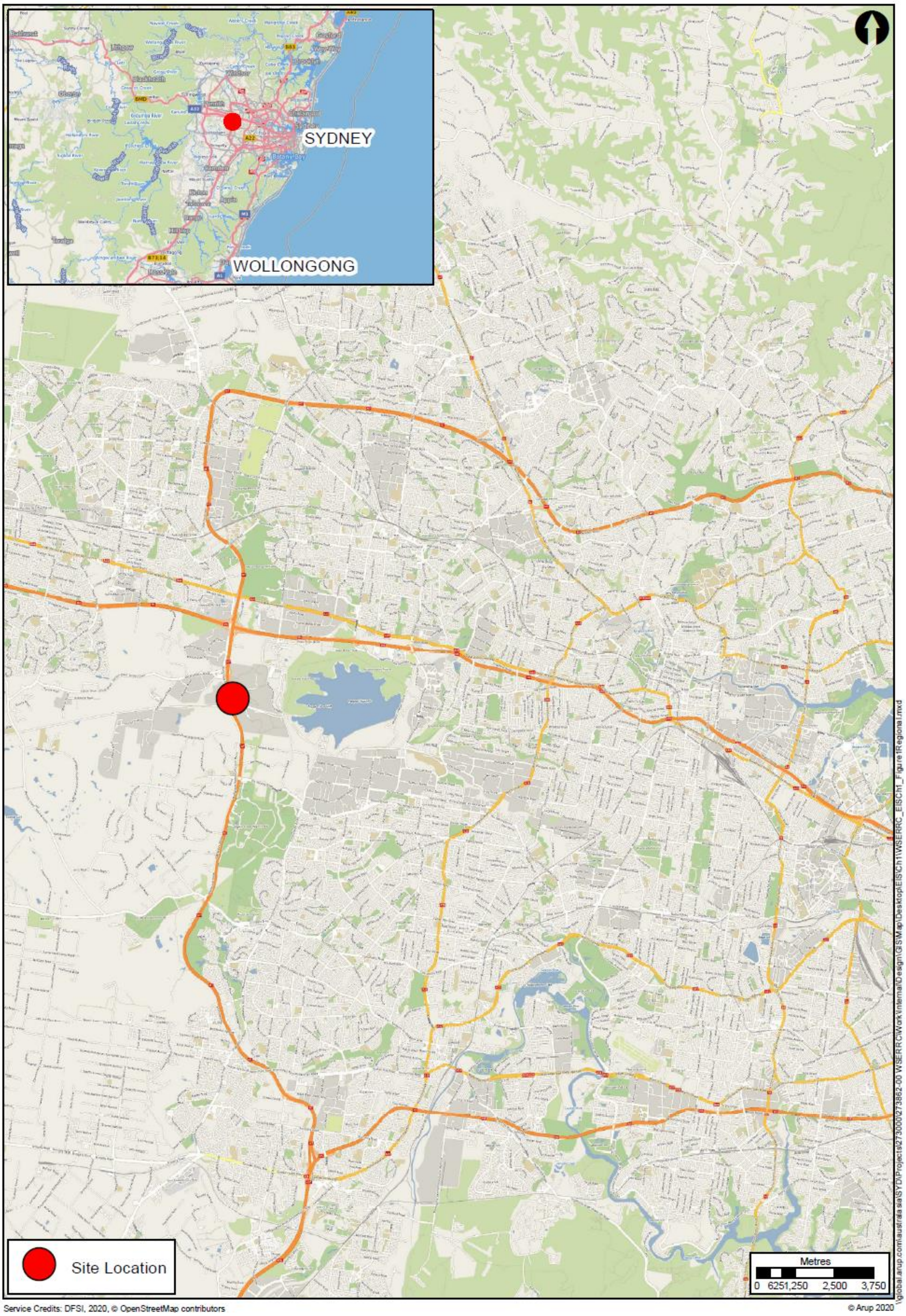


Figure 1 Regional context

Service Credits: DFSI, 2020

Figure 2 Local context

Figure 3 **Proposed Facility Layout**

2.3 Operation

The following section describes the day to day operational characteristics of the EfW facility.

2.3.1 Waste feedstock

The facility will have a normal operational throughput of up to 500,000 tpa of waste, providing about 58 MW of electricity per year on a gross basis. A throughput of up to 500,000 tpa necessitates the use of two boilers, each boiler having an annual throughput of 250,000 t. This is known as having two boiler lines. Each line will have its own dedicated feed hopper, boiler and flue gas treatment. However, the stack and steam turbine will be common to each line, meaning there is only a single stack (with two separated flues) and a single steam turbine servicing the facility. The waste bunker, ash system and crane system will also be common and service the entire facility.

The composition of waste feedstock is variable compared to traditional fuels such as coal and gas. Waste composition audits of target MSW and C&I waste streams have been carried out to understand the calorific value, or energy content, of the waste feedstock and the variability over time.

This has allowed a calorific value to be nominated as the design point for the facility with the thermal treatment technology capable of managing variation in the energy content either side of this design point.

An EfW facility must be designed to operate based on such variations in calorific value. For this reason, each EfW facility is designed using a firing diagram as shown in **Figure 4**. The firing diagram sets out the range of calorific values over which a facility can operate.

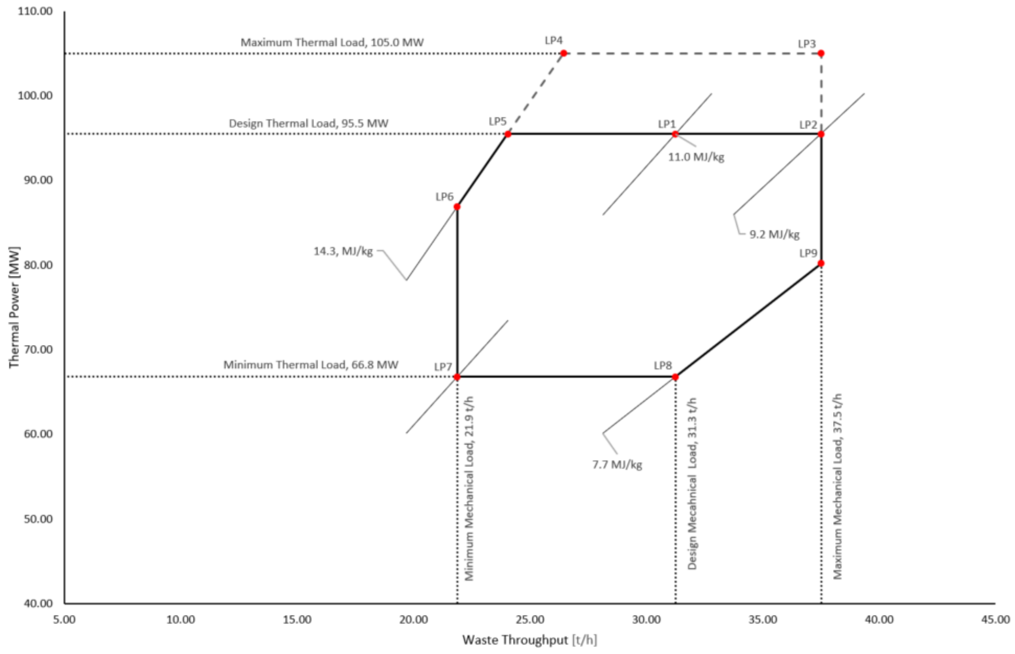


Figure 4 Firing diagram

The firing diagram is identical for both boilers, note that **Figure 4** displays the firing diagram for one boiler only.

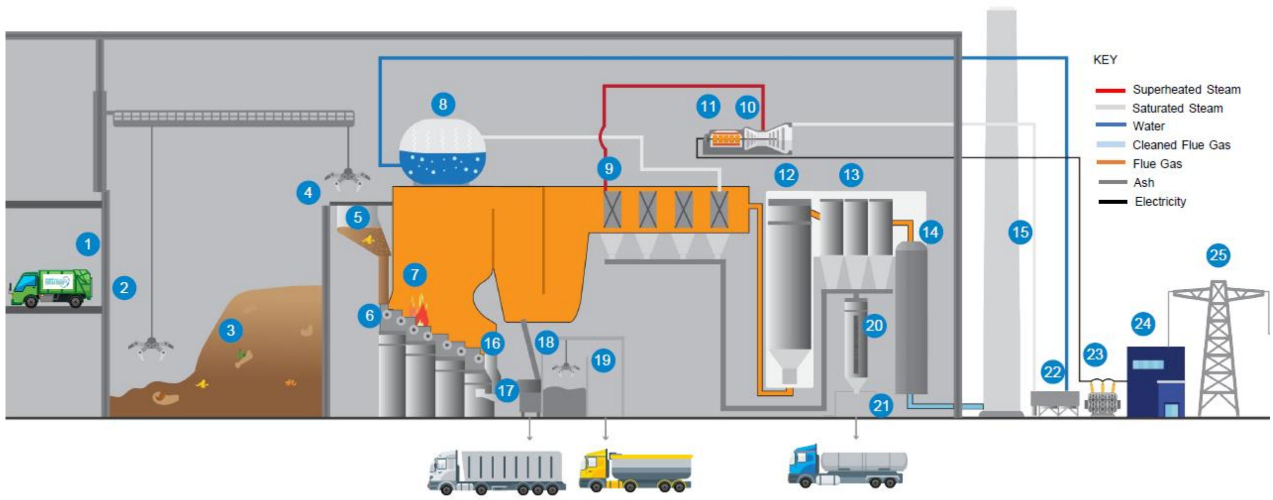
WSERRC is designed to operate in the region of 8,000 hours per year. It cannot operate all the time (8,760 hours per year) as it needs to be taken offline around twice per year for scheduled maintenance. The design point for the facility is a calorific value of 11 MJ/kg, shown by point LP1 in **Figure 4**. This is based on analysis of the waste streams (both MSW and C&I) currently received at the Erskine Park Waste Transfer Station. To achieve an electrical gross output of 58 MW, the facility must maintain a constant thermal input of 95.5 MWth per boiler. The facility aims to achieve a constant boiler load of 100%, hence the amount (mass) of waste loaded into the boiler on an hourly basis can change (via automatic combustion control) as calorific value varies.

For example, at the design point of 11 MJ/kg (LP1), the facility will consume 31.3 tph of waste per line which equates to 500,000 t of waste (250,000 t per line). To achieve 100% boiler load the facility can safely treat waste with a range of calorific values between 9.2 MJ/kg and 14.3 MJ/kg which have an equivalent mass of between 37.5 tph and 24.0 tph respectively (LP5 – LP2).

To deal with short-term fluctuations in waste calorific value, the facility has been designed to also accommodate a boiler load of between 70% and 110% of the design boiler load. This is illustrated by the extreme points on the firing diagram (LP7, LP3).

2.3.2 Process

A schematic process diagram of the facility, depicting the main steps in the process from receival of waste through to flue gas treatment and residue management is shown in **Figure 5**. The main steps in the EfW process for the proposal are further discussed in the following sections with relevant cross-reference to the numbering detailed in **Figure 5.**



LEGEND

1	Waste Receiving hall	7	Boiler	13	Bag filters	20	Flue gas treatment residues (FGTr) and boiler fly ash silo
2	Tipping bay	8	Steam drum	14	Wet scrubber	21	FGTr and boiler fly ash collection for treatment and disposal
3	Waste bunker	9	Superheaters	15	Stack	22	Air cooled condenser
4	Waste crane	10	Steam turbine	16	Incinerator bottom ash (IBA) handling	23	Transformer
5	Feed hopper (chute)	11	Generator	17	Ferrous metals recovery	24	Substation
6	Moving grate	12	Semi dry reactor	18	IBA bunker and separate metals bunker	25	Local electricity grid
				19	IBA collection and separate metals collection		

Figure 5 Schematic of the EfW operational process

2.3.3 Combustion

Waste is fed from the feed hopper to the combustion grate at a variable rate, depending on the calorific value of the waste. The grate will employ advanced moving grate technology which is the most commonly used technology for the thermal treatment of municipal solid waste.

Waste combustion will take place as it slowly moves along the grate which slopes away from the waste feed chute. The movement of the grate floor components and the slope of the grate will cause the waste, as it burns, to move forward and downwards from the feed point to the ash discharge point. Movement of the grate floor components will also agitate the waste so that new surfaces will be continuously exposed to the flames. The rate at which the waste moves will be controlled to optimise combustion. Typically, waste takes about 90 minutes to fully combust.

Waste combustion would be automatically controlled via the facility Distributed Control System (DCS) utilising the advanced combustion control systems and feedback from the CEMS.

Steam will flow from the boiler section to the steam turbine. The steam will be superheated and will be of sufficient quality (suitable temperature and pressure) for use in the steam turbine without damage to the turbine. Given the high temperature and pressure environment, the steam system will be equipped with appropriate safety features such as temperature gauges, pressure gauges, level gauges and pressure relief valves. The Distributed Control System (DCS) will be able to control and shut down the facility in case of emergency depending on set limits. It will also include the capability for manual intervention for emergency shutdown.

2.3.4 Flue gas treatment

Combustion gases created through the combustion of waste must be cleaned before being released from the stack. This section provides an overview of the treatment systems employed.

This facility will be capable of cleaning the flue gases in line with the emissions limits as set out in the Industrial Emissions Directive (IED) and the associated Best Available Techniques Reference (BREF) document for waste incineration as published on 3rd December 2019.

Emission Limit Values (ELV's) have not been duplicated in this section of the EIS (they are discussed in the air quality impact assessment technical report). This chapter only provides an overview of the cleaning systems proposed.

An overview of the proposed treatment system for the facility is provided in **Figure 6**.

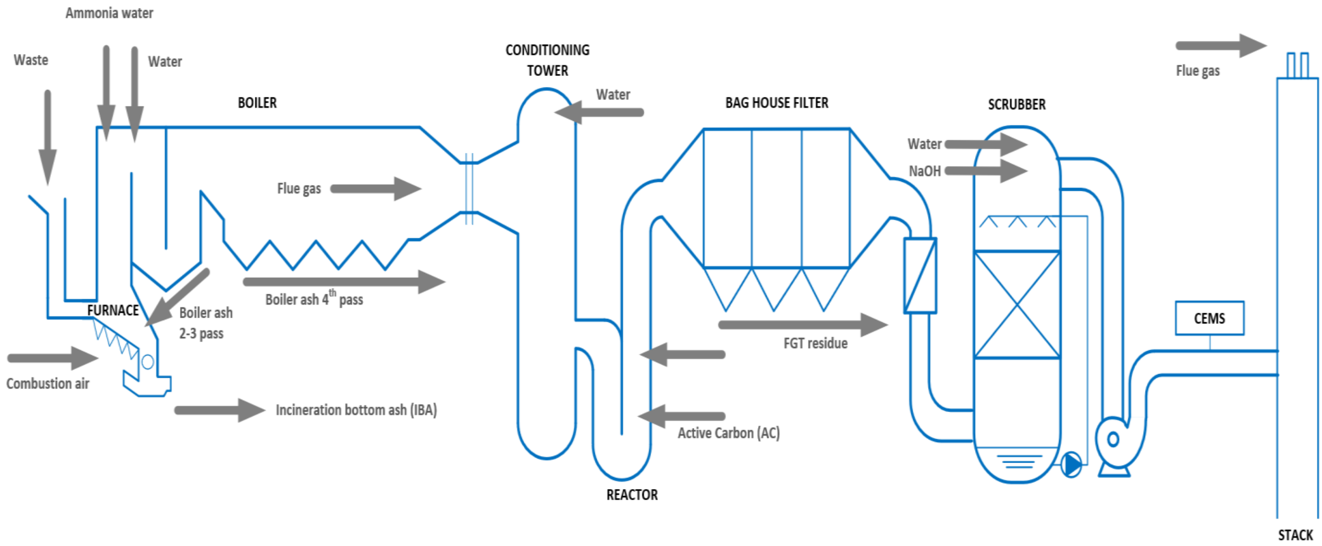


Figure 6 Proposed treatment system

Key components of the flue gas treatment system are outlined in **Table 1**.

Table 1: Key components of the flue gas treatment system

#	Function	Description
1	Selective Non-Catalytic Reduction (SNCR)	SNCR is the technology that has been chosen for the reduction of oxides of nitrogen (NO_x) within the flue gases. Ammonia is injected into the flue gas path and reacts with NO_x to create nitrogen and water, both of which are not harmful to the environment.
2	Reactor (conditioning tower)	Hydrated lime and activated carbon are injected into the flue gas stream in the reactor. This reduces levels of acid gases and filters out harmful pollutants. Water is also injected for conditioning of the flue gases to ensure optimum conditions for treatment.
3	Bag house filter	The bag house filter removes the mixture of activated carbon, hydrated lime, reaction products from the reactor stage and remaining boiler fly ash that is entrained within the flue gas from the reactor stage. They remove the pollutants from the exhaust gas that have been adsorbed into the treatment reagents. The resulting mixture is captured within the filter bags and termed Flue Gas Treatment residues (FGTr).
4	Wet scrubber	The wet scrubber acts as a final stage to further absorb acid gases, reduce ammonia and reduce volumes of particles and heavy metals within the flue gas. A wet scrubber has been chosen due to the significantly improved emissions performance when compared to a fully dry or semi-dry system. An additional benefit of the wet scrubber is the possible reduction in hydrated lime usage that can be achieved in the reactor stage.
5	Induced Draft (ID) fan	The ID fan is used to allow the flue gases to flow through the treatment process.
6	Continuous Emissions Monitoring System (CEMS)	To monitor compliance with the emissions limits set out in the IED and Waste Incineration BREF, and to inform use of reagents, a CEMS system will be installed.
7	Stack	The stack is used to disperse cleaned flue gases from the facility. The stack height and stack parameters are discussed further in the Air Quality chapter of this EIS.

The reagents used for flue gas cleaning include:

- Hydrated lime
- Ammonia water
- Activated Carbon
- Sodium Hydroxide

Reagent dosing will be controlled using real time feedback from the emissions monitoring system. This will allow operational optimisation of consumable use to meet the emissions limits.

2.3.5 Continuous emission monitoring system (CEMS)

Each line will be equipped with a dedicated CEMS. The CEMS allows continuous online monitoring of flue gas properties and allowing the control system to track those pollutants which can feasibly be measured online. The CEMS also allow the system to make automatic adjustments to the combustion system and the injection rates for the various FGT system reagents (hydrated lime, activated carbon and ammonia water). The systems will track trends over time and will give a system response automatically to the operators at various set points to allow action to be taken if needed to ensure approved emission limit values are not breached. The system also generates reports at a user defined frequency to demonstrate environmental performance.

The emissions monitoring will comply with the conditions of the NSW EfW policy, the IED and the BREF document for waste incineration. Continuous monitoring will then be installed for all pollutants that must be continuously monitored including:

- Oxides of nitrogen (NO_x)
- Carbon monoxide (CO)
- Particulates (dust)
- Total Volatile Organic Compounds (TOC's)
- Hydrogen chloride (HCl)
- Hydrogen fluoride (HF) if required under the provisions of the NSW EfW Policy Statement
- Sulfur dioxide (SO_2)
- Ammonia (NH_3)
- Mercury (Hg)

Additionally, the CEMS will monitor auxiliary parameters such as:

- Flue gas flow rate
- Temperature
- Pressure
- Moisture content
- Oxygen
- Carbon dioxide

For those pollutants with levels so small that they are below any possible limits of detection and/or for which online measurement is not technically possible or sufficiently accurate, a periodic sampling and testing regime will instead be created as part of the facilities standard operating procedures and likely EPL needs, to ensure that the facility is constantly in compliance with its environmental obligations.

2.3.6 Ash management

Combustion of solid fuel (including waste) that contains an incombustible fraction will always create ash that must be managed. The proposal will produce three types of ash:

- Incinerator Bottom Ash (IBA) – the inert, non-combustible component of the waste that is left on the grate at the end of the combustion process and is collected at the bottom of the grate.

- Boiler Fly Ash – some of the ash from the combustion process that becomes entrained in the flue gases and makes its way up into the main boiler section. It is then deposited in the boiler sections before any flue gas treatment reagents are injected into the process.
- Flue Gas Treatment residues (FGTr) – FGTr is the name given to any residues that are extracted from the process after the addition of flue gas treatment reagents. FGTr is a combination of spent reagents and the leftover entrained ash within the flue gases that did not become deposited in the boiler section. FGTr will be extracted from the flue gases within the bag house section of the treatment plant.

The following section describes the strategy for management of each of the ash streams.

Incinerator Bottom Ash (IBA)

The IBA contains much of the ash generated by the facility. IBA is discharged from the end of the combustion grate into a water bath which will quench the ash (to reduce the temperature). Wet IBA (approximately 20% moisture content) will be deposited on to a conveying system. WSERRC will include two recovery systems prior to IBA being conveyed to the storage bays:

A scalper which is a device to remove and recover any bulky items entrained within the IBA. This will be deposited in a storage container on site for storage before being removed off-site for recovery.

A ferrous metal separator to recover ferrous metal from the IBA. This will be deposited into a storage container and removed off-site for recovery.

The remaining portion of IBA is transported using a conveyor to the ash storage hall where ash will be stored in bays with a minimum of 5 days storage capacity. IBA will be collected and transported to a dedicated ash facility. This facility is subject to a separate development application process and does not form part of the scope of this application (see Chapter X for further details).

The project's intention over the long term is to create an opportunity in New South Wales to beneficially re-use this bottom ash within construction products. The purpose of this ash facility is storage of IBA, further metal recovery and, subject to further investigation, incorporation of the ash into construction products (either at this facility or by transporting the ash to another facility). Although a precedent has not yet been set in Australia, IBA is currently used in Europe in a variety of construction products including aggregates, roads and landfill capping material. The Dublin (Ireland) reference facility included in this EIS utilises bottom ash (post removal of other recoverable materials such as metals) as a construction material. There are many examples across Europe of similar ash re-use schemes.

In the worst case, if a suitable re-use route cannot be found in Australia, IBA will be disposed of at a licenced landfill.

Approximately 5 days of storage will be installed on site for collection of bottom ashes.

Boiler Fly Ash

Boiler fly ash is the name given to ash that becomes entrained in the flue gases and makes its way through the boiler and treatment system. Along the way, this ash can condense and fall out of the air flow and into the different sections of the boiler. Boiler fly ash that collects in the radiant boiler passes 2 and 3 will be disposed of alongside the IBA. This boiler fly ash is substantially similar in properties to IBA, so to increase the amount of ash that can be recycled, the proposal will divert this proportion of boiler fly ash to the IBA bunker.

Boiler fly ash recovered downstream of pass 3 is not suitable for disposal with the inert IBA due to its higher concentration of heavy metals. So, it will be diverted to the FGTr stream to be transported for pre-treatment at Cleanaway's hazardous solid waste treatment facility at St Mary's. Then it will be disposed of to a licenced restricted solid waste landfill facility such as at Kemps Creek.

Flue Gas Treatment residues (FGTr)

Flue gas treatment residues (FGTr) contain spent flue gas treatment reagents as well as residual boiler fly ash that has remained entrained within the flue gases through the flue gas treatment stages. FGTr is collected within the bag house filters and will be conveyed to silos for temporary storage. The current design includes two silos to allow for redundancy in the system. FGTr are classified hazardous due to their ecotoxicity and physical characteristic, so they cannot be reused in the same way that IBA can. FGTr will be transported for pre-treatment at Cleanaway's hazardous waste treatment facility located at St Mary's before being disposed of to a licenced restricted solid waste landfill facility such as at Kemps Creek.

Waste classification will be conducted in line with relevant NSW EPA guidelines and periodic testing of FGTr will be undertaken. It is typical to begin testing of ash during the commissioning process to confirm properties and waste classification. This will be done in conjunction with the requirements of the NSW EPA under the Protection of the Environment Operations (Waste) Regulations 2014. Given the ash is likely to be classified as hazardous (and therefore a "trackable" waste), engagement will be required with the NSW EPA to put in place a tracking system including allowances for consignment authorisations and tracking certificates.

About 6 days of storage will be installed on-site for collection of FGTr across the silos.

3 Community profile

3.1 General

This section provides an overview of the community potentially impacted by the proposed project. It is noted that the key focus of this assessment is the local community surrounding the site.

The site is located within Blacktown Local Government Area (LGA). Surrounding the site are Fairfield, Penrith, Holroyd and Liverpool LGAs.

The closest boundary for Penrith LGA is at least 3 km from the site, for Holroyd LGA it is at least 5 km from the site and for Liverpool LGA it is at least 6 km from the site. The site is located near the southern boundary of Blacktown LGA where it meets the northern boundary of Fairfield LGA. Consequently, these two areas are the most relevant for this assessment.

The air quality modelling, to be discussed in **Sections 4** and **5**, has determined that potential emissions from the proposed facility do not extend very far in a form that could have relevance for health resulting in a focus on a 3 km grid for modelling (after checking air dispersion over a 30 km and a 10 km grid.

The other LGAs are included in the Western Sydney Local Health District so the statistics considered in **Table 3** based on this grouping are relevant for all these areas.

3.2 Land uses

The existing site includes buildings associated with a disused poultry facility, which will be cleared from the site prior to starting construction.

The site is bounded by the M7 Motorway to the west with the Eastern Creek industrial area located farther west. The now-closed Eastern Creek landfill site (which still has an operational organics recycling facility component) is located to the north and north-east, with the operational Global Renewables waste management facility located immediately to the east. To the south, the site is bounded by the Warragamba Pipeline Corridor with the Austral Bricks facility located farther south.

The nearest residential area is located around 1 km to the south of the site. The Erskine Park residential area is located around 3.5 km to the west with Minchinbury located around 3 km to the north. Horsley Park Public School is located over 2 km south of the site and a childcare centre is located within the Eastern Creek industrial area approximately 1 km to the west of the site.

3.3 Population

Table 2 presents a summary of the populations in the relevant LGAs. The population data have been sourced from 2016 Census and 2016 Socio-Economic data from the Australian Bureau of Statistics. These data are compared to New South Wales and the Australian population.

Table 2: Summary of populations surrounding the proposed project site (ABS Census 2016)

Indicator	Local Government Areas		NSW	Australia
	Blacktown LGA	Fairfield LGA		
Total population	336962	198817	7480228	23401892
Population 0 - 4 years	8% (26928)	6.1% (12090)	6.2% (465135)	6.3% (1464779)
Population 5 - 19 years	21.7% (73027)	20.1% (40012)	18.3% (1369618)	18.5% (4321427)
Population 20 - 64 years	60.1% (215202)	60% (119275)	60.2% (3566775)	59.6% (13938918)
Population 65 years and over	10.2% (21805)	13.8% (27440)	15.6% (922598)	15.7% (3676758)
Median age	33	36	38	38

Indicator	Local Government Areas		NSW	Australia
	Blacktown LGA	Fairfield LGA		
Household size	3.2	3.3	2.6	2.6
Unemployment	7.3%	10.5%	6.3%	6.9%
Tertiary education	20.4%	23.1%	22.4%	22%
SEIFA IRSAD	993	896	--	--
SEIFA IRSAD decile	6	2	--	--
SEIFA IRSD	986	856	--	--
SEIFA IRSD decile	8	1	--	--
Indigenous	2.8%	0.7%	2.9%	2.8%
Born overseas	40.4%	53.9%	27.7%	26.3%

Notes:

SEIFA IRSAD = index of socioeconomic advantage and disadvantage, Decile is related to rank within Australia and ranges from 1 = most disadvantaged to 10 = most advantaged

SEIFA IRSD = index of socioeconomic disadvantage, Decile is related to rank within Australia and ranges from 1 = most disadvantaged to 10 = least disadvantaged

Shading relates to comparison against NSW

lower than

greater than

Based on the population data available and presented in **Table 2**, the Blacktown LGA community has:

- lower proportion of people over 65 than NSW
- lower median age than NSW
- higher proportion of people under 19 than NSW
- similar proportion of indigenous people than NSW
- higher unemployment than NSW
- higher proportion of people born overseas than NSW
- higher household size than NSW
- similar proportion of people with tertiary education to NSW as a whole

The Blacktown LGA is an area with less socioeconomic disadvantage and more socioeconomic advantage compared to Australia overall.

Based on the population data available and presented in **Table 2**, the Fairfield LGA community has:

- lower proportion of people over 65 than NSW
- similar median age to NSW overall
- higher proportion of people under 19 than NSW
- lower proportion of indigenous people than NSW
- higher unemployment than NSW
- higher proportion of people born overseas than NSW
- higher household size than NSW
- similar proportion of people with tertiary education to NSW as a whole

The Fairfield LGA is an area with more socioeconomic disadvantage and less socioeconomic advantage compared to Australia overall.

The indicators outlined in **Table 2** generally reflect the vulnerability of the population, its ability to adapt to environmental stresses, and are important to highlight from an equity point of view. The project will be implemented within a community that has a range of potential for increased susceptibility to impacts from the project and decreased susceptibility to impacts from the project.

3.4 Population health

The health of the community is influenced by a complex range of interactive factors including age, socio-economic status, social capital, behaviours, beliefs and lifestyle, life experiences, country of origin, genetic predisposition and access to health and social care. The health indicators available and reviewed in this report generally reflect a wide range of these factors.

Table 3 presents a summary of the general population health considered relevant to the area. The table presents available information on health-related behaviours (i.e. key factors related to lifestyle and behaviours known to be of importance to health) and indicators for the burden of disease within the community compared to NSW in general.

Table 3: Summary of health indicators/data

Health indicator/data	Blacktown LGA	Fairfield LGA	Western Sydney Local Health District	NSW
Health behaviours				
Adults - compliance with fruit consumption guidelines (2019)[1]	Not available	Not available	36.7% (32.1% - 41.3%)	40.6% (39.0% - 42.1%)
Adults - compliance with vegetable consumption guidelines (2019)[1]	Not available	Not available	4.7% (2.3% - 7.1%)	6.3% (5.5% - 7.1%)
Adults – alcohol consumption at rates posing increased long term risk to health (2018) [1]	Not available	Not available	23.9% (20.2% - 27.6%)	31.5% (30.2% - 32.9%)
Adults - body weight (overweight or obese) (2018) [1]	Not available	Not available	55% (50.8% - 59.2%)	54.2 % (52.8% - 55.7%)
Adults – insufficient physical activity (2019) [1]	Not available	Not available	44.7% (39.7% - 49.7%)	38.5% (37.0% - 40.1%)
Current smoker (2018) [1]	Not available	Not available	8.5% (6.1% - 10.8%)	10.3% (9.4% - 11.2%)
Burden of disease				
Morbidity - cardiovascular disease hospitalisations[1] (2018/19)	1830* (1814.7-1845.7)	1395.4* (1374-1417.2)	1587.2* (1562.1-1612.6)	1672.4* (1664.1-1680.7)
Morbidity – respiratory disease hospitalisations (2018/19)[1]	Not available	Not available	1647* (1622-1672.3)	1675.2* (1666.4-1684)
Mortality – all causes (2017)[1]	570.8* (551-591.2) (2016/17)	489.8* (469.6-510.7) (2016/17)	483.7 (469.3-498.5)	508.8* (504.4-513.3)
Prevalence of asthma (adult) (2019)[1]	Not available	Not available	11.7% (8.7-14.8)	11.5% (10.5-12.5)
Prescriptions for asthma medication (adult) Rate per 100000 adults across 2013/14	22193	23171	Not available	Not available
Prevalence of asthma (child) (2017-19)[1] (current asthma data)	Not available	Not available	10.4% (6.8-14.1)	13.1% (11.8-14.4)
Prescriptions for asthma medication (child) Rate per 100000 children across 2013/14	36086	51259	Not available	Not available

* Rate per 100,000 population (age-standardised)
1 Data from NSW Health Stats (http://www.healthstats.nsw.gov.au/)
Shading relates to comparison against NSW:
statistic/data suggestive of a potential higher vulnerability within the population to health stressors
statistic/data suggestive of a potential lower vulnerability within the population to health stressors

Considering the data for the Western Sydney Local Health District, Western Sydney has:

- lower rates of consumption of fresh fruit and vegetables than NSW (i.e. more susceptible)

- lower rates of harmful alcohol consumption than NSW (i.e. less susceptible)
- similar levels of higher body weights, hospitalisations due to respiratory disease, all cause mortality and prevalence of asthma in adults as NSW
- higher rates of poor physical activity than NSW (i.e. more susceptible)
- lower rates of smoking than NSW (i.e. less susceptible)
- lower rate of hospitalisation due to cardiovascular diseases (including COPD) than NSW (i.e. less susceptible)
- lower rate of asthma in children than NSW (i.e. less susceptible)

Statistics on the basis of local government areas were more limited.

Considering the data for Blacktown LGA, the following can be noted:

- higher rates of hospitalisation due to cardiovascular diseases (including COPD) than NSW (i.e. more susceptible)
- higher mortality rate for all causes than NSW (i.e. more susceptible)

Considering the data for Fairfield LGA, the following can be noted:

- lower rates of hospitalisation due to cardiovascular diseases (including COPD) than NSW (i.e. less susceptible)
- similar mortality rate for all causes as NSW

In general, the key indicators of health for the population in the community around the proposed facility are somewhat similar to those for NSW but some characteristics suggest a population that is potentially more vulnerable to health stressors and some characteristics suggest a population that is less vulnerable to health stressors.

4 Assessment of health impacts: methodology

4.1 Approach

This section explains the methodology adopted to assess the potential for health impacts relevant to the construction and operation of the facility.

4.2 Site History

The proposal site history indicates that the site has been used for mixed-use commercial and industrial activities, including a poultry factory farm in the 1970s. A Biosecurity Direction was issued to the previous site owner dated 24 January 2019 from the Department of Primary Industries (DPI) concerning the presence of Salmonella on site. The current site owners worked with DPI to address the Salmonella issue in accordance with established procedures. The applicant has since received a letter from DPI dated 26 May 2020 which confirmed the site is now considered a "resolved premise" and, therefore, the Biosecurity Direction has been revoked.

No further matters relating to the historical use of the site need to be considered in this risk assessment for the proposed facility.

4.3 Types of emissions

4.3.1 Emissions to air

The primary type of emissions that need to be assessed for this risk assessment are emissions to air. The conceptual model for describing how people might be impacted by emissions to air from this facility is outlined in **Section 4.4**. Description of the processes for modelling the dispersion of air emissions are provided in **Sections 4.5** and **4.6**. The methodology and assessment of the potential risks from these emissions are provided in **Section 5**.

4.3.2 Emissions to water

The proposal does not include emissions from the process to water (i.e. to trade waste/sewer directly or via some sort of treatment plant).

As with any industrial site in Sydney, procedures for the management of rainfall on the site will be required. Given that operations related to the energy from waste process will occur inside buildings, management of rainfall on the site are expected to be straightforward and just revolve around collecting water from the roof of each building and the roadways as is normal at all such sites.

The potential for contamination of groundwater by this proposed facility has also been considered. The depth of groundwater at the site varies from around 0.1 m below ground level close to the existing pond on the eastern boundary to around 6 m below ground level along the southern boundary. The existing water quality for groundwater at the site has been assessed as part of this project. The monitoring found minor exceedances of water quality guidelines for a number of metals indicative of regional groundwater issues common in urban areas.

Construction of this facility will result in most of the site being covered by hardstand and roads. The procedures for handling the arrival of waste at the site will include driving trucks containing waste (covered) directly into the bunker. To manage odours at the site, the bunker will be fitted with doors that open and close very rapidly. Also, the base of the bunker and the rest of the plant will be substantial.

This combination of procedures required to meet licence requirements for managing odours and waste materials, the covering of most of the site by hardstand and roads and the engineering of the structures on the site means there is very little potential for chemicals in waste materials to leach into soil and into the groundwater.

No further consideration of potential for surface water or groundwater to be affected by the facility is required.

4.3.3 Solid waste

Emissions of solid waste will be required. Incinerator bottom ash, boiler fly ash and flue gas treatment residues will be produced by the process. Engineering controls such as keeping ash wet, undertaking any movement of such wastes within enclosed areas within the main building only, transporting incinerator bottom ash in closed bins and collecting, storing and transporting flue gas treatment residues in sealed containers will ensure that these wastes are tightly controlled. Where possible, recycling of these solid wastes will also be developed to recover metals and other resources and to minimise the disposal of these materials in landfill. Incinerator bottom ash is most likely to be able to be recycled/reused.

No further assessment of emissions from these wastes is required.

4.4 Conceptual site model

Understanding how a community member may come into contact with pollutants released in air emissions from the proposed EfW facility is a vital step in assessing potential health risk from these emissions. A conceptual site model provides a holistic view of these exposures, outlining the ways a community may come in contact with these pollutants. An illustration of the conceptual site model for this assessment is provided in the following **Figures**.

There are three main ways a person may be exposed to a chemical substance emitted from the proposed EfW facility:

- inhalation (breathing it in)
- ingestion (eating or drinking it – direct or indirect) or
- dermally (absorbing it through the skin).

The inhalation pathway is the first to be assessed. There are a few steps in determining whether such pollutants would be present in the area surrounding the proposed facility:

- Estimating the levels in the stack prior to discharge
- Combining the stack concentrations with the local weather (wind, rain etc) to work out how much could reach the local neighbourhood

The following figures show the processes which govern how the emissions get mixed into the atmosphere.

Figure 7: Steam rising as it is discharged from an industrial facility

Gases (and fine particles) are emitted at around 60-70^{o}C from the stack and they are pushed out of the stack using fans (i.e. at some speed) so these gases (and fine particles) rise up into the air from the top of the stack – because hot gases rise and because gases are travelling at a faster speed than the air surrounding the stack also rise. This can be seen in **Figure 7**.

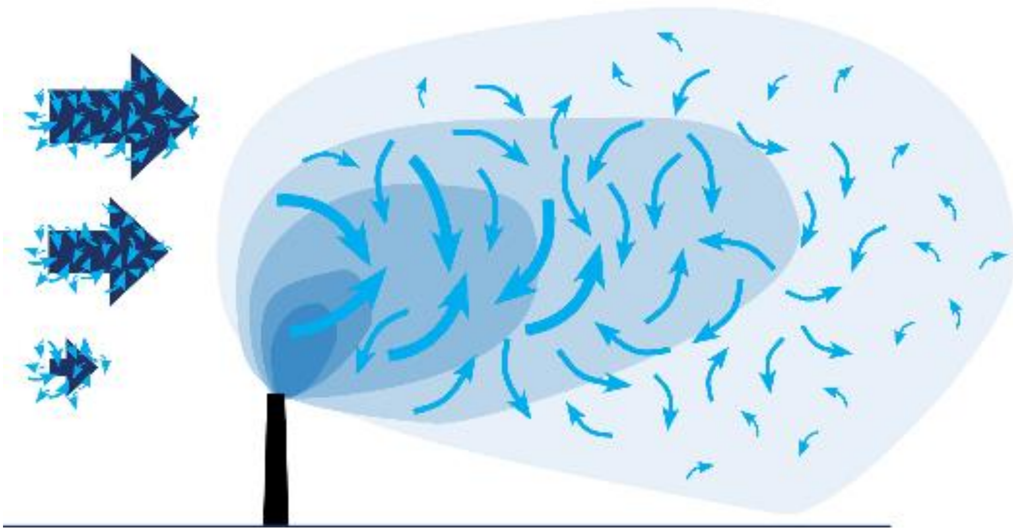


Figure 8: Turbulence in the air, how it mixes and dilutes pollutants (NSW Chief Scientist 2018)

As the gases (and fine particles) cool and slow down a bit they begin to interact with the wind above the stack (i.e. >76.5 m high). This mixes the gases (and fine particles) into the atmosphere decreasing the actual concentration present in any particular location. **Figure 8** shows most of the pollutants remain up in the atmosphere away from where people could breathe them in. However, small amounts do eventually reach ground level.

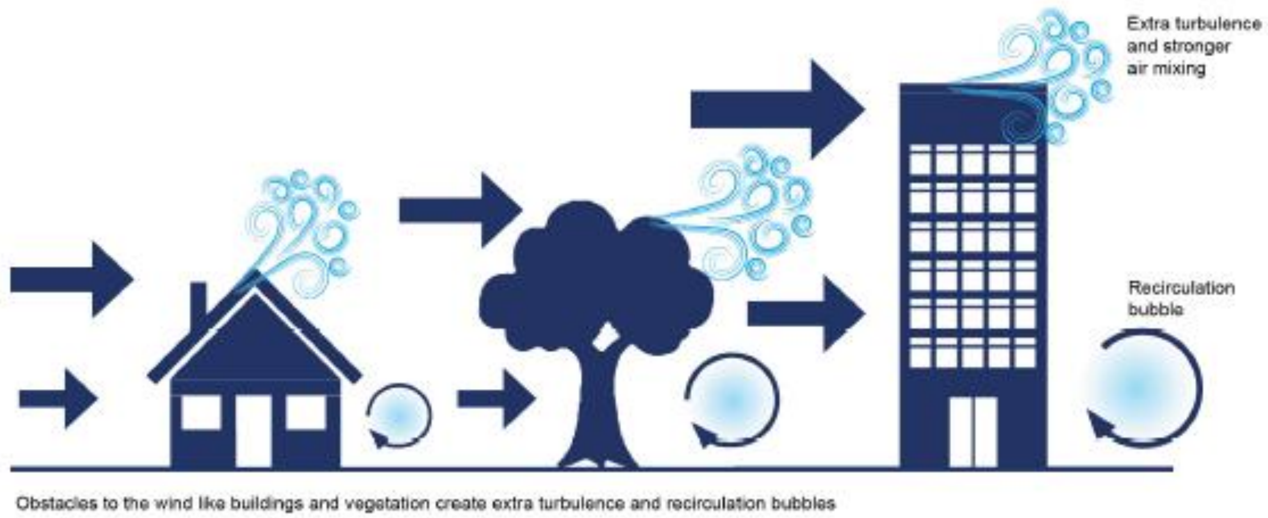


Figure 9: Turbulence in the air and how it is affected by buildings and vegetation (NSW Chief Scientist 2018)

The air dispersion modelling determines what proportion of the amount in the stack could reach ground level. Such modelling looks at worst case weather characteristics as well as the turbulence due to buildings and terrain (as shown in **Figure 9**). The approach taken in the modelling ensures that the amount that could reach ground level in areas where people live or work neighbouring the proposed facility are not underestimated. It is these ground level concentrations that are then used to assess potential for health impacts.

For some of the emissions from the proposed EfW facility, inhalation is the only route of exposure. This is due to the substance's chemical properties, which make the other pathways inconsequential. Gases such as NO_2, SO_2, HCl, HF and CO can be considered in this category.

Other chemicals are more likely to be attached to particles. Fine particulate matter is normally classified as particles less than 10 micrometres (i.e. PM_{10}) and particles less than 2.5 micrometres (i.e. $PM_{2.5}$). For combustion sources like the proposed facility, most of the particles that could be released would be classified as $PM_{2.5}$. These particles may also fall from the air onto the ground. These particles (and anything attached to them) can mix with soil and then be ingested either directly through incidental consumption of soil/dust or indirectly through food grown or raised in the soil (fruit, vegetables and eggs, meat or milk). Skin contact with the soil is also possible.

The air dispersion modelling also estimates the rate at which particles in the emissions could fall out of the sky (due to gravity) or get washed out of the sky (due to rain). It is this deposition rate that is then used to estimate how much of chemicals attached to particles could get into soil or water around the facility.

The deposition rate allows calculation of potential accumulation in soil which people might come into contact with or where they might grow fruit and vegetables etc. This covers the other two pathways of exposure – ingestion or dermal contact (i.e. skin contact).

The deposition rate also allows calculation of potential washoff of particles from roof into a rainwater tank or deposition onto the surface of a large water body like Prospect Reservoir.

It is noted that this assessment assumes that these particles (with attached chemicals) will be present in the atmosphere where people can breathe them in and that they will fall out of the atmosphere onto the ground where they mix into the soil or water. This is a conservative approach as it does result in some double counting (i.e. where some of the particles are assessed as both being in the air people breathe and falling onto the ground to mix into the soil or water).

In this instance, metals and organics that are bound to the heavier particulate matter that may fall out and deposit onto the ground are assessed for inhalation, ingestion and dermal contact with soil and ingestion and dermal contact with water.

Table 4 lists the substances considered in the EfW emissions and the exposure pathway/s of potential concern for each one.

Table 4: Substances and routes of exposure

Substance	Route of exposure
Nitrogen dioxide (NO_2)	**Inhalation only** as these are gases
Sulfur dioxide (SO_2)	
Hydrogen chloride (HCl)	
Hydrogen fluoride (HF)	
Carbon monoxide (CO)	
Total organic compounds (TOC)	
Ammonia	
PM_{10}	**Inhalation only** as these particulates are very small and will remain suspended in air. It is noted that other exposure pathways have also been assessed for the individual chemical substances bound to these particles. These other pathways relate to the individual chemical substances, rather than the physical size of the particulates and assume these particles settle to the ground.
$PM_{2.5}$	
Antimony	**Inhalation** of these pollutants adhered to fine particulates **Ingestion and dermal contact** with these pollutants deposited to soil or water **Ingestion** of produce grown in soil potentially impacted by these pollutants (i.e. homegrown fruit and vegetables and eggs – where the pollutants can be taken up/bioaccumulated into plants and animals). As the area surrounding the site has some farms, the raising of livestock for meat or milk is permitted and has also been assessed.
Arsenic	
Beryllium	
Cadmium	
Chromium	
Cobalt	
Copper	
Lead	
Manganese	
Mercury	
Nickel	
Selenium	
Thallium	
Tin	
Vanadium	
Dioxins & furans	

The full set of exposure pathways considered in this assessment are shown in **Figures 10, 11** and **12**.

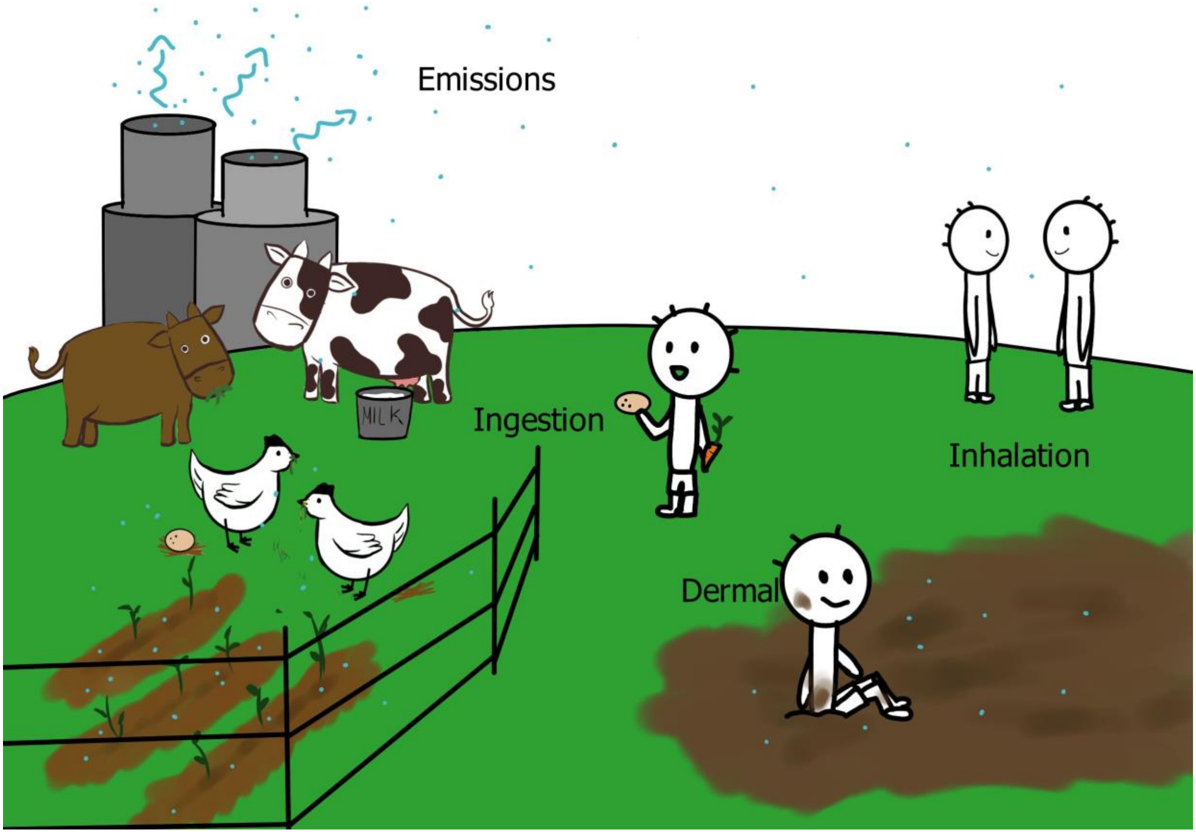


Figure 10: Conceptual site model (illustrative only)

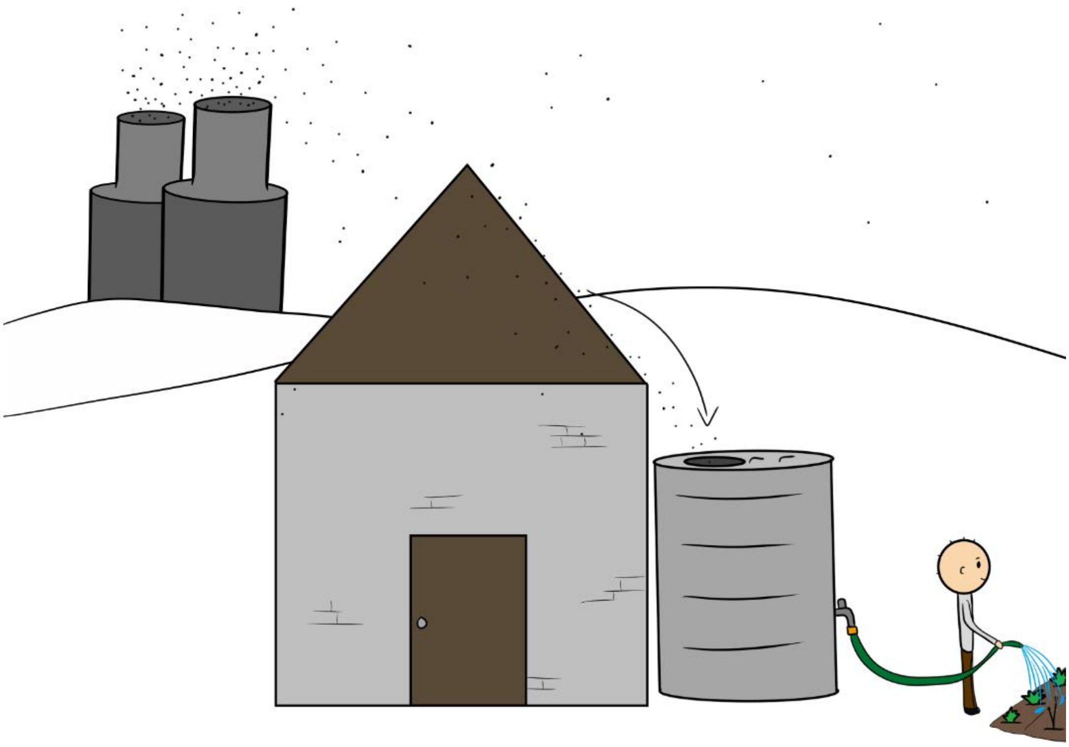


Figure 11: Conceptual site model (illustrative only) – Rainwater tanks

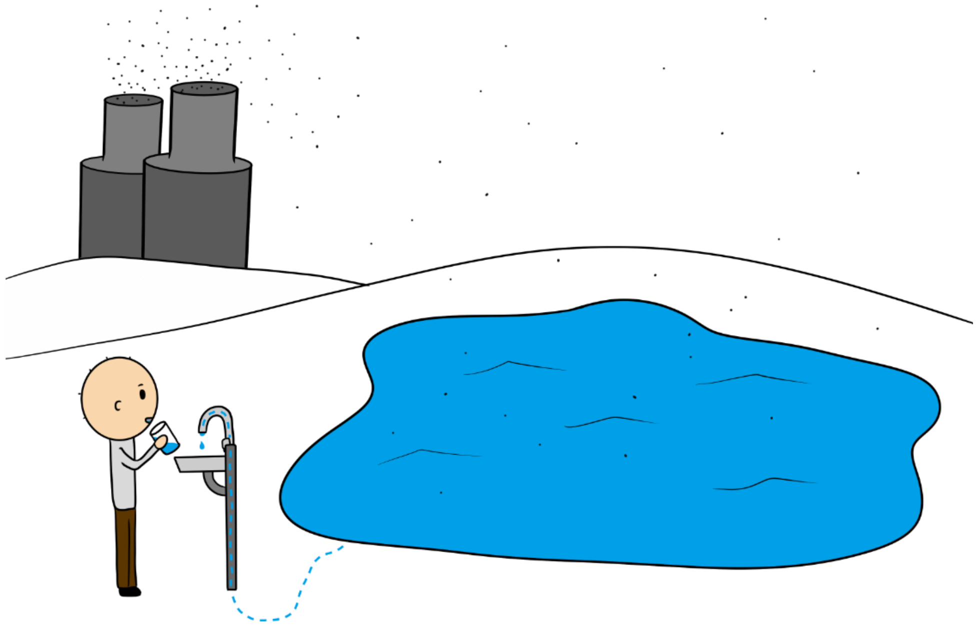


Figure 12: Conceptual site model (illustrative only) – Prospect Reservoir

The assessment presented has relied on the Todoroski Air Sciences Air Quality and Odour Impact Assessment (AQIA) (Todoroski Air Sciences 2020). No independent review of the AQIA has been undertaken. Hence, this assessment has relied on the data provided directly from the Air Quality Impact Assessment Team.

The characterisation of risk follows the general principles outlined in the enHealth document Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a).

4.5 Existing Air Quality

Todoroski Air Sciences (2020) provides a detailed assessment of local air quality relevant for the site.

Monitoring stations are operated by NSW DPIE that are relevant for this location. These include stations at Liverpool (13.5 km from site), Bringelly (14 km from site), St Mary (8.6 km from site) and Prospect (6.1 km from site). Information about these stations is available at the NSW DPIE website - https://www.environment.nsw.gov.au/topics/air/monitoring-air-quality/sydney/monitoring-stations .

These stations collect data for oxides of nitrogen (NOx), sulfur dioxide (SO_2), particulate matter (PM10, PM2.5) and carbon monoxide (CO). These stations also collect meteorological data.

In addition, Todoroski Air Sciences (2020) describe ambient air quality monitoring undertaken specifically for the project. Two monitors were installed to monitor local air quality for 3 months from October 2019 to January 2020. **Figure 13** shows the locations of both these monitors and the two relevant government monitoring stations.

Figure 13: Monitoring station locations

These monitors collected data for the same parameters as observed at the government monitoring stations. The monitors were located to the south southwest of the site and to the south east of the site. Both locations were considered relevant for assessing current local air quality in residential areas that could be most affected by the proposed facility.

The data collected at these monitors was compared with the data collected over the same time period at the St Marys and Prospect monitoring stations operated by the government. The results and the trends between the standard monitoring stations and these local sites were similar indicating these locations close to the facility are predominantly influenced by regional air quality such as is measured at the relevant monitoring stations – St Marys and Prospect. Consequently, using the data collected over the long term at the government monitoring stations available from these two stations to characterise existing air quality around the site is relevant and appropriate.

It is important to note that these criteria pollutants are always present in ambient air in cities, rural areas and in remote areas. There are many sources of such chemicals from human activities. All combustion processes will generate such pollutants. Consequently, establishing existing concentrations without the newly proposed plant is critical to interpreting the potential for impact of the new facility.

These background concentrations are used to ensure that all relevant existing sources (whether large facilities or from vehicles or homes) are considered in the assessment. There is an additional large facility that is currently proposed to be installed in a nearby location to this proposed facility – the Next Generation Energy from Waste Facility. This assessment has also included consideration of emissions from this proposed facility as they are not accounted for in the current background data because the plant has not yet been built (or approved).

Table 5 lists the adopted background concentrations for the criteria pollutants as recommended in Todoroski Air Sciences (2020).

Table 5: Adopted Background Concentrations – Criteria Pollutants

Criteria Pollutant	Averaging Period	Adopted Existing Ambient Concentration ($\mu g/m^3$)	EPA Criterion ($\mu g/m^3$)
PM_{10}	Annual	17.6	25
	24 hour	Contemporaneous	50
$PM_{2.5}$	Annual	8.2	8
	24 hour	Contemporaneous	25
SO_2	Annual	1.5	60
	24 hour	8.6	228
	1 hour	77	570
NO_2	Annual	Contemporaneous	62
	1 hour	109	246
CO	8 hour	--	10000
	1 hour	2375	30000

4.6 Modelling

4.6.1 General

Modelling was undertaken using a combination of the CALPUFF Modelling System and The Air Pollution Model (TAPM). The CALPUFF Modelling System includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to standard, routinely available meteorological and geophysical datasets. TAPM is a prognostic air model used to simulate the upper air data for CALMET input. CALPUFF is endorsed for this purpose by the NSW EPA (Todoroski Air Sciences 2020).

The modelling was undertaken to predict the concentration of emissions from the proposed EfW facility (Todoroski Air Sciences 2020).

The model uses:

- local terrain (topography and buildings)
- meteorological data
- plant design (for example stack location and height)
- air emissions estimates (stack concentrations)

to predict the ground level concentrations and deposition of pollutants within the defined study area (the modelling grid), and more specifically at the discrete receptor locations (Todoroski Air Sciences 2020).

The air quality modelling used a grid that was centred on 33deg49.0min south and 150deg51.0min east. The full grid that was subject to initial assessment was 30 km x 30 km around this point. The detailed modelling then evaluated potential concentrations for relevant chemicals at ground level across a grid of 10 km x 12 km centred on the facility. The grid used a 100 m resolution. The grid also included 35 vertical levels, so it looked at the movement of emissions from the stack in 3 dimensions.

4.6.2 Meteorology

The information describing this grid in the model included all the relevant local terrain and meteorological data. Wind patterns around the facility were described by the wind roses shown in

Figure 14. The annual pattern indicates that winds blow predominantly from the south west toward the north east around this facility.

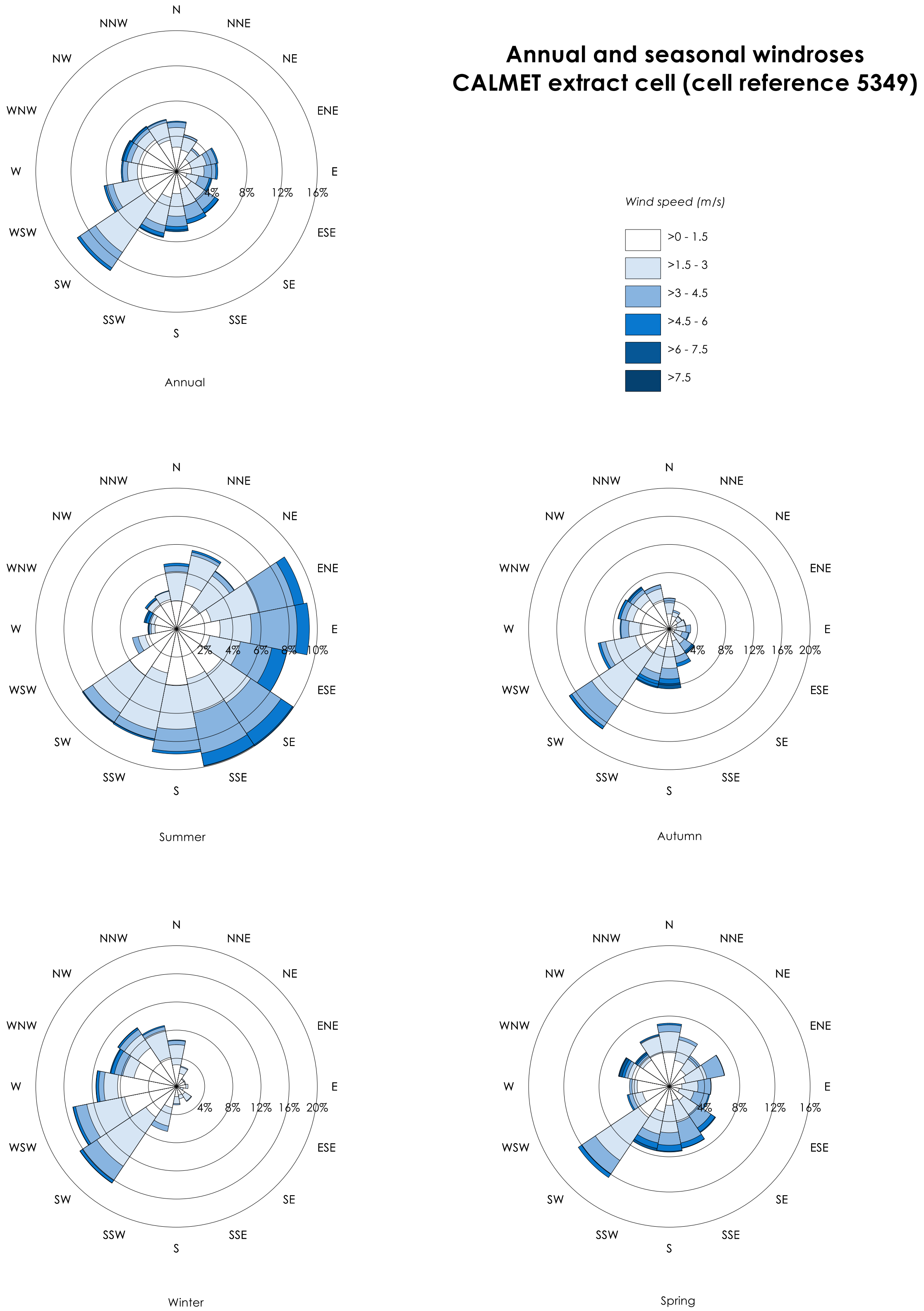


Figure 14: Annual and seasonal windroses

Information about rainfall and temperature and other relevant meteorological parameters is shown in **Figure 15.** These results are for the year 2015. An analysis of data for a number of years in line with NSW EPA guidance was undertaken and the data for 2015 was determined to be relevant for long term trends (Todoroski Air Sciences 2020).

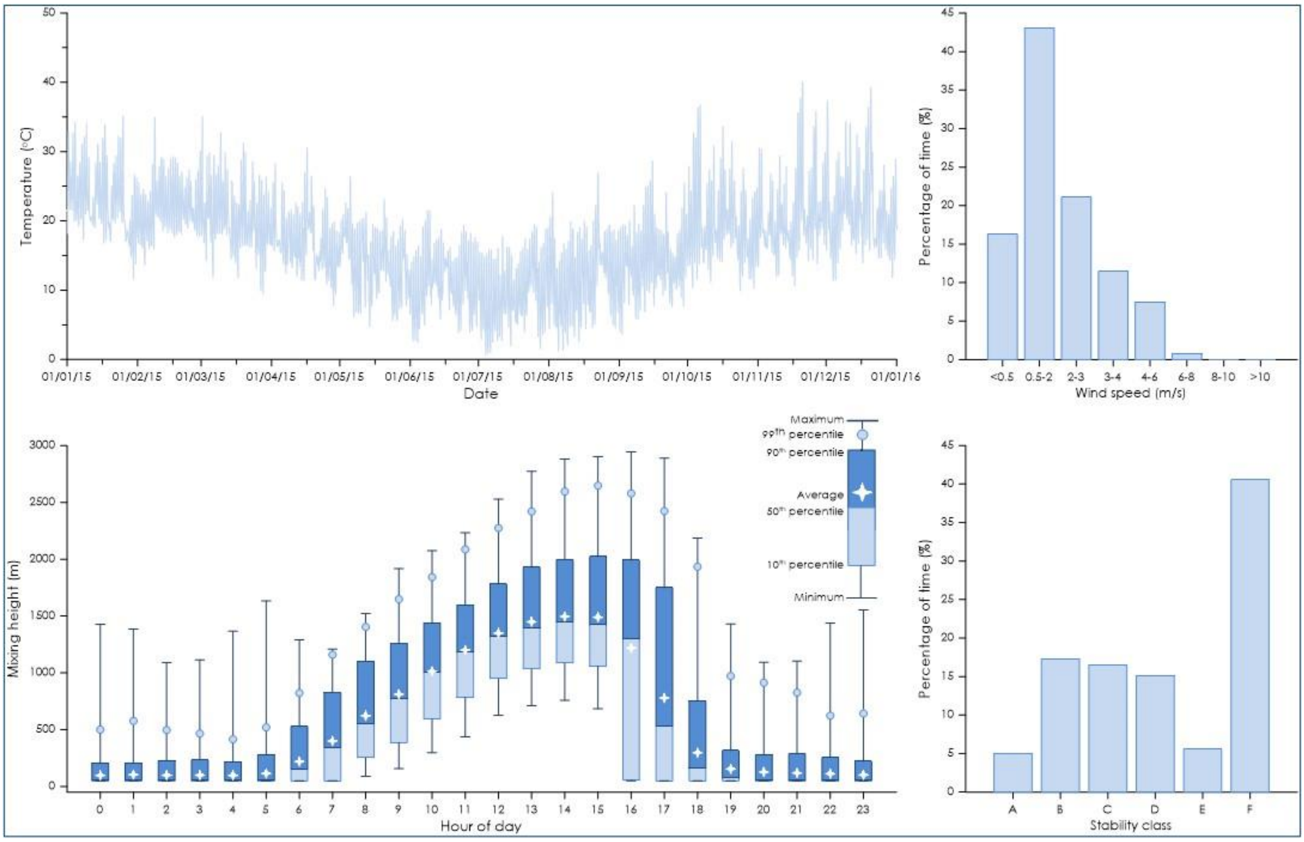


Figure 15: Meteorological analysis

4.6.3 Stack Parameters

The stack parameters (i.e. plant design parameters) considered in the dispersion modelling scenarios for the various different load points for the combination of the two lines are summarised below in **Table 6.** The concept of load points is discussed in **Section 2.3.1**.

The plant will have two lines and each will have a stack. Each stack has a diameter of 2 m and a height of approximately 75 m (±5 m). Todoroski Air Sciences (2020) note that a difference in stack height of ±5 m is unlikely to have any tangible effect on the emissions. Emissions are released from both identical flue lines and emitted via a common stack structure.

The differences in stack parameters between load points arise because the flow rate through the plant depends on the energy content of the waste being burned at a particular time. At times the energy content of the waste will be a bit lower than average and this will result in a slightly lower flow rate and temperature than average conditions. At other times, the energy content of the waste will be a bit higher than average and this will result in a slightly higher temperature and flow rate than average conditions. Overall, it is expected that the plant will operate around LP1 for around 90% of the time. Emissions at the other load points have been reviewed to ensure calculations have not underestimated potential risks.

Table 6: Emission source parameters for the combined stack used in the modelling for this assessment

Parameter	Exit velocity (m/s)	Exit temp. (K)	Flow rate (Nm^3/s)	Flow rate (Am^3/s)
LP1	20.9	334	379,260	472,869
LP2	22.1	336	388,820	499,137
LP3	23.6	335	422,510	533,126
LP4	21.3	331	403,678	482,208
LP5	19.4	331	366,980	438,371
LP6	17.6	331	333,952	398,918
LP7	14.6	334	265,482	331,009
LP8	16.2	337	278,124	365,726
LP9	19.4	337	333,749	438,871

4.6.4 Stack Concentrations

The final step in the process for modelling ground level concentrations in relevant locations is to determine how to estimate what concentrations of each chemical will be assumed to be in the stack to allow the calculation of emission rates.

There are a number of ways to estimate what stack concentrations may be relevant for a facility that has not yet been constructed including:

- Assuming stack concentrations will be at the levels specified in legislation or policy relevant for the location where the plant is proposed to be constructed
- Assuming stack concentrations will be similar to those measured at a facility that uses similar waste types for fuel and which has similar pollution control technology

In this case the legislation/policies relevant in NSW include:

- Protection of the Environment (Operations) Clean Air Regulation (NSW Government 2010)
- NSW EPA Energy from Waste Policy (NSW EPA 2015)
- European Union Industrial Emissions Directive (EU IED) (EU 2010)
- European Union Best Available Techniques for Waste Incineration (BREF) (EU 2019)

The types of waste to be used as fuel will be a mix of waste from commercial businesses (offices etc) and from kerbside collections of waste from homes. Both of these waste types will either be separated at source or will be pre-sorted to ensure all relevant waste materials that can be reused or recycled are taken out so that only residual materials that would otherwise be landfilled will be used as fuel.

There are hundreds of energy from waste facilities in Europe. A number of existing facilities have been chosen for comparison in this assessment. These facilities include:

- Dublin Energy from Waste Facility, Ireland
- Filborna Energy from Waste Facility, Sweden

The pollution control equipment used at these facilities are essentially the same as proposed for this facility. The Dublin facility is a little larger than this facility and the Filborna facility is smaller. The wastes used as fuels for these facilities are similar to what is to be used for this facility. These facilities all use a mix of commercial/industrial waste and residual from domestic waste which is what is proposed for this facility. No unusual wastes that could add extra amounts of a particular pollutant or additional pollutants are to be used as fuel at this site.

A detailed assessment of the nature of the proposed wastes for use here compared to the nature of the wastes used at the Dublin facility has been undertaken and is reported in the Waste and Resource Management Technical Report.

Consequently, it is expected that the emissions from this facility will be similar to the emissions from these reference facilities. Detailed monitoring data are available for the Dublin facility and these have been considered in detail within the air quality modelling.

For this facility, the stack concentrations for this facility have been estimated based on an understanding of the engineering of all the equipment that will be installed, the requirements of all the legislation/policies and the type of waste that will be used as fuel. The stack concentrations that have been estimated in this fashion have then been compared to existing reference facilities to demonstrate that the values assumed in the modelling are appropriate and relevant.

This assessment considered each load point to develop five modelling scenarios for the proposal. These include:

- Scenario 1 – Represents the maximum ***annual average*** regulatory limit emissions to be released from the stack (comprising two flues) at the design point operating conditions (LP1).
- Scenario 2 – Represents the maximum ***24-hour average*** regulatory limit emissions to be released from the stack (comprising two flues) at the design point operating conditions (LP1), and at the most impacting load point operational condition at any location (LP Max), in any hour of the year. The scenario evaluates the expected maximum 24-hour average impacts and is consistent with the upper range of the best practice achievable emission limits (BAT-AELs).
- Scenario 3 – Represents the maximum ***1-hour average*** regulatory limit emissions to be released from the stack (comprising two flues) at the design point operating conditions (LP1), and at the most impacting load point condition at any location (LP Max), in any hour of the year. The scenario models the maximum 1-hour emissions under the worst case operating load and air dispersion conditions to quantify the maximum short term 1-hour and 24-hr average impacts.
- Scenario 4 – The scenario evaluates ***worst case upset*** conditions and the upper range of potential impacts at the proposed licence limits, at the most impacting load point condition at any location, in any hour of the year. The scenario conservatively assumes maximum hourly emissions are generated for 24-hours.

An additional scenario (EPA Limit modelling scenario) was also modelled. The scenario conservatively assumes maximum regulatory limit hourly emissions at all hours of the year to be released from the stack (comprising two flues) at the design point operating conditions (LP1). It is noted that this scenario cannot actually occur, and it has been modelled to conservatively estimate hypothetical maximum impacts for a regulatory limit scenario.

Table 7 shows the combinations for each of these scenarios.

Table 7: Definition for each scenario

Scenario	1-hr Average		24-hr Average		Annual Average	
	LP1	LP Max	LP1	LP Max	LP1	LP Max
SC1 – Regulatory Limit AA (annual average)					✓	
SC2 – Regulatory Limit 24-hr			✓	✓		
SC3 – Regulatory Limit 1-hr	✓	✓				
SC4 – Worst-case upset		✓		✓*		
EPA Limit Modelling scenario – Regulatory 1-hour limits, all hours of the year	✓		✓*		✓*	

* assumes maximum hourly emissions are generated every hour for 24-hours, or all hours of the year

The most relevant information in regard to health impacts from this facility is that related to longer term average concentrations – i.e. annual averages.

The emissions expected for the plant over the longer term are those for scenario 1. The estimated ground level concentrations for scenario 1 have been assessed for all pathways in **Section 5**.

The EPA Limit modelling scenario has been included to show that the worst case emissions (those that could occur for 1 hour) could occur every hour of the year all year round and the risks would still be acceptable. The estimated ground level concentrations for this scenario have also been assessed for all pathways in **Section 5**.

The plant design stack emission concentrations for the Project are outlined in **Table 8**. The emissions for 1-hour and 24-hour averaging periods are generally similar to the **IED (2010)** and the **BREF-WI (2019)** values, given that these are the benchmarks used for the plant design.

Table 8: Modelled stack emission concentrations

Pollutant	Units	Design/modelled concentrations		
		Max ½ hour average(1)	Max 24-hour average(2)	Annual Average
CO(3)	mg/Nm^3	100	50	20
TOC (VOC)(4)	mg/Nm^3	20	10	2
$PM_{2.5}$	mg/Nm^3	28.5	4.8	1.9
PM_{10}	mg/Nm^3	29.4	4.9	2.0
TSP	mg/Nm^3	30	5	2
HCl	mg/Nm^3	60	6	2
HF	mg/Nm^3	4	1	0.4
SO_2 + SO_3	mg/Nm^3	200	30	5
NO_x (calculated as NO_2)	mg/Nm^3	400	120	90
NH_3	mg/Nm^3	30	10	2
Hg	mg/Nm^3	0.035	0.02	0.005
Cd+Tl	mg/Nm^3	0.02(5)	--	0.0005
Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V	mg/Nm^3	0.3(5)	--	0.1
Dioxins, I-TEQ	ng/Nm^3	0.06	0.06	0.06

(1) The ½ hour max design level has been conservatively modelled as a 1 hour average maximum concentration for the purposes of this assessment. (*Note this is a conservative assessment as the maximum actual 1 hour average will be ~12.5% lower than using the maximum half hour average as a 1 hour average*)
(2) 24-hour emission limit according to **EU Commission for WI, 2019** (EU 2019)
(3) CO is a surrogate for VOC, and is thus not modelled
(4) TOC taken to be a surrogate for the volatile chemicals subset of the TOC (i.e. an overestimate of volatile organic chemicals
(5) Spot sampling, average of three samples each obtained for at least ½ hour

The emissions considered in the AQIA relate to oxides of nitrogen (NOx), sulfur dioxide (SO_2), carbon monoxide (CO), particulates as PM_{10} and $PM_{2.5}$, hydrogen fluoride (HF), hydrogen chloride

(HCl), metals (cadmium, thallium, beryllium, mercury, antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel, selenium, tin, vanadium), volatile organic compounds (as benzene), and dioxins and furans. For chromium, it was assumed that the total chromium reported comprises 100% chromium VI.

The NSW EPA's Janssen Method (NO to NO_2 conversion using empirical relationship) "Level 2 assessment - Contemporaneous Impact and Background" approach has been applied to estimate the NO_X to NO_2 conversion ratio at all locations in the domain to assess potential incremental and cumulative (both background/existing only and background/existing plus proposed Next Generation facility) impacts for 1-hour average and annual average NO_2 concentrations in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (NSW EPA 2016).

Table 9 shows a comparison of the proposed stack concentrations and the measured concentrations and the licence limits in place for the Dublin Energy from Waste facility. The comparison shows that the levels being assumed to be present in the stack for the purpose of this assessment (as listed in **Table 8**) are conservative in comparison to the levels likely to be emitted by this facility as measured in the Dublin facility.

Table 9: Summary of Dublin Waste to Energy facility in-stack concentrations

Pollutant	Units	Line 1		Line 2		BAT-AELs Upper Limit	IED[3]	Dublin In-stack limit
		Average[1]	Maximum[2]	Average[1]	Maximum[2]			
CO	mg/m^3	6.37[6]	11.47[6]	9.69[(6)]	15.03[6]	**50**	**100**	**100**
TOCs (as Carbon)	mg/m^3	0.27[6]	0.34[6]	0.54[(6)]	1.35[6]	**10**	**20**	**20**
TSP	mg/m^3	0.43#	0.95#	0.62#	1.25#			
PM_{10}	mg/m^3	0.16[7]	0.34[7]	0.17[7]	0.34[7]	**5**	**30**	**30**
$PM_{2.5}$	mg/m^3	0.15[7]	0.29[7]	0.16[7]	0.37[7]			
HCl	mg/m^3	0.02#	0.03#	0.02#	0.04#	**6**	**60**	**60**
HF	mg/m^3	0.11[6]	0.42[6]	0.12[6]	0.50[6]	**<1**	**4**	**4**
SO_2	mg/m^3	7.36[6]	24.62[6]	6.33[6]	19.80[6]	**30**	**200**	**200**
NO_X (as NO_2)	mg/m^3	154.81[6]	196.50[6]	157.58[6]	208.50[6]	**120**	**400**	**400**
Hg	mg/m^3	1.49×10^{-03}#	6.90×10^{-03}#	9.83×10^{-04}#	3.10×10^{-03}#	**0.02**	**0.05[4]**	**0.05[4]**
Cd & Tl	mg/m^3	6.78×10^{-04}#	8.10×10^{-04}#	7.36×10^{-04}#	1.00×10^{-03}#	**0.02**	**0.05[4]**	**0.05[4]**
Sb + As + Pb + Cr + Co + Cu + Mn + Ni +V	mg/m^3	0.03#	0.05#	0.04#	0.10#	**0.2**	**0.5[4]**	**0.5[4]**
Dioxins and furans upper limit (worst case where non-detected congeners are assumed to be present at limit of reporting								
Dioxins & Furans (NATO I-TEQ)	ng/m^3	4.97×10^{-03}\$	3.13×10^{-02}\$	7.18×10^{-04}\$	2.00×10^{-03}\$	**0.04**	**0.1[5]**	**0.1[5]**
Dioxins and furans upper limit (worst case where non-detected congeners are assumed to not be present at all								
Dioxins & Furans (NATO I-TEQ)	ng/m^3	4.86×10^{-03}\$	3.13×10^{-02}\$	5.63×10^{-04}\$	2.00×10^{-03}\$	**0.04**	**0.1[5]**	**0.1[5]**

Notes:

1 Average across all available stack testing reports between December 2017 and October 2019

2 Maximum recorded across all available stack testing results

3 IED emission limit value, column A, ½ hour max.

4 IED emission limit value, sampling period of a minimum of 30 minutes and a maximum of 8 hours

5 IED emission limit value, sampling period of a minimum of 6 hours and a maximum of 8 hours
6 30 minute sampling period
7 1 hour sampling period
average of 12x 16 minute sampling periods
$ 6 hour sampling period

Table 10 shows those values compared with the limits specified in NSW legislation and in the EU regulations for waste incineration (EU 2019; Neuwahl et al. 2019; NSW Government 2010).

Table 10: Comparison of expected emissions with relevant international and NSW emission limits

Pollutant	Units	1-hour averages				24-hour averages				Annual averages			
		Expected stack emission*	IED[1]	BAT-AELs (upper limit)[2]	POEO[3]	Expected stack emission*	IED[1]	BAT-AELs (upper limit)[2]	POEO[3]	Expected stack emission*	IED[1]	BAT-AELs (upper limit)[2]	POEO[3]
TOC	mg/m^3	≤ 20	20	-	40 (29)	≤ 10	10	10	-	≤ 2	-	-	-
Dust	mg/m^3	≤ 30	30	-	50 (36)	≤ 5	10	5	-	≤ 2	-	-	-
$PM_{2.5}$	mg/m^3	≤ 28.5	-	-	-	≤ 4.8	-	-	-	≤ 1.9	-	-	-
PM_{10}	mg/m^3	≤ 29.4	-	-	-	≤ 4.9	-	-	-	≤ 2.0	-	-	-
HCl	mg/m^3	≤ 60	60	-	100 (71)	≤ 6	10	6	-	≤ 2	-	-	-
HF	mg/m^3	≤ 4	4	-	-	≤ 1	1	1	50 (36)	≤ 0.4	-	-	-
$SO_2 + SO_3$	mg/m^3	≤ 200	200	-	-	≤ 30	50	30	-	≤ 5	-	-	-
NOx (calculated as NO_2)	mg/m^3	≤ 350	400	-	500 (357)	≤ 120	200	120	-	≤ 90	-	-	-
NH_3	mg/m^3	≤ 30	-	-	-	≤ 10	-	10	-	≤ 2	-	-	-
Hg	mg/m^3	≤ 0.035	0.05	0.035	0.2 (0.14)	≤ 0.02	-	0.02[4]	-	≤ 0.005	-	0.015[5]	-
Cd+Tl	mg/m^3	≤ 0.02	0.05	0.02[4]	-		-	-	-	≤ 0.0005	-	-	-
Cd	mg/m^3	--	-	-	0.2 (0.14)		-	-	-	-	-	-	-
Sb + As + Pb + Cr + Co + Cu + Mn + Ni +V	mg/m^3	≤ 0.3	0.5	0.3[4]	-	-	-	-	-	≤ 0.1	-	-	-
Dioxins, I-TEQ	ng/m^3	-	-	0.04[4#]	0.1	≤ 0.06	0.1	-	-	≤ 0.06	-	0.065[5#]	-
Type 1 and Type 2 metals[6]	mg/m^3	-	-	-	1 (0.71)	-	-	-	-	-	-	-	-

Notes:

* ½ hour IED design value conservatively modelled as 1-hr ave. (actual 1 hr, ave. is ~12.5% lower than the design level, e.g. for NO_2 the 1-hr ave. level emitted is 350 mg/m^3, vs. the ½hr ave. design level of 400 mg/m^3)

1 European Union Industrial Emissions Directive 2010/75/EU – Air Emission Daily Limit Values (EU 2010)

2 Commission Implementing Decision (EU) 2019/2010 Of 12 November 2019 Establishing the Best Available Techniques (BAT) Conclusions, Under Directive 2010/75/Eu Of The European Parliament And Of The Council, For Waste Incineration (EU 2019).

3 Protection of the Environment Operations (Clean Air) Regulation 2010 – Group 6 [POEO], Sampling period of 1 hour or the minimum sampling period specified in the relevant test method referred to in the POEO. HF has a sampling period over a daily average, 11% O_2 (assuming O_2 reference of 7% is then converted to 11% O_2) (NSW Government 2010).

4 Average over the sample period – Hg measurement taken from continuous measurements. Metals (Cd+Tl, Hg, Sb + As + Pb + Cr + Co + Cu + Mn + Ni +V) have sampling period of a minimum 30 minutes and a maximum of 8 hours. Dioxins and furans have a sampling period of a minimum 6 hours and a maximum of 8 hours.

5 Long-term sampling period average – Hg long-term sampling period of 2-4 weeks.

6 Type 1 metals include Sb + As + Cd + Pb + Hg, Type 2 metals include Be + Cr + Co + Mn + Ni + Se + Sn + V.

It is noted that the long term criteria for dioxins are less stringent than the short term criteria in Table 7 in the newly released (EU 2019), hence it appears that the averaging periods have been inadvertently switched in that table.

Data from the Dublin Waste to Energy facility used as a reference plant for this proposal was used to work out the proportions of each metal likely to be present in the emissions for such a plant. These proportions have then been used to determine concentrations for each metal individually for use in risk calculations. The proportions are shown in **Table 11**.

Table 11: Metal distribution - Dublin Waste to Energy reference facility

Pollutant	Units	Line1			Line2			Average fraction across both Lines
		Average[1]	Maximum[2]	Fraction (%)	Average[1]	Maximum[2]	Fraction (%)	
Normal parameter assessed								
Cd+Tl	mg/m^3	0.000678	0.000810	100%	0.000736	0.001	100%	100%
Specific monitoring for each metal								
Cd	mg/m^3	0.000352	0.000433	52%	0.000385	0.000567	55%	53%
Tl	mg/m^3	0.000322	0.0004	48%	0.000319	0.000467	45%	47%
Normal parameter assessed								
Sb + As + Pb + Cr + Co + Cu + Mn + Ni +V	mg/m^3	0.03	0.052	100%	0.0364	0.0950	100%	100%
Specific monitoring for each metal								
As	mg/m^3	0.000641	0.00207	3%	0.000648	0.002	2%	3%
Co	mg/m^3	0.000333	0.000367	1%	0.00162	0.00930	3%	2%
Cr	mg/m^3	0.00597	0.0202	21%	0.00650	0.0149	21%	21%
Cu	mg/m^3	0.00681	0.0174	22%	0.00803	0.0322	22%	22%
Mn	mg/m^3	0.00111	0.00213	5%	0.00161	0.00433	7%	6%
Ni	mg/m^3	0.0127	0.0334	39%	0.0162	0.0638	34%	36%
Pb	mg/m^3	0.00177	0.00663	7%	0.00197	0.00583	7%	7%
Sb	mg/m^3	0.000459	0.0007	2%	0.000489	0.000867	2%	2%
V	mg/m^3	0.000274	0.0004	1%	0.0003	0.000467	1%	1%

Notes:

1 Average across all available stack testing reports between December 2017 and October 2019

2 Maximum recorded across all available stack testing results

The assumed concentrations in the stack for each pollutant for each scenario (and proportions for each metal) were then combined with the engineering information about the design of the stack (size, exit velocity etc) to determine the emission rates for each chemical. These emission rates are then used in the air quality model to determine ground level concentrations across the grid and at the relevant receptor locations.

This resulted in the model calculating ground level concentrations at more than 3100 individual locations across the grid (i.e. every 100 m across the grid). In addition, ground level concentrations at more than 300 specific locations for residences, schools, pre-schools, places of worship, commercial offices, retail, restaurants, clubs, industrial facilities and farms were also calculated. **Figure 16** shows the sensitive locations in the grid (Todoroski Air Sciences 2020).

The assessment of potential impacts on the surrounding community has considered the location where maximum impacts from the project may occur. In addition, impacts in the wider region have also been considered.

This assessment of health risks has used estimated ground level concentrations at the following locations:

- maximum anywhere across the grid in the off-site area
- maximum at a residential location
- maximum at a commercial/retail/industrial location

- maximum at one of the other places
- maximum on-site for visitors to the facility.

These ground level concentrations have been used in the calculations to determine risks.

Using the maximum value in each of these categories results in an estimate of risks for the worst case in each situation. All other locations in each of these categories will have lower risks than these and so demonstrating that the risks for these locations are acceptable confirms that the risks at all locations in each category are acceptable.

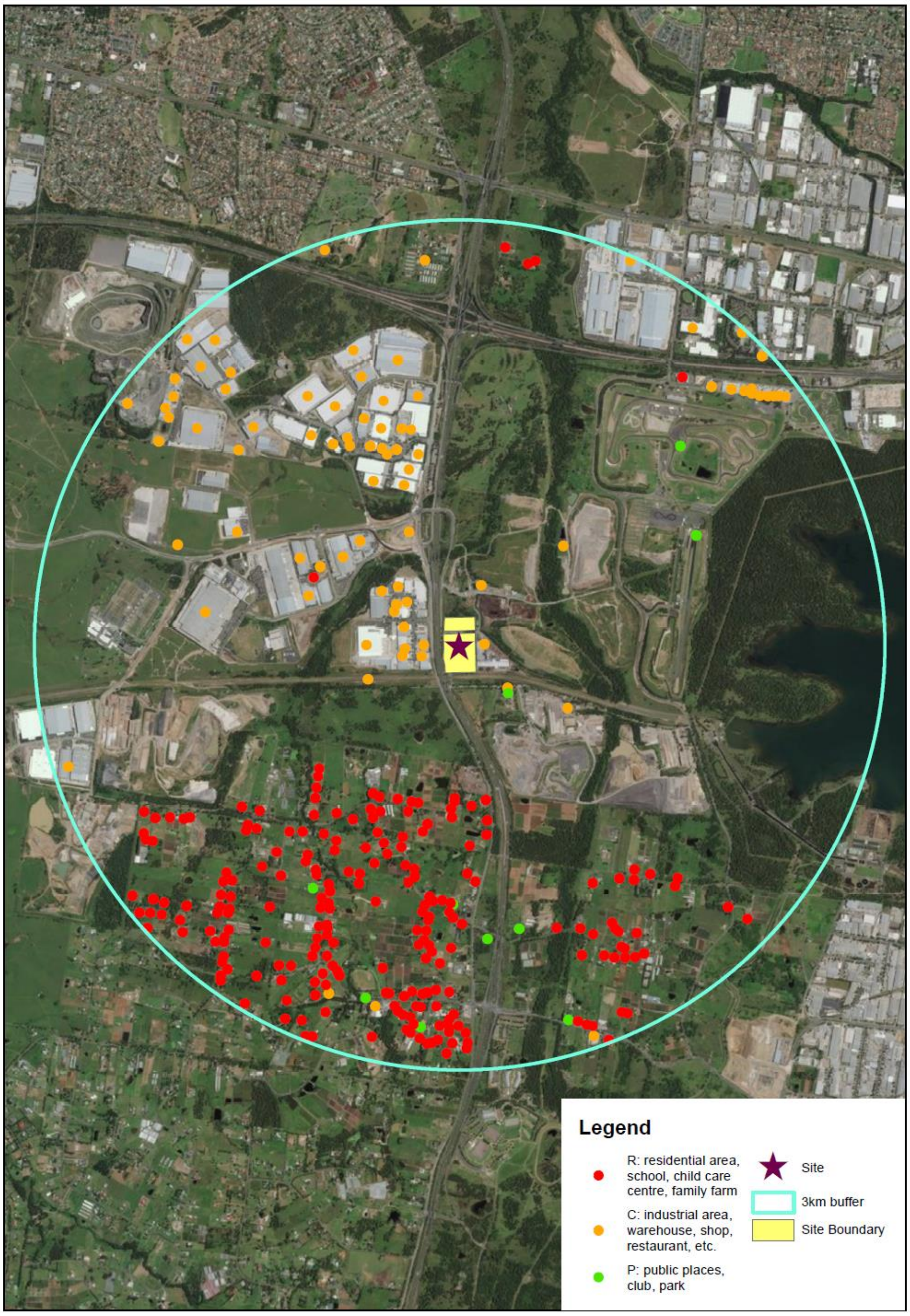


Figure 16: Sensitive locations in the modelling grid

4.7 Additional Considerations – Prospect Reservoir

The State Environmental Planning Policy (Western Sydney Parklands) 2009 is relevant to consideration of this development (NSW Government 2009). This SEPP requires that any development within the area regulated within this policy be shown to have only a neutral (i.e. no change) or beneficial impact on the quality of water in the bulk water supply infrastructure shown on the relevant maps included in the regulation.

The bulk water infrastructure that is located in this area includes the pipelines that take water to and from Prospect Reservoir and Prospect Reservoir itself.

The normal operation of the proposed facility cannot impact on the quality of water within enclosed pipes as there is no mechanism for exposure to any emissions from the facility. However, as discussed in **Section 4.4**, the potential for deposition onto the surface of water within Prospect Reservoir and for washoff from the small catchment for this water body has been considered in this assessment.

The assessment has been designed to show that there is only a neutral impact on the quality of water – i.e. an immeasurably small change to concentrations of chemicals which are naturally occurring and already present in most waterways.

4.8 Additional Considerations – PFAS

Another group of chemicals that has been of concern to communities are the per- and polyfluoroalkyl substances (PFAS) which have been discussed in the media for sites where fire fighting foams may have been used (Defence bases and airports, in particular).

PFAS are a family of man-made fluorine-containing chemicals. They do not occur naturally in the environment. They have unique properties that make materials stain- and water-resistant. These unique properties also make them persistent in the environment and highly mobile in soil and water (i.e. they readily leach into groundwater). These chemicals are highly water soluble (and often present as ions in solution) and most of the commonly present substances are not volatile. (HEPA 2020).

These chemicals have been used in a wide range of products including:

- Fire fighting foams
- Packaging materials for food
- Waterproofing or stainproofing agents (e.g. scotchguard)
- Non-stick products (e.g. Teflon)
- Polishes
- Waxes
- Paints
- Cleaning products
- Surfactants used in chrome plating or electronics manufacture (HEPA 2020)

It is possible that low levels may be present in residual household waste due to their widespread use in products used in the general community and around homes (HEPA 2020). PFAS have been reported to be present in leachate from some landfills in Australia (Gallen et al. 2017).

Concerns regarding this group of chemicals were raised internationally around 2000. A number of chemicals in this group have since been included on the list of chemicals regulated by the Stockholm Treaty – an international treaty to which Australia is a party that requires uses of listed chemicals (long lived/persistent ones) to be reduced or eliminated.

Since 2000 many uses of these chemicals have been phased out. Such reductions are expected to continue given the listing of these chemicals on the Stockholm Treaty. As a result, the presence of these chemicals in current and future residual household waste would be expected to continue to decrease and to already be much lower than the levels currently discussed in the scientific literature for existing landfills.

Methods for the analysis of these chemicals in air are not routinely available (HEPA 2020). There is no requirement for analysis of these chemicals in emissions from similar plants in Europe due to the difficulty in undertaking such analysis. As a result, there are no monitoring data available and it is not currently possible to undertake a detailed quantitative assessment.

It is noted, however, that this facility has the capacity to manage small amounts of such chemicals appropriately if they were to be present in residual waste. The flue gas treatment technology proposed for this facility can address the presence of these chemicals using the following:

- Combustion chamber – PFAS are usually present in products that could be waste as mixtures. Within those mixtures some chemicals are readily degradable at temperatures easily reached in the chamber. Some of the chemicals do require higher temperatures to breakdown. It is noted that much of the chamber will have temperatures in excess of 1000^{o}C and these temperatures along with sufficient oxygen will allow for effective combustion of these chemicals.
- Acid gas treatment (injection of lime) – the flue gas treatment technology proposed includes a process for removing acid gases from the air – this treatment process will assist in the removal of the breakdown products from the destruction of PFAS
- Activated carbon treatment – activated carbon is added to the waste gases to remove metals and a range of other chemicals – this technology will also assist in removing PFAS
- Baghouse – chemicals attached to particles (including activated carbon particles) are captured within the baghouse – this will include PFAS
- Wet scrubber – after the baghouse the gases flowing through the plant will be treated through a wet scrubber – this will remove more particles from the gases (including ones with PFAS attached) and, as PFAS are highly water soluble, this step will also remove any remaining PFAS that might still be present as a gas.

Risks due to the presence of the expected very low to negligible levels of these chemicals within residual waste to be combusted at this facility are expected to be low to negligible.

5 Assessment of health impacts from air emissions: results

5.1 General

This section provides the assessment of potential health risks from emissions to air from the proposed facility.

5.2 Construction

Construction activities for this facility include clearing the current buildings from the site, preparation of the site for the proposed buildings and roads (earthworks, levelling etc), construction of those buildings and roads, construction of the revised site entry way and renovation of relevant intersections. **Figure 3** shows the proposed site layout.

As with most construction projects (residential, industrial, commercial), emissions of dust during earthworks or while the ground is cleared of vegetation and emissions from vehicles used on-site are the main issues relevant to health risks. Such activities and emissions are temporary and sporadic during such projects so the potential for such emissions can be difficult to predict.

Todoroski Air Sciences (2020) undertake a review of the potential for such emissions. The assessment used two approaches – a qualitative one based on guidance from the Institute of Air Quality Management (IAQM) and a quantitative one based on modelling dust from construction activities as provided by the USEPA.

The qualitative approach found that the potential for dust was elevated due to the size of the site and the type and number of vehicles likely to be used. The potential for risks to health were quite low, however, due to the distance to sensitive locations.

The quantitative assessment included estimating dust from the loading/unloading of material, vehicles travelling on-site and off-site, dozer ripping and pushing material, graders maintaining haul road surfaces and windblown dust from exposed areas and stockpiles. The same model as used for emissions during operation (CALPUFF) was used to estimate dispersion of dust from these activities based on expected levels of dust recommended by the USEPA. The modelling assumed these activities would occur over a 6 month period. The results of this modelling showed that any increases in dust at the closest sensitive locations were negligible.

A range of mitigation measures were recommended to ensure dust is well managed during construction. These included:

- a dust management plan (a normal requirement for such sites)
- planning site layout to minimise use of vehicles on unsealed areas where possible
- managing rainfall at the site to minimise erosion of cleared areas
- dust monitoring during works
- requiring vehicles to be turned off when stationary
- use of mains power rather than diesel generators wherever possible, setting speed limits for vehicles at the site (and enforcing them)
- dust suppression (such as water sprays, extraction for cutting/grinding, minimising drop heights, covers on bins, clean equipment regularly and maintaining equipment to manufacturers specifications).

These mitigation measures are normal requirements for such developments and will ensure that dust emissions from the site are well below the levels modelled in this assessment.

5.3 Criteria Pollutants

Criteria air pollutants are those that are targeted by the National Environment Protection (Ambient Air Quality) Measure (NEPC 2016). They are common air pollutants that need to managed well to maintain acceptable air quality. There are many sources of these air pollutants including all combustion sources – fires, bushfires, cooking, vehicles, wood fired heaters, open fireplaces, ship engines, power stations etc – and other sources like windblown dust and salt spray.

The pollutants included are PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO. The ambient air quality NEPM also contains guidance about lead. It was included in the criteria pollutants when lead was used in petrol. Lead is included with the other air pollutants in **Section 5.4**.

The ground level concentrations of these criteria pollutants have been estimated in the air quality modelling (Todoroski Air Sciences 2020).

The assessment has evaluated the following:

- Incremental changes in ground level concentrations of these criteria pollutants from this facility
- Cumulative ground level concentrations for the combination of this facility and the existing air concentrations
- Cumulative ground level concentrations for the combination of this facility and the existing air concentrations and the emissions from the proposed Next Generation facility nearby.

Todoroski Air Sciences undertook a detailed assessment of the combination of the potential ground level concentrations due to this facility and the existing levels of criteria pollutants as well as the potential emissions for the proposed Next Generation facility. They undertook what is known as a contemporaneous assessment where they model the emissions from the facility for each hour of the year and combine that with the background levels for every hour of the year from the government monitoring stations. This assessment is more realistic than just taking the maximum concentrations for any hour for the facility and combining it with a single value for the background/existing level as the conditions that might result in a higher level from the facility or a higher background level may not occur under the same conditions (Todoroski Air Sciences 2020).

Sections 5.3.1 to **5.3.4** discuss each of these pollutants and provide the modelled ground level concentrations in each of these locations and the relevant Australian guidelines for these pollutants – the guidelines from the National Environment Protection (Ambient Air Quality) Measure (NEPC 2016). The NEPM criteria relate to total exposures to these criteria pollutants (PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO) which means background or existing levels plus any additional impact from the proposed facility.

The results for the criteria pollutants have been assessed for:

- maximum off-site location
- maximum residential location
- maximum commercial/industrial location
- maximum other places location
- maximum on-site location

5.3.1 Sulfur oxides (SOx)

Sulfur oxides are formed during combustion when chemicals containing sulfur present in fuels (such as coal, gas, petrol etc) react with oxygen to form sulfur oxides. Burning of coal in power stations in Europe resulted in acid rain affecting forests. The acid rain was primarily a result of the formation of sulfur oxides as the coal was burnt. Sulfur oxides are also released from volcanos. Wildfires and other types of fires are also sources to the atmosphere of these chemicals (USEPA 2018a).

Sulfur dioxide (SO_2) is the main sulfur oxide that can have impacts on people. Exposure to elevated levels can result in irritation of the respiratory system and can make breathing difficult. The most affected by exposure to these chemicals are people with asthma (USEPA 2018a).

Guidelines are available from the NSW EPA and NEPC (NEPC 1998 amended 2016) which indicate acceptable concentrations of sulfur dioxide.

These guidelines are based on protection from adverse health effects following both short term (acute) and longer term (chronic) exposure for all members of the population including sensitive populations like asthmatics, children and the elderly.

Table 12 shows the comparison of modelled SO_2 levels and the relevant NEPM guidelines for the facility alone, the facility plus the existing/background levels and this facility plus the proposed Next Generation facility as well as the existing/background levels.

Table 12: SO_2 impacts from the project

Parameter	SO_2 ($\mu g/m^3$)		
	1-hour average	**24-hour average**	**Annual average**
Guideline (NEPM 2016)	570	228	60
Maximum off-site location			
Contribution from project	265	5.49	0.06
Project + background	342	14.09	1.6
Project + background + Next Generation facility	346	14.46	1.6
% contribution of project to NEPM	46%	2.4%	0.3%
Maximum residential location			
Contribution from project	175	3.25	0.04
Project + background	252	11.85	1.5
Project + background + Next Generation facility	255	12.24	1.6
% contribution of project to NEPM	31%	1.4%	0.3%
Maximum commercial location			
Contribution from project	238	3.49	0.04
Project + background	316	12.09	1.5
Project + background + Next Generation facility	319	12.53	1.6
% contribution of project to NEPM	42%	1.5%	0.3%
Maximum other places location			
Contribution from project	124	4.03	0.04
Project + background	200	12.63	1.5
Project + background + Next Generation facility	203	12.98	1.6
% contribution of project to NEPM	22%	1.8%	0.3%
Maximum on-site location			
Contribution from project	285	2.83	0.02
Project + background	362	11.43	1.5
Project + background + Next Generation facility	365	11.79	1.6
% contribution of project to NEPM	50%	1.3%	0.3%

For this project, the short term and long term concentrations of sulfur dioxide are well below the relevant National guidelines. The existing long term average concentration of sulfur dioxide in the local area is 1.5 µg/m^3 (annual average). The contribution from the facility to this long term average is small and the overall average doesn't really change.

On this basis, the operation of the facility is not expected to significantly contribute to or change ambient levels of SO_2. Regardless, there are no health risk issues of concern in relation to these emissions as they are well within National guidelines.

5.3.2 Nitrogen Oxides (NOx)

Nitrogen oxides (NOx) refer to a collection of highly reactive gases containing nitrogen and oxygen, most of which are colourless and odourless. Nitrogen oxide gases form when fuel is burnt including when waste is used as fuel. Motor vehicles, along with industrial, commercial and residential (e.g. gas heating or cooking) combustion sources, are primary producers of nitrogen oxides.

In Sydney, the NSW Government estimated that for calendar year 2013 on-road vehicles accounted for about 53 per cent of emissions of nitrogen oxides, industrial facilities accounted for 12 per cent, other mobile sources accounted for about 26 per cent, with the remainder from domestic/ commercial or natural sources (NSW EPA 2019).

In terms of health effects, nitrogen dioxide is the only oxide of nitrogen that may be of concern (WHO 2000a). Nitrogen dioxide is a colourless and tasteless gas with a sharp odour. Nitrogen dioxide can cause inflammation of the respiratory system and increase susceptibility to respiratory infection. Exposure to elevated levels of nitrogen dioxide has also been associated with increased mortality, particularly related to respiratory disease, and with increased hospital admissions for asthma and heart disease patients (WHO 2013a). Asthmatics, the elderly and people with existing cardiovascular and respiratory disease are particularly susceptible to the effects of elevated nitrogen dioxide (Morgan et al. 2013; NEPC 2010). The health effects associated with exposure to nitrogen dioxide depend on the duration of exposure as well as the concentration.

Guidelines are available from the NSW EPA and NEPC (NEPC 1998 amended 2016) which indicate acceptable concentrations of nitrogen dioxide.

These guidelines are based on protection from adverse health effects following both short term (acute) and longer term (chronic) exposure for all members of the population including sensitive populations like asthmatics, children and the elderly.

Table 13 shows the comparison of modelled NO_2 levels and the relevant NEPM guidelines for the facility alone, the facility plus the existing/background levels and this facility plus the proposed Next Generation facility as well as the existing/background levels.

Table 13: NO_2 impacts from the project

Parameter	NO_2 (µg/m^3)	
	1-hour average	Annual average
Guideline (NEPM 2016)	246 (0.12 ppm)	62 (0.03 ppm)
Maximum off-site location		
Contribution from project	174	1.47
Project + background	200	22
Project + background + Next Generation facility	200	22
% contribution of project to NEPM	71%	2.3%
Maximum residential location		
Contribution from project	48	1.21
Project + background	109	22
Project + background + Next Generation facility	109	22

Parameter	NO_2 (µg/m^3)	
	1-hour average	Annual average
% contribution of project to NEPM	20%	2%
Maximum commercial location		
Contribution from project	35	1.35
Project + background	109	22
Project + background + Next Generation facility	109	22
% contribution of project to NEPM	14%	2.2%
Maximum other places location		
Contribution from project	39	0.99
Project + background	109	22
Project + background + Next Generation facility	109	22
% contribution of project to NEPM	16%	1.6%
Maximum on-site location		
Contribution from project	9	0.21
Project + background	109	22
Project + background + Next Generation facility	109	22
% contribution of project to NEPM	3.7%	0.3%

For this project, the contribution of nitrogen dioxide from the facility is quite small when compared to existing concentrations in the local area which are 109 µg/m^3 for 1 hour average and 22 µg/m^3 for annual average. There is essentially no change from these background levels due to the facility.

On this basis, the operation of the facility is not expected to significantly contribute to or change ambient levels of NO_2. Regardless, there are no health risk issues of concern in relation to these emissions as they are well within current National guidelines.

5.3.3 Carbon monoxide

Motor vehicles are the dominant source of carbon monoxide in air (DECCW 2009). Carbon monoxide is produced during combustion when there is a limited supply of oxygen. This facility is designed to optimise the oxygen available in the combustion zone so the production of carbon monoxide should be very low.

It is well known that excess levels of carbon monoxide in enclosed spaces can cause significant impacts. This may occur when indoor gas or other types of heaters are not operating correctly and are left on overnight.

The sorts of effects that can be expected due to exposure to CO are those linked with carboxyhaemoglobin (COHb) in blood – i.e. where CO replaces oxygen in the blood preventing oxygen from being transported around the body. In addition, association between exposure to carbon monoxide and cardiovascular hospital admissions and mortality, especially in the elderly for cardiac failure, myocardial infarction and ischemic heart disease; and some birth outcomes (such as low birth weights) have been identified (NEPC 2010).

Guidelines are available in Australia from NEPC (NEPC 1998 amended 2016) and NSW EPA that are based on the protection of adverse health effects associated with carbon monoxide.

Table 14 shows the comparison of modelled CO levels and the relevant NEPM guidelines for the facility alone, the facility plus the existing/background levels and this facility plus the proposed Next Generation facility as well as the existing/background levels.

Table 14: CO impacts from the project

Parameter	CO (µg/m³)	
	1-hour average	8-hour average
Guideline (NEPM 2016)	30000	10000
Maximum off-site location		
Contribution from project	133	94
Project + background	2508	1655
Project + background + Next Generation facility	2511	1657
% contribution of project to NEPM	0.4%	0.9%
Maximum residential location		
Contribution from project	88	58
Project + background	2463	1626
Project + background + Next Generation facility	2465	1627
% contribution of project to NEPM	0.3%	0.6%
Maximum commercial location		
Contribution from project	119	79
Project + background	2494	1646
Project + background + Next Generation facility	2497	1648
% contribution of project to NEPM	0.4%	0.8%
Maximum other places location		
Contribution from project	62	41
Project + background	2437	1608
Project + background + Next Generation facility	2439	1610
% contribution of project to NEPM	0.2%	0.4%
Maximum on-site location		
Contribution from project	143	94
Project + background	2518	1662
Project + background + Next Generation facility	2520	1663
% contribution of project to NEPM	0.5%	0.9%

For this project, the maximum concentration of carbon monoxide over an 8 hour average from the facility alone is estimated to be 94 µg/m³. This is only 0.9% of the NEPM criteria. The background maximum 1 hour average concentration of CO adopted for this assessment was 2375 µg/m³ compared to the concentration at the worst case location for the facility of 133 µg/m³.

On this basis, the operation of the facility is not expected to significantly contribute to or change ambient levels of CO, and there are no health risk issues of concern in relation to these emissions.

5.3.4 Particles

Particles or particulate matter (PM) is a widespread air pollutant with a mixture of physical and chemical characteristics that vary by location (and source). Unlike many other pollutants, particulates comprise a broad class of diverse materials and substances, with varying morphological (shape), chemical, physical and thermodynamic properties, with sizes that vary from less than 0.005 microns to greater than 100 microns.

Particles are always present in the air from a wide range of sources. Such sources include bushfires, other types of fires, cooking, BBQs, vehicle emissions, wood fired heaters, windblown dust, salt spray (when near ocean) as well as large facilities using combustion like power stations and energy from waste facilities. The most important aspect to consider in regard to health and exposure to particles is the difference (if any) in the concentration of particles in air due to the facility.

The main focus of studies about health effects due to particles in air is the smaller particles. These fine particles are small enough to reach deep into the lungs, so they are the most relevant for assessing potential health effects.

Particles are measured as those particles less than 10 micron in size (PM_{10}) or those that are less than 2.5 micron in size ($PM_{2.5}$). It is important to note that PM_{10} includes all the particles that are less than 2.5 microns in size as well as the ones that larger than 2.5 microns but less than 10 microns. The same goes for $PM_{2.5}$ – it includes all the ultrafine particles (those less than 1 micron or 0.1 micron) as well as those between 1 and 2.5 microns. This means these ultrafine particles are included in the health effects assessments even if not specifically mentioned. In this case the predominant particles being emitted by this facility are those that are less than 2.5 microns ($PM_{2.5}$)

Numerous epidemiological studies[5] have reported significant positive associations between particulate air pollution measured as PM_{10} and $PM_{2.5}$ and adverse health outcomes, in particular, mortality as well as a range of adverse cardiovascular and respiratory effects. Studies have shown links between PM_{10} and $PM_{2.5}$ and a wide range of health effects (USEPA 2012, 2018b; WHO 2013b). In particular, the links between $PM_{2.5}$ and health effects have been shown to be causal. These health effects were considered in the derivation of the NEPM air guideline for PM_{10} and $PM_{2.5}$.

Guidelines are available in Australia from NEPC (NEPC 1998 amended 2016) and NSW EPA that are based on the protection of adverse health effects associated with particles.

Review of these guidelines by NEPC identified additional supporting studies[6] for the evaluation of potential adverse health effects (Golder 2013; NEPC 2010). The review recommended an amendment to the guidelines for particles which comes into effect in 2025. The change is that the 24 hour average for $PM_{2.5}$ drops from 25 to 20 µg/m^3 and the annual average drops from 8 to 7 µg/m^3. The change was approved in late 2015 and took effect in February 2016 (NEPC 2016).

Tables 15 ($PM_{2.5}$) and **16 (PM_{10})** show the comparison of modelled particle levels and the relevant NEPM guidelines for the facility alone, the facility plus the existing/background levels and this facility plus the proposed Next Generation facility as well as the existing/background levels.

Table 15: $PM_{2.5}$ impacts from the project

Parameter	$PM_{2.5}$ (µg/m^3)	
	24-hour average	Annual average
Guideline (NEPM 2016)	25	8
Maximum off-site location		
Contribution from project	0.87	0.02
Project + background	30	8
Project + background + Next Generation facility	30	8
% contribution of project to NEPM	3.5%	4.3%
Maximum residential location		

5 Epidemiology is the study of diseases in populations. Epidemiological evidence can only show that this risk factor is associated (correlated) with a higher incidence of disease in the population exposed to that risk factor. The higher the correlation the more certain the association. Causation (ie that a specific risk factor actually causes a disease) cannot be proven with only epidemiological studies. For causation to be determined a range of other studies need to be considered in conjunction with the epidemiology studies.

6 Many of the more current studies are epidemiology studies that relate to a mix of urban air pollutants (including particulate matter) where it is more complex to determine the effects that can be attributed to carbon monoxide exposure only.

Parameter	PM$_{2.5}$ (µg/m^3)	
	24-hour average	Annual average
Contribution from project	0.51	0.01
Project + background	30	8
Project + background + Next Generation facility	30	8
% contribution of project to NEPM	2%	2.8%
Maximum commercial location		
Contribution from project	0.55	0.02
Project + background	30	8
Project + background + Next Generation facility	30	8
% contribution of project to NEPM	2.2%	3.1%
Maximum other places location		
Contribution from project	0.64	0.02
Project + background	30	8
Project + background + Next Generation facility	30	8
% contribution of project to NEPM	2.6%	3.1%
Maximum on-site location		
Contribution from project	0.45	0.01
Project + background	30	8
Project + background + Next Generation facility	30	8
% contribution of project to NEPM	1.8%	1.6%

Table 16: PM$_{10}$ impacts from the project

Parameter	PM$_{10}$ (µg/m^3)	
	24-hour average	Annual average
Guideline (NEPM 2016)	50	30
Maximum off-site location		
Contribution from project	0.9	0.02
Project + background	70	18
Project + background + Next Generation facility	70	18
% contribution of project to NEPM	1.8%	1.2%
Maximum residential location		
Contribution from project	0.53	0.02
Project + background	69	18
Project + background + Next Generation facility	69	18
% contribution of project to NEPM	1%	0.8%
Maximum commercial location		
Contribution from project	0.57	0.02
Project + background	69	18
Project + background + Next Generation facility	69	18
% contribution of project to NEPM	1.1%	0.9%
Maximum other places location		
Contribution from project	0.66	0.02
Project + background	69	18
Project + background + Next Generation facility	69	18
% contribution of project to NEPM	1.3%	0.9%
Maximum on-site location		
Contribution from project	0.46	0.01
Project + background	69	18
Project + background + Next Generation facility	69	18
% contribution of project to NEPM	0.9%	0.4%

These results indicate that the proposed facility will make little change to the local concentrations of particles in ambient air.

It is noted that, while the contribution from this plant is small, the background air quality is at or around the NEPM guideline value. Further assessment of the potential for health impacts from particles has been undertaken. Two types of additional assessment have been undertaken – contemporaneous assessment and the use of exposure response relationships.

Contemporaneous assessment

Todoroski Air Sciences (2020) has also undertaken a contemporaneous assessment for $PM_{2.5}$ and PM_{10}. This type of assessment is undertaken when the existing or background levels are close to or above relevant guideline values. Contemporaneous assessment calculates the cumulative levels (i.e. the emissions from the proposed facility plus the background levels) of $PM_{2.5}$ and PM_{10} separately for every hour of the year - matching the meteorological conditions for each hour. This allows an evaluation of whether the proposed facility makes any difference to the total number of days per year that $PM_{2.5}$ and PM_{10} might exceed guideline values.

In this case, there are no additional days where exceedances of guidelines might occur by the very small additional contribution to background for particles from this facility.

Exposure response relationships

Another assessment technique is to refine this assessment using exposure response relationships developed by the WHO to estimate the incremental individual risk associated with the change in $PM_{2.5}$ from the facility.

This calculation has been undertaken on the basis of the most significant health indicator, namely mortality, for which changes in $PM_{2.5}$ have been identified to have a causal relationship. It is noted that the relationship for PM_{10} is not as strong, hence the focus is on exposures to $PM_{2.5}$. Using this health indicator also covers a wide range of other health effects associated with $PM_{2.5}$ – the exposure response relationships for these other effects give lower levels of effect for the same change in particle levels.

The calculation considers the baseline mortality rate for Blacktown and Fairfield LGAs – this is the mortality rate that currently exists in these areas without this facility. The rate in Blacktown LGA is 570.8 per 100,000 for 2016/17 (all ages and all causes) (refer to **Table 3**). The rate in Fairfield LGA is 489.8 per 100,000 for 2016/17 (all ages and all causes) (refer to **Table 3**).

These baseline rates are used along with the incremental change in $PM_{2.5}$ due to the facility as inputs to the relevant exposure-response relationship developed by the World Health Organisation (WHO) for assessing all-cause mortality due to exposure to $PM_{2.5}$.

Further details and calculations are presented in **Appendix A**. These calculations assume that a person is present at the relevant location for 24 hours a day, every day of the year.

For the incremental level of $PM_{2.5}$ at the maximum off-site location, the maximum individual risk is 6-7 x 10^{-7}. Values for any location further from the facility than this maximum off-site location (immediately outside the boundary fence or on the access roads) will have lower risks than this value.

This risk level (6-7 x 10^{-7}) is considered to be very low and more than 10 fold lower than the mortality risk criteria outlined by NEPM (NEPC 2011b). On this basis, changes in $PM_{2.5}$ (and, therefore, PM_{10}) derived from this proposed facility are considered to have a negligible impact on the health of the community.

5.4 Other Pollutants

5.4.1 Approach

For all other pollutants (i.e. not criteria pollutants discussed in **Section 5.3**), inhalation exposures have considered both short-term/acute exposures (based on worst case conditions) as well as chronic exposures (based on long term normal operating conditions). The results for the 1 hour, 24 hour and annual averages for each of the pollutants assessed at the grid maximum (i.e. the maximum anywhere across the 10 x 12 km grid) as well as at the maximum locations for residential, commercial/industrial and other relevant land uses (schools, preschools, places of worship, farms etc). Todoroski Air Sciences (2020) included an initial assessment of a 30 x 30 km grid to ensure there were no characteristics of the terrain surrounding the facility that could result in higher concentrations outside the 10 x 12 km grid.

In addition to exposures via inhalation, exposure via direct contact with soil onto which particles have deposited or via consumption of home grown produce grown in such soil have also been assessed.

Specifically, the following exposure pathways have been considered:

- Deposition onto soil and direct contact with that soil
- Deposition onto soil and uptake into fruit and vegetables
- Deposition onto soil and uptake into eggs
- Deposition onto soil and uptake into meat
- Deposition onto soil and uptake into milk
- Deposition onto roof and collection in household rainwater tanks
- Deposition onto the surface of Prospect Reservoir and use of water for drinking (and washoff of deposited particles into the reservoir from the surrounding catchment)

It is noted that the pathways related to consumption of fruit, vegetables, eggs, meat or milk refer to home grown produce. This means the calculations are designed to assess consumption of meat and milk on a farm where cattle are kept by the people living or working at the farm.

The calculations are not relevant for the production of meat or milk for the commercial food supply. This is because the calculations undertaken for this assessment assume the consumption of meat or milk from the same location all year round by a person. When meat or milk are included in the commercial food supply, consumption by a single person of meat or milk from the same animals or from animals from the same farm all year round is not possible. The risks for meat or milk in the commercial food supply will be much lower than those calculated in this assessment.

Details of the methodology and equations used to undertake this assessment are provided in **Appendix B**. Also included in **Appendix B** are the assumed values for the parameters used in these calculations.

The approach adopted is in line with national guidance including:

- enHealth, 2012. Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards.
- enHealth 2012. Australian Exposure Factors Guide
- NEPC 1999 amended 2013. Schedule B4 of National Environment Protection (Assessment of Site Contamination) Measure

and has considered international guidance from the World Health Organisation and the US Environmental Protection Agency where relevant.

5.4.2 Identification of Complete Exposure Pathways

The receptors and exposure pathways considered in this assessment are shown in **Table 17**.

Table 17: Summary of Key Exposure Groups and Pathways

Receptor	Media	Exposure Pathways									
		Inhalation	Incidental Ingestion Soil	Dermal Contact Soil	Ingestion of eggs	Ingestion of fruit & vegetables	Ingestion of fruit	Ingestion of Milk	Ingestion of Meat	Ingestion of water from rainwater tank	Dermal contact of water from rainwater tank
Maximum Off-site	Gases	✓	×	×	×	×	×	×	×	×	×
	Particles	✓	✓	✓	×	×	×	×	×	×	×
Maximum Residential	Gases	✓	×	×	×	×	×	×	×	×	×
	Particles	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maximum Commercial/ Industrial	Gases	✓	×	×	×	×	×	×	×	×	×
	Particles	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maximum Other Places	Gases	✓	×	×	×	×	×	×	×	×	×
	Particles	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Maximum On-site	Gases	✓	×	×	×	×	×	×	×	×	×
	Particles	✓	×	×	×	×	×	×	×	×	×

Notes:
✓ Exposure pathway complete
× Incomplete exposure pathway

The closest residential location in any direction is at least 1 km away from the proposed facility to the south. The predominant winds across the year are those coming from the southwest blowing toward the northeast. Such winds would not blow emissions from the facility toward these houses. Other residential areas are 3 to 3.5 km away from the facility.

The sites surrounding the proposed facility are commercial/industrial and buildings where people work at these sites are 200-500 m from the proposed facility. The closest location used as a school, preschool, church or other similar location in any direction is 1 km away from the proposed facility – the child care centre in the Eastern Creek industrial area.

The following exposure scenarios have been assessed:

- maximum off-site location – exposures via inhalation and direct contact with soil are the only ones relevant. This location is on the boundary of the facility or on the roads immediately outside the boundary. In this case, there is a major freeway and access roads to the surrounding industrial facilities in the area relevant for this maximum location.

- maximum residential location – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and use of a rainwater tank
- maximum commercial/industrial location – exposure via inhalation and direct contact with soil
- maximum commercial/industrial location should these sites change land use to residential – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and use of a rainwater tank
- maximum other places location – exposure via inhalation and direct contact with soil
- maximum other places location should these sites change land use to residential – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and use of a rainwater tank
- maximum farm location – exposure via inhalation, direct contact with soil and consumption of home grown fruit, vegetables and eggs and, in addition, consumption of home grown milk and meat and use of a rainwater tank
- maximum on-site location – exposure via inhalation for visitors to the education centre and staff working in the café/gallery (i.e. not related to operation of the proposed facility)
- Prospect Reservoir – exposure via consumption of drinking water where particles have deposited onto the water in the reservoir and have washed off into the reservoir from the land surrounding when it rains

These exposure scenarios have been assessed for both operational scenarios assessed for the plant – Scenario 1 (annual averages using expected maximum design stack concentrations) and the EPA Limit modelling scenario (annual average ground level concentrations using maximum 1 hour regulatory stack concentrations).

The land uses immediately surrounding the site are:

- long standing industrial facilities which are not likely to move
- current and former landfills which cannot easily be converted to residential land use
- Western Sydney Parklands designated as long term green space.

Consequently, it is not expected that land use in the immediate vicinity of the plant could change significantly. However, the maximum locations for current residential, commercial/industrial or other places have been assessed for residential land use. The farm scenario has only been assessed for the maximum location for the current farms as it is not likely that the current industrial sites or the former or current landfill areas could be used for agricultural purposes.

The specific assumptions made in this assessment in regard to how people can be exposed are listed in **Table 18**.

Table 18: Exposure parameter assumptions

Parameter		Residential		Farm		Commercial (including café/gallery staff on-site)	Education Centre Visitors
		Young children	Adults	Young children	Adults	Adult	Pre school child
BW	Body weight	15	70	15	70	70	15
		((enHealth 2012b) and ASC NEPM (NEPC 1999 amended 2013d))					
EF	Exposure frequency (days/year)	365	365	365	365	240	12
		All year				Working year	Assume a child (or a teacher) may visit the facility once per month
ED	Exposure duration (years)	6	29	6	29	30	10
		As per (enHealth 2012b) and ASC NEPM (NEPC 1999 amended 2013d)					Professional judgement
AT	Averaging time (days)	Threshold = ED x 365 days/year Non-threshold = 70 years x 365 days/year					
C_M	Concentration of chemical substance in media or relevance (soil, fruit and vegetables, eggs, meat, milk) (mg/kg)	Calculations undertaken on the basis of the maximum predicted impacts relevant to areas where multi-pathway exposures may occur					
IR_M	**Ingestion rate of media**						
	Soil (mg/day)	100	50	100	50	25 (where relevant)	NR
		Ingestion rate of outdoor soil and dust (tracked or deposited indoors) as per enHealth (enHealth 2012b)					
	Fruit and vegetables (kg/day)	0.28	0.4	0.28	0.4	NR	
		85% from aboveground crops 16% from root crops	73% from aboveground crops 27% from root crops	85% from aboveground crops 16% from root crops	73% from aboveground crops 27% from root crops		

<table>
<tr><th colspan="2" rowspan="2">Parameter</th><th colspan="2">Residential</th><th colspan="2">Farm</th><th>Commercial (including café/gallery staff on-site)</th><th>Education Centre Visitors</th></tr>
<tr><th>Young children</th><th>Adults</th><th>Young children</th><th>Adults</th><th>Adult</th><th>Pre school child</th></tr>
<tr><td></td><td></td><td>(Total fruit and vegetable intakes per day as per ASC NEPM (NEPC 1999 amended 2013d))</td><td>(Total fruit and vegetable intakes per day as per ASC NEPM (NEPC 1999 amended 2013d))</td><td>(Total fruit and vegetable intakes per day as per ASC NEPM (NEPC 1999 amended 2013d))</td><td>(Total fruit and vegetable intakes per day as per ASC NEPM (NEPC 1999 amended 2013d))</td><td colspan="2"></td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Eggs (kg/day)</td><td>0.036</td><td>0.059</td><td>0.036</td><td>0.059</td><td colspan="2" rowspan="2">NR</td></tr>
<tr><td colspan="4">Ingestion rate of eggs per day – P90 consumption for consumers from FSANZ (FSANZ 2017)</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Meat (kg/day)</td><td colspan="2" rowspan="2">NR</td><td>0.085</td><td>0.16</td><td colspan="2" rowspan="2">NR</td></tr>
<tr><td colspan="2">Ingestion rate of beef per day – P90 consumption for consumers from FSANZ (FSANZ 2017) Relevant for consumer for home slaughtered meat</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Milk (kg/day)</td><td colspan="2" rowspan="2">NR</td><td>1.097</td><td>1.295</td><td colspan="2" rowspan="2">NR</td></tr>
<tr><td colspan="2">Ingestion rate of milk per day – P90 consumption for consumers from FSANZ (FSANZ 2017) Relevant for consumer of on farm produced milk</td></tr>
<tr><td rowspan="4">FI</td><td colspan="7">Fraction of media ingested derived from impacted media, or fraction of produce consumed each day derived from the property</td></tr>
<tr><td rowspan="2">Soil</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td><td>100%</td></tr>
<tr><td colspan="6">Assume all soil contact that occurs during a day comes from the one property</td></tr>
<tr><td></td><td>10%</td><td>10%</td><td>35%</td><td>35%</td><td colspan="2">NR</td></tr>
</table>

Parameter		Residential		Farm		Commercial (including café/gallery staff on-site)	Education Centre Visitors
		Young children	Adults	Young children	Adults	Adult	Pre school child
	Fruit and vegetables	Standard conservative assumption for backyard production (NEPC 1999 amended 2013d))		Standard conservative assumption for rural residential production			
	Eggs	100%	100%	100%	100%	NR	
		Assume all eggs consumed are home-produced					
	Meat	NR		100%	100%	NR	
				Assume all meat consumed on farm is produced at the farm (i.e. home slaughtered)			
	Milk	NR		100%	100%	NR	
				Assume all milk consumed on farm is produced at the farm			
B	Bioavailability or absorption of chemical substance via ingestion	100%	100%	100%	100%	100%	100%
		Conservative assumption – maximum possible					
SA	Surface area of body exposed to soil per day (cm^2/day)	2700	6300	2700	6300	3800	2700
		Exposed skin surface area relevant to adults/children and workplaces as per ASC NEPM (NEPC 1999 amended 2013d)					
AF	Adherence factor, amount of soil that adheres to the skin per unit area which depends on soil properties and area of body (mg/cm^2 per event)	0.5	0.5	0.5	0.5	0.5	0.5
		Default (conservative) value from ASC NEPM (NEPC 1999 amended 2013d)					
ABSd	Dermal absorption fraction (unitless)	Chemical specific Refer to **Tables B1 and B2**					
CF	Conversion factor						
	Soil	1×10^{-6} to convert mg to kg (Conversion of units relevant to soil ingestion and dermal contact)					

5.4.3 Inhalation

5.4.3.1 Acute/short term

The assessment of acute exposures is based on comparing the maximum predicted 1-hour average concentration (at the grid maximum (i.e. maximum location for all receptors off the site – these maximum 1 hour averages are the same for both Scenario 1 and the EPA Limit modelling scenario) with health-based criteria relevant to an acute or short-term exposure, also based on a 1-hour average exposure time. In addition, the other types of land use locations in the off-site area have also been compared with health-based criteria relevant to an acute or short-term exposure, also based on a 1-hour average exposure time.

Information about the relevant short term health based criteria adopted for each chemical from reputable sources is provided in **Appendix B**.

The ratio of the maximum predicted concentration to the acute guideline is termed a hazard or risk quotient (RQ). When the maximum predicted concentration for an individual chemical is less than the guideline value that results in a risk quotient less than 1. To deal with exposure to mixtures of chemicals, all risk quotients for the individual chemicals are summed to give a risk index. When that value is less than 1, it means the concentrations of each chemical must be well below the individual guideline values.

Table 19 presents a summary of the relevant health-based guidelines, the predicted maximum 1-hour average concentration and the calculated RQ/RI for the maximum location in the off-site area for both Scenario 1 and the EPA Limit modelling scenario.

All other locations will have lower concentrations than at this location so will have lower RQs and RI. Tables showing the assessments for these other locations are included in **Appendix C**.

Table 19: Review of acute exposures and risks (maximum off-site – 1 hour average) – Scenario 3

Pollutants	Acute air guideline (1-hour average) (mg/m^3)	Modelled Air Concentration		Calculated RQ
		(µg/m^3)	(mg/m^3)	Maximum – Regulatory
Hydrogen chloride (HCl)	0.66[2]	80	0.08	1.2E-01
Hydrogen fluoride (HF)	0.06[2]	5.3	5.3×10^{-03}	8.9E-02
Ammonia	0.18[2]	40	0.04	2.2E-01
Cadmium	0.0054[2]	0.014	1.4×10^{-05}	2.6E-03
Thallium	0.001[2]	0.012	1.2×10^{-05}	1.2E-02
Beryllium	0.0023[4]	0.0011	1.1×10^{-06}	4.9E-04
Mercury	0.0006[3]	0.046	4.6×10^{-05}	7.7E-02
Antimony	1.5[4]	0.0083	8.3×10^{-06}	5.5E-06
Arsenic	0.003[2]	0.01	1.0×10^{-05}	3.4E-03
Lead	0.15[4]	0.028	2.8×10^{-05}	1.9E-04
Chromium (VI)	0.0013[2]	0.083	8.3×10^{-05}	6.4E-02
Cobalt	0.0002[2]	0.0088	8.8×10^{-06}	4.4E-02
Copper	0.1[3]	0.087	8.7×10^{-05}	8.7E-04
Manganese	0.0091[2]	0.024	2.4×10^{-05}	2.7E-03
Nickel	0.0011[2]	0.14	1.4×10^{-04}	1.3E-01
Selenium	0.002[2]	0.028	2.8×10^{-05}	1.4E-02
Vanadium	0.02[2]	0.0048	4.8×10^{-06}	2.4E-04
Tin	0.02[2]	0.029	2.9×10^{-05}	1.5E-03

Pollutants	Acute air guideline (1-hour average) (mg/m³)	Modelled Air Concentration		Calculated RQ
		(µg/m³)	(mg/m³)	Maximum – Regulatory
Dioxins & furans (PCDD/PCDF WHO TEQ)	0.0000013[4]	1.1×10^{-07}	1.1×10^{-10}	8.5E-05
Benzene#	0.17[2]	27	2.7×10^{-02}	1.6E-01
			Total RI (other pollutants)	**0.94**
			Target (acceptable RI)	**≤ 1**

References for health-based acute air guidelines (1-hour average):
1 = NEPM health based guideline (NEPC 2016)
2 = Guideline available from the Texas Commission on Environmental Quality (TCEQ), https://www.tceq.texas.gov/toxicology/esl/list_main.html/#esl_2
3 = Guideline available from California Office of Environmental Health Hazard Assessment (OEHHA) https://oehha.ca.gov/air/general-info/oehha-acute-8-hour-and-chronic-reference-exposure-level-rel-summary
4 = Guideline available from the USEPA as Protective Action Criteria (PAC), where the most conservative value has been adopted with an adjustment of 100 fold to adjust the PAC value which is essentially an occupational value to a public health value https://www.energy.gov/ehss/protective-action-criteria-pac-aegls-erpgs-teels-rev-29-chemicals-concern-may-2016

Risks associated with acute exposures are considered to be in compliance with relevant guidelines (i.e. acceptable) when all individual RQs and the total RI are less than or equal to 1.

Based on the assessment presented in **Table 19**, all the individual RQs and the total RI are less than 1. In this case, the individual risk quotients are between 5 times and 100000 times lower than the relevant guideline based on short term exposure in air. The risk index (i.e. sum of all the risk quotients for each chemical) is also below 1.

On this basis, there are no acute risk issues of concern in relation to inhalation exposures for the proposed facility.

5.4.3.2 Chronic exposures – approach

For the assessment of chronic exposures via inhalation, almost all the pollutants evaluated have a threshold guideline value that enables the predicted annual average concentration to be compared with a health based, or acceptable, guideline (i.e. reference concentrations). In addition, the assessment has considered potential intakes of these chemical substances from other sources, i.e. background intakes.

A small number of pollutants require assessment using a non-threshold approach. For these pollutants, health authorities determine a unit risk to be applied.

Information about the reference doses and unit risks adopted for each chemical from reputable sources is provided in **Appendix B**.

To assess risk via inhalation, the long term average concentration of each pollutant from this facility is compared to the reference concentration recommended by health authorities as posing negligible risk as discussed in **Appendix B**.

For threshold pollutants, the chronic exposure based quotients and index are calculated as follows:

$$\text{RQ}=\frac{\text{Exposure Concentration}}{(\text{Health based criteria or Tolerable Concentration (TC)})\text{x}(100\%\text{-Background})}$$

Where:

Exposure concentration = concentration in air relevant to the exposure period – annual average (mg/m³)

Health based criteria or TC = health-based threshold protective of all health effects for the community (mg/m^3)

Background = proportion of the TC to which people are already exposed from other sources/exposures such as water, soil or products (%). This part of the calculation means that if people are normally exposed to some amount of this pollutant, that exposure a person already has is taken into account.

$$\text{Risk Index (RI)} = \sum_{\text{all chemicals and pathways}} \text{RQs}$$

For non-threshold pollutants, the increased risk of cancer is calculated using the following approach:

$$\text{"}Carcinogenic\ Risk\text{" ("}inhalation\text{")"} = Exposure\ concentration\text{" ("}adjusted\ for\ site - specific\ assumptions\text{")"} * Inhalation\ Unit\ Risk\text{"}$$

Appendix C presents all the calculations undertaken for inhalation exposures for the various land use types including maximum off-site, residential, commercial/industrial, other places and on-site.

Sections 5.4.3.3 to 5.4.3.5 present the calculated individual substance quotients and indices relevant to the assessment of chronic inhalation exposures for both the threshold and non-threshold pollutants for all relevant receptors.

In addition, the combination of this facility and the proposed Next Generation facility located to the east has been assessed for the worst case assessment – maximum off-site location for this facility plus the maximum off-site location for the Next Generation facility should it proceed. It has been assumed that both of these locations could occur at the same spot and that it is possible for residential land use to occur in that location. No other scenarios have been assessed for this cumulative case as all other cases provide a lower risk than that for residential land uses.

Potential risks due to exposures to all listed gases and chemical substances attached to fine particles have been assumed to be additive and the total RI (the sum of all individual substance RQ's) is also presented.

5.4.3.3 Chronic exposures – residential

Exposure to people living at a location and being home 24 hours a day, 365 days per year has been assessed for the ground level concentration at:

- maximum off-site location
- maximum residential location (current)
- maximum location for the other places assessed (i.e. schools, preschool, places of worship etc) (potential future location of a residence)
- maximum commercial/industrial location (potential future location of a residence)

These modelled concentrations have been assessed for the emissions assumed for operational scenario 1 (maximum expected) (**Table 20/21**) and the EPA Limit modelling scenario (maximum regulatory) (**Table 22/23**).

In addition, the worst case cumulative ground level concentration for the maximum off-site location (Scenario 1) for this proposal and the maximum off-site location for the proposed Next Generation facility has been determined and has been assumed to be present at a location where someone might live. These results have been included in **Table 20/21**.

The maximum off-site location for either of these proposals will be a location close to the boundary of the relevant facility. It is not likely to be a location where houses might be constructed (e.g. on the road outside the facility). Also, the maximum off-site locations for each of these developments will not be in the same spot so using the combination of these values to determine the potential cumulative ground level concentrations will be an overestimate (i.e. conservative).

The location of the maximum off-site ground level concentration for a particular chemical for this facility will vary depending on the nature of the chemical (gas vs attached to particles), topography and meteorology.

Table 20: Calculated chronic risks for inhalation exposures – Residential – Scenario 1

Pollutants	Calculated RQ – Maximum off-site	Calculated RQ – Maximum residential	Calculated RQ – Maximum other places	Calculated RQ – Maximum commercial /ind	Calculated RQ – Cumulative with Next Generation
Hydrogen chloride (HCl)	0.0009	0.0006	0.0003	0.0007	0.002
Hydrogen fluoride (HF)	0.0002	0.0001	0.00005	0.0001	0.0002
Ammonia	0.00008	0.00005	0.00002	0.00006	0.00008
Cadmium	0.0003	0.0002	0.00009	0.0002	0.004
Thallium#	0.0000004	0.0000003	0.0000001	0.0000003	0.000001
Beryllium	0.0002	0.0002	0.00007	0.0002	0.0002
Mercury	0.0001	0.00008	0.00004	0.00009	0.0001
Antimony	0.00005	0.00003	0.00001	0.00004	0.0001
Arsenic	0.00001	0.000008	0.000004	0.000008	0.00004
Lead	0.00006	0.00004	0.00002	0.00005	0.0005
Chromium (Cr VI assumed)	0.001	0.0006	0.0003	0.0007	0.001
Cobalt#	0.0001	0.00007	0.00003	0.00007	0.0002
Copper	0.0000002	0.0000001	0.00000006	0.0000002	0.0000002
Manganese	0.0002	0.0002	0.00007	0.0002	0.0009
Nickel	0.01	0.007	0.003	0.008	0.02
Selenium#	0.00006	0.00004	0.00002	0.000008	0.00001
Vanadium#	0.00001	0.000007	0.000004	0.00004	0.0002
Tin#	0.0000001	0.00000009	0.00000004	0.0000001	0.0000002
Dioxin	0.0001	0.00007	0.00003	0.00008	0.0001
Benzene	0.0009	0.0006	0.0003	0.0007	0.001
Total RI (other pollutants)	**0.01**	**0.009**	**0.004**	**0.01**	**0.03**
Negligible risk	**≤1**				

Notes:
Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations
\# marked chemicals could not be assessed across the whole grid for the Next Generation facility as the emission rates were not listed in the publicly available documents. Instead the grid maximum value (i.e. maximum off-site location) listed in Table 20 in the HHRA for the Next Generation facility has been directly summed to the maximum off-site location for this facility

At the maximum off-site location, nickel has the highest risk quotient for operational scenario 1. The maximum concentration of nickel anywhere in the off-site area is 100 fold lower than the guideline issued by health authorities for continuous exposure (i.e. 24 hours a day 365 days a year). The other pollutants range from 1000 to 10 million times lower than the relevant guidelines. The sum of all risk quotients for the various chemicals indicates that the overall risk is 100 times lower than the maximum acceptable value.

For the cumulative case, the same pattern exists. Nickel has the highest risk quotient. The maximum cumulative concentration of nickel is 50 fold lower than the guideline issued by health authorities for continuous exposure (i.e. 24 hours a day 365 days a year). The other pollutants range from 500 to 5 million times lower than the relevant guidelines. The sum of all risk quotients for the various chemicals indicates that the overall risk is more than 30 times lower than the maximum acceptable value.

Table 21: Non-threshold chronic risks for inhalation exposures – Residential – Scenario 1

Pollutants	Calculated Risk – Maximum off-site	Calculated Risk – Maximum residential	Calculated Risk – Maximum other places	Calculated RQ – Maximum commercial/ind	Calculated RQ – Cumulative with Next Generation
Benzene	$7x10^{-8}$	$5x10^{-8}$	$2x10^{-8}$	$5x10^{-8}$	$8x10^{-8}$
Negligible risk	**$\leq1x10^{-5}$**				

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

This assessment has assumed all total volatile organic carbon (TVOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TVOC or TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values which allows this to be a conservative assessment.

At the maximum off-site location, the maximum concentration of benzene anywhere in the off-site area is approximately 150 fold lower than the guideline issued by health authorities for continuous exposure (i.e. 24 hours a day 365 days a year).

The maximum (worst case) cumulative concentration of benzene for the combination of this facility and the proposed Next Generation facility is approximately 125 fold lower than the guideline issued by health authorities for continuous exposure (i.e. 24 hours a day 365 days a year).

Table 22: Calculated chronic risks for inhalation exposures – Residential – EPA Limit modelling scenario

Pollutants	Calculated RQ – Maximum off-site	Calculated RQ – Maximum residential	Calculated RQ – Maximum other places	Calculated RQ – Maximum commercial/ind
Hydrogen chloride (HCl)	0.03	0.02	0.02	0.02
Hydrogen fluoride (HF)	0.002	0.001	0.001	0.001
Ammonia	0.001	0.0007	0.0008	0.0008
Cadmium	0.01	0.008	0.0009	0.009
Thallium	0.00002	0.00001	0.00001	0.00001
Beryllium	0.0002	0.0002	0.0002	0.0002
Mercury	0.0009	0.0006	0.0007	0.0007
Antimony	0.0001	0.00009	0.0001	0.0001
Arsenic	0.00004	0.00002	0.00003	0.00003
Lead	0.0002	0.0001	0.0001	0.0001
Chromium (Cr VI assumed)	0.003	0.002	0.002	0.002
Cobalt	0.0003	0.0002	0.0002	0.0002
Copper	0.0000006	0.0000004	0.0000005	0.0000005
Manganese	0.0007	0.0005	0.0005	0.0005
Nickel	0.03	0.02	0.02	0.02
Selenium	0.00001	0.000007	0.000008	0.000008
Vanadium	0.0002	0.0001	0.0001	0.0001
Tin	0.0000001	0.00000009	0.0000001	0.0000001
Dioxin	0.0002	0.0001	0.0002	0.0002
Benzene	0.009	0.006	0.007	0.007
Total RI (other pollutants)	**0.09**	**0.06**	**0.06**	**0.06**
Negligible risk	**≤1**			

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum off-site location, nickel and hydrogen chloride have the highest risk quotients for the EPA Limit modelling scenario. The maximum concentrations for these chemicals anywhere in the off-site area are 30 fold lower than the guideline issued by health authorities for continuous exposure (i.e. 24 hours a day 365 days a year). The other pollutants range from 100 to 2.5 million times lower than the relevant guidelines. The sum of all risk quotients for the various chemicals indicates that the overall risk is 11 times lower than the maximum acceptable value.

Table 23: Non-threshold chronic risks for inhalation exposures – Residential – EPA Limit modelling scenario

Pollutants	Calculated Risk – Maximum off-site	Calculated Risk – Maximum residential	Calculated Risk – Maximum other places	Calculated RQ – Maximum commercial/ind
Benzene	$7x10^{-7}$	$5x10^{-7}$	$5x10^{-7}$	$5x10^{-7}$
Negligible risk	**$\leq 1x10^{-5}$**			

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum off-site location, the concentration of benzene anywhere in the off-site area is approximately 15 fold lower than the guideline issued by health authorities for continuous exposure (i.e. 24 hours a day 365 days a year).

This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.

5.4.3.4 Chronic exposures – commercial/industrial

Exposure to people working at a location for 10 hours a day, 240 days per year has been assessed for the ground level concentrations at the maximum off-site location and the maximum current commercial/industrial.

These modelled concentrations have been assessed for the emissions assumed for operational scenario 1 (maximum expected) (**Table 24/25**) and the EPA Limit modelling scenario (maximum regulatory) (**Table 26/27**).

Table 24: Calculated chronic risks for inhalation exposures – commercial/industrial – Scenario 1

Pollutants	Calculated RQ – Maximum off-site	Calculated RQ – Maximum commercial/industrial
Hydrogen chloride (HCl)	0.0003	0.0002
Hydrogen fluoride (HF)	0.00005	0.00003
Ammonia	0.00002	0.00002
Cadmium	0.00008	0.00006
Thallium	0.0000001	0.00000008
Beryllium	0.00007	0.00005
Mercury	0.00004	0.00003
Antimony	0.00001	0.00001
Arsenic	0.000003	0.000002
Lead	0.00002	0.00001
Chromium (Cr VI assumed)	0.0003	0.0002
Cobalt	0.00003	0.00002
Copper	0.00000006	0.00000004
Manganese	0.00006	0.00005
Nickel	0.003	0.002
Selenium	0.000003	0.000002
Vanadium	0.00002	0.00001
Tin	0.00000004	0.00000003

Pollutants	Calculated RQ – Maximum off-site	Calculated RQ – Maximum commercial/industrial
Dioxin	0.00003	0.00002
Benzene	0.0003	0.0002
Total RI (other pollutants)	**0.004**	**0.003**
Negligible risk	**≤1**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum off-site location, nickel has the highest risk quotient for operational scenario 1. The maximum concentration of nickel anywhere in the off-site area is 300 fold lower than the guideline issued by health authorities for work day exposure (i.e. 10 hours a day 240 days a year). The other pollutants range from 3000 to 25 million times lower than the relevant guidelines.

Table 25: Non-threshold chronic risks for inhalation exposures – commercial/industrial – Scenario 1

Pollutants	Calculated Risk – Maximum off-site	Calculated Risk – Maximum commercial/industrial
Benzene	2×10^{-8}	1×10^{-8}
Negligible risk	**$\leq 1 \times 10^{-5}$**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum off-site location, the concentration of benzene anywhere in the off-site area is approximately 500 fold lower than the guideline issued by health authorities for work day exposure (i.e. 10 hours a day 240 days a year).

This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.

Table 26: Calculated chronic risks for inhalation exposures – commercial/industrial – EPA Limit modelling scenario

Pollutants	Calculated RQ – Maximum off-site	Calculated RQ – Maximum commercial/industrial
Hydrogen chloride (HCl)	0.008	0.006
Hydrogen fluoride (HF)	0.0005	0.0003
Ammonia	0.0003	0.0002
Cadmium	0.003	0.002
Thallium	0.000004	0.000003
Beryllium	0.00007	0.00005
Mercury	0.0002	0.0002
Antimony	0.00004	0.00003
Arsenic	0.00001	0.000007
Lead	0.00005	0.00004
Chromium (Cr VI assumed)	0.0008	0.0006
Cobalt	0.00008	0.00006
Copper	0.0000002	0.0000001
Manganese	0.0002	0.0001
Nickel	0.008	0.006
Selenium	0.000003	0.000002
Vanadium	0.00005	0.00003
Tin	0.00000004	0.00000003
Dioxin	0.00006	0.00004
Benzene	0.003	0.002

Pollutants	Calculated RQ – Maximum off-site	Calculated RQ – Maximum commercial/industrial
Total RI (other pollutants)	**0.02**	**0.02**
Negligible risk	**≤1**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum off-site location, nickel has the highest risk quotient for the EPA Limit modelling scenario. The maximum concentration of nickel anywhere in the off-site area is 125 fold lower than the guideline issued by health authorities for work day exposure (i.e. 10 hours a day 240 days a year). The other pollutants range from 300 to 25 million times lower than the relevant guidelines.

Table 27: Non-threshold chronic risks for inhalation exposures – commercial/industrial – EPA Limit modelling scenario

Pollutants	Calculated Risk – Maximum off-site	Calculated Risk – Maximum commercial/industrial
Benzene	2×10^{-7}	1×10^{-7}
Negligible risk	**$\leq 1 \times 10^{-5}$**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum off-site location, the concentration of benzene anywhere in the off-site area is approximately 50 fold lower than the guideline issued by health authorities for work day exposure (i.e. 10 hours a day 240 days a year).

This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.

5.4.3.5 Chronic exposures – on-site visitors

The potential for risks to visitors to the education centre at the site has been assessed using the maximum on-site ground level concentrations and deposition rate. This scenario has been assessed based on assuming a person could visit the site for 4 hours per day on 12 days per year and that they would be in the worst case location on each occasion. This scenario has been developed to cover the situation where a teacher may regularly bring students to the site over a year – presumably different students each time. It has been assumed the person would only breathe the air on each occasion they visit. Even though it is not expected that the same children will visit the site every time a teacher might, the same scenario has been assessed for both adults and children.

The potential for risks to staff working within the gallery/café has also been assessed. This scenario assumes a person may work at the café 10 hours per day 240 days per year breathing the air outside.

These modelled concentrations have been assessed for the emissions assumed for operational scenario 1 (maximum expected) (**Table 28/29**) and the EPA Limit modelling scenario (maximum regulatory) (**Table 30/31**).

Table 28: Calculated chronic risks for inhalation exposures – on-site – Scenario 1

Pollutants	Calculated RQ – Visitor	Calculated RQ – Gallery/café worker
Hydrogen chloride (HCl)	0.000002	0.0001
Hydrogen fluoride (HF)	0.0000004	0.00002
Ammonia	0.0000002	0.000008
Cadmium	0.0000006	0.00003
Thallium	0.0000000008	0.00000004
Beryllium	0.0000005	0.00003
Mercury	0.0000003	0.00001
Antimony	0.0000001	0.000005
Arsenic	0.00000002	0.000001
Lead	0.0000001	0.000007
Chromium (Cr VI assumed)	0.000002	0.0001
Cobalt	0.0000002	0.00001
Copper	0.0000000004	0.00000002
Manganese	0.0000005	0.00002
Nickel	0.00002	0.001
Selenium	0.00000002	0.000001
Vanadium	0.0000001	0.000006
Tin	0.0000000003	0.00000002
Dioxin	0.0000002	0.00001
Benzene	0.000002	0.00009
Total RI (other pollutants)	**0.00003**	**0.002**
Negligible risk	**≤1**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum on-site location, nickel has the highest risk quotient – i.e. is closest to the maximum acceptable risk – assuming emissions occur as per the assumed stack concentrations for operational scenario 1.

The maximum concentration of nickel on-site is 50000 fold lower than the guideline issued by health authorities relevant for people visiting the education centre (i.e. 4 hours a day 12 days a year). The other pollutants are even lower proportions of the relevant guidelines.

The maximum concentration of nickel on-site is 1000 fold lower than the guideline issued by health authorities relevant for people who work in the gallery/cafe. The other pollutants are even lower proportions of the relevant guidelines.

This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.

Table 29: Non-threshold chronic risks for inhalation exposures – on-site – Scenario 1

Pollutants	Calculated Risk – Visitor	Calculated Risk – Gallery/café worker
Benzene	1×10^{-10}	6×10^{-9}
Negligible risk	**$\leq 1 \times 10^{-5}$**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

For operational scenario 1, the concentration of benzene at the maximum on-site location is approximately 100000 fold lower than the guideline issued by health authorities relevant for people visiting the education centre (i.e. 4 hours a day 12 days a year).

For operational scenario 1, the concentration of benzene at the maximum on-site location is approximately 1500 fold lower than the guideline issued by health authorities relevant for people who work in the gallery/cafe.

This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.

Table 30: Calculated chronic risks for inhalation exposures – on-site – EPA Limit modelling scenario

Pollutants	Calculated RQ – Visitor	Calculated RQ – Gallery/café worker
Hydrogen chloride (HCl)	0.00006	0.003
Hydrogen fluoride (HF)	0.000004	0.0002
Ammonia	0.000002	0.0001
Cadmium	0.00003	0.001
Thallium	0.00000003	0.000002
Beryllium	0.0000005	0.00003
Mercury	0.000002	0.00009
Antimony	0.0000003	0.00002
Arsenic	0.00000007	0.000004
Lead	0.0000004	0.00002
Chromium (Cr VI assumed)	0.000006	0.0003
Cobalt	0.0000006	0.00003
Copper	0.000000001	0.00000006
Manganese	0.000001	0.00007
Nickel	0.00006	0.003
Selenium	0.00000002	0.000001
Vanadium	0.0000003	0.00002
Tin	0.0000000003	0.00000002
Dioxin	0.0000005	0.00002
Benzene	0.00002	0.0009
Total RI (other pollutants)	**0.0002**	**0.009**
Negligible risk	**≤1**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

At the maximum on-site location, nickel has the highest risk quotient – i.e. is closest to the maximum acceptable risk – assuming emissions occur as per the assumed stack concentrations for the EPA Limit modelling scenario.

The maximum concentration of nickel in air on-site is approximately 15000 fold lower than the guideline issued by health authorities relevant for people visiting the education centre (i.e. 4 hours a day 12 days a year). The other pollutants are an even lower proportion of the relevant guidelines.

The maximum concentration of nickel on-site is 300 fold lower than the guideline issued by health authorities relevant for people who work in the gallery/cafe. The other pollutants are even lower proportions of the relevant guidelines.

This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.

Table 31: Non-threshold chronic risks for inhalation exposures – on-site – EPA Limit modelling scenario

Pollutants	Calculated Risk – Visitor	Calculated Risk – Gallery/café worker
Benzene	$1x10^{-9}$	$6x10^{-8}$
Negligible risk	**$\leq 1x10^{-5}$**	

* Refer to **Appendices B** and **C** for detail on health based criteria and risk calculations

For the EPA Limit modelling scenario, the concentration of benzene at the maximum on-site location is approximately 10000 fold lower than the guideline issued by health authorities relevant for people visiting the education centre (i.e. 4 hours a day 12 days a year).

For the EPA Limit modelling scenario, the concentration of benzene at the maximum on-site location is approximately 150 fold lower than the guideline issued by health authorities relevant for people who work in the gallery/cafe.

This assessment has assumed all total organic carbon (TOC) emitted by the facility is present as benzene. This is a conservative assessment as these emissions (measured as TOC) will actually be a mix of chemicals. Benzene has been used to assess this mix as it has the most sensitive guideline values.

5.4.3.6 Chronic exposures – summary

Risks associated with chronic exposures by inhalation are considered to be acceptable/negligible where the individual and total RI's are less than or equal to 1 for all exposure and operational scenarios. Based on the assessment presented in these tables (and in the spreadsheet images in **Appendix C**), all the individual RQs and the total RI's for the maximum inhalation exposures that may occur in residential locations or in commercial/industrial areas are all less than 1.

On this basis, there are no chronic risk issues of concern in relation to inhalation exposures.

5.4.4 Other pathways

5.4.4.1 General

Where pollutants may be bound to particulates, are persistent in the environment and have the potential to bioaccumulate in plants or animals, it is relevant to also assess potential exposures that may occur as a result of particles depositing onto soil where a range of other exposures may then occur.

These exposure pathways include:

- Incidental ingestion and dermal contact with soil (and dust indoors that is derived from outdoor soil or deposited particles);
- Ingestion of homegrown fruit and vegetables where particles may deposit onto the plants and is also present in the soil where the plants are grown, and where pollutants bound to these particles are taken up into these plants;
- Ingestion of eggs where particles may deposit onto the ground and be present in soil (which the pasture/feed grows in and animals also ingest when feeding), and the pollutants bound to these particles are taken up into the eggs.
- Ingestion of milk where particles may deposit onto the ground and be present in soil (which the pasture/feed grows in and animals also ingest when feeding), and the pollutants bound to these particles are taken up into milk (consumed on farm).

- Ingestion of meat where particles may deposit onto the ground and be present in soil (which the pasture/feed grows in and animals also ingest when feeding), and the pollutants bound to these particles are taken up into meat (consumed on farm).

These exposures are only relevant over the longer term so this assessment has used the annual average concentrations determined in the air quality modelling and has assumed that deposition occurs for at least 70 years and it is the accumulated concentration of each chemical at the end of that 70 years that is assessed here.

The calculation of risks posed by multiple pathway exposures only relates to pollutants that are bound to the particles, not to pollutants only present as vapours or gases. Consequently, non-threshold risks for benzene are not assessed for these other pathways. Benzene is present as a gas not attached to particle.

Appendix B includes the equations and assumptions adopted for the assessment of potential exposures via these exposure pathways, with the calculation of risk for each of these exposure pathways presented in **Appendix C**.

Once exposure for each pathway has been assessed, the predicted daily intake of a pollutant from all pathways (i.e. inhalation, direct contact with soil and intake from consumption of home grown produce) can be compared to the reference dose recommended by health authorities as posing negligible risk. Information about the reference doses adopted for each chemical from reputable sources is provided in **Appendix B**.

As discussed in **Section 5.4.2** different combinations of these pathways have been assessed for different land uses.

Sections 5.4.4.2 to **5.4.4.7** present the calculated risks associated with these multiple pathway exposures relevant to both adults and children for the various combinations relevant for each land use. These risks have been calculated on the basis of the maximum predicted deposition rate at the maximum relevant location for each land use type for operational scenario 1 and 5.

The cumulative case for the combination of this facility and the proposed Next Generation facility is discussed in **Section 5.4.4.2**.

Each table presents the total RI for each exposure pathway separately, calculated as the sum over all the pollutants evaluated. The table also includes the calculated RI associated with inhalation exposures provided in **Section 5.4.3**, as these exposures are additive to the other exposure pathways. As noted above, these exposure pathways for deposition of particles are not relevant for benzene (i.e. TOC). This was the only chemical assessed for non-threshold risks in **Sections 5.4.3.2** to **5.4.3.5** so no further consideration of additional non-threshold risks is required here..

5.4.4.2 Maximum off-site

The location in the off-site area with the maximum concentrations will be just outside the boundary of the site.

Scenario 1

Locations close to the facility are for industrial or commercial uses or major roads. None of these locations are relevant for home grown produce. The maximum off-site location has been assessed based on assuming a person could live at that location breathing the air and having direct contact with soil for up to 35 years (6 as a child and 29 as an adult). Home grown produce is not included in this part of the assessment.

Table 32: Summary of risks for multiple pathway exposures– Maximum off-site – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.01	0.01
Soil ingestion (SI)	0.004	0.04
Soil dermal contact (SD)	0.002	0.003
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.02	0.05
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum off-site location, the total risk is approximately 20 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in scenario 1.

Cumulative case

Modelling calculations have not been undertaken for the cumulative case considering both this facility and the proposed Next Generation facility. However, an estimate for risks due to deposition from both facilities can be undertaken by considering the additional contribution from deposition of long lived chemicals to overall exposure from the calculations for this facility alone and applying that to the calculations undertaken in **Section 5.4.3.3** for inhalation in the cumulative case.

The risk index for inhalation for the combination of the maximum off-site location for this facility and the maximum off-site location for the proposed Next Generation facility was 0.03. The additional contribution from deposition in **Table 32** was a five fold increase for children and a two fold increase for adults. This results in a worst case overall risk index for inhalation and deposition for the cumulative case assuming both facilities are approved and constructed of 0.06 to 0.15.

EPA limit modelling case

Table 33: Summary of risks for multiple pathway exposures– Maximum off-site – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.09	0.09
Soil ingestion (SI)	0.01	0.1
Soil dermal contact (SD)	0.004	0.008
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.1	0.2
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum off-site location, the total risk is approximately 5 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in the EPA Limit modelling scenario.

5.4.4.3 Residential

The residential exposure scenario has been assessed for three locations:

- Maximum location which is currently used for residential purposes (**Tables 34, 35, 36, 37, 38** and **39**)
- Maximum location which is currently used for commercial/industrial purposes (**Tables 40** and **41**)
- Maximum location currently used for other purposes (e.g. schools, preschools, places of worship etc) (**Tables 42** and **43**)

At each of these locations it has been assumed that a person may live there for up to 35 years (6 as a child and 29 as an adult) breathing the air, coming into contact with soil, growing and consuming home grown produce (fruit, vegetables, eggs).

For each of these locations, exposure (and risk) has been assessed for both operational scenario 1 type emissions and the EPA Limit modelling scenario type emissions.

Scenario 1

Table 34: Summary of risks for multiple pathway exposures– current maximum residential – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.009	0.009
Soil ingestion (SI)	0.0004	0.004
Soil dermal contact (SD)	0.0002	0.0003
Ingestion of homegrown fruit and vegetables (F&V)	0.0003	0.0009
Ingestion of homegrown eggs (E)	0.0008	0.002
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.01	0.01
I + SI + SD + F&V	0.01	0.01
I + SI + SD + E	0.01	0.02
All pathways combined	0.01	0.02
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the current maximum residential location in the area surrounding the proposed facility, the total risk is approximately 50 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in scenario 1 even when all exposure pathways may be relevant.

EPA limit modelling case

Table 35: Summary of risks for multiple pathway exposures– current maximum residential – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.06	0.06
Soil ingestion (SI)	0.001	0.01
Soil dermal contact (SD)	0.0004	0.0007
Ingestion of homegrown fruit and vegetables (F&V)	0.002	0.005

Exposure pathway	Calculated HI	
	Adults	Children
Ingestion of homegrown eggs (E)	0.002	0.005
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.06	0.07
I + SI + SD + F&V	0.06	0.08
I + SI + SD + E	0.06	0.08
All pathways combined	0.06	0.08
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the current maximum residential location in the area surrounding the proposed facility, the total risk is approximately 12 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in the EPA Limit modelling scenario even when all exposure pathways may be relevant.

Scenario 1

Table 36: Summary of risks for multiple pathway exposures– current maximum commercial location if assumed to be a residential location – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.01	0.01
Soil ingestion (SI)	0.002	0.02
Soil dermal contact (SD)	0.0007	0.001
Ingestion of homegrown fruit and vegetables (F&V)	0.001	0.004
Ingestion of homegrown eggs (E)	0.0009	0.002
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.01	0.03
I + SI + SD + F&V	0.01	0.03
I + SI + SD + E	0.01	0.03
All pathways combined	0.02	0.04
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the current maximum commercial location in the area surrounding the proposed facility, the total risk is approximately 30 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in scenario 1 if this site should change to residential land use and all exposure pathways may be relevant.

EPA limit modelling case

Table 37: Summary of risks for multiple pathway exposures– current maximum commercial location if assumed to be a residential location – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.06	0.06
Soil ingestion (SI)	0.006	0.06
Soil dermal contact (SD)	0.002	0.003
Ingestion of homegrown fruit and vegetables (F&V)	0.009	0.02
Ingestion of homegrown eggs (E)	0.008	0.02
Multiple pathways (i.e. combined exposure pathways)		

Exposure pathway	Calculated HI	
	Adults	Children
I + SI + SD	0.07	0.1
I + SI + SD + F&V	0.08	0.1
I + SI + SD + E	0.08	0.1
All pathways combined	0.09	0.3
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the current maximum commercial location in the area surrounding the proposed facility, the total risk is approximately 10 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in the EPA Limit modelling scenario if this site should change to residential land use and all exposure pathways may be relevant.

Scenario 1

Table 38: Summary of risks for multiple pathway exposures– current maximum for other places location if assumed to be a residential location – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.01	0.01
Soil ingestion (SI)	0.0003	0.003
Soil dermal contact (SD)	0.0001	0.0003
Ingestion of homegrown fruit and vegetables (F&V)	0.0003	0.0008
Ingestion of homegrown eggs (E)	0.0008	0.002
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.01	0.01
I + SI + SD + F&V	0.01	0.02
I + SI + SD + E	0.01	0.02
All pathways combined	0.01	0.02
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the current maximum other places location in the area surrounding the proposed facility, the total risk is approximately 50 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in scenario 1 if this site should change to residential land use even when all exposure pathways may be relevant.

EPA limit modelling case

Table 39: Summary of risks for multiple pathway exposures– Current maximum location for Other Places if assumed to be a residential location – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.06	0.06
Soil ingestion (SI)	0.001	0.01
Soil dermal contact (SD)	0.0003	0.0006
Ingestion of homegrown fruit and vegetables (F&V)	0.002	0.004
Ingestion of homegrown eggs (E)	0.002	0.005
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.06	0.07
I + SI + SD + F&V	0.06	0.07

Exposure pathway	Calculated HI	
	Adults	Children
I + SI + SD + E	0.06	0.07
All pathways combined	0.06	0.08
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the current maximum other places location in the area surrounding the proposed facility, the total risk is approximately 12 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in the EPA Limit modelling scenario if this site should change to residential land use even when all exposure pathways may be relevant.

5.4.4.4 Commercial

The maximum commercial/industrial location in the off-site area has been assessed based on assuming a person could work at that location breathing the air and having direct contact with soil 240 days per year for up to 30 years as an adult. Exposure as a child has also been included in case children could regularly visit a workplace. Home grown produce is not included in this part of the assessment.

This assessment is shown in **Tables 40** and **41**.

Scenario 1

Table 40: Summary of risks for multiple pathway exposures– Maximum commercial – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.003	0.01
Soil ingestion (SI)	0.0005	0.01
Soil dermal contact (SD)	0.0003	0.0009
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.004	0.02
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum commercial/industrial location in the area surrounding the proposed facility, the total risk is at least 50 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in scenario 1 for a workplace.

EPA limit modelling case

Table 41: Summary of risks for multiple pathway exposures– Maximum commercial – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.02	0.02
Soil ingestion (SI)	0.004	0.04
Soil dermal contact (SD)	0.001	0.002
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.02	0.06

Exposure pathway	Calculated HI	
	Adults	Children
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum commercial/industrial location in the area surrounding the proposed facility, the total risk is at least 15 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in the EPA Limit modelling scenario for a workplace.

5.4.4.5 Nearby farms

The exposure scenario for a farm has been assessed for the maximum location amongst the existing farms. It is assumed that a person may live at the farm for up to 35 years (6 as a child and 29 as an adult) breathing the air, coming into contact with soil, growing and consuming home grown produce (fruit, vegetables, eggs) and, in addition, keeping livestock for on farm consumption of meat and milk. For each of these locations, exposure (and risk) has been assessed for both operational scenario 1 type emissions and the EPA Limit modelling scenario type emissions.

This assessment is shown in **Tables 42** and **43**.

Scenario 1

Table 42: Summary of risks for multiple pathway exposures– maximum farm location – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.005	0.005
Soil ingestion (SI)	0.0002	0.002
Soil dermal contact (SD)	0.00008	0.0002
Ingestion of homegrown fruit and vegetables (F&V)	0.0006	0.001
Ingestion of homegrown eggs (E)	0.0004	0.001
Ingestion of homegrown meat (B)	0.004	0.009
Ingestion of homegrown milk (M)	0.001	0.005
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.005	0.007
I + SI + SD + F&V	0.006	0.008
I + SI + SD + E	0.006	0.008
I + SI + SD + F&V + E	0.006	0.009
I + SI + SD + B	0.009	0.02
I + SI + SD + M	0.007	0.01
All pathways combined	0.01	0.02
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum farm location in the area surrounding the proposed facility, the total risk is at least 50 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in scenario 1 considering all pathways combined.

EPA limit modelling case

Table 43: Summary of risks for multiple pathway exposures– maximum farm location – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Inhalation (I)	0.07	0.07
Soil ingestion (SI)	0.0007	0.006
Soil dermal contact (SD)	0.0002	0.0003
Ingestion of homegrown fruit and vegetables (F&V)	0.004	0.008
Ingestion of homegrown eggs (E)	0.0009	0.002
Ingestion of homegrown meat (B)	0.007	0.02
Ingestion of homegrown milk (M)	0.004	0.02
Multiple pathways (i.e. combined exposure pathways)		
I + SI + SD	0.07	0.08
I + SI + SD + F&V	0.07	0.08
I + SI + SD + E	0.07	0.08
I + SI + SD + F&V + E	0.07	0.09
I + SI + SD + B	0.08	0.09
I + SI + SD + M	0.07	0.09
All pathways combined	0.08	0.1
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum farm location in the area surrounding the proposed facility, the total risk is at least 10 fold lower than the guidance issued by health authorities indicates is acceptable for emissions at the level assessed in the EPA Limit modelling scenario considering all pathways combined.

5.4.4.6 Rainwater tanks

The potential for impacts on rainwater tanks in the off-site area has been estimated using the maximum deposition rate for each chemical at the maximum location for residential and commercial/industrial land uses.

NSW HEALTH has issued guidance about the use of rainwater tanks in urban areas for drinking (https://www.health.nsw.gov.au/environment/water/Pages/rainwater.aspx) . They note that the most reliable drinking water supply in urban areas will be the public water supply from Sydney Water (or equivalent). In urban areas, the quality of water in rainwater tanks can be affected by microorganisms or by chemicals from heavy traffic and other emissions while that supplied in the public water supply is filtered and disinfected as well as regularly monitored to ensure it is of appropriate quality. NSW Health does support the use of rainwater tanks for the supply of water for non-drinking uses.

Noting this advice, the estimated concentrations in a rainwater tank have been assessed considering both ingestion and direct contact exposure pathways in a similar fashion to the calculations for contact with soil. The assumptions used in the calculations are those relevant to the Australian Drinking Water Guidelines from NHMRC (NHMRC 2011 updated 2018). This assessment has been undertaken for both operational scenarios.

Drinking water guidelines are used to define water of a quality that is suitable for uses around the home, so these guidelines are considered appropriate to assess water used for various domestic uses including showering, cooking, cleaning and irrigation.

Appendix B includes the equations and assumptions adopted for the assessment of potential exposures via deposition into a rainwater tank, with the calculation of risk presented in **Appendix C**.

The rainwater tank exposure scenario has been assessed for three locations:

- Maximum location which is currently used for residential purposes (**Tables 44** and **45**)
- Maximum location which is currently used for commercial/industrial purposes (**Tables 46** and **47**)
- Maximum location currently used for farming (**Tables 48** and **49**)

Maximum residential

Table 44: Summary of risks for rainwater tanks– maximum residential– Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Water ingestion	0.0005	0.0004
Water dermal contact	0.000004	0.00001
Total	0.0005	0.0004
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum residential location in the area surrounding the proposed facility, the total risk related to using water from a rainwater tank is at least 2000 fold lower for operational scenario 1 than the guidance issued by health authorities as acceptable.

Table 45: Summary of risks for rainwater tanks– maximum residential – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Water ingestion	0.001	0.0009
Water dermal contact	0.00001	0.00003
Total	0.001	0.0009
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum residential location in the area surrounding the proposed facility, the total risk related to using water from a rainwater tank is at least 1000 fold lower for the EPA Limit modelling scenario than the guidance issued by health authorities as acceptable.

Maximum commercial

Table 46: Summary of risks for rainwater tanks– maximum commercial – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Water ingestion	0.002	0.002
Water dermal contact	0.00002	0.00005
Total	0.002	0.002
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum commercial/industrial location in the area surrounding the proposed facility, the total risk related to using water from a rainwater tank is at least 500 fold lower for operational scenario 1 than the guidance issued by health authorities as acceptable.

Table 47: Summary of risks for rainwater tanks– maximum commercial – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Water ingestion	0.004	0.004
Water dermal contact	0.00004	0.0001
Total	0.004	0.004
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum commercial/industrial location in the area surrounding the proposed facility, the total risk related to using water from a rainwater tank is at least 250 fold lower for the EPA Limit modelling scenario than the guidance issued by health authorities as acceptable.

Maximum farm

Table 48: Summary of risks for rainwater tanks– maximum farm – Scenario 1

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Water ingestion	0.0002	0.0002
Water dermal contact	0.000002	0.000005
Total	0.0002	0.0002
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum farm location in the area surrounding the proposed facility, the total risk related to using water from a rainwater tank is at least 5000 fold lower for operational scenario 1 than the guidance issued by health authorities as acceptable.

Table 49: Summary of risks for rainwater tanks– maximum farm – EPA Limit modelling scenario

Exposure pathway	Calculated HI	
	Adults	Children
Individual exposure pathways		
Water ingestion	0.0005	0.0005
Water dermal contact	0.000005	0.00001
Total	0.0005	0.0005
Negligible risk	**≤1**	**≤1**

Refer to **Appendix C** for detailed risk calculations for each exposure pathway

At the maximum farm location in the area surrounding the proposed facility, the total risk related to using water from a rainwater tank is at least 2000 fold lower for the EPA Limit modelling scenario than the guidance issued by health authorities as acceptable.

5.4.4.7 Prospect Reservoir

The concentration in Prospect Reservoir depends on the deposition rate of dust onto the surface of the water and onto the surrounding catchment, the volume of the reservoir and the volume of rainfall each year.

One part of the calculation is to determine the concentrations of relevant chemical due to particles falling on the surface of the reservoir and mixing into the dam water. Another part of the calculation is to determine the additional amount of each chemical that could be due to particles falling on the ground surrounding the reservoir (the catchment) that then get washed into the reservoir during rain.

In both cases there are other sources of these chemicals in normal urban environments and due to the geological makeup of soil in the area. The calculations undertaken for this assessment have just addressed the additional amounts of these chemicals that could be present due to emissions from this facility.

The estimated concentrations in the Reservoir have then been directly compared to the Australian Drinking Water Guidelines from NHMRC (NHMRC 2011 updated 2018). This assessment has been undertaken for both operational scenarios.

Drinking water guidelines are used to define water of a quality that is suitable for uses around the home, so these guidelines are considered appropriate to assess water used for various domestic uses including showering, cooking, cleaning and irrigation.

Appendix B includes the equations and assumptions adopted for the assessment of potential exposures via deposition into the Reservoir, with the calculation of risk presented in **Appendix C**. This assessment is shown in **Tables 50** and **51**.

Table 50: Drinking water assessment for Prospect Reservoir – Scenario 1

Pollutants	Estimated dissolved concentration in reservoir (mg/L)	Drinking water guideline (mg/L)	Risk Quotient
Cadmium	0.000000005	0.002 A	0.000002
Thallium	0.00000001	0.0002 U	0.00005
Beryllium	0.000000001	0.06 A	0.00000002
Mercury	0.000000008	0.001 A	0.000008
Antimony	0.00000006	0.003 A	0.00002
Arsenic	0.0000001	0.01 A	0.00001
Lead	0.00000001	0.01 A	0.000001
Chromium (Cr VI assumed)	0.000002	0.05 A	0.00003
Cobalt	0.00000006	0.006 U	0.00001
Copper	0.0000008	2 A	0.0000004
Manganese	0.0000001	0.5 A	0.0000002
Nickel	0.0000007	0.02 A	0.00004
Selenium	0.000006	0.01 A	0.0006
Vanadium	0.000000001	0.086 U	0.00000002
Tin	0.0000001	0.7 A	0.0000002
Dioxins	0.000000000000002	0.00000001 U	0.0000002
		Total RI (other pollutants)	**0.0008**
		Negligible risk	**≤1**

Notes:

A = Australian Drinking Water Guidelines (NHMRC 2011 updated 2018)

U = USEPA Regional Screening Levels for residential tap water (USEPA 2020)

The estimated concentrations in Prospect Reservoir for operational scenario 1 are at least 1500 times lower than the individual drinking water guidelines that apply to each pollutant. Overall, when the risk quotients are summed the combination of these concentrations results in a risk that is 1250 fold lower than the guidance issued by health authorities as acceptable.

Table 51: Drinking water assessment for Prospect Reservoir – EPA Limit modelling scenario

Pollutants	Estimated dissolved concentration in reservoir (mg/L)	Drinking water guideline (mg/L)	Risk Quotient
Cadmium	0.0000002	0.002 A	0.00009
Thallium	0.0000004	0.0002 U	0.002
Beryllium	0.000000001	0.06 A	0.00000002
Mercury	0.00000006	0.001 A	0.00006
Antimony	0.0000002	0.003 A	0.00006
Arsenic	0.0000004	0.01 A	0.00004
Lead	0.00000003	0.01 A	0.000003
Chromium (Cr VI assumed)	0.000004	0.05 A	0.00009
Cobalt	0.0000002	0.006 U	0.00003
Copper	0.000002	2 A	0.000001
Manganese	0.0000004	0.5 A	0.0000007
Nickel	0.000002	0.02 A	0.0001
Selenium	0.000006	0.01 A	0.0006
Vanadium	0.000000004	0.086 U	0.00000005
Tin	0.0000001	0.7 A	0.0000002
Dioxins	0.000000000000002	0.00000001 U	0.0000002
		Total RI (other pollutants)	**0.003**
		Negligible risk	**≤1**

Notes:

A = Australian Drinking Water Guidelines (NHMRC 2011 updated 2018)

U = USEPA Regional Screening Levels for residential tap water (USEPA 2020)

The estimated concentrations in Prospect Reservoir for the EPA Limit modelling scenario are at least 500 times lower than the individual drinking water guidelines that apply to each pollutant. Overall, when the risk quotients are summed the combination of these concentrations results in a risk that is at least 300 fold lower than the guidance issued by health authorities as acceptable.

In addition to considering how far below drinking water guidelines these estimated concentrations are, it is also important to note that they are so small as to be not able to be detected using routine and specialised analyses. The normal limits of reporting for metals are in the range of 0.0001-0.01 mg/L depending on which metal is being measured. For dioxins, the limit of reporting is at least 0.0000000001 mg/L.

Most of these chemicals are already present in most waters and these additional concentrations arising from the emissions from this proposed facility are immeasurably small changes in existing concentrations.

5.5 Summary

This assessment has shown:

- No unacceptable risks for criteria pollutants (NO_x, SO_x, CO, $PM_{2.5}$, PM_{10})
- No unacceptable risks for short term exposures from the proposed facility at the maximum off-site location – all other locations will have lower concentrations and so risks will be lower

- No unacceptable risks for relevant exposure scenarios considering long term exposures at:
  - Maximum off-site location
  - Maximum residential location (and maximum commercial/industrial and maximum other places if land use changes to residential)
  - Maximum commercial/industrial location
  - Maximum other places location (including farms)
  - Maximum on-site location
- No unacceptable risks for relevant exposure scenarios for rainwater tanks or Prospect Reservoir
- No unacceptable risks for worst case scenario for the cumulative case considering both this facility and the proposed Next Generation facility

5.6 Uncertainties

The characterisation of potential health risks related to exposures to emissions to air from the proposed EfW facility has utilised data from the air quality modelling as well as a number of assumptions. The following presents further discussion on these data and parameters, the level of uncertainty in these values and whether changes in these values will change the outcome of the assessment presented.

Air modelling

The modelling of air emissions has been undertaken by Todoroski Air Sciences (2020) using a regulatory approved model, which utilises meteorological and terrain data for the local area. The emissions data used in the assessment were based on measured emissions from a reference facility (expected) and on the maximum permissible levels as provided in NSW regulation or the EU Industrial Emissions Directive. It is expected that the modelled ground level concentrations are appropriately conservative.

Inhalation exposures

<u>Residential exposures:</u>

It is assumed that residents are home 24 hours per day, every day of the year for as long as they live at their home. This is an overestimate as most people spend time away from home at childcare, school, work or other activities and for holidays away from the home. When they are away from their houses they will breathe the air (and whatever it contains) in the location where they are, not that present at their homes. As a result, the risks calculated for inhalation exposures are considered conservative.

For the purposes of this assessment, it has been assumed that someone might be present at the worst case location anywhere off-site for 24 hours a day, 365 days per year. Even at this location (which will be on the road outside the facility or on the M7), the total risk is at least 10-100 fold less than the maximum acceptable value. It is not possible for anyone to live at this location. In addition, the potential risks via inhalation have been assessed for the maximum residential, commercial/industrial and other places locations for the residential scenario. This covers the situation if land use changes at a site closer to the facility at some time in the future.

It is noted that for most of the sites immediately surrounding the proposed facility, it is not possible for the land use to change to residential because they are:

- long standing industrial facilities which are not likely to move
- current and former landfills which cannot easily be converted to residential land use
- Western Sydney Parklands designated as long term green space.

Industrial workers:

For workers at commercial/industrial sites around the proposed facility, it has been assumed that they are present for 10 hours a day for 240 days of the year. This scenario is slightly more conservative than the commercial/industrial scenario used to generate guidelines for such land in the National Environment Protection (Assessment of Site Contamination) Measure where workers are assumed to be present for 8 hours per day. A longer day has been assumed for this assessment given the existing uses on the sites immediately surrounding the proposed facility.

Multi-pathway exposures

These have been calculated on the basis of modelled dust deposition rates. It is noted that, due to presence of extensive flue gas treatment equipment in the proposed facility, the deposition rate is estimated to be very low. The potential for deposition to increase concentrations in soil for the relevant chemicals that could be present in the emissions from the proposed facility has still been estimated.

The quantification of potential intakes via ingestion of soil, fruit and vegetables, milk, meat and/or eggs, and dermal contact with soil, has adopted a number of assumptions relating to how the dust mixes in with soil, how much accumulates in fruit and vegetables, milk, meat and eggs, and how people may be exposed. These assumptions have used conservative models and uptake factors that are likely to overestimate the accumulation of pollutants in soil, fruit and vegetables, milk, meat and eggs. In addition, default exposure parameters have been adopted assuming exposures occur all day every day, which is conservative. For example, ingestion rates for each of the food types have been based on guidance from FSANZ about a high end consumer – i.e. when they surveyed people the values chosen for use in these calculations are the amounts a person in the top 10% of people consuming that food type said they ate on the survey day.

Overall, the approach taken will have overestimated actual exposures and risks. Changes in the assumptions to those more representative of actual exposures will result in lower levels of risk, rather than higher levels of risk.

6 Impacts from the transport of waste material

The SEARS include a requirement for discussion of the potential for health impacts from air emissions generated by waste transportation (i.e. truck movements or rail transport) required for this project.

This matter has been assessed/discussed in the air quality impact assessment and in the traffic assessment (Todoroski Air Sciences 2020, ARUP 2020).

During construction there are expected to be 85 truck movements a day to and from the site and 600 workers on-site. Parking for workers will be provided on-site (Todoroski Air Sciences 2020, ARUP 2020).

During operations there are expected to be up to 236 vehicle movements per day to and from the site on average. This includes cars for staff and visitors as well as the trucks bringing waste to the site (Todoroski Air Sciences 2020, ARUP 2020).

This is an increase compared to the former use of the site for egg production. Vehicle movements were around 70 per day.

The waste to be treated at this facility (i.e. residual municipal solid waste (MSW) and residual commercial and industrial (C&I) waste streams) will be primarily sourced from the general area around the facility.

These waste streams currently exist and are transported around the region to locations for sorting. Once sorted the residual materials that cannot be recycled are currently transported to a landfill for final disposal.

Existing landfills that receive such waste from various parts of Sydney include locations such as SUEZ Kemps Creek Resource Recovery Park, SUEZ Lucas Heights Resource Recovery Park, Veolia Woodlawn, Summerhill Waste Management Centre (City of Newcastle) and others.

Currently, kerbside waste is collected in the local area and taken to the Cleanaway Erskine Park Landfill. Here it is sorted and the residual waste is taken to a landfill in Newcastle (Summerhill) or to the ResourceCo facility in Wetherill Park. Commercial/industrial waste is also taken to the Erskine Park Landfill for sorting.

If this proposed facility were to be approved, the same system would be in place to collect kerbside waste so there would be no change in transport emissions from this part of the process. There would also be no change in emissions for waste being delivered to the Erskine Park Landfill from commercial/industrial customers.

Any change would result from the change in travel for trucks handling residual waste from the Erskine Park Landfill. Instead of the material being transported to Newcastle or to Wetherill Park (or other locations outside the immediate area), it would be transported to this facility.

This proposed facility is located approximately 6.5 km from the Erskine Park Landfill while the ResourceCo facility at Wetherill Park is approximately 12 km from the Erskine Park Landfill. The landfill in Newcastle is more than 100 km from the Erskine Park Landfill. This means, currently, residual waste travels either 12 km or more than 100 km. For the new facility, this waste will only travel 6.5 km.

It is expected that 50% of the waste coming to the site will be from the Erskine Park transfer facility. The vehicles delivering this waste will have large capacity to minimise the number of movements per day. The access road will be upgraded as part of this project to ensure it is adequate for the situation.

Todoroski Air Sciences has undertaken modelling of the change in expected emissions from truck movements within 10 km of this facility. The change in emissions has been modelled using the assumptions about amounts and end points for waste listed in **Table 52**. The modelling looked at the kilometres travelled for trucks delivering waste to the various locations from each suburb within 10 km of this facility. These kilometres travelled were then multiplied by exhaust emission factors for heavy duty diesel (rigid or articulated) trucks from the NSW EPA Air Emissions Inventory (NSW EPA 2012). The modelling has then looked at the change in emissions for each suburb with 10 km of this facility.

Table 52: Waste movement assumptions

From site	To site	Assumed % of waste	Yearly volume (tonnes)	Daily volume (tonnes)	Truck capacity (tonnes)	Number of trucks (daily)
Without proposal						
Cleanaway Erskine Park	ResourceCo	38%	95,000	317	20	16
Cleanaway Erskine Park	Summer Hill	62%	155,000	517	20	26
With proposal						
Cleanaway Erskine Park	WSERRC	50%	250,000	833	20	42
ResourceCo	WSERRC	25%	125,000	417	7	60
SUEZ Kemps Creek	WSERRC	25%	125,000	417	7	60

The results of the modelling are provided in **Table 53**. Where there is a negative value listed for the change in emissions in this table, it means there is an overall decrease in emissions resulting from this proposal.

Table 53: Change in air emissions for transporting waste

Postcode	Total existing road emissions (t/yr)			Change in emissions due to proposal (t/yr)		
	NO_x	$PM_{2.5}$	VOC	NO_x	$PM_{2.5}$	VOC
2145	590.7	24.9	214.8	-0.01	0.00	0.00
2146	133	5.6	51.3	0.00	0.00	0.00
2147	283	11.6	113.5	0.00	0.00	0.00
2148	593	24.6	215.3	-1.12	-0.03	-0.06
2164	437	18.9	135.6	0.25	0.04	0.07
2165	169	7.0	71	-0.01	0.00	0.00
2166	190	7.7	96	-0.01	0.00	0.00
2168	81	3.1	40	0.00	0.00	0.00
2170	1170	47.2	387	-0.02	0.00	0.00
2171	377	15.1	104	0.00	0.00	0.00
2175	271	10.8	58.6	1.22	0.09	0.18
2176	173	7.1	90	0.02	0.00	0.00
2177	64.0	2.6	33.2	0.02	0.00	0.00
2178	127	5.2	33.3	2.48	0.15	0.30
2748	145	5.7	43	0.00	0.00	0.00
2759	75	2.9	35	-0.08	0.00	-0.01
2760	281.3	11.4	101.4	0.00	0.00	0.00
2761	311.9	12.5	89.2	-1.22	-0.04	-0.07
2766	676	27.6	171.2	0.39	0.01	0.02
2767	58	2.5	30.0	0.01	0.00	0.00

Postcode	Total existing road emissions (t/yr)			Change in emissions due to proposal (t/yr)		
	NO_x	$PM_{2.5}$	VOC	NO_x	$PM_{2.5}$	VOC
2770	263	10.3	112	-1.37	-0.04	-0.08
Total	**6469**	**264**	**2225**	**0.55**	**0.18**	**0.35**
Change in emissions expressed as fraction of total road emissions				**0.01%**	**0.07%**	**0.02%**

Consequently, the changes in emissions from the transportation of materials on public roads are negligible relative to the current situation.

7 Conclusions

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Cleanaway and Macquarie Capital to undertake a Human Health Risk Assessment (HHRA) for an energy from waste facility in Western Sydney.

Based on the assessment undertaken the following has been concluded:

Table 54: Summary of health impacts – air quality

<table>
<tr><th colspan="2">Impacts associated with air emissions</th></tr>
<tr><td>Benefits</td><td>There are no benefits to the off-site community in relation to air emissions, but the proposed facility will assist in more beneficial management of waste in NSW due to a decrease in material going to landfill as well as provide jobs in the area and act as a mechanism for greenhouse gas abatement. These matters are discussed further in the overall environmental impact statement.</td></tr>
<tr><td>Impacts</td><td>Based on the available data and information in relation to emissions to air from the proposed facility, potential impacts on the health of the community have been assessed. The impact assessment has concluded the following:
▪ No unacceptable risks for criteria pollutants (NO_x, SO_x, CO, $PM_{2.5}$, PM_{10}) – due to the facility alone or in changing the background/existing levels
▪ No unacceptable risks for short term exposures from the proposed facility at the maximum off-site location – all other locations will have lower concentrations and so risks will be lower
▪ No unacceptable risks for relevant exposure scenarios considering long term exposures at
○ Maximum off-site location
○ Maximum residential location (and maximum commercial/industrial and maximum other places if land use change to residential)
○ Maximum commercial/industrial location
○ Maximum other places location (including farms)
○ Maximum on-site location
▪ No unacceptable risks for relevant exposure scenarios for rainwater tanks or Prospect Reservoir
▪ No unacceptable risks for worst case scenario for the cumulative case considering both this facility and the proposed Next Generation facility

Assessment of traffic impacts due to transport of waste to the site has shown negligible changes to the existing situation so no change in health impacts is expected.</td></tr>
<tr><td>Mitigation</td><td>Mitigation measures include:
▪ proper operation and maintenance of the facility
▪ detailed monitoring of emissions (including continuous monitoring for relevant pollutants)
▪ monitoring of the proper operation of pollution control/flue gas equipment using sensors to detect breakage in the baghouse etc
▪ automated doors that rapidly open and close for each tipping bay
▪ transport of waste to the site using enclosed trucks or other relevant techniques
▪ waste will always be unloaded within the building housing the tipping bays and storage bunker</td></tr>
</table>

8 References

Site Specific References

Todoroski Air Sciences 2020, DRAFT Air Quality and Odour Impact Assessment (AQIA). Western Sydney Energy and Resource Recovery Centre (WSERRC)

ARUP 2020. Project Description

Air Quality Modelling Output Spreadsheets

ARUP 2020, Cleanaway & Macquarie Capital Western Sydney Energy and Resource Recovery Centre Traffic and Transport Technical Report

Australian Bureau of Statistics, 2016. Selected characteristics retrieved from QuickStats, TableBuilder and DataPacks. www.abs.gov.au. Accessed May 2020.

Other References

ATSDR 2012a, *Toxicological Profile for Chromium*, Agency for Toxic Substances and Disease Registry, United States Department of Health and Human Services, Atlanta, Georgia, USA. <http://www.atsdr.cdc.gov/ToxProfiles/tp7.pdf>.

ATSDR 2012b, *Toxicological Profile for Manganese*, US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. <https://www.atsdr.cdc.gov/ToxProfiles/tp151.pdf>.

ATSDR 2012c, *Toxicological Profile for Vanadium*, Agency for Toxic Substances and Disease Registry.

Baars, AJ, Theelen, RMC, Janssen, PJCM, Hesse, JM, Apeldorn, MEv, Meijerink, MCM, Verdam, L & Zeilmaker, MJ 2001, *Re-evaluation of human-toxicological maximum permissible risk levels*, RIVM.

CRC CARE 2011, *Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 1: Technical development document*, CRC for Contamination Assessment and Remediation of the Environment, CRC CARE Technical Report no. 10, Adelaide. <http://www.crccare.com/products-and-services/health-screening-levels>.

DEH 2005, *National Dioxins Program, Technical Report No. 12, Human Health Risk Assessment of Dioxins in Australia*, Office of Chemical Safety, Australian Government Department of the Environment and Heritage.

enHealth 2012a, *Environmental Health Risk Assessment, Guidelines for assessing human health risks from environmental hazards*, Commonwealth of Australia, Canberra. <http://www.health.gov.au/internet/main/publishing.nsf/content/804F8795BABFB1C7CA256F1900045479/$File/DoHA-EHRA-120910.pdf >.

enHealth 2012b, *Australian Exposure Factors Guide*, Commonwealth of Australia, Canberra. <http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-publicat-environ.htm>.

EPHC 2005, *National Dioxins Program - National Action Plan for Addressing Dioxins in Australia*, Environment Protection and Heritage Council. <http://www.nepc.gov.au/system/files/resources/74b7657d-04ce-b214-d5d7-51dcbce2a231/files/cmgt-rev-national-dioxins-program-national-action-plan-addressing-dioxins-australia-200510.pdf>.

EPHC 2010, *Expansion of the multi-city mortality and morbidity study, Final Report*, Environment Protection and Heritage Council.

EU 2010, *Directive 2010/75/EU of the European Parliament and of the Council on Industrial Emissions (Integrated Pollution Prevention and Control)*. <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32010L0075>.

EU 2019, 'Commission Implementing Decision (EU) 2019/2010 of 12 November 2019 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for waste incineration (notified under document C(2019) 7987) (Text with EEA relevance)', *Official Journal of the European Union,* vol. 312, pp. 55-91.

FSANZ 2017, *Supporting Document 2 Assessment of potential dietary exposure to perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS) occurring in foods sampled* *from contaminated sites*, Food Standards Australia and New Zealand, Commonwealth Department of Health. <http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas-hbgv.htm>.

Gallen, C, Drage, D, Eaglesham, G, Grant, S, Bowman, M & Mueller, JF 2017, 'Australia-wide assessment of perfluoroalkyl substances (PFASs) in landfill leachates', *Journal of Hazardous Materials,* vol. 331, 2017/06/05/, pp. 132-141.

Golder 2013, *Exposure Assessment and Risk Characterisation to Inform Recommendations for Updating Ambient Air Quality Standards for PM2.5, PMN10, O3, NO2, SO2*, Golder Associates for National Environment Protection Council Service Corporation. <https://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/exposure-assessment-risk-characterisation.pdf>.

HEPA 2020, *PFAS National Environmental Management Plan Version 2.0*, The National Chemicals Working Group (NCWG) Of The Heads of EPAs Australia and New Zealand (HEPA). <http://www.environment.gov.au/protection/chemicals-management/pfas>.

Jalaudin, B & Cowie, C 2012, *Health Risk Assessment - Preliminary Work to Identify Concentration-Response Functions for Selected Ambient Air Pollutants*, Woolcock Institute of Medical Research. <http://www.nepc.gov.au/system/files/pages/18ae5913-2e17-4746-a5d6-ffa972cf4fdb/files/health-report.pdf>.

Krewski, D, Jerrett, M, Burnett, RT, Ma, R, Hughes, E, Shi, Y, Turner, MC, Pope, CA, 3rd, Thurston, G, Calle, EE, Thun, MJ, Beckerman, B, DeLuca, P, Finkelstein, N, Ito, K, Moore, DK, Newbold, KB, Ramsay, T, Ross, Z, Shin, H & Tempalski, B 2009, 'Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality', *Research report*, no. 140, May, pp. 5-114; discussion 115-136.

Lizárraga-Mendiola, L, Vázquez-Rodríguez, G, Blanco-Piñón, A, Rangel-Martínez, Y & González-Sandoval, M 2015, 'Estimating the Rainwater Potential per Household in an Urban Area: Case Study in Central Mexico', *Water,* vol. 7, no. 9, pp. 4622-4637.

Morgan, G, Broom, R & Jalaludin, B 2013, *Summary for Policy Makers of the Health Risk Assessment on Air Pollution in Australia*, Prepared for National Environment Protection Council by the University Centre for Rural Health, North Coast, Education Research Workforce, A collaboration between The University of Sydney, Southern Cross University, The University of Western Sydney, The University of Wollongong, Canberra.

NEPC 1998 amended 2016, *National Environment Protection (Ambient Air Quality) Measure*, National Environment Protection Council. <http://www.nepc.gov.au/nepms/ambient-air-quality>.

NEPC 1999 amended 2013a, *Schedule B1, Guideline on Investigation Levels For Soil and Groundwater, National Environment Protection (Assessment of Site Contamination) Measure*, National Environment Protection Council. <https://www.legislation.gov.au/Details/F2013L00768/Download>.

NEPC 1999 amended 2013b, *Schedule B7, Guideline on Health-Based Investigation Levels, National Environment Protection (Assessment of Site Contamination) Measure*, National Environment Protection Council. <https://www.legislation.gov.au/Details/F2013L00768/Download>.

NEPC 1999 amended 2013c, *Schedule B4, Guideline on Site-Specific Health Risk Assessment Methodology, National Environment Protection (Assessment of Site Contamination) Measure*, National Environment Protection Council. <https://www.legislation.gov.au/Details/F2013L00768/Download>.

NEPC 1999 amended 2013d, *Schedule B7, Guideline on Derivation of Health-Based Investigation Levels, National Environment Protection (Assessment of Site Contamination) Measure*, National Environment Protection Council. <https://www.legislation.gov.au/Details/F2013L00768/Download>.

NEPC 2004, *National Environment Protection (Air Toxics) Measure*, National Environment Protection Council. <http://scew.gov.au/nepms/air-toxics>.

NEPC 2010, *Review of the National Environment Protection (Ambient Air Quality) Measure, Discussion Paper, Air Quality Standards*, National Environmental Protection Council.

NEPC 2011a, *National Environment Protection (Air Toxics) Measure*, National Environment Protection Council <http://www.nepc.gov.au/nepms/air-toxics>.

NEPC 2011b, *Methodology for setting air quality standards in Australia Part A*, National Environment Protection Council, Adelaide.

NEPC 2016, *National Environment Protection (Ambient Air Quality) Measure*, Federal Register of Legislative Instruments F2016C00215.

Neuwahl, F, Cusano, G, Gomez Benavides, J, Holbrook, S & Roudier, S 2019, *Best available techniques (BAT) reference document for waste incineration - Industrial emissions directive 2010/75/EU, Integrated pollution prevention and control*, JRC Science for Policy Series, EUR 29971. <https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/best-available-techniques-bat-reference-document-waste-incineration-industrial-emissions>.

NHMRC 1999, *Toxicity Assessment for Carcinogenic Soil Contaminants*, National Health and Medical Research Council.

NHMRC 2002, *Dioxins: Recommendation for a Tolerable Monthly Intake for Australians*, National Health and Medical Research Council and Therapeutic Goods Administration.

NHMRC 2011 updated 2018, *Australian Drinking Water Guidelines 6, Version 3.5 Updated August 2018, National Water Quality Management Strategy*, National Health and Medical Research Council, National Resource Management Ministerial Council, Canberra.

NSW Chief Scientist 2018, *Advisory Committee on Tunnel Air Quality - Technical Paper 5: Road Tunnel Stack Emissions*, Advisory Committee on Tunnel Air Quality, NSW Chief Scientist and Engineer. <https://chiefscientist.nsw.gov.au/reports/advisory-committee-on-tunnel-air-quality>.

NSW EPA 2012, *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales, 2008 Calendar Year, On-Road Mobile Emissions:Results*, NSW Environment Protection Authority, Sydney.

NSW EPA 2015, *NSW Energy from Waste Policy Statement*, NSW Environment Protection Authority, Sydney. <https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/epa/150011enfromwasteps.pdf>.

NSW EPA 2016, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, State of NSW and Environment Protection Authority, Sydney.

NSW EPA 2019, *Air Emissions Inventory for the Greater Metropolitan Region in New South Wales 2013 Calendar Year Consolidated Natural and Human-Made Emissions: Results*, NSW Environment Protection Authority, NSW Government. <https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/air/19p1917-air-emissions-inventory-2013.pdf?la=en&hash=9217ADF2C8D5647147FF00F447258319D00BB75D>.

NSW Government 2009, *State Environmental Planning Policy (Western Sydney Parklands)*, NSW Government. <https://legislation.nsw.gov.au/#/view/EPI/2009/91>.

NSW Government 2010, *Protection of the Environment Operations (Clean Air) Regulation*, NSW Government. <http://www.legislation.nsw.gov.au/maintop/view/inforce/subordleg+428+2010+cd+0+N>.

OEHHA 2012, *Air Toxics Hot Spots Program, Risk Assessment Guidelines, Technical Support Document, Exposure Assessment and Stochastic Analysis*, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency.

OEHHA 2015, *Air Toxics Hot Spots Program, Risk Assessment Guidelines, Guidance Manual for Preparation of Health Risk Assessments*, Air, Community, and Environmental Research Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency.

Ostro, B, Broadwin, R, Green, S, Feng, WY & Lipsett, M 2006, 'Fine particulate air pollution and mortality in nine California counties: results from CALFINE', *Environmental health perspectives,* vol. 114, no. 1, Jan, pp. 29-33.

Pope, IC, Burnett, RT, Thun, MJ & et al. 2002, 'Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution', *JAMA,* vol. 287, no. 9, pp. 1132-1141.

RAIS *The Risk Assessment Information System*, Department of Energy's (DOE's) Oak Ridge Operations Office (ORO).

SAHC 1998, *The Health Risk Assessment and Management of Contaminated Sites, Proceedings of the Fourth National Workshop on the Assessment of Site Contamination*.

Stevens, B 1991, '2,3,7,8-Tetrachlorobenzo-p-Dioxin in the Agricultural Food Chain: Potential Impact of MSW Incineration on Human Health', in HA Hattemer-Frey & T Curtis (eds), *Health Effects of Municipal Waste Incineration*, CRC Press.

TCEQ 2014, *Development Support Document, Ammonia*, Texas Commission on Environmental Quality.

TCEQ 2015a, *Hydrogen Fluoride and Other Soluble Inorganic Fluorides*, Texas Commission on Environmental Quality.

TCEQ 2015b, *Hydrogen Chloride, Development Support Document*, Texas Commission on Environmental Quality.

TCEQ 2016, *Effects Screening Levels*, <https://www.tceq.texas.gov/toxicology/esl>.

UK EA 2009, *Contaminants of soil: updated collation of toxicological data and intake values for humans, Nickel*. <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291234/scho0409bpvz-e-e.pdf>.

USEPA 1989, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, Office of Emergency and Remedial Response, United States Environmental Protection Agency, Washington.

USEPA 2004, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part E, Supplemental Guidance for Dermal Risk Assessment)*, United States Environmental Protection Agency, Washington, D.C.

USEPA 2005, *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, Office of Solid Waste and Emergency Response, US Environmental Protection Agency. <https://archive.epa.gov/epawaste/hazard/tsd/td/web/html/risk.html>.

USEPA 2009, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part F, Supplemental Guidance for Inhalation Risk Assessment)*, United States Environmental Protection Agency, Washington, D.C.

USEPA 2012, *Provisional Assessment of Recent Studies on Health Effects of Particulate Matter Exposure*, National Center for Environmental Assessment RTP Division, Office of Research and Development, U.S. Environmental Protection Agency.

USEPA 2018a, *Risk and Exposure Assessment for the Review of thePrimary National Ambient Air Quality Standard for Sulfur Oxides*, U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Health and Environmental Impacts Division Research Triangle Park, NC. <https://www.epa.gov/sites/production/files/2018-05/documents/primary_so2_naaqs_-_final_rea_-_may_2018.pdf>.

USEPA 2018b, *Integrated Science Assessment for Particulate Matter (External Review Draft), EPA/600/R-18/179*, National Center for Environmental Assessment—RTP Division, Office of Research and Development, U.S. Environmental Protection Agency.

USEPA 2020, *Regional Screening Levels (RSLs), May 2020*, United States Environmental Protection Agency. <https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>.

USEPA IRIS *Integrated Risk Information System (IRIS)*, United States Environmental Protection Agency.

van Vlaardingen, PLA, Posthumus, R & Posthuma-Doodeman, CJAM 2005, *Environmental Risk Limits for Nine Trace Elements*, National Institute for Public Health and the Environment, RIVM.

WHO 1999, *Manganese and its Compounds. Concise International Chemicals Assessment Document 12*, United Nations Environment Programme, the International Labour Organisation, and the World Health Organization. <http://www.inchem.org/documents/cicads/cicads/cicad12.htm>.

WHO 2000a, *WHO air quality guidelines for Europe, 2nd edition, 2000 (CD ROM version)*, World Health Organisation.

WHO 2000b, *Diphenylmethane Diisocyanate (MDI), Concise International Chemical Assessment Document 27*, United Nations Environment Programme, the International Labour Organization, and the World Health Organization. <http://www.inchem.org/documents/cicads/cicads/cicad27.htm>.

WHO 2000c, *Air Quality Guidelines for Europe, Second Edition*, Copenhagen. <http://www.euro.who.int/en/publications/abstracts/air-quality-guidelines-for-europe>.

WHO 2000d, *Guidelines for Air Quality*, World Health Organisation, Geneva.

WHO 2003, *Elemental Mercury and Inorganic Mercury Compounds: Human Health Aspects*, World Health Organization, Geneva.

WHO 2006a, *Health risks or particulate matter from long-range transboundary air pollution*, World Health Organisation Regional Office for Europe.

WHO 2006b, *Cobalt and Inorganic Cobalt Compounds. Concise International Chemical Assessment Document No. 69*. <http://www.inchem.org/documents/cicads/cicads/cicad69.htm>.

WHO 2010, *WHO Guidelines for Indoor Air Quality, Selected Pollutants*, WHO Regional Office for Europe.

WHO 2011, *Guidelines for Drinking-water Quality, Fourth Edition*, International Program on Chemical Safety, World Health Organisation. <http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/>.

WHO 2013a, *Review of evidence on health aspects of air pollution - REVIHAAP Project, Technical Report*, World Health Organization, Regional Office for Europe.

WHO 2013b, *Health Effects of Particulate Matter, Policy implications for countries in eastern Europe, Caucasus and central Asia*, WHO Regional Office for Europe.

WHO 2017, *Guidelines for Drinking Water Quality, Fourth Edition incorporating the First Addendum*, World Health Organisation. <http://www.who.int/water_sanitation_health/publications/drinking-water-quality-guidelines-4-including-1st-addendum/en/>.

Appendix A Calculation of risks from $PM_{2.5}$

Calculation of risk: $PM_{2.5}$

A quantitative assessment of risk for particles uses a mathematical relationship between an exposure concentration (i.e. concentration in air) and a response (namely a health effect). This relationship is termed an exposure-response relationship. Such relationships are relevant for the range of health effects (or endpoints) identified as relevant (to the nature of the emissions assessed) and robust (as determined by the World Health Organisation review).

An exposure-response relationship can have a threshold (i.e. where there is a safe level of exposure, below which there are no adverse effects) or the relationship can have no threshold (and is regarded as linear) where there is some potential for adverse effects at any level of exposure.

In relation to the health effects associated with exposure to particulate matter, no threshold has been identified. This means the WHO has adopted non-threshold approaches to develop the exposure-response relationships. These non-threshold based relationships have been identified for the health endpoints considered relevant for particles.

Risk calculations relevant to exposures of the community to $PM_{2.5}$ have been undertaken utilising concentration-response functions relevant to the most significant health effect associated with exposure to $PM_{2.5}$, namely mortality (all cause). In this case, the concentration in air that people breathe is the measure of exposure for the exposure-response relationship.

The assessment of potential risks associated with exposure to particles involves the calculation of a relative risk (RR). For the purpose of this assessment the shape of the exposure-response function used to calculate the relative risk is assumed to be linear[7]. The calculation of a relative risk based on the change in exposure concentration from baseline/existing (i.e. based on incremental impacts from the project) can be calculated on the basis of the following equation (Ostro 2004):

Equation 1 $$RR = \exp[\beta(X-X0)]$$

Where:

R = relative risk

X-X0 = the change in particulate matter concentration to which the population is exposed (µg/m³)

β = regression/slope coefficient, or the slope of the exposure-response function which can also be expressed as the per cent change in response per 1 µg/m³ increase in particulate matter exposure.

7 Some reviews have identified that a log-linear exposure-response function may be more relevant for some of the health endpoints considered in this assessment. Review of outcomes where a log-linear exposure-response function has been adopted (Ostro 2004) for $PM_{2.5}$ identified that the log-linear relationship calculated slightly higher relative risks compared with the linear relationship within the range 10–30 micrograms per cubic metre,(relevant for evaluating potential impacts associated with air quality goals or guidelines) but lower relative risks below and above this range. For this assessment (where impacts from a particular project are being evaluated) the impacts assessed relate to concentrations of $PM_{2.5}$ that are well below 10 micrograms per cubic metre and hence use of the linear relationship is expected to provide a more conservative estimate of relative risk.

Based on this equation, where the published studies have derived relative risk values that are associated with a 10 micrograms per cubic metre increase in exposure, the β coefficient can be calculated using the following equation:

Equation 2

$$\beta = \frac{\ln(RR)}{10}$$

Where:

RR = relative risk for the relevant health endpoint as published (µg/m³)

10 = increase in particulate matter concentration associated with the RR (where the RR is associated with a 10 µg/m³ increase in concentration).

The assessment of health impacts for a particular population associated with exposure to particles has been undertaken utilising the methodology presented by the WHO (Ostro 2004)[8] where the exposure-response relationships identified have been directly considered on the basis of the approach outlined below.

An additional risk can be calculated as:

Equation 3 $\quad$ **Risk=β x ∆X x B**

Where:

β = slope coefficient relevant to the per cent change in response to a 1 µg/m³ change in exposure

ΔX = change (increment) in exposure concentration in µg/m³ relevant to the project at the point of exposure

B = baseline incidence of a given health effect per person (e.g. annual mortality rate)

The calculation of the incremental individual risk for relevant health endpoints associated with exposure to particulate matter as outlined by the WHO (Ostro 2004) has considered the following four elements:

- Estimates of the changes in particulate matter exposure levels (i.e. incremental impacts) due to the project for the relevant modelled scenarios – these have been modelled for the proposed project, with the maximum change overall and in residential areas addressed. For this assessment, the change in $PM_{2.5}$ relates to the change in annual average air concentrations and the value considered in this assessment is 0.02 µg/m³.

8 For regional guidance, such as that provided for Europe by the WHO (WHO 2006a) regional background incidence data for relevant health endpoints are combined with exposure-response functions to present an impact function, which is expressed as the number/change in incidence/new cases per 100,000 population exposed per microgram per cubic metre change in particulate matter exposure. These impact functions are simpler to use than the approach adopted in this assessment, however, in utilising this approach it is assumed that the baseline incidence of the health effects is consistent throughout the whole population (as used in the studies) and is specifically applicable to the sub-population group being evaluated. For the assessment of exposures in the areas evaluated surrounding the project it is more relevant to utilise local data in relation to baseline incidence rather than assume that the population is similar to that in Europe (where these relationships are derived).

- The calculation has considered the baseline mortality rate for Blacktown and Fairfield LGAs. The rate in Blacktown LGA is 570.8 per 100,000 for 2016/17 (all ages and all causes) (refer to **Table 7**). The rate in Fairfield LGA is 489.8 per 100,000 for 2016/17 (all ages and all causes) (refer to **Table 7**).
- The baseline incidence is, therefore, 0.005708 for Blacktown LGA and 0.004898 for Fairfield LGA
- Exposure-response relationships expressed as a percentage change in health endpoint per microgram per cubic metre change in particles exposure, where a relative risk (RR) is determined (refer to Equation 1).
- The concentration response function used in this report is that recommended in a NEPC published report (Jalaudin & Cowie 2012). It was derived from a study in the United States which examined the health outcomes of hundreds of thousands of people living in cities all over the United States. These people were exposed to many different concentrations of $PM_{2.5}$ (Pope et al. 2002).
- The study found a relative risk (RR) of all-cause mortality of 1.06 per 10 µg/m^3 change in $PM_{2.5}$, and that this risk relationship was in the form of an exponential function. Based on a RR of 1.06 per 10 µg/m^3 change in $PM_{2.5}$, this results in a β = 0.0058. It is noted that the exposure response relationship established in this study was re-affirmed in a follow-up study (that included approximately 500,000 participants in the US) (Krewski et al. 2009) and is consistent with findings from California (Ostro et al. 2006). The relationship is also more conservative (i.e. estimates a higher risk at the same concentration) than a study undertaken in Australia and New Zealand (EPHC 2010).

The above approach (while presented slightly differently) is consistent with that presented in Australia (Burgers & Walsh 2002), US (OEHHA 2002; USEPA 2005b, 2010) and Europe (Martuzzi et al. 2002; Sjoberg et al. 2009).

Based on the air quality modelling data and the population health statistics in the area, the calculated incremental individual risk is:

$$Risk = \beta \times \Delta X \times B$$

$$= 0.0058 \times 0.02 \times 0.005708$$

$$= 7 \times 10^{-7} \text{ (Blacktown)}$$

$$Risk = \beta \times \Delta X \times B$$

$$= 0.0058 \times 0.02 \times 0.004898$$

$$= 6 \times 10^{-7} \text{ (Fairfield)}$$

Appendix B Methodology and assumptions for Other Pollutants

B1 Introduction

This appendix presents the methodology and assumptions adopted in the calculation of risks related to the assessment of acute and chronic risks via inhalation and other pathways assessed for chronic exposure that may occur following deposition of particles with relevant persistent chemicals attached.

B2 Acute toxicity reference values

Acute toxicity reference values are values protective for exposure over short time periods. It is not possible for such concentrations to be present in air at ground level around this facility for extended periods as equipment at the facility would fail if operated under these conditions.

There are a number of reputable sources including the following:

- **Texas Commission on Environmental Quality (2015)**. Short term criteria have been obtained from the TCEQ Environmental Screening Levels (TCEQ 2016). Texas Commission on Environmental Quality (TCEQ) Acute Reference Value (Acute ReV), which is based on a target HI of 1, consistent with the target HI adopted in the derivation of guidelines in Australia (enHealth 2012a; NEPC 1999 amended 2013b, 2004) by the WHO (WHO 2000d, 2000c, 2010). These are used as the primary source of acute guidelines as they specifically relate to and consider studies relevant to a 1-hour exposure and they have undergone the most recent detailed review process.
- California Office of Environmental Health Hazard Assessment (OEHHA) acute Reference Exposure Level (REL), which are all based on a target HI of 1 with RELs relevant to 1-hour average exposures adopted.
- USEPA Protective Action Criteria (PAC) values, which are all based on a target HI of 1. PACs threshold values that the public may be exposed, with varying levels of protection, as a result of elevated exposure. For this assessment the most conservative PAC value has been adopted, PAC-1, which is the concentration above which the public, including sensitive individuals, may be exposed to for 1 hour and may experience discomfort, irritation or other non-sensory effects that are not disabling and transient (i.e. reversible upon cessation of exposure). Exposures below these thresholds are considered protective of these effects. These values have only been adopted where no acute guidelines are available from the above (or any other reliable source).

Based on the above the following acute TRVs have been adopted in this assessment:

Table B1: Short term toxicity reference values

Chemical	Acute health based criteria (inhalation only)		
	Acute air guideline (mg/m^3)	Averaging time	Source of guideline
Hydrogen chloride (HCl)	0.66	1 hour	TCEQ (2015)
Hydrogen fluoride (HF)	0.06	1 hour	TCEQ (2015)
Ammonia	0.18	1 hour	TCEQ
Cadmium (Cd)	0.0054	1 hour	TCEQ
Thallium (Tl)	0.001	1 hour	TCEQ

Chemical	Acute health based criteria (inhalation only)		
	Acute air guideline (mg/m^3)	Averaging time	Source of guideline
Beryllium (Be)	0.0023	1 hour	USEPA PAC-1
Mercury (Hg)	0.0006	1 hour	OEHHA
Antimony (Sb)	1.5	1 hour	USEPA PAC-1
Arsenic (As)	0.003	1 hour	TCEQ
Lead (Pb)	0.15	1 hour	USEPA PAC-1
Chromium (Cr VI assumed)	0.0013	1 hour	TCEQ
Cobalt (Co)	0.0002	1 hour	TCEQ
Copper (Cu)	0.1	1 hour	OEHHA
Manganese (Mn)	0.0091	1 hour	TCEQ
Nickel (Ni)	0.0011	1 hour	TCEQ
Selenium (Se)	0.002	1 hour	TCEQ
Vanadium (V)	0.02	1 hour	TCEQ
Tin (Sn)	0.02	1 hour	TCEQ
Dioxins and furans	0.0000013	1 hour	USEPA PAC-1#
Benzene	0.17	1 hour	TCEQ

adjusted from occupational relevant value to public health relevant value

B3 Chronic toxicity reference values

Approach

The quantitative assessment of potential risks to human health for any substance requires the consideration of the health end-points and, where carcinogenicity is identified; the mechanism of action needs to be understood. This will determine whether the chemical substance is considered a threshold or non-threshold chemical substance. The risks for these two different mechanisms are calculated differently so it is important to recognise the relevant health endpoints/mechanisms correctly.

A threshold chemical has a concentration below which health effects are not considered to occur. IT is assumed that for a non-threshold chemical substance it is theoretically possible to cause health effects at any concentration, and it is the level of health risk posed by the concentration of the chemical substance that is assessed. The following paragraphs provide further context around these concepts.

For chemical substances that are not carcinogenic, a threshold exists below which there are no adverse effects (for all relevant end-points). The threshold typically adopted in risk calculations (a tolerable daily intake [TDI] or tolerable concentration [TC]) is based on the lowest no observed adverse effect level (NOAEL), typically from animal or human (e.g. occupational) studies, and the application of a number of safety or uncertainty factors to calculate the reference dose or tolerable intake. Intakes/exposures lower than the TDI/TC are considered safe, or not associated with an adverse health risk (NHMRC 1999).

Where the chemical substance has the potential for carcinogenic effects, the mechanism of action needs to be understood as this defines the way that the dose-response is assessed. Carcinogenic effects are associated with multi-step and multi-mechanism processes that may include genetic damage, altering gene expression and stimulating proliferation of transformed cells. Some carcinogens have the potential to result in genetic (DNA) damage (gene mutation, gene amplification, chromosomal rearrangement) and are termed genotoxic carcinogens. For these carcinogens, it is assumed that any exposure may result in one mutation or one DNA damage event and that may be sufficient to initiate the process for the development of cancer sometime during a lifetime (NHMRC 1999). Hence no safe-dose or threshold is assumed, and assessment of risk is based on a linear non-threshold approach using slope factors or unit risk values.

For other (non-genotoxic) carcinogens, while some form of genetic damage (or altered cell growth) is still necessary for cancer to develop, it is not the primary mode of action for these chemical substances. For these chemical substances, carcinogenic effects are associated with indirect mechanisms (that do not directly interact with genetic material) and for these other mechanisms a threshold is believed to exist so these chemicals are assessed in the same fashion as the threshold chemicals described above.

In the case of particulate matter (PM_{10} or $PM_{2.5}$), current health evidence has not been able to find a concentration below which health impacts do not exist. Thus, the quantification of risk for $PM_{2.5}$ follows a non-threshold approach as described in **Appendix A**.

Values adopted

Chronic toxicity reference values (TRVs) associated with inhalation, ingestion and dermal exposures have been adopted from credible peer-reviewed sources as detailed in the ASC NEPM (NEPC 1999 amended 2013c) and enHealth (enHealth 2012a).

For the gaseous pollutants considered in this assessment, only inhalation TRVs are relevant and have been adopted. For inorganics (metals etc) as well as dioxins, TRVs relevant to all exposure pathways have been adopted. Background intakes of these pollutants have been estimated on the basis of existing available information as noted.

Table B2 presents the TRVs adopted for the assessment of chronic health effects associated with exposure to the other pollutants considered in this assessment.

Table B2: Summary of chronic TRVs adopted for pollutants – threshold effects

Pollutant	Inhalation TRV (mg/m^3)	Oral/dermal TRV (mg/kg/day)	GI absorption factor*	Dermal absorption*	Background intakes (as percentage of TRV)
Hydrogen chloride (HCl)	0.026 [T]	NA (gaseous pollutant)			0%
Hydrogen fluoride (HF)	0.029 [T]	NA (gaseous pollutant)			0%
Ammonia	0.32 [T]	NA (gaseous pollutant)			0%
Cadmium	0.000005 [W]	0.0008 [W]	100%	0	60%
Thallium	0.0028 [R]	0.0008 [U]	3%	0	0%
Beryllium	0.00002 [W, U]	0.002 [W, U]	100%	0.001	10%
Mercury (as inorganic and elemental)	0.0002 [W]	0.0006 [W]	7%	0.001	40%
Antimony	0.0002 [U]	0.00086 [NH]	15%	0	0%
Arsenic	0.001 [D]	0.002 [N]	100%	0.005	50%
Lead	0.0005 [N]	0.0035 [NH]	100%	0	50%
Chromium (Cr VI assumed)	0.0001 [U]	0.001 [A]	100%	0	10%
Cobalt	0.0001 [W]	0.0014 [D]	100%	0.001	20%
Copper	0.49 [R]	0.14 [W]	100%	0	60%
Manganese	0.00015 [W]	0.14 [A]	100%	0	50%
Nickel	0.00002 [E]	0.012 [W]	100%	0.005	60%
Vanadium	0.0001 [A]	0.002 [D]	100%	0	0%
Tin	0.7 [R]	0.2 [D]	100%	0	50%

Dioxins and furans	8.05E-09 R	2.3E-09 NH	100%	0.03	54%
Benzene	0.03 U	NA (gaseous pollutant)			10%
PAHs	Non-threshold chemical				

Notes for Table B2:

* GI factor and dermal absorption values adopted from RAIS (accessed in 2018) (RAIS)

** Background intakes relate to intakes from inhalation, drinking water and food products. The values adopted based on information provided in the ASC NEPM (NEPC 1999 amended 2013d) and relevant sources as noted for the TRVs. Gaseous pollutant background intakes are not known and hence for this assessment they have been assumed to be negligible

R = No inhalation-specific TRV available, hence inhalation exposures assessed on the basis of route-extrapolation from the oral TRV, as per USEPA guidance (USEPA 2009)

A = TRV available from ATSDR, relevant to chronic intakes (ATSDR 2012c, 2012b, 2012a)

D = TRV available from RIVM (Baars et al. 2001; van Vlaardingen et al. 2005)

E = TRV available from the UK Environment Agency (UK EA 2009)

N = Inhalation guideline adopted for lead from the NEPM (NEPC 2016), and arsenic oral/dermal value as adopted in ASC-NEPM (NEPC 1999 amended 2013d).

NH = Dioxin value (and background intakes, which includes natural soil) adopted from NHMRC (NHMRC 2002) and Environment Australia (DEH 2005; EPHC 2005), and antimony and lead value consistent with that adopted by NHMRC to assess intakes in drinking water (NHMRC 2011 updated 2018)

T = TRV available from TCEQ, relevant to chronic inhalation exposures (and HI=1) (TCEQ 2014, 2015b, 2015a)

U = TRV available from the USEPA IRIS (current database) (USEPA IRIS)

W = TRV available from the WHO, relevant to chronic inhalation exposures (WHO 1999, 2000c, 2000b, 2006b, 2017), noting inhalation value adopted for mercury is for elemental mercury (worst case) (WHO 2003, 2011)

B4 Quantification of inhalation exposure

Intakes via inhalation have been assessed on the basis of the inhalation guidance available from the USEPA and recommended for use in the ASC NEPM and enHealth (enHealth 2012a; NEPC 1999 amended 2013d; USEPA 2009).

This guidance requires the calculation of an exposure concentration which is based on the concentration in air and the time/duration spent in the area of impact. It is not dependent on age or body weight. The following equation outlines the calculation of an inhalation exposure concentration, and **Table B3** provides details of the assumptions adopted in this assessment:

$$\text{Exposure Concentration} = C_a \bullet \frac{ET \bullet EF \bullet ED}{AT} \quad (mg/m^3)$$

Table B3: Inhalation exposure assumptions

Parameter		Value adopted	Basis
Ca	Concentration of chemical substance in air (mg/m^3)	Modelled from facility, adopting the maximum predicted anywhere (i.e. grid maximum) and the maximum from all discrete receptors	Calculations undertaken on the basis of the maximum predicted impacts
ET	Exposure time (dependent on activity) (hours/day)	Industrial workers: 8 hours/day Residents: 24 hours/day	Assume someone is exposed at the maximum location all day, every day of the year, and workers are exposed every work day
EF	Exposure frequency (days/year)	Industrial workers: 240 days/year Residents: 365 days/year	
ED	Exposure duration (years)	Industrial workers: 30 years Residents: 35 years	Duration of work and residency as per enHealth (enHealth 2012b)
AT	Averaging time (hours)	Threshold = ED x 365 days/year x 24 hours/day	As per enHealth (enHealth 2012a) guidance

		Non-threshold = 70 years x 365 days/year x 24 hours/day	

Threshold Risk

The quantification of potential exposure and risks to human health associated with the presence of key chemicals in air (or other media) involves comparing the estimated exposure concentration with the threshold concentration adopted from relevant sources of toxicity reference values as listed in **Table B2**. The calculated ratio is termed a Hazard or Risk Index (HI/RI), which is the sum of all ratios (termed Hazard or Risk Quotients [HQ/RQ]) over all relevant pathways of exposure.

These are calculated using the following equations for inhalation exposures:

$$\text{Hazard or Risk Quotient (HQ or RQ)(inhalation)} = \frac{\text{Exposure Concentration in air (adjusted for site-specific assumptions)}}{\text{(TRV-background)}}$$

$$\text{Hazard or Risk Index (HI or RI)} = \sum_{\text{all chemicals and pathways}} \text{H(R)Qs}$$

The interpretation of an acceptable HI/RI needs to recognise an inherent degree of conservatism that is built into the establishment of appropriate guideline (threshold) values (using many uncertainty factors) and in the way exposures are calculated.

Hence, in reviewing and interpreting the calculated HI/RI, the following is noted:

- A HI/RI less than or equal to a value of 1 (where intake or exposure is less than or equal to the threshold) represents no cause for concern (as per risk assessment industry practice, supported by protocols outlined in enHealth and the ASC NEPM (enHealth 2012a; NEPC 1999 amended 2013a, 1999 amended 2013c); and
- A HI/RI greater than 1 requires further consideration within the context of the assessment undertaken, particularly with respect to the level of conservatism in the assumptions adopted for the quantification of exposure and the level of uncertainty within the toxicity (threshold) values adopted (enHealth 2012a; NEPC 1999 amended 2013a, 1999 amended 2013c).

Non-Threshold Risk

Non-threshold carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential non-threshold carcinogen. The numerical estimate of excess lifetime cancer risk is calculated as follows for inhalation exposures:

$$\text{Carcinogenic Risk (inhalation)} = \text{Exposure concentration (adjusted for site-specific assumptions)} * \text{Inhalation Unit Risk}$$

The total non-threshold carcinogenic risk is the sum of the risk for each chemical for each pathway.

enHealth and ASC NEPM define an acceptable non-threshold carcinogenic risk (as a sum over all non-threshold chemicals and exposure pathways) as equal to or less than $1x10^{-5}$. On this basis, a total Target Risk value of $>1 \times 10^{-5}$ has been adopted as indicating conditions that would warrant further assessment. Risk values $\leq 1 \times 10^{-5}$ are considered to be representative of acceptable risks (enHealth 2012a; NEPC 1999 amended 2013a, 1999 amended 2013c).

The risk quotients and index are provided in the spreadsheet pages in **Appendix C** and they are summarised in **Section 5.4.3**.

B5 Multiple pathway exposures

B5.1 Ingestion and dermal absorption

Emissions from the stack contain gases and particles. Chemicals like the metals are usually attached to the particles. The particles can settle out of the air onto the ground over time or due to rain. Such particles mix with the soil and so these chemicals that are deposited on the ground via the particles have the potential to be ingested by people either directly (through accidental/incidental consumption of dirt) or indirectly (through eating food grown or raised (fruits, vegetables, eggs, milk, meat) at a property that might be impacted by the deposited dust).

The assessment of the potential ingestion of chemical substances has been undertaken using the approach presented by enHealth and the USEPA (enHealth 2012a; USEPA 1989). This approach is presented in the following equation, and parameters adopted in this assessment are presented in **Table B4**:

$$\text{Daily Chemical Intake}_{\text{Ingestion}} = C_M \bullet \frac{IR_M \bullet FI \bullet B \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

where:

TRV	= Toxicity reference value relevant for the chemical (mg/kg/day)
BI_O	= Background intake (% of TRV)
IRs	= Ingestion rate of soil (mg/day)
B	= Bioavailability or absorption of chemical via ingestion (unitless) (assumed to be 100%)
CF	= Conversion factor of $1x10^{-6}$ to convert mg to kg
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
BW	= Body weight (kg)
AT	= Averaging time for threshold exposures, (=ED x 365 days)

Chemicals attached to particles that are deposited on the ground also have the potential to be absorbed through the skin when skin comes in contact with soil or dust (into which these particles have mixed).

The assessment of the potential dermal absorption of chemical substances has been generally undertaken using the approach presented by the USEPA (USEPA 1989, 2004). The USEPA define a simple approach to the evaluation of dermal absorption associated with soil contact. This is presented in the following equation and parameters adopted in this assessment are presented in **Table B4**:

$$\text{Daily Chemical Intake}_{\text{Dermal}} = C_M \bullet \frac{SA \bullet AF \bullet ABSd \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

where:

TRV	= Toxicity reference value relevant for the chemical (mg/kg/day)
BI_O	= Background intake (% of TRV)
SA	= Surface area of skin exposed (cm^2)
AF	= adherence factor (mg soil/cm^2 skin)
ABSd	= chemical specific factor for absorption through skin
B	= Bioavailability or absorption of chemical via ingestion (unitless) (assumed to be 100%)

CF	= Conversion factor of $1x10^{-6}$ to convert mg to kg
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
BW	= Body weight (kg)
AT	= Averaging time for threshold exposures, (=ED x 365 days)

Table B4: Exposure parameter assumptions

Parameter		Value adopted – Young children	Value adopted – Adults	Basis
C_M	Concentration of chemical substance in media or relevance (soil, fruit and vegetables or eggs) (mg/kg)	Modelled based on deposition of particulates to soil, adopting the maximum from all residential receptors		Calculations undertaken on the basis of the maximum predicted impacts relevant to areas where multi-pathway exposures may occur
IR_M	Ingestion rate of media			
	Soil (mg/day)	100 mg/day	50 mg/day	Ingestion rate of outdoor soil and dust (tracked or deposited indoors) as per enHealth (enHealth 2012b)
	Fruit and vegetables (kg/day)	0.28 kg/day 85% from aboveground crops 16% from root crops	0.4 kg/day 73% from aboveground crops 27% from root crops	Total fruit and vegetable intakes per day as per ASC NEPM (NEPC 1999 amended 2013d)
	Eggs (kg/day)	0.013 kg/day	0.023 kg/day	Ingestion rate of eggs per day – mean consumption for consumers from FSANZ (FSANZ 2017)
FI	Fraction of media ingested derived from impacted media, or fraction of produce consumed each day derived from the property			
	Soil	100%	100%	Assume all soil contact occurs on the one property
	Fruit and vegetables	35%	35%	Rate assumed for rural area (higher than the default of 10% for urban areas)
	Eggs	200%	200%	Assume higher intake of home-produced eggs in rural areas (SAHC 1998)
B	Bioavailability or absorption of chemical substance via ingestion	100%	100%	Conservative assumption
SA	Surface area of body exposed to soil per day (cm^2/day)	2700	6300	Exposed skin surface area relevant to adults as per ASC NEPM (NEPC 1999 amended 2013d)
AF	Adherence factor, amount of soil that adheres to the skin per unit area which depends on soil properties and area of body (mg/cm^2 per event)	0.5	0.5	Default (conservative) value from ASC NEPM (NEPC 1999 amended 2013d)
ABSd	Dermal absorption fraction (unitless)	Chemical specific		Refer to **Table B2**
CF	Conversion factor			
	Soil	$1x10^{-6}$ to convert mg to kg		Conversion of units relevant to soil ingestion and dermal contact
	Produce	1		No units conversion required for these calculations
BW	Body weight	15	70	As per enHealth (enHealth 2012b) and ASC NEPM (NEPC 1999 amended 2013d)

Parameter		Value adopted		Basis
		Young children	Adults	
EF	Exposure frequency (days/year)	365	365	Assume residents exposed every day
ED	Exposure duration (years)	6 years	29	Duration of residency as per enHealth (enHealth 2012b) and split between young children and adults as per ASC NEPM (NEPC 1999 amended 2013d)
AT	Averaging time (days)	Threshold = ED x 365 days/year Non-threshold = 70 years x 365 days/year		As per enHealth (enHealth 2012a) guidance

B5.2 Calculation of concentrations in various media

Potential Concentrations in Soil

The potential accumulation of persistent and bioaccumulative chemical substances in soil, which may be the result of deposition from a number of air emissions source, can be estimated using a soil accumulation model (OEHHA 2015; Stevens 1991).

The concentration in soil, which may be the result of deposition following emission of persistent chemical substances, can be calculated using the following equation, with assumptions adopted in this assessment presented in **Table B5**.

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000 \qquad \text{(mg/kg)}$$

Table B5: Assumptions adopted to estimate soil concentrations

Parameter		Value adopted		Basis
		Surface soil*	Agricultural soil*	
DR	Particle deposition rate for accidental release (mg/m^2/year)	Adopted maximum deposition rate for discrete receptors		Relevant to areas where multi-pathway exposures may occur
k	Chemical-specific soil-loss constant (1/year) = ln(2)/$T^{0.5}$	Calculated	Calculated	
$T^{0.5}$	Chemical half-life in soil (years)	Chemical specific	Chemical specific	Default values adopted for pollutants considered as per OEHHA (2015)
t	Accumulation time (years)	70 years	70 years	Default value (OEHHA 2015)
d	Soil mixing depth (m)	0.01 m	0.15 m	Default values (OEHHA 2015)
ρ	Soil bulk-density (g/m^3)	1600000	1600000	Default for fill material (CRC CARE 2011)
1000	Conversion from g to kg	Default conversion of units		

* Surface soil values adopted for the assessment of direct contact exposures. All other exposures including produce and meat/milk intakes utilise soil concentrations calculated for agricultural intakes (OEHHA 2015)

Homegrown fruit and vegetables

Plants may become contaminated with persistent chemical substances via deposition directly onto the plant outer surface and following uptake via the root system. Both mechanisms have been assessed.

The potential concentration of persistent chemical substances that may be present within the plant following atmospheric deposition can be estimated using the following equation (Stevens 1991), with the parameters and assumptions adopted outlined in **Table B6**:

$$C_p = \frac{DR \cdot F \cdot \left[1 - e^{-k \cdot t}\right]}{Y \cdot k} \qquad \text{(mg/kg plant – wet weight)}$$

The potential uptake of persistent chemical substances into edible crops via the roots can be estimated using the following equation (OEHHA 2015; USEPA 2005), with the parameters and assumptions adopted outlined in **Table B6:**

$$C_{rp} = C_s \cdot RUF \qquad \text{(mg/kg plant – wet weight)}$$

Table B6: Assumptions adopted to estimate concentration in fruit and vegetables

Parameter		Value adopted	Basis
DR	Particle deposition rate for accidental release (mg/m²/day)	Adopted maximum deposition rate for discrete receptors	Relevant to areas where multi-pathway exposures may occur
F	Fraction for the surface area of plant (unitless)	0.051	Relevant to aboveground exposed crops as per Stevens (1991) and OEHHA (OEHHA 2012)
k	Chemical-specific loss constant for particles on plants (1/days) = ln(2)/$T^{0.5}$	calculated	
$T^{0.5}$	Chemical half-life on plant (day)	14 days	Weathering of particulates on plant surfaces does occur and in the absence of measured data, it is generally assumed that organics deposited onto the outer portion of plant surfaces have a weathering half life of 14 days (Stevens, 1991)
t	Deposition time or length of growing season (days)	70 days	Relevant to aboveground crops based on the value relevant to tomatoes, consistent with the value adopted by Stevens (1991)
Y	Crop yield (kg/m²)	2 kg/m²	Value for aboveground crops (OEHHA 2015)
Cs	Concentration of pollutant in soil (mg/kg)	Calculated value for agricultural soil	Calculated as described above and assumptions in **Table B5**
RUF	Root uptake factor (unitless)	Chemical specific value adopted	Root uptake factors from RAIS (RAIS) (soil to wet weight of plant)

Eggs, beef and milk

The concentration of bioaccumulative pollutants in animal products is calculated on the basis of the intakes of these pollutants by the animal (chicken or cow) and the transfer of these pollutants to the edible produce. The approach adopted in this assessment has involved calculation of intakes from pasture, assumed to be grown on the property, and soil.

The concentration (C_P) calculated in eggs, beef or milk is calculated using the following equation (OEHHA 2015), with parameters and assumptions adopted presented in **Table B7**:

$$C_P = (FI \times IR_C \times C + IR_S \times C_s \times B) \times TF_P$$

Table B7: Assumptions adopted to estimate concentration in animal produce

Parameter		Value adopted	Basis
FI	Fraction of grain/crop ingested by animals each day derived from the property (unitless)	100%	Assume all pasture/crops ingested by chickens and cows are grown on the property
IR_C	Ingestion rate of pasture/crops by each animal considered (kg/day)		
	Chickens	0.12 kg/day	Ingestion rate from OEHHA (2015)
	Beef cattle	9 kg/day	Ingestion rate from OEHHA (2015)
	Lactating cattle	22 kg/day	Ingestion rate for lactating cattle from OEHHA (2015)
C	Concentration of pollutant in crops consumed by animals (mg/kg)	Assume equal to that calculated in aboveground produce	Calculated as described above with assumptions in **Table B6**
IR_S	Ingestion rate of soil by animals each day (kg/day)		
	Chickens	0.0024 kg/day	Based on data from OEHHA 2015 (2% total produce intakes from soil)
	Beef cattle	0.45 kg/day	Based on data from OEHHA 2015 (5% total produce intakes from soil from pasture)
	Lactating cattle	1.1 kg/day	Based on data from OEHHA 2015 (5% total produce intakes from soil from pasture)
Cs	Concentration of pollutant in soil (mg/kg)	Calculated value for agricultural soil	Calculated as described above and assumptions in **Table B5**
B	Bioavailability of soil ingested (unitless)	100%	Conservative assumption
TF_P	Transfer factor for the produce of interest		
	Eggs	Chemical specific	Transfer factors adopted from OEHHA (2015)
	Beef	Chemical specific	Transfer factors adopted from OEHHA (2015) and RAIS
	Milk	Chemical specific	Transfer factors adopted from OEHHA (2015) and RAIS

Rainwater tanks

The concentration in rainwater tanks depends on the deposition rate of dust, the size of the roof, the volume of rainfall each year and how much of the rain that falls onto the roof is captured in the tank. The concentration in rainwater for Project related emissions, which may be used for all household purposes is calculated as follows, where the parameters adopted for this assessment are detailed in **Table B8**:

$$C_W = \frac{DM}{VR \times Kd \times \rho}$$

$$VR = \frac{R \times Area \times Rc}{1000}$$

Table B8: Assumptions adopted to estimate concentration in rainwater tank

Parameter		Value adopted	Basis
DM	Mass of dust deposited on the roof each year (mg)	DR x Area	
DR	Particle deposition rate for accidental release (mg/m^2/year)	Modelled in the Air Quality Assessment for each receptor	Relevant to areas where multi-pathway exposures may occur
Area	Area of the roof (m^2)	200	Based on the average roof size for a 4 bedroom house in Australia (refer to Footnote 1)
VR	Volume of water collected from the roof each year	calculated	Equation as above
R	Rainfall each year (mm)	663.2	Average rainfall at Mudgee Airport for all years of records (1994 – 2019). No first flush devise is considered,hence all rainfall is considered
Rc	Runoff coefficient	0.7	Assumes 30% loss in capture of water into the tank (Lizárraga-Mendiola et al. 2015)
1000	Conversion from mm to m		
Kd	Soil-water partition coefficient (cm^3/g)	Chemical-specific	All values from RAIS (RAIS)
ρ	Soil bulk density (g/m^3)	0.5	Assumed for loose deposited dust on roof (upper end measured for powders)

1 - https://www.nedlands.wa.gov.au/sites/default/files/Rainwater%20tank%20factsheet.pdf

Prospect Reservoir

The concentration in Prospect Reservoir depends on the deposition rate of dust onto the surface of the water and onto the surrounding catchment, the volume of the reservoir and the volume of rainfall each year.

One part of the calculation is to determine the concentrations of relevant chemical due to particles falling on the surface of the reservoir and mixing into the dam water. Another part of the calculation is to determine the additional amount of each chemical that could be due to particles falling on the ground surrounding the reservoir (the catchment) that then get washed into the reservoir during rain.

In both cases there are other sources of these chemicals in normal urban environments and due to the geological makeup of soil in the area. These calculations have just addressed the additional amounts of these chemicals that could be present due to emissions from this facility.

The calculations have used the deposition rate for each of the chemicals (as they are attached to particles) and the area over which such deposition occurs to determine the mass of each chemical that may get mixed into the dam. This mass is then mixed into the entire volume of the reservoir and adjusted based on solubility to get the concentration that could be present in the water.

The mass has only been mixed into the dam as a static water body with no water entering or leaving the dam – a volume of 1.25×10^{11} L. In reality, rain would add water into the dam across the year which would add an additional 8.7×10^{9} L on average (another 10% approximately). Water would also be added as needed using the pipeline from Warragamba Dam. Water would be removed from the dam to move into the distribution system (which would take the dissolved chemicals with it) and by evaporation (which would leave some of the dissolved chemicals in the reservoir). It is considered that assuming the dam is a static water body is a conservative assessment – i.e. it will overestimate the concentrations that could be present in the reservoir and, therefore, the risks.

The concentration in water in the reservoir due to the potential emissions from the proposed facility is determined using the following calculations. The parameters adopted for this assessment are detailed in **Table B9**.

$$C_W = \frac{DM}{\text{Volume of reservoir} \times Kd \times \rho}$$

Table B9: Assumptions adopted to estimate concentration in Prospect Reservoir

Parameter		Value adopted	Basis
DM	Mass of dust deposited on the reservoir and the surrounding land each year (mg)	DR x Area for reservoir and DR x Area x runoff coefficient (Rc) for catchment	Calculated
DR	Particle deposition rate (mg/m^2/year)	Modelled across the Prospect Reservoir catchment by Todoroski Air Sciences	Relevant to areas where multi-pathway exposures may occur
Area	Area of the catchment and reservoir (m^2)	10000000 m^2 (5200000 m^2 of which is the reservoir itself)	Water NSW fact sheet on Prospect Reservoir (https://www.waternsw.com.au/supply/Greater-Sydney/dams/prospect-dam) 5.2 km^2 surface area for reservoir and 10 km^2 for catchment

Parameter		Value adopted	Basis
VR	Volume of water collected from the catchment each year	calculated	Equation as above
Volume	Volume of water in the reservoir	5200000 m^2 (surface area) * 24 m (deep) = 1.25 x 10^8 m^3 (i.e. 1.25×10^{-11} L)	Water NSW fact sheet on Prospect Reservoir (https://www.waternsw.com.au/supply/Greater-Sydney/dams/prospect-dam) 5.2 km^2 surface area and 24 m depth
R	Rainfall each year (mm)	874	Average rainfall at Prospect Reservoir for all years of records (1887 – 2020)
Rc	Runoff coefficient	0.7	Assumes 70% of particles which deposit on to the ground get washed off into the reservoir. This is based on the value used for runoff from a roof into a rainwater tank (Lizárraga-Mendiola et al. 2015). It is expected that the runoff coefficient will be lower for wash off from the ground due to the interaction with soil, vegetation and structures.
1000	Conversion from mm to m		
Kd	Soil-water partition coefficient (cm^3/g)	Chemical-specific	All values from RAIS (RAIS)
ρ	Soil bulk density (g/m^3)	0.5	Assumed for loose deposited dust on ground (upper end measured for powders)

Appendix C Risk calculations

Scenario 1

Maximum Off-Site

Acute (1 Hour Average)

Predicted ground level concentrations and screening assessment - acute exposures - Maximum Location Off-site

		Air Concentration (ug/m^3)	Air Concentration (mg/m^3)	Calculated HI
COPC	**Acute air guideline (mg/m3)**	**Grid Maximum Off-site**	**Grid Maximum Off-site**	**Grid Maximum Off-site**
Hydrogen chloride (HCl)	0.66	8.0E+01	8.0E-02	1.2E-01
Hydrogen fluoride (HF)	0.06	5.3E+00	5.3E-03	8.9E-02
Ammonia	0.18	4.0E+01	4.0E-02	2.2E-01
Cadmium (Cd)	0.0054	1.4E-02	1.4E-05	2.6E-03
Thallium (Tl)	0.001	1.2E-02	1.2E-05	1.2E-02
Beryllium (Be)	0.0023	1.1E-03	1.1E-06	4.9E-04
Mercury (Hg)	0.0006	4.6E-02	4.6E-05	7.7E-02
Antimony (Sb)	1.5	8.3E-03	8.3E-06	5.5E-06
Arsenic (As)	0.003	1.0E-02	1.0E-05	3.4E-03
Lead (Pb)	0.15	2.8E-02	2.8E-05	1.9E-04
Chromium (Cr VI assumed)	0.0013	8.3E-02	8.3E-05	6.4E-02
Cobalt (Co)	0.0002	8.8E-03	8.8E-06	4.4E-02
Copper (Cu)	0.1	8.7E-02	8.7E-05	8.7E-04
Manganese (Mn)	0.0091	2.4E-02	2.4E-05	2.7E-03
Nickel (Ni)	0.0011	1.4E-01	1.4E-04	1.3E-01
Selenium (Se)	0.002	2.8E-02	2.8E-05	1.4E-02
Vanadium (V)	0.02	4.8E-03	4.8E-06	2.4E-04
Tin (Sn)	0.02	2.9E-02	2.9E-05	1.5E-03
Dioxins and furans	0.0000013	1.1E-07	1.1E-10	8.6E-05
Benzene	0.17	2.7E+01	2.7E-02	1.6E-01
				9.4E-01

Chronic Exposures

Predicted ground level concentrations - chronic exposures

	6									
	Air Concentration - annual average (ug/m3)	Air Concentration - annual average (mg/m3)	Exposure pathways							
COPC	Maximum Off-site	Maximum Off-site	inhalation	soil ingestion	soil - dermal	egg ingestion	fruit and vegetable ingestion	rainwater tank	meat ingestion	milk ingestion
Nitrogen dioxide (NO2)	3.31E-01	3.3E-04	y							
Sulfur dioxide (SO2)	6.09E-02	6.1E-05	y							
Hydrogen chloride (HCl)	2.44E-02	2.4E-05	y							
Hydrogen fluoride (HF)	4.87E-03	4.9E-06	y							
Ammonia	2.44E-02	2.4E-05	y							
PM10	2.39E-02	2.4E-05	y							
PM2.5	2.31E-02	2.3E-05	y							
Cadmium (Cd)	3.25E-06	3.3E-09	y	y	y					
Thallium (Tl)	2.84E-06	2.8E-09	y	y	y					
Beryllium (Be)	1.02E-05	1.0E-08	y	y	y					
Mercury (Hg)	6.09E-05	6.1E-08	y	y	y					
Antimony (Sb)	2.54E-05	2.5E-08	y	y	y					
Arsenic (As)	3.09E-05	3.1E-08	y	y	y					
Lead (Pb)	8.54E-05	8.5E-08	y	y	y					
Chromium (Cr VI assumed)	2.54E-04	2.5E-07	y	y	y					
Cobalt (Co)	2.69E-05	2.7E-08	y	y	y					
Copper (Cu)	2.67E-04	2.7E-07	y	y	y					
Manganese (Mn)	7.47E-05	7.5E-08	y	y	y					
Nickel (Ni)	4.38E-04	4.4E-07	y	y	y					
Selenium (Se)	2.54E-04	2.5E-07	y	y	y					
Vanadium (V)	1.47E-05	1.5E-08	y	y	y					
Tin (Sn)	2.69E-04	2.7E-07	y	y	y					
Dioxins and furans	1.10E-09	1.1E-12	y	y	y					
Benzene	2.44E-02	2.4E-05	y							

	Deposition Rate - annual average (mg/m2/year)		Deposition Rate - annual average (mg/m2/year)
COPC	Maximum Off-site		Maximum Off-site
Cadmium (Cd)	4.02E-03		4.02E-03
Thallium (Tl)	3.56E-03		3.56E-03
Beryllium (Be)	1.27E-02		1.27E-02
Mercury (Hg)	7.58E-02		7.58E-02
Antimony (Sb)	3.03E-02		3.03E-02
Arsenic (As)	4.55E-02		4.55E-02
Lead (Pb)	1.06E-01		1.06E-01
Chromium (Cr VI assumed)	3.18E-01		3.18E-01
Cobalt (Co)	3.03E-02		3.03E-02
Copper (Cu)	3.34E-01		3.34E-01
Manganese (Mn)	9.10E-02		9.10E-02
Nickel (Ni)	5.46E-01		5.46E-01
Selenium (Se)	3.35E-01		3.35E-01
Vanadium (V)	1.52E-02		1.52E-02
Tin (Sn)	3.17E-01		3.17E-01
Dioxins and furans	9.10E-07		9.10E-07

Inhalation - gases and particulates

Grid maximum (i.e. highest ground level concentration anywhere off-site in modelling grid)

$$\boldsymbol{Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}}$$ **(mg/m^3) for gases**

$$\boldsymbol{Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}}$$ **(mg/m^3) for chemicals attached to particles**

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	3.3E-04	1.7E-04	3.3E-04	--		5.9E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	6.1E-05	3.0E-05	6.1E-05	--		1.2E-03	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	2.4E-05	1.2E-05	2.4E-05	--		9.4E-04	6%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	4.9E-06	2.4E-06	4.9E-06	--		1.7E-04	1%
Ammonia		3.2E-01	0%	3.2E-01	2.4E-05	1.2E-05	2.4E-05	--		7.6E-05	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	3.3E-09	6.1E-10	1.2E-09	--		3.0E-04	2%
Thallium (Tl)		2.8E-03	0%	2.8E-03	2.8E-09	5.3E-10	1.1E-09	--		3.8E-07	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	1.0E-08	1.9E-09	3.8E-09	--		2.4E-04	2%
Mercury (Hg)		2.0E-04	10%	1.8E-04	6.1E-08	1.1E-08	2.3E-08	--		1.3E-04	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	2.5E-08	4.8E-09	9.5E-09	--		4.8E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	3.1E-08	5.8E-09	1.2E-08	--		1.2E-05	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	8.5E-08	1.6E-08	3.2E-08	--		6.4E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	2.5E-07	4.8E-08	9.5E-08	--		9.5E-04	7%
Cobalt (Co)		1.0E-04	0%	1.0E-04	2.7E-08	5.0E-09	1.0E-08	--		1.0E-04	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	2.7E-07	5.0E-08	1.0E-07	--		2.0E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	7.5E-08	1.4E-08	2.8E-08	--		2.3E-04	2%
Nickel (Ni)		2.0E-05	20%	1.6E-05	4.4E-07	8.2E-08	1.6E-07	--		1.0E-02	70%
Selenium (Se)		2.1E-02	60%	8.4E-03	2.5E-07	4.8E-08	9.5E-08	--		1.1E-05	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	1.5E-08	2.8E-09	5.5E-09	--		5.5E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.7E-07	5.0E-08	1.0E-07	--		1.4E-07	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.1E-12	2.1E-13	4.1E-13	--		1.1E-04	1%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	2.4E-05	1.2E-05	2.4E-05	7.3E-8		9.0E-04	6%
							TOTAL	**7.3E-08**		**0.0146**	

Inhalation - gases and particulates

Grid maximum (i.e. highest ground level concentration anywhere off-site in modelling grid)

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ **(mg/m^3) for gases**

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ **(mg/m^3) for chemicals attached to particles**

Parameters Relevant to Quantification of Community Exposures - Commercial/Industrial		
Exposure Time at Home (ET, hr/day)	10	Assume workers at work site 10 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Only exposed at the work site
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	262800	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	3.3E-04	3.9E-05	9.1E-05	--		1.6E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	6.1E-05	7.1E-06	1.7E-05	--		3.3E-04	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	2.4E-05	2.9E-06	6.7E-06	--		2.6E-04	6%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	4.9E-06	5.7E-07	1.3E-06	--		4.6E-05	1%
Ammonia		3.2E-01	0%	3.2E-01	2.4E-05	2.9E-06	6.7E-06	--		2.1E-05	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	3.3E-09	1.4E-10	3.3E-10	--		8.3E-05	2%
Thallium (Tl)		2.8E-03	0%	2.8E-03	2.8E-09	1.2E-10	2.9E-10	--		1.0E-07	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	1.0E-08	4.5E-10	1.1E-09	--		6.6E-05	2%
Mercury (Hg)		2.0E-04	10%	1.8E-04	6.1E-08	2.7E-09	6.3E-09	--		3.5E-05	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	2.5E-08	1.1E-09	2.6E-09	--		1.3E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	3.1E-08	1.4E-09	3.2E-09	--		3.2E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	8.5E-08	3.8E-09	8.8E-09	--		1.8E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	2.5E-07	1.1E-08	2.6E-08	--		2.6E-04	7%
Cobalt (Co)		1.0E-04	0%	1.0E-04	2.7E-08	1.2E-09	2.8E-09	--		2.8E-05	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	2.7E-07	1.2E-08	2.7E-08	--		5.6E-08	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	7.5E-08	3.3E-09	7.7E-09	--		6.4E-05	2%
Nickel (Ni)		2.0E-05	20%	1.6E-05	4.4E-07	1.9E-08	4.5E-08	--		2.8E-03	70%
Selenium (Se)		2.1E-02	60%	8.4E-03	2.5E-07	1.1E-08	2.6E-08	--		3.1E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	1.5E-08	6.5E-10	1.5E-09	--		1.5E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.7E-07	1.2E-08	2.8E-08	--		3.9E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.1E-12	4.8E-14	1.1E-13	--		3.0E-05	1%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	2.4E-05	2.9E-06	6.7E-06	1.7E-8		2.5E-04	6%
							TOTAL	**1.7E-08**		**0.00401**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - Grid Maximum - Off-site

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	4.0E-03	1.8E-02	1.2E-03
Thallium (Tl)	273973	2.5E-06	3.6E-03	1.6E-02	1.0E-03
Beryllium (Be)	273973	2.5E-06	1.3E-02	5.6E-02	3.7E-03
Mercury (Hg)	273973	2.5E-06	7.6E-02	3.3E-01	2.2E-02
Antimony (Sb)	273973	2.5E-06	3.0E-02	1.3E-01	8.8E-03
Arsenic (As)	273973	2.5E-06	4.5E-02	2.0E-01	1.3E-02
Lead (Pb)	273973	2.5E-06	1.1E-01	4.6E-01	3.1E-02
Chromium (Cr VI assumed)	273973	2.5E-06	3.2E-01	1.4E+00	9.3E-02
Cobalt (Co)	273973	2.5E-06	3.0E-02	1.3E-01	8.8E-03
Copper (Cu)	273973	2.5E-06	3.3E-01	1.5E+00	9.7E-02
Manganese (Mn)	273973	2.5E-06	9.1E-02	4.0E-01	2.7E-02
Nickel (Ni)	273973	2.5E-06	5.5E-01	2.4E+00	1.6E-01
Selenium (Se)	273973	2.5E-06	3.3E-01	1.5E+00	9.8E-02
Vanadium (V)	273973	2.5E-06	1.5E-02	6.6E-02	4.4E-03
Tin (Sn)	273973	2.5E-06	3.2E-01	1.4E+00	9.2E-02
Dioxins and furans	15.00	4.6E-02	9.1E-07	1.2E-06	7.9E-08

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - Grid Maximum Off-site

$$\textit{Daily Chemical Intake}_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.8E-02	5.2E-09	1.3E-08	--		3.9E-05	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.6E-02	4.6E-09	1.1E-08	--		1.4E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.6E-02	1.6E-08	4.0E-08	--		2.5E-05	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.3E-01	9.8E-08	2.4E-07	--		6.6E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.3E-01	3.9E-08	9.5E-08	--		1.1E-04	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.0E-01	5.9E-08	1.4E-07	--		1.4E-04	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.6E-01	1.4E-07	3.3E-07	--		1.9E-04	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.4E+00	4.1E-07	1.0E-06	--		1.1E-03	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.3E-01	3.9E-08	9.5E-08	--		8.5E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.5E+00	4.3E-07	1.0E-06	--		1.9E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.0E-01	1.2E-07	2.8E-07	--		4.1E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.4E+00	7.1E-07	1.7E-06	--		3.6E-04	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.5E+00	4.3E-07	1.0E-06	--		4.4E-04	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	6.6E-02	2.0E-08	4.7E-08	--		2.4E-05	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.4E+00	4.1E-07	9.9E-07	--		9.9E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.2E-06	3.5E-13	8.4E-13	--		8.0E-04	20%
								TOTAL			0.00401	

Dermal Exposure to Chemicals via Contact with Soil - Grid Maximum Off-site

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		1.8E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		1.6E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.6E-02	1.0E-09	2.5E-09	--		1.6E-6	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	3.3E-01	6.2E-09	1.5E-08	--		4.1E-5	2%
Antimony (Sb)		8.6E-04		8.6E-04		1.3E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.0E-01	1.9E-08	4.5E-08	--		4.5E-5	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		4.6E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.4E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.3E-01	2.5E-09	6.0E-09	--		5.3E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.5E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		4.0E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.4E+00	2.2E-07	5.4E-07	--		1.1E-4	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.5E+00			--		--	
Vanadium (V)		2.0E-03		2.0E-03		6.6E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.4E+00			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	1.2E-06	6.6E-13	1.6E-12	--		1.5E-3	88%
								TOTAL			0.00171	

Exposure to Chemicals via Incidental Ingestion of Soil - Grid Maximum Off-site

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.8E-02	1.0E-08	1.2E-07	--		3.7E-04	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.6E-02	8.9E-09	1.0E-07	--		1.3E-04	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.6E-02	3.2E-08	3.7E-07	--		2.3E-04	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.3E-01	1.9E-07	2.2E-06	--		6.1E-03	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.3E-01	7.6E-08	8.8E-07	--		1.0E-03	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.0E-01	1.1E-07	1.3E-06	--		1.3E-03	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.6E-01	2.7E-07	3.1E-06	--		1.8E-03	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.4E+00	8.0E-07	9.3E-06	--		1.0E-02	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.3E-01	7.6E-08	8.8E-07	--		7.9E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.5E+00	8.3E-07	9.7E-06	--		1.7E-04	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.0E-01	2.3E-07	2.7E-06	--		3.8E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.4E+00	1.4E-06	1.6E-05	--		3.3E-03	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.5E+00	8.4E-07	9.8E-06	--		4.1E-03	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	6.6E-02	3.8E-08	4.4E-07	--		2.2E-04	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.4E+00	7.9E-07	9.2E-06	--		9.2E-05	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.2E-06	6.8E-13	7.9E-12	--		7.4E-03	20%
								TOTAL			0.0375	

Dermal Exposure to Chemicals via Contact with Soil - Grid Maximum Off-site

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		1.8E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		1.6E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.6E-02	4.3E-10	5.0E-09	--		3.1E-6	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	3.3E-01	2.6E-09	3.0E-08	--		8.3E-5	2%
Antimony (Sb)		8.6E-04		8.6E-04		1.3E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.0E-01	7.7E-09	9.0E-08	--		9.0E-5	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		4.6E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.4E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.3E-01	1.0E-09	1.2E-08	--		1.1E-5	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.5E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		4.0E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.4E+00	9.2E-08	1.1E-06	--		2.2E-4	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.5E+00			--		--	
Vanadium (V)		2.0E-03		2.0E-03		6.6E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.4E+00			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	1.2E-06	2.7E-13	3.2E-12	--		3.0E-3	88%
								TOTAL			0.00343	

Cumulative Case (this facility and proposed Next Generation facility)

Predicted ground level concentrations - chronic exposures

	6	
	Air Concentration - annual average (ug/m3)	Air Concentration - annual average (mg/m3)
COPC	Maximum Off-site	Maximum Off-site
Hydrogen chloride (HCl)	4.33E-02	4.3E-05
Hydrogen fluoride (HF)	6.93E-03	6.9E-06
Ammonia	2.67E-02	2.7E-05
Cadmium (Cd)	3.83E-05	3.8E-08
Thallium (Tl)	9.33E-06	9.3E-09
Beryllium (Be)	1.02E-05	1.0E-08
Mercury (Hg)	6.56E-05	6.6E-08
Antimony (Sb)	7.30E-05	7.3E-08
Arsenic (As)	1.08E-04	1.1E-07
Lead (Pb)	7.01E-04	7.0E-07
Chromium (Cr VI assumed)	2.54E-04	2.5E-07
Cobalt (Co)	6.33E-05	6.3E-08
Copper (Cu)	2.86E-04	2.9E-07
Manganese (Mn)	2.87E-04	2.9E-07
Nickel (Ni)	1.04E-03	1.0E-06
Selenium (Se)	2.68E-04	2.7E-07
Vanadium (V)	5.37E-05	5.4E-08
Tin (Sn)	2.91E-04	2.9E-07
Dioxins and furans	1.11E-09	1.1E-12
Benzene	2.58E-02	2.6E-05

Inhalation - gases and particulates
Cumulative maxium off-site for this facility and the proposed Next Generation facility

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	4.3E-05	2.2E-05	4.3E-05	--		1.7E-03	5%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	6.9E-06	3.5E-06	6.9E-06	--		2.4E-04	1%
Ammonia		3.2E-01	0%	3.2E-01	2.7E-05	1.3E-05	2.7E-05	--		8.4E-05	0%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	3.8E-08	7.2E-09	1.4E-08	--		3.6E-03	10%
Thallium (Tl)		2.8E-03	0%	2.8E-03	9.3E-09	1.7E-09	3.5E-09	--		1.2E-06	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	1.0E-08	1.9E-09	3.8E-09	--		2.4E-04	1%
Mercury (Hg)		2.0E-04	10%	1.8E-04	6.6E-08	1.2E-08	2.5E-08	--		1.4E-04	0%
Antimony (Sb)		2.0E-04	0%	2.0E-04	7.3E-08	1.4E-08	2.7E-08	--		1.4E-04	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	1.1E-07	2.0E-08	4.1E-08	--		4.1E-05	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	7.0E-07	1.3E-07	2.6E-07	--		5.3E-04	2%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	2.5E-07	4.8E-08	9.5E-08	--		9.5E-04	3%
Cobalt (Co)		1.0E-04	0%	1.0E-04	6.3E-08	1.2E-08	2.4E-08	--		2.4E-04	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	2.9E-07	5.4E-08	1.1E-07	--		2.2E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	2.9E-07	5.4E-08	1.1E-07	--		9.0E-04	3%
Nickel (Ni)		2.0E-05	20%	1.6E-05	1.0E-06	1.9E-07	3.9E-07	--		2.4E-02	71%
Selenium (Se)		2.1E-02	60%	8.4E-03	2.7E-07	5.0E-08	1.0E-07	--		1.2E-05	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	5.4E-08	1.0E-08	2.0E-08	--		2.0E-04	1%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.9E-07	5.4E-08	1.1E-07	--		1.6E-07	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.1E-12	2.1E-13	4.2E-13	--		1.1E-04	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	2.6E-05	1.3E-05	2.6E-05	7.7E-8		9.5E-04	3%
							TOTAL	7.7E-08		0.0343	

EPA Limit modelling scenario

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Grid Maximum Off-site (EPA Limit Modelling Scenario)	Air Concentration - annual average (mg/m3) Grid Maximum Off-site (EPA Limit Modelling Scenario)
Nitrogen dioxide (NO2)	1.47E+00	1.5E-03
Sulfur dioxide (SO2)	2.44E+00	2.4E-03
Hydrogen chloride (HCl)	7.31E-01	7.3E-04
Hydrogen fluoride (HF)	4.87E-02	4.9E-05
Ammonia	3.65E-01	3.7E-04
PM10	3.58E-01	3.6E-04
PM2.5	3.47E-01	3.5E-04
Cadmium (Cd)	1.30E-04	1.3E-07
Thallium (Tl)	1.14E-04	1.1E-07
Beryllium (Be)	1.02E-05	1.0E-08
Mercury (Hg)	4.26E-04	4.3E-07
Antimony (Sb)	7.62E-05	7.6E-08
Arsenic (As)	9.26E-05	9.3E-08
Lead (Pb)	2.56E-04	2.6E-07
Chromium (Cr VI assumed)	7.63E-04	7.6E-07
Cobalt (Co)	8.06E-05	8.1E-08
Copper (Cu)	8.00E-04	8.0E-07
Manganese (Mn)	2.24E-04	2.2E-07
Nickel (Ni)	1.32E-03	1.3E-06
Selenium (Se)	2.54E-04	2.5E-07
Vanadium (V)	4.42E-05	4.4E-08
Tin (Sn)	2.69E-04	2.7E-07
Dioxins and furans	2.19E-09	2.2E-12
Benzene	2.44E-01	2.4E-04

COPC	Deposition Rate - annual average (mg/m2/year) Grid Maximum Off-site (EPA Limit Modelling Scenario)	Deposition Rate - annual average (mg/m2/year) Grid Maximum Off-site (EPA Limit Modelling Scenario)
Cadmium (Cd)	1.61E-01	1.61E-01
Thallium (Tl)	1.43E-01	1.43E-01
Beryllium (Be)	1.27E-02	1.27E-02
Mercury (Hg)	5.31E-01	5.31E-01
Antimony (Sb)	9.10E-02	9.10E-02
Arsenic (As)	1.36E-01	1.36E-01
Lead (Pb)	3.18E-01	3.18E-01
Chromium (Cr VI assumed)	9.55E-01	9.55E-01
Cobalt (Co)	9.10E-02	9.10E-02
Copper (Cu)	1.00E+00	1.00E+00
Manganese (Mn)	2.73E-01	2.73E-01
Nickel (Ni)	1.64E+00	1.64E+00
Selenium (Se)	3.35E-01	3.35E-01
Vanadium (V)	4.55E-02	4.55E-02
Tin (Sn)	3.17E-01	3.17E-01
Dioxins and furans	1.82E-06	1.82E-06

Inhalation - gases and particulates
Grid maximum (i.e. highest ground level concentration anywhere off-site in modelling grid)
EPA Limit Modelling Scenario

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	1.5E-03	7.4E-04	1.5E-03	--		2.6E-02	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	2.4E-03	1.2E-03	2.4E-03	--		4.9E-02	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	7.3E-04	3.7E-04	7.3E-04	--		2.8E-02	32%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	4.9E-05	2.4E-05	4.9E-05	--		1.7E-03	2%
Ammonia		3.2E-01	0%	3.2E-01	3.7E-04	1.8E-04	3.7E-04	--		1.1E-03	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	1.3E-07	2.4E-08	4.9E-08	--		1.2E-02	14%
Thallium (Tl)		2.8E-03	0%	2.8E-03	1.1E-07	2.1E-08	4.3E-08	--		1.5E-05	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	1.0E-08	1.9E-09	3.8E-09	--		2.4E-04	0%
Mercury (Hg)		2.0E-04	10%	1.8E-04	4.3E-07	8.0E-08	1.6E-07	--		8.9E-04	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	7.6E-08	1.4E-08	2.9E-08	--		1.4E-04	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	9.3E-08	1.7E-08	3.5E-08	--		3.5E-05	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	2.6E-07	4.8E-08	9.6E-08	--		1.9E-04	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	7.6E-07	1.4E-07	2.9E-07	--		2.9E-03	3%
Cobalt (Co)		1.0E-04	0%	1.0E-04	8.1E-08	1.5E-08	3.0E-08	--		3.0E-04	0%
Copper (Cu)		4.9E-01	0%	4.9E-01	8.0E-07	1.5E-07	3.0E-07	--		6.1E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	2.2E-07	4.2E-08	8.4E-08	--		7.0E-04	1%
Nickel (Ni)		2.0E-05	20%	1.6E-05	1.3E-06	2.5E-07	4.9E-07	--		3.1E-02	35%
Selenium (Se)		2.1E-02	60%	8.4E-03	2.5E-07	4.8E-08	9.5E-08	--		1.1E-05	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	4.4E-08	8.3E-09	1.7E-08	--		1.7E-04	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.7E-07	5.0E-08	1.0E-07	--		1.4E-07	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	2.2E-12	4.1E-13	8.2E-13	--		2.2E-04	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	2.4E-04	1.2E-04	2.4E-04	7.3E-7		9.0E-03	10%
							TOTAL	7.3E-07		0.0887	

Inhalation - gases and particulates
Grid maximum (i.e. highest ground level concentration anywhere off-site in modelling grid)
EPA Limit Modelling Scenario

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Commercial/Industrial		
Exposure Time at Home (ET, hr/day)	10	Assume workers at work site 10 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Only exposed at the work site
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	240	Days at work (NEPM)
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	262800	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	1.5E-03	1.7E-04	4.0E-04	--		7.2E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	2.4E-03	2.9E-04	6.7E-04	--		1.3E-02	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	7.3E-04	8.6E-05	2.0E-04	--		7.7E-03	32%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	4.9E-05	5.7E-06	1.3E-05	--		4.6E-04	2%
Ammonia		3.2E-01	0%	3.2E-01	3.7E-04	4.3E-05	1.0E-04	--		3.1E-04	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	1.3E-07	5.7E-09	1.3E-08	--		3.3E-03	14%
Thallium (Tl)		2.8E-03	0%	2.8E-03	1.1E-07	5.0E-09	1.2E-08	--		4.2E-06	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	1.0E-08	4.5E-10	1.1E-09	--		6.6E-05	0%
Mercury (Hg)		2.0E-04	10%	1.8E-04	4.3E-07	1.9E-08	4.4E-08	--		2.4E-04	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	7.6E-08	3.4E-09	7.8E-09	--		3.9E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	9.3E-08	4.1E-09	9.5E-09	--		9.5E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	2.6E-07	1.1E-08	2.6E-08	--		5.3E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	7.6E-07	3.4E-08	7.8E-08	--		7.8E-04	3%
Cobalt (Co)		1.0E-04	0%	1.0E-04	8.1E-08	3.6E-09	8.3E-09	--		8.3E-05	0%
Copper (Cu)		4.9E-01	0%	4.9E-01	8.0E-07	3.5E-08	8.2E-08	--		1.7E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	2.2E-07	9.9E-09	2.3E-08	--		1.9E-04	1%
Nickel (Ni)		2.0E-05	20%	1.6E-05	1.3E-06	5.8E-08	1.4E-07	--		8.4E-03	35%
Selenium (Se)		2.1E-02	60%	8.4E-03	2.5E-07	1.1E-08	2.6E-08	--		3.1E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	4.4E-08	1.9E-09	4.5E-09	--		4.5E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.7E-07	1.2E-08	2.8E-08	--		3.9E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	2.2E-12	9.6E-14	2.3E-13	--		6.1E-05	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	2.4E-04	2.9E-05	6.7E-05	1.7E-7		2.5E-03	10%
							TOTAL	**1.7E-07**		**0.0243**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000 \quad \textbf{(mg/kg)}$$

ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		**Surface (for direct contact)**	**Depth (for agricultural pathways)**	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - Grid Maximum - Off-site

Chemical	**Half-life in soil years**	**Degradation constant (k) per year**	**Deposition Rate (DR) mg/m^2/year**	**Surface Concentration in Soil mg/kg**	**Agricultural Concentration in Soil mg/kg**
Cadmium (Cd)	273973	2.5E-06	1.6E-01	7.0E-01	4.7E-02
Thallium (Tl)	273973	2.5E-06	1.4E-01	6.2E-01	4.2E-02
Beryllium (Be)	273973	2.5E-06	1.3E-02	5.6E-02	3.7E-03
Mercury (Hg)	273973	2.5E-06	5.3E-01	2.3E+00	1.5E-01
Antimony (Sb)	273973	2.5E-06	9.1E-02	4.0E-01	2.7E-02
Arsenic (As)	273973	2.5E-06	1.4E-01	6.0E-01	4.0E-02
Lead (Pb)	273973	2.5E-06	3.2E-01	1.4E+00	9.3E-02
Chromium (Cr VI assumed)	273973	2.5E-06	9.6E-01	4.2E+00	2.8E-01
Cobalt (Co)	273973	2.5E-06	9.1E-02	4.0E-01	2.7E-02
Copper (Cu)	273973	2.5E-06	1.0E+00	4.4E+00	2.9E-01
Manganese (Mn)	273973	2.5E-06	2.7E-01	1.2E+00	8.0E-02
Nickel (Ni)	273973	2.5E-06	1.6E+00	7.2E+00	4.8E-01
Selenium (Se)	273973	2.5E-06	3.3E-01	1.5E+00	9.8E-02
Vanadium (V)	273973	2.5E-06	4.5E-02	2.0E-01	1.3E-02
Tin (Sn)	273973	2.5E-06	3.2E-01	1.4E+00	9.2E-02
Dioxins and furans	15.00	4.6E-02	1.8E-06	2.4E-06	1.6E-07

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - Grid Maximum Off-site (EPA Limit Modelling Scenario)

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Soil Concentration (mg/kg)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.0E-01	2.1E-07	5.0E-07	--		1.6E-03	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.2E-01	1.8E-07	4.5E-07	--		5.6E-04	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.6E-02	1.6E-08	4.0E-08	--		2.5E-05	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.3E+00	6.9E-07	1.7E-06	--		4.6E-03	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	4.0E-01	1.2E-07	2.8E-07	--		3.3E-04	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	6.0E-01	1.8E-07	4.3E-07	--		4.3E-04	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.4E+00	4.1E-07	1.0E-06	--		5.7E-04	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	4.2E+00	1.2E-06	3.0E-06	--		3.3E-03	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.0E-01	1.2E-07	2.8E-07	--		2.5E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.4E+00	1.3E-06	3.1E-06	--		5.6E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.2E+00	3.5E-07	8.5E-07	--		1.2E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.2E+00	2.1E-06	5.1E-06	--		1.1E-03	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.5E+00	4.3E-07	1.0E-06	--		4.4E-04	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.0E-01	5.9E-08	1.4E-07	--		7.1E-05	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.4E+00	4.1E-07	9.9E-07	--		9.9E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.4E-06	7.0E-13	1.7E-12	--		1.6E-03	11%
								TOTAL			0.01490	

Exposure to Chemicals via Incidental Ingestion of Soil - Grid Maximum Off-site (EPA Limit Modelling Scenario)

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.0E-01	4.0E-07	4.7E-06	--		1.5E-02	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.2E-01	3.6E-07	4.2E-06	--		5.2E-03	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.6E-02	3.2E-08	3.7E-07	--		2.3E-04	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.3E+00	1.3E-06	1.5E-05	--		4.3E-02	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	4.0E-01	2.3E-07	2.7E-06	--		3.1E-03	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	6.0E-01	3.4E-07	4.0E-06	--		4.0E-03	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.4E+00	8.0E-07	9.3E-06	--		5.3E-03	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	4.2E+00	2.4E-06	2.8E-05	--		3.1E-02	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.0E-01	2.3E-07	2.7E-06	--		2.4E-03	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.4E+00	2.5E-06	2.9E-05	--		5.2E-04	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.2E+00	6.8E-07	8.0E-06	--		1.1E-04	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.2E+00	4.1E-06	4.8E-05	--		1.0E-02	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.5E+00	8.4E-07	9.8E-06	--		4.1E-03	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.0E-01	1.1E-07	1.3E-06	--		6.6E-04	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.4E+00	7.9E-07	9.2E-06	--		9.2E-05	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.4E-06	1.4E-12	1.6E-11	--		1.5E-02	11%
								TOTAL			0.1391	

Dermal Exposure to Chemicals via Contact with Soil - Grid Maximum Off-site (EPA Limit Modelling Scenario)

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		7.0E-01			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		6.2E-01			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.6E-02	1.0E-09	2.5E-09	--		1.6E-6	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.3E+00	4.3E-08	1.0E-07	--		2.9E-4	8%
Antimony (Sb)		8.6E-04		8.6E-04		4.0E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	6.0E-01	5.6E-08	1.3E-07	--		1.3E-4	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.4E+00			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		4.2E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	4.0E-01	7.4E-09	1.8E-08	--		1.6E-5	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		4.4E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.2E+00			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	7.2E+00	6.7E-07	1.6E-06	--		3.4E-4	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.5E+00			--		--	
Vanadium (V)		2.0E-03		2.0E-03		2.0E-01			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.4E+00			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	2.4E-06	1.3E-12	3.2E-12	--		3.0E-3	79%
								TOTAL			0.00380	

Dermal Exposure to Chemicals via Contact with Soil - Grid Maximum Off-site (EPA Limit Modelling Scenario)

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT}$$ **(mg/kg/day)**

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		7.0E-01			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		6.2E-01			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.6E-02	4.3E-10	5.0E-09	--		3.1E-6	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.3E+00	1.8E-08	2.1E-07	--		5.8E-4	8%
Antimony (Sb)		8.6E-04		8.6E-04		4.0E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	6.0E-01	2.3E-08	2.7E-07	--		2.7E-4	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.4E+00			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		4.2E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	4.0E-01	3.1E-09	3.6E-08	--		3.2E-5	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		4.4E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.2E+00			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	7.2E+00	2.8E-07	3.2E-06	--		6.7E-4	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.5E+00			--		--	
Vanadium (V)		2.0E-03		2.0E-03		2.0E-01			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.4E+00			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	2.4E-06	5.5E-13	6.4E-12	--		6.0E-3	79%
								TOTAL			0.00759	

Residential

Current Maximum Residential Location

Predicted ground level concentrations - chronic exposures

	6	
	Air Concentration - annual average (ug/m3)	Air Concentration - annual average (mg/m3)
COPC	Maximum Residential	Maximum Residential
Nitrogen dioxide (NO2)	2.73E-01	2.7E-04
Sulfur dioxide (SO2)	3.93E-02	3.9E-05
Hydrogen chloride (HCl)	1.57E-02	1.6E-05
Hydrogen fluoride (HF)	3.15E-03	3.1E-06
Ammonia	1.57E-02	1.6E-05
PM10	1.54E-02	1.5E-05
PM2.5	1.49E-02	1.5E-05
Cadmium (Cd)	2.10E-06	2.1E-09
Thallium (Tl)	1.83E-06	1.8E-09
Beryllium (Be)	6.61E-06	6.6E-09
Mercury (Hg)	3.93E-05	3.9E-08
Antimony (Sb)	1.64E-05	1.6E-08
Arsenic (As)	1.99E-05	2.0E-08
Lead (Pb)	5.51E-05	5.5E-08
Chromium (Cr VI assumed)	1.64E-04	1.6E-07
Cobalt (Co)	1.74E-05	1.7E-08
Copper (Cu)	1.72E-04	1.7E-07
Manganese (Mn)	4.83E-05	4.8E-08
Nickel (Ni)	2.83E-04	2.8E-07
Selenium (Se)	1.64E-04	1.6E-07
Vanadium (V)	9.52E-06	9.5E-09
Tin (Sn)	1.74E-04	1.7E-07
Dioxins and furans	7.08E-10	7.1E-13
Benzene	1.57E-02	1.6E-05

	Deposition Rate - annual average (mg/m2/year)	Deposition Rate - annual average (mg/m2/year)
COPC	Maximum Residential	Maximum Residential
Cadmium (Cd)	3.78E-04	3.78E-04
Thallium (Tl)	3.35E-04	3.35E-04
Beryllium (Be)	1.20E-03	1.20E-03
Mercury (Hg)	7.13E-03	7.13E-03
Antimony (Sb)	2.85E-03	2.85E-03
Arsenic (As)	4.28E-03	4.28E-03
Lead (Pb)	9.99E-03	9.99E-03
Chromium (Cr VI assumed)	3.00E-02	3.00E-02
Cobalt (Co)	2.85E-03	2.85E-03
Copper (Cu)	3.14E-02	3.14E-02
Manganese (Mn)	8.56E-03	8.56E-03
Nickel (Ni)	5.14E-02	5.14E-02
Selenium (Se)	3.15E-02	3.15E-02
Vanadium (V)	1.43E-03	1.43E-03
Tin (Sn)	2.98E-02	2.98E-02
Dioxins and furans	8.56E-08	8.56E-08

Inhalation - gases and particulates
Maximum Residential

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	2.7E-04	1.4E-04	2.7E-04	--		4.9E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	3.9E-05	2.0E-05	3.9E-05	--		7.9E-04	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	1.6E-05	7.9E-06	1.6E-05	--		6.1E-04	6%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.1E-06	1.6E-06	3.1E-06	--		1.1E-04	1%
Ammonia		3.2E-01	0%	3.2E-01	1.6E-05	7.9E-06	1.6E-05	--		4.9E-05	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	2.1E-09	3.9E-10	7.9E-10	--		2.0E-04	2%
Thallium (Tl)		2.8E-03	0%	2.8E-03	1.8E-09	3.4E-10	6.9E-10	--		2.5E-07	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	6.6E-09	1.2E-09	2.5E-09	--		1.5E-04	2%
Mercury (Hg)		2.0E-04	10%	1.8E-04	3.9E-08	7.4E-09	1.5E-08	--		8.2E-05	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	1.6E-08	3.1E-09	6.2E-09	--		3.1E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	2.0E-08	3.7E-09	7.5E-09	--		7.5E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	5.5E-08	1.0E-08	2.1E-08	--		4.1E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	1.6E-07	3.1E-08	6.2E-08	--		6.2E-04	7%
Cobalt (Co)		1.0E-04	0%	1.0E-04	1.7E-08	3.3E-09	6.5E-09	--		6.5E-05	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	1.7E-07	3.2E-08	6.5E-08	--		1.3E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	4.8E-08	9.1E-09	1.8E-08	--		1.5E-04	2%
Nickel (Ni)		2.0E-05	20%	1.6E-05	2.8E-07	5.3E-08	1.1E-07	--		6.6E-03	70%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.6E-07	3.1E-08	6.2E-08	--		7.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	9.5E-09	1.8E-09	3.6E-09	--		3.6E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	1.7E-07	3.3E-08	6.5E-08	--		9.3E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	7.1E-13	1.3E-13	2.7E-13	--		7.2E-05	1%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.6E-05	7.9E-06	1.6E-05	4.7E-8		5.8E-04	6%
							TOTAL	**4.7E-08**		**0.00944**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - Maximum Residential

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	3.8E-04	1.7E-03	1.1E-04
Thallium (Tl)	273973	2.5E-06	3.4E-04	1.5E-03	9.8E-05
Beryllium (Be)	273973	2.5E-06	1.2E-03	5.2E-03	3.5E-04
Mercury (Hg)	273973	2.5E-06	7.1E-03	3.1E-02	2.1E-03
Antimony (Sb)	273973	2.5E-06	2.9E-03	1.2E-02	8.3E-04
Arsenic (As)	273973	2.5E-06	4.3E-03	1.9E-02	1.2E-03
Lead (Pb)	273973	2.5E-06	1.0E-02	4.4E-02	2.9E-03
Chromium (Cr VI assumed)	273973	2.5E-06	3.0E-02	1.3E-01	8.7E-03
Cobalt (Co)	273973	2.5E-06	2.9E-03	1.2E-02	8.3E-04
Copper (Cu)	273973	2.5E-06	3.1E-02	1.4E-01	9.2E-03
Manganese (Mn)	273973	2.5E-06	8.6E-03	3.7E-02	2.5E-03
Nickel (Ni)	273973	2.5E-06	5.1E-02	2.2E-01	1.5E-02
Selenium (Se)	273973	2.5E-06	3.2E-02	1.4E-01	9.2E-03
Vanadium (V)	273973	2.5E-06	1.4E-03	6.2E-03	4.2E-04
Tin (Sn)	273973	2.5E-06	3.0E-02	1.3E-01	8.7E-03
Dioxins and furans	15.00	4.6E-02	8.6E-08	1.1E-07	7.4E-09

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum Residential

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.7E-03	4.9E-10	1.2E-09	--		3.7E-06	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.5E-03	4.3E-10	1.0E-09	--		1.3E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.2E-03	1.6E-09	3.7E-09	--		2.3E-06	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.1E-02	9.2E-09	2.2E-08	--		6.2E-05	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.2E-02	3.7E-09	8.9E-09	--		1.0E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.9E-02	5.5E-09	1.3E-08	--		1.3E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.4E-02	1.3E-08	3.1E-08	--		1.8E-05	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.3E-01	3.9E-08	9.4E-08	--		1.0E-04	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.2E-02	3.7E-09	8.9E-09	--		8.0E-06	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.4E-01	4.1E-08	9.8E-08	--		1.8E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.7E-02	1.1E-08	2.7E-08	--		3.8E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.2E-01	6.6E-08	1.6E-07	--		3.3E-05	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-01	4.1E-08	9.8E-08	--		4.1E-05	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	6.2E-03	1.8E-09	4.5E-09	--		2.2E-06	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.3E-01	3.9E-08	9.3E-08	--		9.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.1E-07	3.3E-14	7.9E-14	--		7.5E-05	20%
								TOTAL			0.000378	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Residential

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration (mg/kg)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor $(mg/kg-day)^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)		Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		1.7E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		1.5E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.2E-03	9.8E-11	2.4E-10	--		1.5E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	3.1E-02	5.8E-10	1.4E-09	--		3.9E-6	2%
Antimony (Sb)		8.6E-04		8.6E-04		1.2E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	1.9E-02	1.7E-09	4.2E-09	--		4.2E-6	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		4.4E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.3E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.2E-02	2.3E-10	5.6E-10	--		5.0E-7	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.4E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		3.7E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.2E-01	2.1E-08	5.1E-08	--		1.1E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.4E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		6.2E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.3E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	1.1E-07	6.2E-14	1.5E-13	--		1.4E-4	88%
								TOTAL			0.000161	

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum Residential

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.7E-03	9.5E-10	1.1E-08	--		3.4E-05	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.5E-03	8.4E-10	9.8E-09	--		1.2E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.2E-03	3.0E-09	3.5E-08	--		2.2E-05	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.1E-02	1.8E-08	2.1E-07	--		5.8E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.2E-02	7.1E-09	8.3E-08	--		9.7E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.9E-02	1.1E-08	1.2E-07	--		1.2E-04	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.4E-02	2.5E-08	2.9E-07	--		1.7E-04	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.3E-01	7.5E-08	8.7E-07	--		9.7E-04	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.2E-02	7.1E-09	8.3E-08	--		7.4E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.4E-01	7.8E-08	9.2E-07	--		1.6E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.7E-02	2.1E-08	2.5E-07	--		3.6E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.2E-01	1.3E-07	1.5E-06	--		3.1E-04	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-01	7.9E-08	9.2E-07	--		3.8E-04	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	6.2E-03	3.6E-09	4.2E-08	--		2.1E-05	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.3E-01	7.5E-08	8.7E-07	--		8.7E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.1E-07	6.4E-14	7.4E-13	--		7.0E-04	20%
								TOTAL			0.00352	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Residential

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor $(mg/kg\text{-}day)^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		1.7E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		1.5E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.2E-03	4.0E-11	4.7E-10	--		2.9E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	3.1E-02	2.4E-10	2.8E-09	--		7.8E-6	2%
Antimony (Sb)		8.6E-04		8.6E-04		1.2E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	1.9E-02	7.2E-10	8.4E-09	--		8.4E-6	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		4.4E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.3E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.2E-02	9.6E-11	1.1E-09	--		1.0E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.4E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		3.7E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.2E-01	8.7E-09	1.0E-07	--		2.1E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.4E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		6.2E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.3E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	1.1E-07	2.6E-14	3.0E-13	--		2.8E-4	88%
								TOTAL			**0.000322**	

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops	Uptake via Roots from Soil
$C_p = \frac{DR \bullet F \bullet \left[1 - e^{-k \bullet t}\right]}{Y \bullet k}$ (mg/kg plant – wet weight)	$C_{rp} = C_s \bullet RUF$ (mg/kg plant – wet weight)
where: DR= Particle deposition rate for accidental release (mg/m^2/day) F= Fraction for the surface area of plant (unitless) k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$ $T_{0.5}$= Chemical half-life as particulate on plant (days) t= Deposition time (days) Y= Crop yield (kg/m^2)	**where**: Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg) RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations - Maximum Residential

Chemical	Half-life on plant ($T_{0.5}$)#	Loss constant (k) &	Deposition Rate (DR)	Aboveground Produce Concentration via Deposition	Root Uptake Factor (RUF)$	Soil Concentration (Cs)	Below Ground Produce Concentration
	days	per day	mg/m^2/day	mg/kg ww	unitless	mg/kg	mg/kg ww
Cadmium (Cd)	14	0.05	1.0E-06	5.2E-07	0.125	1.1E-04	1.4E-05
Thallium (Tl)	14	0.05	9.2E-07	4.6E-07	0.001	9.8E-05	9.8E-08
Beryllium (Be)	14	0.05	3.3E-06	1.6E-06	0.0025	3.5E-04	8.7E-07
Mercury (Hg)	14	0.05	2.0E-05	9.8E-06	0.225	2.1E-03	4.7E-04
Antimony (Sb)	14	0.05	7.8E-06	3.9E-06	0.05	8.3E-04	4.2E-05
Arsenic (As)	14	0.05	1.2E-05	5.9E-06	0.04	1.2E-03	5.0E-05
Lead (Pb)	14	0.05	2.7E-05	1.4E-05	0.0113	2.9E-03	3.3E-05
Chromium (Cr VI assumed)	14	0.05	8.2E-05	4.1E-05	0.00188	8.7E-03	1.6E-05
Cobalt (Co)	14	0.05	7.8E-06	3.9E-06	0.005	8.3E-04	4.2E-06
Copper (Cu)	14	0.05	8.6E-05	4.3E-05	0.1	9.2E-03	9.2E-04
Manganese (Mn)	14	0.05	2.3E-05	1.2E-05	0.0625	2.5E-03	1.6E-04
Nickel (Ni)	14	0.05	1.4E-04	7.0E-05	0.015	1.5E-02	2.2E-04
Selenium (Se)	14	0.05	8.6E-05	4.3E-05	0.00625	9.2E-03	5.7E-05
Vanadium (V)	14	0.05	3.9E-06	2.0E-06	0.00138	4.2E-04	5.7E-07
Tin (Sn)	14	0.05	8.2E-05	4.1E-05	0.0075	8.7E-03	6.5E-05
Dioxins and furans	14	0.05	2.3E-10	1.2E-10	0.000876	7.4E-09	6.5E-12

$ Root uptake factors from RAIS (soil to wet weight of plant)

& Loss constant is 1/half life

\# Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - Maximum Residential

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Above ground produce concentration (mg/kg wet weight)	Root crops concentrations (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.2E-07	1.4E-05	9.7E-10	2.3E-09	--		7.3E-06	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	4.6E-07	9.8E-08	8.5E-11	2.1E-10	--		2.6E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-06	8.7E-07	3.4E-10	8.2E-10	--		5.1E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.8E-06	4.7E-04	3.2E-08	7.6E-08	--		2.1E-04	61%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.9E-06	4.2E-05	3.3E-09	8.0E-09	--		9.4E-06	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.9E-06	5.0E-05	4.2E-09	1.0E-08	--		1.0E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.4E-05	3.3E-05	4.5E-09	1.1E-08	--		6.2E-06	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	4.1E-05	1.6E-05	8.1E-09	2.0E-08	--		2.2E-05	6%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.9E-06	4.2E-06	9.4E-10	2.3E-09	--		2.0E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.3E-05	9.2E-04	6.6E-08	1.6E-07	--		2.8E-06	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.2E-05	1.6E-04	1.2E-08	2.9E-08	--		4.1E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.0E-05	2.2E-04	2.6E-08	6.4E-08	--		1.3E-05	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	4.3E-05	5.7E-05	1.1E-08	2.7E-08	--		1.1E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.0E-06	5.7E-07	3.7E-10	9.0E-10	--		4.5E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	4.1E-05	6.5E-05	1.1E-08	2.7E-08	--		2.7E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.2E-10	6.5E-12	2.1E-14	5.0E-14	--		4.7E-05	14%
									TOTAL			**0.000345**	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - Maximum Residential

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.2E-07	1.4E-05	4.2E-10	4.9E-09	--		1.5E-05	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	4.6E-07	9.8E-08	6.4E-11	7.5E-10	--		9.3E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-06	8.7E-07	2.4E-10	2.8E-09	--		1.8E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.8E-06	4.7E-04	1.3E-08	1.6E-07	--		4.3E-04	51%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.9E-06	4.2E-05	1.6E-09	1.9E-08	--		2.2E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.9E-06	5.0E-05	2.1E-09	2.4E-08	--		2.4E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.4E-05	3.3E-05	2.7E-09	3.1E-08	--		1.8E-05	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	4.1E-05	1.6E-05	5.9E-09	6.9E-08	--		7.7E-05	9%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.9E-06	4.2E-06	6.3E-10	7.4E-09	--		6.6E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.3E-05	9.2E-04	2.9E-08	3.4E-07	--		6.1E-06	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.2E-05	1.6E-04	5.6E-09	6.5E-08	--		9.3E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.0E-05	2.2E-04	1.5E-08	1.8E-07	--		3.7E-05	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	4.3E-05	5.7E-05	7.3E-09	8.5E-08			3.5E-05	4%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.0E-06	5.7E-07	2.8E-10	3.2E-09	--		1.6E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	4.1E-05	6.5E-05	7.1E-09	8.3E-08	--		8.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.2E-10	6.5E-12	1.6E-14	1.9E-13	--		1.8E-04	21%
									TOTAL			0.000853	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$$ (mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - Maximum Residential

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	5.2E-07	1.1E-04	1.0E-02	1.2E-08	OEHHA (2015)
Thallium (Tl)	4.6E-07	9.8E-05	1.7E-02	1.7E-08	
Beryllium (Be)	1.6E-06	3.5E-04	9.0E-02	3.3E-07	OEHHA (2015)
Mercury (Hg)	9.8E-06	2.1E-03	8.0E-01	1.8E-05	OEHHA (2015)
Antimony (Sb)	3.9E-06	8.3E-04	4.2E-04	3.7E-09	
Arsenic (As)	5.9E-06	1.2E-03	7.0E-02	9.2E-07	OEHHA (2015)
Lead (Pb)	1.4E-05	2.9E-03	4.0E-02	1.2E-06	OEHHA (2015)
Chromium (Cr VI assumed)	4.1E-05	8.7E-03	9.2E-03	8.5E-07	OEHHA (2003)
Cobalt (Co)	3.9E-06	8.3E-04	3.8E-02	3.3E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	4.3E-05	9.2E-03	3.8E-02	3.7E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	1.2E-05	2.5E-03	3.8E-02	1.0E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	7.0E-05	1.5E-02	2.0E-02	3.2E-06	OEHHA (2015)
Selenium (Se)	4.3E-05	9.2E-03	3.0E+00	2.9E-04	OEHHA (2015)
Vanadium (V)	2.0E-06	4.2E-04	3.8E-02	1.7E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	4.1E-05	8.7E-03	3.8E-02	3.5E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	1.2E-10	7.4E-09	1.0E+01	8.8E-10	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs - Maximum Residential

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.059	Ingestion rate of eggs relevant for adults as per P90 from FSANZ 2017
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Egg concentration (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.2E-08	4.1E-12	9.8E-12	--		3.1E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.7E-08	6.1E-12	1.5E-11	--		1.8E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.3E-07	1.2E-10	2.8E-10	--		1.8E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.8E-05	6.1E-09	1.5E-08	--		4.1E-05	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.7E-09	1.3E-12	3.1E-12	--		3.6E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	9.2E-07	3.2E-10	7.8E-10	--		7.8E-07	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.2E-06	4.3E-10	1.0E-09	--		5.9E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	8.5E-07	3.0E-10	7.2E-10	--		8.0E-07	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.3E-07	1.2E-10	2.8E-10	--		2.5E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.7E-06	1.3E-09	3.1E-09	--		5.5E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.0E-06	3.5E-10	8.4E-10	--		1.2E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.2E-06	1.1E-09	2.7E-09	--		5.6E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.9E-04	1.0E-07	2.5E-07	--		1.0E-04	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.7E-07	5.8E-11	1.4E-10	--		7.0E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.5E-06	1.2E-09	2.9E-09	--		2.9E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	8.8E-10	3.1E-13	7.4E-13	--		7.0E-04	83%
								TOTAL			0.000849	

Exposure to Chemicals via Ingestion of Eggs - Maximum Residential

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.036	Ingestion rate of eggs relevant for young children as per P90 from FSANZ 2017
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.2E-08	2.4E-12	2.8E-11	--		8.7E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.7E-08	3.6E-12	4.2E-11	--		5.2E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.3E-07	6.8E-11	8.0E-10	--		5.0E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.8E-05	3.6E-09	4.2E-08	--		1.2E-04	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.7E-09	7.6E-13	8.9E-12	--		1.0E-08	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	9.2E-07	1.9E-10	2.2E-09	--		2.2E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.2E-06	2.5E-10	3.0E-09	--		1.7E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	8.5E-07	1.7E-10	2.0E-09	--		2.3E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.3E-07	6.9E-11	8.0E-10	--		7.2E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.7E-06	7.6E-10	8.8E-09	--		1.6E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.0E-06	2.1E-10	2.4E-09	--		3.4E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.2E-06	6.5E-10	7.6E-09	--		1.6E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.9E-04	6.0E-08	7.0E-07	--		2.9E-04	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.7E-07	3.4E-11	4.0E-10	--		2.0E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.5E-06	7.2E-10	8.4E-09	--		8.4E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	8.8E-10	1.8E-13	2.1E-12	--		2.0E-03	83%
								TOTAL			0.00242	

EPA Limit modelling scenario

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Maximum Residential	Air Concentration - annual average (mg/m3) Maximum Residential
Nitrogen dioxide (NO2)	1.21E+00	1.2E-03
Sulfur dioxide (SO2)	1.57E+00	1.6E-03
Hydrogen chloride (HCl)	4.72E-01	4.7E-04
Hydrogen fluoride (HF)	3.15E-02	3.1E-05
Ammonia	2.36E-01	2.4E-04
PM10	2.31E-01	2.3E-04
PM2.5	2.24E-01	2.2E-04
Cadmium (Cd)	8.40E-05	8.4E-08
Thallium (Tl)	7.33E-05	7.3E-08
Beryllium (Be)	6.61E-06	6.6E-09
Mercury (Hg)	2.75E-04	2.8E-07
Antimony (Sb)	4.92E-05	4.9E-08
Arsenic (As)	5.98E-05	6.0E-08
Lead (Pb)	1.65E-04	1.7E-07
Chromium (Cr VI assumed)	4.93E-04	4.9E-07
Cobalt (Co)	5.21E-05	5.2E-08
Copper (Cu)	5.17E-04	5.2E-07
Manganese (Mn)	1.45E-04	1.4E-07
Nickel (Ni)	8.50E-04	8.5E-07
Selenium (Se)	1.64E-04	1.6E-07
Vanadium (V)	2.86E-05	2.9E-08
Tin (Sn)	1.74E-04	1.7E-07
Dioxins and furans	1.42E-09	1.4E-12
Benzene	1.57E-01	1.6E-04

COPC	Deposition Rate - annual average (mg/m2/year) Maximum Residential	Deposition Rate - annual average (mg/m2/year) Maximum Residential
Cadmium (Cd)	1.51E-02	1.51E-02
Thallium (Tl)	1.34E-02	1.34E-02
Beryllium (Be)	1.20E-03	1.20E-03
Mercury (Hg)	4.99E-02	4.99E-02
Antimony (Sb)	8.56E-03	8.56E-03
Arsenic (As)	1.28E-02	1.28E-02
Lead (Pb)	3.00E-02	3.00E-02
Chromium (Cr VI assumed)	8.99E-02	8.99E-02
Cobalt (Co)	8.56E-03	8.56E-03
Copper (Cu)	9.42E-02	9.42E-02
Manganese (Mn)	2.57E-02	2.57E-02
Nickel (Ni)	1.54E-01	1.54E-01
Selenium (Se)	3.15E-02	3.15E-02
Vanadium (V)	4.28E-03	4.28E-03
Tin (Sn)	2.98E-02	2.98E-02
Dioxins and furans	1.71E-07	1.71E-07

Inhalation - gases and particulates
Grid maximum (i.e. highest ground level concentration anywhere off-site in modelling grid)
EPA limit modelling scenario

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	1.2E-03	6.1E-04	1.2E-03	--		2.2E-02	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	1.6E-03	7.9E-04	1.6E-03	--		3.1E-02	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	4.7E-04	2.4E-04	4.7E-04	--		1.8E-02	32%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.1E-05	1.6E-05	3.1E-05	--		1.1E-03	2%
Ammonia		3.2E-01	0%	3.2E-01	2.4E-04	1.2E-04	2.4E-04	--		7.4E-04	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	8.4E-08	1.6E-08	3.1E-08	--		7.9E-03	14%
Thallium (Tl)		2.8E-03	0%	2.8E-03	7.3E-08	1.4E-08	2.7E-08	--		9.8E-06	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	6.6E-09	1.2E-09	2.5E-09	--		1.5E-04	0%
Mercury (Hg)		2.0E-04	10%	1.8E-04	2.8E-07	5.2E-08	1.0E-07	--		5.7E-04	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	4.9E-08	9.2E-09	1.8E-08	--		9.2E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	6.0E-08	1.1E-08	2.2E-08	--		2.2E-05	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	1.7E-07	3.1E-08	6.2E-08	--		1.2E-04	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	4.9E-07	9.2E-08	1.8E-07	--		1.8E-03	3%
Cobalt (Co)		1.0E-04	0%	1.0E-04	5.2E-08	9.8E-09	2.0E-08	--		2.0E-04	0%
Copper (Cu)		4.9E-01	0%	4.9E-01	5.2E-07	9.7E-08	1.9E-07	--		4.0E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	1.4E-07	2.7E-08	5.4E-08	--		4.5E-04	1%
Nickel (Ni)		2.0E-05	20%	1.6E-05	8.5E-07	1.6E-07	3.2E-07	--		2.0E-02	35%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.6E-07	3.1E-08	6.2E-08	--		7.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	2.9E-08	5.4E-09	1.1E-08	--		1.1E-04	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	1.7E-07	3.3E-08	6.5E-08	--		9.3E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.4E-12	2.7E-13	5.3E-13	--		1.4E-04	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.6E-04	7.9E-05	1.6E-04	4.7E-7		5.8E-03	10%
							TOTAL	**4.7E-07**		**0.0573**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - maximum residential - EPA limit modelling scenario

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	1.5E-02	6.6E-02	4.4E-03
Thallium (Tl)	273973	2.5E-06	1.3E-02	5.9E-02	3.9E-03
Beryllium (Be)	273973	2.5E-06	1.2E-03	5.2E-03	3.5E-04
Mercury (Hg)	273973	2.5E-06	5.0E-02	2.2E-01	1.5E-02
Antimony (Sb)	273973	2.5E-06	8.6E-03	3.7E-02	2.5E-03
Arsenic (As)	273973	2.5E-06	1.3E-02	5.6E-02	3.7E-03
Lead (Pb)	273973	2.5E-06	3.0E-02	1.3E-01	8.7E-03
Chromium (Cr VI assumed)	273973	2.5E-06	9.0E-02	3.9E-01	2.6E-02
Cobalt (Co)	273973	2.5E-06	8.6E-03	3.7E-02	2.5E-03
Copper (Cu)	273973	2.5E-06	9.4E-02	4.1E-01	2.7E-02
Manganese (Mn)	273973	2.5E-06	2.6E-02	1.1E-01	7.5E-03
Nickel (Ni)	273973	2.5E-06	1.5E-01	6.7E-01	4.5E-02
Selenium (Se)	273973	2.5E-06	3.2E-02	1.4E-01	9.2E-03
Vanadium (V)	273973	2.5E-06	4.3E-03	1.9E-02	1.2E-03
Tin (Sn)	273973	2.5E-06	3.0E-02	1.3E-01	8.7E-03
Dioxins and furans	15.00	4.6E-02	1.7E-07	2.2E-07	1.5E-08

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - maximum residential - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	6.6E-02	2.0E-08	4.7E-08	--		1.5E-04	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	5.9E-02	1.7E-08	4.2E-08	--		5.2E-05	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.2E-03	1.6E-09	3.7E-09	--		2.3E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.2E-01	6.5E-08	1.6E-07	--		4.3E-04	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.7E-02	1.1E-08	2.7E-08	--		3.1E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.6E-02	1.7E-08	4.0E-08	--		4.0E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.3E-01	3.9E-08	9.4E-08	--		5.3E-05	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.9E-01	1.2E-07	2.8E-07	--		3.1E-04	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.7E-02	1.1E-08	2.7E-08	--		2.4E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.1E-01	1.2E-07	2.9E-07	--		5.3E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.1E-01	3.3E-08	8.0E-08	--		1.1E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	6.7E-01	2.0E-07	4.8E-07	--		1.0E-04	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-01	4.1E-08	9.8E-08	--		4.1E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.9E-02	5.5E-09	1.3E-08	--		6.7E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.3E-01	3.9E-08	9.3E-08	--		9.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.2E-07	6.6E-14	1.6E-13	--		1.5E-04	11%
								TOTAL			**0.00140**	

Dermal Exposure to Chemicals via Contact with Soil - maximum residential - EPA limit modelling scenario

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT}$$ **(mg/kg/day)**

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		6.6E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		5.9E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.2E-03	9.8E-11	2.4E-10	--		1.5E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.2E-01	4.1E-09	9.8E-09	--		2.7E-5	8%
Antimony (Sb)		8.6E-04		8.6E-04		3.7E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	5.6E-02	5.2E-09	1.3E-08	--		1.3E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.3E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		3.9E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	3.7E-02	7.0E-10	1.7E-09	--		1.5E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		4.1E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.1E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	6.7E-01	6.3E-08	1.5E-07	--		3.2E-5	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.4E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		1.9E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.3E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	2.2E-07	1.2E-13	3.0E-13	--		2.8E-4	79%
								TOTAL			**0.000357**	

Exposure to Chemicals via Incidental Ingestion of Soil - maximum residential - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	6.6E-02	3.8E-08	4.4E-07	--		1.4E-03	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	5.9E-02	3.4E-08	3.9E-07	--		4.9E-04	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.2E-03	3.0E-09	3.5E-08	--		2.2E-05	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.2E-01	1.2E-07	1.5E-06	--		4.0E-03	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.7E-02	2.1E-08	2.5E-07	--		2.9E-04	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.6E-02	3.2E-08	3.7E-07	--		3.7E-04	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.3E-01	7.5E-08	8.7E-07	--		5.0E-04	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.9E-01	2.2E-07	2.6E-06	--		2.9E-03	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.7E-02	2.1E-08	2.5E-07	--		2.2E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.1E-01	2.4E-07	2.7E-06	--		4.9E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.1E-01	6.4E-08	7.5E-07	--		1.1E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	6.7E-01	3.9E-07	4.5E-06	--		9.4E-04	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-01	7.9E-08	9.2E-07	--		3.8E-04	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.9E-02	1.1E-08	1.2E-07	--		6.2E-05	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.3E-01	7.5E-08	8.7E-07	--		8.7E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.2E-07	1.3E-13	1.5E-12	--		1.4E-03	11%
								TOTAL			**0.0131**	

Dermal Exposure to Chemicals via Contact with Soil - maximum residential - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		6.6E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		5.9E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	5.2E-03	4.0E-11	4.7E-10	--		2.9E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.2E-01	1.7E-09	2.0E-08	--		5.5E-5	8%
Antimony (Sb)		8.6E-04		8.6E-04		3.7E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	5.6E-02	2.2E-09	2.5E-08	--		2.5E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.3E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		3.9E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	3.7E-02	2.9E-10	3.4E-09	--		3.0E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		4.1E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.1E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	6.7E-01	2.6E-08	3.0E-07	--		6.3E-5	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.4E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		1.9E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.3E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	2.2E-07	5.1E-14	6.0E-13	--		5.7E-4	79%
								TOTAL			**0.000714**	

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops	Uptake via Roots from Soil
$C_p = \frac{DR \bullet F \bullet \left[1 - e^{-k \bullet t}\right]}{Y \bullet k}$ (mg/kg plant – wet weight)	$C_{rp} = C_s \bullet RUF$ (mg/kg plant – wet weight)
where: DR= Particle deposition rate for accidental release (mg/m^2/day) F= Fraction for the surface area of plant (unitless) k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$ $T_{0.5}$= Chemical half-life as particulate on plant (days) t= Deposition time (days) Y= Crop yield (kg/m^2)	**where**: Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg) RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations - maximum residential - EPA limit modelling scenario

Chemical	Half-life on plant ($T_{0.5}$)# days	Loss constant (k) & per day	Deposition Rate (DR) mg/m^2/day	Aboveground Produce Concentration via Deposition mg/kg ww	Root Uptake Factor (RUF)$ unitless	Soil Concentration (Cs) mg/kg	Below Ground Produce Concentration mg/kg ww
Cadmium (Cd)	14	0.05	4.1E-05	2.1E-05	0.125	4.4E-03	5.5E-04
Thallium (Tl)	14	0.05	3.7E-05	1.8E-05	0.001	3.9E-03	3.9E-06
Beryllium (Be)	14	0.05	3.3E-06	1.6E-06	0.0025	3.5E-04	8.7E-07
Mercury (Hg)	14	0.05	1.4E-04	6.8E-05	0.225	1.5E-02	3.3E-03
Antimony (Sb)	14	0.05	2.3E-05	1.2E-05	0.05	2.5E-03	1.2E-04
Arsenic (As)	14	0.05	3.5E-05	1.8E-05	0.04	3.7E-03	1.5E-04
Lead (Pb)	14	0.05	8.2E-05	4.1E-05	0.0113	8.7E-03	9.9E-05
Chromium (Cr VI assumed)	14	0.05	2.5E-04	1.2E-04	0.00188	2.6E-02	4.9E-05
Cobalt (Co)	14	0.05	2.3E-05	1.2E-05	0.005	2.5E-03	1.2E-05
Copper (Cu)	14	0.05	2.6E-04	1.3E-04	0.1	2.7E-02	2.7E-03
Manganese (Mn)	14	0.05	7.0E-05	3.5E-05	0.0625	7.5E-03	4.7E-04
Nickel (Ni)	14	0.05	4.2E-04	2.1E-04	0.015	4.5E-02	6.7E-04
Selenium (Se)	14	0.05	8.6E-05	4.3E-05	0.00625	9.2E-03	5.7E-05
Vanadium (V)	14	0.05	1.2E-05	5.9E-06	0.00138	1.2E-03	1.7E-06
Tin (Sn)	14	0.05	8.2E-05	4.1E-05	0.0075	8.7E-03	6.5E-05
Dioxins and furans	14	0.05	4.7E-10	2.3E-10	0.000876	1.5E-08	1.3E-11

$ Root uptake factors from RAIS (soil to wet weight of plant)

& Loss constant is 1/half life

\# Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - maximum residential - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)				NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)	(%)	(mg/kg wet weight)	(mg/kg wet weight)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.1E-05	5.5E-04	3.9E-08	9.4E-08	--		2.9E-04	14%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.8E-05	3.9E-06	3.4E-09	8.3E-09	--		1.0E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-06	8.7E-07	3.4E-10	8.2E-10	--		5.1E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	6.8E-05	3.3E-03	2.2E-07	5.3E-07	--		1.5E-03	71%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.2E-05	1.2E-04	1.0E-08	2.4E-08	--		2.8E-05	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.8E-05	1.5E-04	1.3E-08	3.0E-08	--		3.0E-05	1%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.1E-05	9.9E-05	1.3E-08	3.2E-08	--		1.8E-05	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.2E-04	4.9E-05	2.4E-08	5.9E-08	--		6.5E-05	3%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.2E-05	1.2E-05	2.8E-09	6.8E-09	--		6.1E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.3E-04	2.7E-03	2.0E-07	4.8E-07	--		8.5E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.5E-05	4.7E-04	3.6E-08	8.7E-08	--		1.2E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.1E-04	6.7E-04	7.9E-08	1.9E-07	--		4.0E-05	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	4.3E-05	5.7E-05	1.1E-08	2.7E-08	--		1.1E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.9E-06	1.7E-06	1.1E-09	2.7E-09	--		1.4E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	4.1E-05	6.5E-05	1.1E-08	2.7E-08	--		2.7E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.3E-10	1.3E-11	4.1E-14	1.0E-13	--		9.4E-05	5%
									TOTAL			0.00209	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - maximum residential - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.1E-05	5.5E-04	1.7E-08	2.0E-07	--		6.2E-04	13%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.8E-05	3.9E-06	2.6E-09	3.0E-08	--		3.7E-05	1%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-06	8.7E-07	2.4E-10	2.8E-09	--		1.8E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	6.8E-05	3.3E-03	9.3E-08	1.1E-06	--		3.0E-03	65%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.2E-05	1.2E-04	4.8E-09	5.6E-08	--		6.5E-05	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.8E-05	1.5E-04	6.2E-09	7.2E-08	--		7.2E-05	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.1E-05	9.9E-05	8.0E-09	9.4E-08	--		5.4E-05	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.2E-04	4.9E-05	1.8E-08	2.1E-07	--		2.3E-04	5%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.2E-05	1.2E-05	1.9E-09	2.2E-08	--		2.0E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.3E-04	2.7E-03	8.8E-08	1.0E-06	--		1.8E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.5E-05	4.7E-04	1.7E-08	1.9E-07	--		2.8E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.1E-04	6.7E-04	4.6E-08	5.3E-07	--		1.1E-04	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	4.3E-05	5.7E-05	7.3E-09	8.5E-08			3.5E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.9E-06	1.7E-06	8.3E-10	9.7E-09	--		4.8E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	4.1E-05	6.5E-05	7.1E-09	8.3E-08	--		8.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.3E-10	1.3E-11	3.2E-14	3.7E-13	--		3.5E-04	8%
									TOTAL			0.00463	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$$ (mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - maximum residential - EPA limit modelling scenario

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	2.1E-05	4.4E-03	1.0E-02	4.7E-07	OEHHA (2015)
Thallium (Tl)	1.8E-05	3.9E-03	1.7E-02	6.9E-07	
Beryllium (Be)	1.6E-06	3.5E-04	9.0E-02	3.3E-07	OEHHA (2015)
Mercury (Hg)	6.8E-05	1.5E-02	8.0E-01	1.2E-04	OEHHA (2015)
Antimony (Sb)	1.2E-05	2.5E-03	4.2E-04	1.1E-08	
Arsenic (As)	1.8E-05	3.7E-03	7.0E-02	2.8E-06	OEHHA (2015)
Lead (Pb)	4.1E-05	8.7E-03	4.0E-02	3.7E-06	OEHHA (2015)
Chromium (Cr VI assumed)	1.2E-04	2.6E-02	9.2E-03	2.5E-06	OEHHA (2003)
Cobalt (Co)	1.2E-05	2.5E-03	3.8E-02	1.0E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	1.3E-04	2.7E-02	3.8E-02	1.1E-05	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	3.5E-05	7.5E-03	3.8E-02	3.0E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	2.1E-04	4.5E-02	2.0E-02	9.5E-06	OEHHA (2015)
Selenium (Se)	4.3E-05	9.2E-03	3.0E+00	2.9E-04	OEHHA (2015)
Vanadium (V)	5.9E-06	1.2E-03	3.8E-02	5.0E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	4.1E-05	8.7E-03	3.8E-02	3.5E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	2.3E-10	1.5E-08	1.0E+01	1.8E-09	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs - maximum residential - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.059	Ingestion rate of eggs relevant for adults as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Egg concentration (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	4.7E-07	1.6E-10	3.9E-10	--		1.2E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.9E-07	2.4E-10	5.8E-10	--		7.3E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.3E-07	1.2E-10	2.8E-10	--		1.8E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.2E-04	4.3E-08	1.0E-07	--		2.9E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.1E-08	3.9E-12	9.4E-12	--		1.1E-08	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.8E-06	9.7E-10	2.3E-09	--		2.3E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.7E-06	1.3E-09	3.1E-09	--		1.8E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.5E-06	8.9E-10	2.1E-09	--		2.4E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.0E-06	3.5E-10	8.4E-10	--		7.5E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.1E-05	3.8E-09	9.3E-09	--		1.7E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.0E-06	1.0E-09	2.5E-09	--		3.6E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.5E-06	3.3E-09	8.0E-09	--		1.7E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.9E-04	1.0E-07	2.5E-07	--		1.0E-04	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.0E-07	1.7E-10	4.2E-10	--		2.1E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.5E-06	1.2E-09	2.9E-09	--		2.9E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.8E-09	6.2E-13	1.5E-12	--		1.4E-03	78%
								TOTAL			**0.00181**	

Exposure to Chemicals via Ingestion of Eggs - maximum residential - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.036	Ingestion rate of eggs relevant for young children as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	4.7E-07	9.6E-11	1.1E-09	--		3.5E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.9E-07	1.4E-10	1.7E-09	--		2.1E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.3E-07	6.8E-11	8.0E-10	--		5.0E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.2E-04	2.5E-08	3.0E-07	--		8.2E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.1E-08	2.3E-12	2.7E-11	--		3.1E-08	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.8E-06	5.7E-10	6.6E-09	--		6.6E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.7E-06	7.6E-10	8.9E-09	--		5.1E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.5E-06	5.2E-10	6.1E-09	--		6.8E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.0E-06	2.1E-10	2.4E-09	--		2.1E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.1E-05	2.3E-09	2.6E-08	--		4.7E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.0E-06	6.2E-10	7.2E-09	--		1.0E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.5E-06	2.0E-09	2.3E-08	--		4.7E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.9E-04	6.0E-08	7.0E-07	--		2.9E-04	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.0E-07	1.0E-10	1.2E-09	--		6.0E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.5E-06	7.2E-10	8.4E-09	--		8.4E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.8E-09	3.6E-13	4.2E-12	--		4.0E-03	78%
								TOTAL			0.00514	

Maximum Commercial/Industrial Location assuming it could be residential in the future

Scenario 1

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Maximum from grid	Air Concentration - annual average (mg/m3) Maximum from grid
Nitrogen dioxide (NO2)	3.05E-01	3.0E-04
Sulfur dioxide (SO2)	4.44E-02	4.4E-05
Hydrogen chloride (HCl)	1.78E-02	1.8E-05
Hydrogen fluoride (HF)	3.55E-03	3.6E-06
Ammonia	1.78E-02	1.8E-05
PM10	1.74E-02	1.7E-05
PM2.5	1.69E-02	1.7E-05
Cadmium (Cd)	2.37E-06	2.4E-09
Thallium (Tl)	2.07E-06	2.1E-09
Beryllium (Be)	7.46E-06	7.5E-09
Mercury (Hg)	4.44E-05	4.4E-08
Antimony (Sb)	1.85E-05	1.9E-08
Arsenic (As)	2.25E-05	2.3E-08
Lead (Pb)	6.23E-05	6.2E-08
Chromium (Cr VI assumed)	1.86E-04	1.9E-07
Cobalt (Co)	1.96E-05	2.0E-08
Copper (Cu)	1.95E-04	1.9E-07
Manganese (Mn)	5.45E-05	5.5E-08
Nickel (Ni)	3.20E-04	3.2E-07
Selenium (Se)	1.86E-04	1.9E-07
Vanadium (V)	1.08E-05	1.1E-08
Tin (Sn)	1.96E-04	2.0E-07
Dioxins and furans	7.99E-10	8.0E-13
Benzene	1.78E-02	1.8E-05

COPC	Deposition Rate - annual average (mg/m2/year) Maximum from grid	Deposition Rate - annual average (mg/m2/year) Maximum from grid
Cadmium (Cd)	1.64E-03	1.64E-03
Thallium (Tl)	1.45E-03	1.45E-03
Beryllium (Be)	5.19E-03	5.19E-03
Mercury (Hg)	3.09E-02	3.09E-02
Antimony (Sb)	1.24E-02	1.24E-02
Arsenic (As)	1.85E-02	1.85E-02
Lead (Pb)	4.33E-02	4.33E-02
Chromium (Cr VI assumed)	1.30E-01	1.30E-01
Cobalt (Co)	1.24E-02	1.24E-02
Copper (Cu)	1.36E-01	1.36E-01
Manganese (Mn)	3.71E-02	3.71E-02
Nickel (Ni)	2.22E-01	2.22E-01
Selenium (Se)	1.37E-01	1.37E-01
Vanadium (V)	6.18E-03	6.18E-03
Tin (Sn)	1.29E-01	1.29E-01
Dioxins and furans	3.71E-07	3.71E-07

Inhalation - gases and particulates
Maximum Commercial/Industrial/Retail Location

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Workers		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	3.0E-04	1.5E-04	3.0E-04	--		5.4E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	4.4E-05	2.2E-05	4.4E-05	--		8.9E-04	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	1.8E-05	8.9E-06	1.8E-05	--		6.8E-04	6%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.6E-06	1.8E-06	3.6E-06	--		1.2E-04	1%
Ammonia		3.2E-01	0%	3.2E-01	1.8E-05	8.9E-06	1.8E-05	--		5.6E-05	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	2.4E-09	4.4E-10	8.9E-10	--		2.2E-04	2%
Thallium (Tl)		2.8E-03	0%	2.8E-03	2.1E-09	3.9E-10	7.8E-10	--		2.8E-07	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	7.5E-09	1.4E-09	2.8E-09	--		1.7E-04	2%
Mercury (Hg)		2.0E-04	10%	1.8E-04	4.4E-08	8.3E-09	1.7E-08	--		9.3E-05	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	1.9E-08	3.5E-09	7.0E-09	--		3.5E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	2.3E-08	4.2E-09	8.4E-09	--		8.4E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	6.2E-08	1.2E-08	2.3E-08	--		4.7E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	1.9E-07	3.5E-08	7.0E-08	--		7.0E-04	7%
Cobalt (Co)		1.0E-04	0%	1.0E-04	2.0E-08	3.7E-09	7.4E-09	--		7.4E-05	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	1.9E-07	3.6E-08	7.3E-08	--		1.5E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	5.5E-08	1.0E-08	2.0E-08	--		1.7E-04	2%
Nickel (Ni)		2.0E-05	20%	1.6E-05	3.2E-07	6.0E-08	1.2E-07	--		7.5E-03	70%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.9E-07	3.5E-08	7.0E-08	--		8.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	1.1E-08	2.0E-09	4.0E-09	--		4.0E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.0E-07	3.7E-08	7.4E-08	--		1.1E-07	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	8.0E-13	1.5E-13	3.0E-13	--		8.1E-05	1%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.8E-05	8.9E-06	1.8E-05	5.3E-8		6.6E-04	6%
							TOTAL	5.3E-08		0.0107	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		**Surface (for direct contact)**	**Depth (for agricultural pathways)**	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - Maximum Commercial

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	1.6E-03	7.2E-03	4.8E-04
Thallium (Tl)	273973	2.5E-06	1.5E-03	6.4E-03	4.2E-04
Beryllium (Be)	273973	2.5E-06	5.2E-03	2.3E-02	1.5E-03
Mercury (Hg)	273973	2.5E-06	3.1E-02	1.4E-01	9.0E-03
Antimony (Sb)	273973	2.5E-06	1.2E-02	5.4E-02	3.6E-03
Arsenic (As)	273973	2.5E-06	1.9E-02	8.1E-02	5.4E-03
Lead (Pb)	273973	2.5E-06	4.3E-02	1.9E-01	1.3E-02
Chromium (Cr VI assumed)	273973	2.5E-06	1.3E-01	5.7E-01	3.8E-02
Cobalt (Co)	273973	2.5E-06	1.2E-02	5.4E-02	3.6E-03
Copper (Cu)	273973	2.5E-06	1.4E-01	5.9E-01	4.0E-02
Manganese (Mn)	273973	2.5E-06	3.7E-02	1.6E-01	1.1E-02
Nickel (Ni)	273973	2.5E-06	2.2E-01	9.7E-01	6.5E-02
Selenium (Se)	273973	2.5E-06	1.4E-01	6.0E-01	4.0E-02
Vanadium (V)	273973	2.5E-06	6.2E-03	2.7E-02	1.8E-03
Tin (Sn)	273973	2.5E-06	1.3E-01	5.6E-01	3.8E-02
Dioxins and furans	15.00	4.6E-02	3.7E-07	4.8E-07	3.2E-08

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum Commercial

$$\textit{Daily Chemical Intake}_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	Time at one work location as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	12775	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.2E-03	2.6E-09	5.1E-09	--		1.6E-05	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.4E-03	2.3E-09	4.5E-09	--		5.7E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	8.1E-09	1.6E-08	--		1.0E-05	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-01	4.8E-08	9.7E-08	--		2.7E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.4E-02	1.9E-08	3.9E-08	--		4.5E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.1E-02	2.9E-08	5.8E-08	--		5.8E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.9E-01	6.8E-08	1.4E-07	--		7.7E-05	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.7E-01	2.0E-07	4.1E-07	--		4.5E-04	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.4E-02	1.9E-08	3.9E-08	--		3.4E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.9E-01	2.1E-07	4.2E-07	--		7.6E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.6E-01	5.8E-08	1.2E-07	--		1.7E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.7E-01	3.5E-07	7.0E-07	--		1.4E-04	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	2.1E-07	4.3E-07	--		1.8E-04	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.7E-02	9.7E-09	1.9E-08	--		9.7E-06	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	2.0E-07	4.0E-07	--		4.0E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	4.8E-07	1.7E-13	3.4E-13	--		3.3E-04	20%
								TOTAL			0.001636	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Commercial

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	12775	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor $(mg/kg\text{-}day)^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		7.2E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		6.4E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	5.1E-10	1.0E-09	--		6.4E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.4E-01	3.0E-09	6.1E-09	--		1.7E-5	2%
Antimony (Sb)		8.6E-04		8.6E-04		5.4E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	8.1E-02	9.1E-09	1.8E-08	--		1.8E-5	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.9E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		5.7E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	5.4E-02	1.2E-09	2.4E-09	--		2.2E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		5.9E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.6E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	9.7E-01	1.1E-07	2.2E-07	--		4.6E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		2.7E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	4.8E-07	3.3E-13	6.5E-13	--		6.1E-4	88%
								TOTAL			0.000698	

Exposure to Chemicals via Incidental Ingestion of Soil

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.2E-03	4.1E-09	4.8E-08	--		1.5E-04	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.4E-03	3.6E-09	4.2E-08	--		5.3E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	1.3E-08	1.5E-07	--		9.5E-05	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-01	7.7E-08	9.0E-07	--		2.5E-03	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.4E-02	3.1E-08	3.6E-07	--		4.2E-04	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.1E-02	4.6E-08	5.4E-07	--		5.4E-04	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.9E-01	1.1E-07	1.3E-06	--		7.2E-04	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.7E-01	3.2E-07	3.8E-06	--		4.2E-03	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.4E-02	3.1E-08	3.6E-07	--		3.2E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.9E-01	3.4E-07	4.0E-06	--		7.1E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.6E-01	9.3E-08	1.1E-06	--		1.5E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.7E-01	5.6E-07	6.5E-06	--		1.4E-03	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	3.4E-07	4.0E-06	--		1.7E-03	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.7E-02	1.5E-08	1.8E-07	--		9.0E-05	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	3.2E-07	3.8E-06	--		3.8E-05	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	4.8E-07	2.8E-13	3.2E-12	--		3.0E-03	20%
								TOTAL			**0.0153**	

Dermal Exposure to Chemicals via Contact with Soil

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \textbf{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		7.2E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		6.4E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	1.8E-10	2.0E-09	--		1.3E-6	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.4E-01	1.0E-09	1.2E-08	--		3.4E-5	2%
Antimony (Sb)		8.6E-04		8.6E-04		5.4E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	8.1E-02	3.1E-09	3.6E-08	--		3.6E-5	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.9E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		5.7E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	5.4E-02	4.2E-10	4.9E-09	--		4.3E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		5.9E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.6E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	9.7E-01	3.8E-08	4.4E-07	--		9.1E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		2.7E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	4.8E-07	1.1E-13	1.3E-12	--		1.2E-3	88%
								TOTAL			**0.00140**	

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops

$$C_p = \frac{DR \bullet F \bullet \left[1 - e^{-k \bullet t}\right]}{Y \bullet k}$$ (mg/kg plant – wet weight)

where:
DR= Particle deposition rate for accidental release (mg/m^2/day)
F= Fraction for the surface area of plant (unitless)
k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$
$T_{0.5}$= Chemical half-life as particulate on plant (days)
t= Deposition time (days)
Y= Crop yield (kg/m^2)

Uptake via Roots from Soil

$$C_{rp} = C_s \bullet RUF$$ (mg/kg plant – wet weight)

where:
Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg)
RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations

Chemical	Half-life on plant ($T_{0.5}$)#	Loss constant (k) &	Deposition Rate (DR)	Aboveground Produce Concentration via Deposition	Root Uptake Factor (RUF)$	Soil Concentration (Cs)	Below Ground Produce Concentration
	days	per day	mg/m^2/day	mg/kg ww	unitless	mg/kg	mg/kg ww
Cadmium (Cd)	14	0.05	4.5E-06	2.2E-06	0.125	4.8E-04	6.0E-05
Thallium (Tl)	14	0.05	4.0E-06	2.0E-06	0.001	4.2E-04	4.2E-07
Beryllium (Be)	14	0.05	1.4E-05	7.1E-06	0.0025	1.5E-03	3.8E-06
Mercury (Hg)	14	0.05	8.5E-05	4.2E-05	0.225	9.0E-03	2.0E-03
Antimony (Sb)	14	0.05	3.4E-05	1.7E-05	0.05	3.6E-03	1.8E-04
Arsenic (As)	14	0.05	5.1E-05	2.5E-05	0.04	5.4E-03	2.2E-04
Lead (Pb)	14	0.05	1.2E-04	5.9E-05	0.0113	1.3E-02	1.4E-04
Chromium (Cr VI assumed)	14	0.05	3.6E-04	1.8E-04	0.00188	3.8E-02	7.1E-05
Cobalt (Co)	14	0.05	3.4E-05	1.7E-05	0.005	3.6E-03	1.8E-05
Copper (Cu)	14	0.05	3.7E-04	1.9E-04	0.1	4.0E-02	4.0E-03
Manganese (Mn)	14	0.05	1.0E-04	5.1E-05	0.0625	1.1E-02	6.8E-04
Nickel (Ni)	14	0.05	6.1E-04	3.0E-04	0.015	6.5E-02	9.7E-04
Selenium (Se)	14	0.05	3.7E-04	1.9E-04	0.00625	4.0E-02	2.5E-04
Vanadium (V)	14	0.05	1.7E-05	8.4E-06	0.00138	1.8E-03	2.5E-06
Tin (Sn)	14	0.05	3.5E-04	1.8E-04	0.0075	3.8E-02	2.8E-04
Dioxins and furans	14	0.05	1.0E-09	5.1E-10	0.000876	3.2E-08	2.8E-11

$ Root uptake factors from RAIS (soil to wet weight of plant)
& Loss constant is 1/half life
# Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)				NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.2E-06	6.0E-05	4.2E-09	1.0E-08	--		3.2E-05	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.0E-06	4.2E-07	3.7E-10	8.9E-10	--		1.1E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.1E-06	3.8E-06	1.5E-09	3.5E-09	--		2.2E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	4.2E-05	2.0E-03	1.4E-07	3.3E-07	--		9.2E-04	61%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.7E-05	1.8E-04	1.4E-08	3.5E-08	--		4.1E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.5E-05	2.2E-04	1.8E-08	4.4E-08	--		4.4E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.9E-05	1.4E-04	1.9E-08	4.7E-08	--		2.7E-05	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.8E-04	7.1E-05	3.5E-08	8.5E-08	--		9.4E-05	6%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.7E-05	1.8E-05	4.1E-09	9.8E-09	--		8.8E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.9E-04	4.0E-03	2.9E-07	6.9E-07	--		1.2E-05	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.1E-05	6.8E-04	5.2E-08	1.3E-07	--		1.8E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.0E-04	9.7E-04	1.1E-07	2.8E-07	--		5.8E-05	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.9E-04	2.5E-04	4.8E-08	1.2E-07	--		4.8E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.4E-06	2.5E-06	1.6E-09	3.9E-09	--		2.0E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.8E-04	2.8E-04	4.9E-08	1.2E-07	--		1.2E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	5.1E-10	2.8E-11	8.9E-14	2.2E-13	--		2.0E-04	14%
									TOTAL			0.00149	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.2E-06	6.0E-05	1.8E-09	2.1E-08	--		6.7E-05	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.0E-06	4.2E-07	2.8E-10	3.2E-09	--		4.0E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.1E-06	3.8E-06	1.1E-09	1.2E-08	--		7.7E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	4.2E-05	2.0E-03	5.8E-08	6.7E-07	--		1.9E-03	51%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.7E-05	1.8E-04	6.9E-09	8.0E-08	--		9.3E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.5E-05	2.2E-04	8.9E-09	1.0E-07	--		1.0E-04	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.9E-05	1.4E-04	1.2E-08	1.4E-07	--		7.7E-05	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.8E-04	7.1E-05	2.6E-08	3.0E-07	--		3.3E-04	9%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.7E-05	1.8E-05	2.7E-09	3.2E-08	--		2.8E-05	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.9E-04	4.0E-03	1.3E-07	1.5E-06	--		2.6E-05	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.1E-05	6.8E-04	2.4E-08	2.8E-07	--		4.0E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.0E-04	9.7E-04	6.6E-08	7.7E-07	--		1.6E-04	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.9E-04	2.5E-04	3.1E-08	3.7E-07			1.5E-04	4%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.4E-06	2.5E-06	1.2E-09	1.4E-08	--		7.0E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.8E-04	2.8E-04	3.1E-08	3.6E-07	--		3.6E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	5.1E-10	2.8E-11	6.9E-14	8.0E-13	--		7.6E-04	21%
									TOTAL			0.00369	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$$ (mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - Regulatory scenario

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	2.2E-06	4.8E-04	1.0E-02	5.0E-08	OEHHA (2015)
Thallium (Tl)	2.0E-06	4.2E-04	1.7E-02	7.5E-08	
Beryllium (Be)	7.1E-06	1.5E-03	9.0E-02	1.4E-06	OEHHA (2015)
Mercury (Hg)	4.2E-05	9.0E-03	8.0E-01	7.6E-05	OEHHA (2015)
Antimony (Sb)	1.7E-05	3.6E-03	4.2E-04	1.6E-08	
Arsenic (As)	2.5E-05	5.4E-03	7.0E-02	4.0E-06	OEHHA (2015)
Lead (Pb)	5.9E-05	1.3E-02	4.0E-02	5.3E-06	OEHHA (2015)
Chromium (Cr VI assumed)	1.8E-04	3.8E-02	9.2E-03	3.7E-06	OEHHA (2003)
Cobalt (Co)	1.7E-05	3.6E-03	3.8E-02	1.4E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	1.9E-04	4.0E-02	3.8E-02	1.6E-05	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	5.1E-05	1.1E-02	3.8E-02	4.3E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	3.0E-04	6.5E-02	2.0E-02	1.4E-05	OEHHA (2015)
Selenium (Se)	1.9E-04	4.0E-02	3.0E+00	1.3E-03	OEHHA (2015)
Vanadium (V)	8.4E-06	1.8E-03	3.8E-02	7.2E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	1.8E-04	3.8E-02	3.8E-02	1.5E-05	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	5.1E-10	3.2E-08	1.0E+01	3.8E-09	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.014	Ingestion rate of eggs relevant for adults as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.0E-08	4.2E-12	1.0E-11	--		3.2E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	7.5E-08	6.2E-12	1.5E-11	--		1.9E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.4E-06	1.2E-10	2.9E-10	--		1.8E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	7.6E-05	6.3E-09	1.5E-08	--		4.2E-05	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.6E-08	1.3E-12	3.2E-12	--		3.7E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	4.0E-06	3.3E-10	8.0E-10	--		8.0E-07	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.3E-06	4.4E-10	1.1E-09	--		6.1E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.7E-06	3.0E-10	7.4E-10	--		8.2E-07	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.4E-06	1.2E-10	2.9E-10	--		2.6E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.6E-05	1.3E-09	3.2E-09	--		5.7E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.3E-06	3.6E-10	8.7E-10	--		1.2E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.4E-05	1.1E-09	2.7E-09	--		5.7E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.3E-03	1.0E-07	2.5E-07	--		1.1E-04	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	7.2E-07	6.0E-11	1.4E-10	--		7.2E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.5E-05	1.3E-09	3.0E-09	--		3.0E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.8E-09	3.2E-13	7.6E-13	--		7.2E-04	83%
								TOTAL			0.000873	

Exposure to Chemicals via Ingestion of Eggs

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.006	Ingestion rate of eggs relevant for young children as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.0E-08	1.7E-12	2.0E-11	--		6.3E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	7.5E-08	2.6E-12	3.0E-11	--		3.8E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.4E-06	4.9E-11	5.8E-10	--		3.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	7.6E-05	2.6E-09	3.0E-08	--		8.5E-05	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.6E-08	5.5E-13	6.4E-12	--		7.5E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	4.0E-06	1.4E-10	1.6E-09	--		1.6E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.3E-06	1.8E-10	2.1E-09	--		1.2E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.7E-06	1.3E-10	1.5E-09	--		1.6E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.4E-06	5.0E-11	5.8E-10	--		5.2E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.6E-05	5.5E-10	6.4E-09	--		1.1E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.3E-06	1.5E-10	1.7E-09	--		2.5E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.4E-05	4.7E-10	5.5E-09	--		1.1E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.3E-03	4.3E-08	5.0E-07	--		2.1E-04	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	7.2E-07	2.5E-11	2.9E-10	--		1.4E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.5E-05	5.2E-10	6.0E-09	--		6.0E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.8E-09	1.3E-13	1.5E-12	--		1.4E-03	83%
								TOTAL			0.00175	

EPA Limit modelling scenario

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Max Commercial	Air Concentration - annual average (mg/m3) Max Commercial
Nitrogen dioxide (NO2)	1.35E+00	1.4E-03
Sulfur dioxide (SO2)	1.78E+00	1.8E-03
Hydrogen chloride (HCl)	5.33E-01	5.3E-04
Hydrogen fluoride (HF)	3.55E-02	3.6E-05
Ammonia	2.66E-01	2.7E-04
PM10	2.61E-01	2.6E-04
PM2.5	2.53E-01	2.5E-04
Cadmium (Cd)	9.48E-05	9.5E-08
Thallium (Tl)	8.28E-05	8.3E-08
Beryllium (Be)	7.46E-06	7.5E-09
Mercury (Hg)	3.11E-04	3.1E-07
Antimony (Sb)	5.56E-05	5.6E-08
Arsenic (As)	6.76E-05	6.8E-08
Lead (Pb)	1.87E-04	1.9E-07
Chromium (Cr VI assumed)	5.57E-04	5.6E-07
Cobalt (Co)	5.88E-05	5.9E-08
Copper (Cu)	5.84E-04	5.8E-07
Manganese (Mn)	1.64E-04	1.6E-07
Nickel (Ni)	9.60E-04	9.6E-07
Selenium (Se)	1.86E-04	1.9E-07
Vanadium (V)	3.23E-05	3.2E-08
Tin (Sn)	1.96E-04	2.0E-07
Dioxins and furans	1.60E-09	1.6E-12
Benzene	1.78E-01	1.8E-04

COPC	Deposition Rate - annual average (mg/m2/year) Max Commercial
Cadmium (Cd)	6.55E-02
Thallium (Tl)	5.81E-02
Beryllium (Be)	5.19E-03
Mercury (Hg)	2.16E-01
Antimony (Sb)	3.71E-02
Arsenic (As)	5.56E-02
Lead (Pb)	1.30E-01
Chromium (Cr VI assumed)	3.89E-01
Cobalt (Co)	3.71E-02
Copper (Cu)	4.08E-01
Manganese (Mn)	1.11E-01
Nickel (Ni)	6.67E-01
Selenium (Se)	1.37E-01
Vanadium (V)	1.85E-02
Tin (Sn)	1.29E-01
Dioxins and furans	7.42E-07

Deposition Rate - annual average (mg/m2/year) Max Commercial
6.55E-02
5.81E-02
5.19E-03
2.16E-01
3.71E-02
5.56E-02
1.30E-01
3.89E-01
3.71E-02
4.08E-01
1.11E-01
6.67E-01
1.37E-01
1.85E-02
1.29E-01
7.42E-07

Inhalation - gases and particulates
Maximum Commercial as Residential
EPA limit modelling scenario

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	1.4E-03	6.8E-04	1.4E-03	--		2.4E-02	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	1.8E-03	8.9E-04	1.8E-03	--		3.6E-02	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	5.3E-04	2.7E-04	5.3E-04	--		2.0E-02	32%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.6E-05	1.8E-05	3.6E-05	--		1.2E-03	2%
Ammonia		3.2E-01	0%	3.2E-01	2.7E-04	1.3E-04	2.7E-04	--		8.3E-04	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	9.5E-08	1.8E-08	3.6E-08	--		8.9E-03	14%
Thallium (Tl)		2.8E-03	0%	2.8E-03	8.3E-08	1.6E-08	3.1E-08	--		1.1E-05	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	7.5E-09	1.4E-09	2.8E-09	--		1.7E-04	0%
Mercury (Hg)		2.0E-04	10%	1.8E-04	3.1E-07	5.8E-08	1.2E-07	--		6.5E-04	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	5.6E-08	1.0E-08	2.1E-08	--		1.0E-04	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	6.8E-08	1.3E-08	2.5E-08	--		2.5E-05	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	1.9E-07	3.5E-08	7.0E-08	--		1.4E-04	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	5.6E-07	1.0E-07	2.1E-07	--		2.1E-03	3%
Cobalt (Co)		1.0E-04	0%	1.0E-04	5.9E-08	1.1E-08	2.2E-08	--		2.2E-04	0%
Copper (Cu)		4.9E-01	0%	4.9E-01	5.8E-07	1.1E-07	2.2E-07	--		4.5E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	1.6E-07	3.1E-08	6.1E-08	--		5.1E-04	1%
Nickel (Ni)		2.0E-05	20%	1.6E-05	9.6E-07	1.8E-07	3.6E-07	--		2.2E-02	35%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.9E-07	3.5E-08	7.0E-08	--		8.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	3.2E-08	6.0E-09	1.2E-08	--		1.2E-04	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.0E-07	3.7E-08	7.4E-08	--		1.1E-07	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.6E-12	3.0E-13	6.0E-13	--		1.6E-04	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.8E-04	8.9E-05	1.8E-04	5.3E-7		6.6E-03	10%
							TOTAL	**5.3E-07**		**0.0647**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - EPA limit modelling scenario

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	6.6E-02	2.9E-01	1.9E-02
Thallium (Tl)	273973	2.5E-06	5.8E-02	2.5E-01	1.7E-02
Beryllium (Be)	273973	2.5E-06	5.2E-03	2.3E-02	1.5E-03
Mercury (Hg)	273973	2.5E-06	2.2E-01	9.5E-01	6.3E-02
Antimony (Sb)	273973	2.5E-06	3.7E-02	1.6E-01	1.1E-02
Arsenic (As)	273973	2.5E-06	5.6E-02	2.4E-01	1.6E-02
Lead (Pb)	273973	2.5E-06	1.3E-01	5.7E-01	3.8E-02
Chromium (Cr VI assumed)	273973	2.5E-06	3.9E-01	1.7E+00	1.1E-01
Cobalt (Co)	273973	2.5E-06	3.7E-02	1.6E-01	1.1E-02
Copper (Cu)	273973	2.5E-06	4.1E-01	1.8E+00	1.2E-01
Manganese (Mn)	273973	2.5E-06	1.1E-01	4.9E-01	3.2E-02
Nickel (Ni)	273973	2.5E-06	6.7E-01	2.9E+00	1.9E-01
Selenium (Se)	273973	2.5E-06	1.4E-01	6.0E-01	4.0E-02
Vanadium (V)	273973	2.5E-06	1.9E-02	8.1E-02	5.4E-03
Tin (Sn)	273973	2.5E-06	1.3E-01	5.6E-01	3.8E-02
Dioxins and furans	15.00	4.6E-02	7.4E-07	9.6E-07	6.4E-08

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - EPA limit modelling scenario

$$\textit{Daily Chemical Intake}_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.9E-01	8.5E-08	2.0E-07	--		6.4E-04	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.5E-01	7.5E-08	1.8E-07	--		2.3E-04	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	6.7E-09	1.6E-08	--		1.0E-05	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.5E-01	2.8E-07	6.8E-07	--		1.9E-03	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.6E-01	4.8E-08	1.2E-07	--		1.3E-04	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.4E-01	7.2E-08	1.7E-07	--		1.7E-04	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.7E-01	1.7E-07	4.1E-07	--		2.3E-04	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.7E+00	5.0E-07	1.2E-06	--		1.4E-03	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.6E-01	4.8E-08	1.2E-07	--		1.0E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.8E+00	5.3E-07	1.3E-06	--		2.3E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.9E-01	1.4E-07	3.5E-07	--		5.0E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.9E+00	8.6E-07	2.1E-06	--		4.3E-04	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	1.8E-07	4.3E-07	--		1.8E-04	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.1E-02	2.4E-08	5.8E-08	--		2.9E-05	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	1.7E-07	4.0E-07	--		4.0E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	9.6E-07	2.9E-13	6.9E-13	--		6.5E-04	11%
								TOTAL			**0.00607**	

Dermal Exposure to Chemicals via Contact with Soil - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		2.9E-01			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		2.5E-01			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	4.2E-10	1.0E-09	--		6.4E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	9.5E-01	1.8E-08	4.3E-08	--		1.2E-4	8%
Antimony (Sb)		8.6E-04		8.6E-04		1.6E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.4E-01	2.3E-08	5.5E-08	--		5.5E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		5.7E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.7E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.6E-01	3.0E-09	7.3E-09	--		6.5E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.8E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		4.9E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.9E+00	2.7E-07	6.6E-07	--		1.4E-4	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		8.1E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	9.6E-07	5.4E-13	1.3E-12	--		1.2E-3	79%
								TOTAL			0.00155	

Exposure to Chemicals via Incidental Ingestion of Soil - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Soil Concentration (mg/kg)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.9E-01	1.6E-07	1.9E-06	--		6.0E-03	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.5E-01	1.5E-07	1.7E-06	--		2.1E-03	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	1.3E-08	1.5E-07	--		9.5E-05	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.5E-01	5.4E-07	6.3E-06	--		1.8E-02	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.6E-01	9.3E-08	1.1E-06	--		1.3E-03	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.4E-01	1.4E-07	1.6E-06	--		1.6E-03	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.7E-01	3.2E-07	3.8E-06	--		2.2E-03	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.7E+00	9.7E-07	1.1E-05	--		1.3E-02	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.6E-01	9.3E-08	1.1E-06	--		9.7E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.8E+00	1.0E-06	1.2E-05	--		2.1E-04	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.9E-01	2.8E-07	3.2E-06	--		4.6E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.9E+00	1.7E-06	1.9E-05	--		4.1E-03	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	3.4E-07	4.0E-06	--		1.7E-03	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.1E-02	4.6E-08	5.4E-07	--		2.7E-04	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	3.2E-07	3.8E-06	--		3.8E-05	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	9.6E-07	5.5E-13	6.4E-12	--		6.1E-03	11%
								TOTAL			0.0567	

Dermal Exposure to Chemicals via Contact with Soil - EPA limit modelling scenario

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		2.9E-01			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		2.5E-01			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	1.8E-10	2.0E-09	--		1.3E-6	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	9.5E-01	7.3E-09	8.5E-08	--		2.4E-4	8%
Antimony (Sb)		8.6E-04		8.6E-04		1.6E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.4E-01	9.4E-09	1.1E-07	--		1.1E-4	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		5.7E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.7E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.6E-01	1.3E-09	1.5E-08	--		1.3E-5	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.8E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		4.9E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.9E+00	1.1E-07	1.3E-06	--		2.7E-4	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		8.1E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	9.6E-07	2.2E-13	2.6E-12	--		2.5E-3	79%
								TOTAL			0.00309	

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops	Uptake via Roots from Soil
$C_p = \frac{DR \bullet F \bullet [1 - e^{-k \bullet t}]}{Y \bullet k}$ (mg/kg plant – wet weight)	$C_{rp} = C_s \bullet RUF$ (mg/kg plant – wet weight)
where: DR= Particle deposition rate for accidental release (mg/m^2/day) F= Fraction for the surface area of plant (unitless) k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$ $T_{0.5}$= Chemical half-life as particulate on plant (days) t= Deposition time (days) Y= Crop yield (kg/m^2)	**where**: Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg) RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations - EPA limit modelling scenario

Chemical	Half-life on plant ($T_{0.5}$)#	Loss constant (k) &	Deposition Rate (DR)	Aboveground Produce Concentration via Deposition	Root Uptake Factor (RUF)$	Soil Concentration (Cs)	Below Ground Produce Concentration
	days	per day	mg/m^2/day	mg/kg ww	unitless	mg/kg	mg/kg ww
Cadmium (Cd)	14	0.05	1.8E-04	9.0E-05	0.125	1.9E-02	2.4E-03
Thallium (Tl)	14	0.05	1.6E-04	7.9E-05	0.001	1.7E-02	1.7E-05
Beryllium (Be)	14	0.05	1.4E-05	7.1E-06	0.0025	1.5E-03	3.8E-06
Mercury (Hg)	14	0.05	5.9E-04	3.0E-04	0.225	6.3E-02	1.4E-02
Antimony (Sb)	14	0.05	1.0E-04	5.1E-05	0.05	1.1E-02	5.4E-04
Arsenic (As)	14	0.05	1.5E-04	7.6E-05	0.04	1.6E-02	6.5E-04
Lead (Pb)	14	0.05	3.6E-04	1.8E-04	0.0113	3.8E-02	4.3E-04
Chromium (Cr VI assumed)	14	0.05	1.1E-03	5.3E-04	0.00188	1.1E-01	2.1E-04
Cobalt (Co)	14	0.05	1.0E-04	5.1E-05	0.005	1.1E-02	5.4E-05
Copper (Cu)	14	0.05	1.1E-03	5.6E-04	0.1	1.2E-01	1.2E-02
Manganese (Mn)	14	0.05	3.0E-04	1.5E-04	0.0625	3.2E-02	2.0E-03
Nickel (Ni)	14	0.05	1.8E-03	9.1E-04	0.015	1.9E-01	2.9E-03
Selenium (Se)	14	0.05	3.7E-04	1.9E-04	0.00625	4.0E-02	2.5E-04
Vanadium (V)	14	0.05	5.1E-05	2.5E-05	0.00138	5.4E-03	7.5E-06
Tin (Sn)	14	0.05	3.5E-04	1.8E-04	0.0075	3.8E-02	2.8E-04
Dioxins and furans	14	0.05	2.0E-09	1.0E-09	0.000876	6.4E-08	5.6E-11

$ Root uptake factors from RAIS (soil to wet weight of plant)

& Loss constant is 1/half life

Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Above ground produce concentration (mg/kg wet weight)	Root crops concentrations (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	9.0E-05	2.4E-03	1.7E-07	4.1E-07	--		1.3E-03	14%
Thallium (Tl)		8.0E-04		8.0E-04	100%	7.9E-05	1.7E-05	1.5E-08	3.6E-08	--		4.5E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.1E-06	3.8E-06	1.5E-09	3.5E-09	--		2.2E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.0E-04	1.4E-02	9.6E-07	2.3E-06	--		6.4E-03	71%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.1E-05	5.4E-04	4.3E-08	1.0E-07	--		1.2E-04	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	7.6E-05	6.5E-04	5.5E-08	1.3E-07	--		1.3E-04	1%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.8E-04	4.3E-04	5.8E-08	1.4E-07	--		8.0E-05	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.3E-04	2.1E-04	1.1E-07	2.5E-07	--		2.8E-04	3%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.1E-05	5.4E-05	1.2E-08	2.9E-08	--		2.6E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.6E-04	1.2E-02	8.6E-07	2.1E-06	--		3.7E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.5E-04	2.0E-03	1.6E-07	3.8E-07	--		5.4E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.1E-04	2.9E-03	3.4E-07	8.3E-07	--		1.7E-04	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.9E-04	2.5E-04	4.8E-08	1.2E-07	--		4.8E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.5E-05	7.5E-06	4.9E-09	1.2E-08	--		5.9E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.8E-04	2.8E-04	4.9E-08	1.2E-07	--		1.2E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.0E-09	5.6E-11	1.8E-13	4.3E-13	--		4.1E-04	5%
									TOTAL			0.00906	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	9.0E-05	2.4E-03	7.3E-08	8.5E-07	--		2.7E-03	13%
Thallium (Tl)		8.0E-04		8.0E-04	100%	7.9E-05	1.7E-05	1.1E-08	1.3E-07	--		1.6E-04	1%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.1E-06	3.8E-06	1.1E-09	1.2E-08	--		7.7E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.0E-04	1.4E-02	4.0E-07	4.7E-06	--		1.3E-02	65%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.1E-05	5.4E-04	2.1E-08	2.4E-07	--		2.8E-04	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	7.6E-05	6.5E-04	2.7E-08	3.1E-07	--		3.1E-04	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.8E-04	4.3E-04	3.5E-08	4.1E-07	--		2.3E-04	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.3E-04	2.1E-04	7.7E-08	9.0E-07	--		1.0E-03	5%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.1E-05	5.4E-05	8.2E-09	9.6E-08	--		8.5E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.6E-04	1.2E-02	3.8E-07	4.4E-06	--		7.9E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.5E-04	2.0E-03	7.2E-08	8.4E-07	--		1.2E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.1E-04	2.9E-03	2.0E-07	2.3E-06	--		4.8E-04	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.9E-04	2.5E-04	3.1E-08	3.7E-07			1.5E-04	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.5E-05	7.5E-06	3.6E-09	4.2E-08	--		2.1E-05	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.8E-04	2.8E-04	3.1E-08	3.6E-07	--		3.6E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.0E-09	5.6E-11	1.4E-13	1.6E-12	--		1.5E-03	8%
									TOTAL			0.02008	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$ (mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - EPA limit modelling scenario

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	9.0E-05	1.9E-02	1.0E-02	2.0E-06	OEHHA (2015)
Thallium (Tl)	7.9E-05	1.7E-02	1.7E-02	3.0E-06	
Beryllium (Be)	7.1E-06	1.5E-03	9.0E-02	1.4E-06	OEHHA (2015)
Mercury (Hg)	3.0E-04	6.3E-02	8.0E-01	5.3E-04	OEHHA (2015)
Antimony (Sb)	5.1E-05	1.1E-02	4.2E-04	4.8E-08	
Arsenic (As)	7.6E-05	1.6E-02	7.0E-02	1.2E-05	OEHHA (2015)
Lead (Pb)	1.8E-04	3.8E-02	4.0E-02	1.6E-05	OEHHA (2015)
Chromium (Cr VI assumed)	5.3E-04	1.1E-01	9.2E-03	1.1E-05	OEHHA (2003)
Cobalt (Co)	5.1E-05	1.1E-02	3.8E-02	4.3E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	5.6E-04	1.2E-01	3.8E-02	4.8E-05	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	1.5E-04	3.2E-02	3.8E-02	1.3E-05	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	9.1E-04	1.9E-01	2.0E-02	4.1E-05	OEHHA (2015)
Selenium (Se)	1.9E-04	4.0E-02	3.0E+00	1.3E-03	OEHHA (2015)
Vanadium (V)	2.5E-05	5.4E-03	3.8E-02	2.2E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	1.8E-04	3.8E-02	3.8E-02	1.5E-05	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	1.0E-09	6.4E-08	1.0E+01	7.6E-09	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.059	Ingestion rate of eggs relevant for adults as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.0E-06	7.0E-10	1.7E-09	--		5.3E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	3.0E-06	1.0E-09	2.5E-09	--		3.2E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.4E-06	5.0E-10	1.2E-09	--		7.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	5.3E-04	1.9E-07	4.5E-07	--		1.2E-03	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	4.8E-08	1.7E-11	4.1E-11	--		4.7E-08	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.2E-05	4.2E-09	1.0E-08	--		1.0E-05	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.6E-05	5.6E-09	1.3E-08	--		7.7E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.1E-05	3.9E-09	9.3E-09	--		1.0E-05	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.3E-06	1.5E-09	3.7E-09	--		3.3E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.8E-05	1.7E-08	4.0E-08	--		7.2E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.3E-05	4.5E-09	1.1E-08	--		1.6E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	4.1E-05	1.4E-08	3.5E-08	--		7.2E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.3E-03	4.4E-07	1.1E-06	--		4.4E-04	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.2E-06	7.6E-10	1.8E-09	--		9.1E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.5E-05	5.3E-09	1.3E-08	--		1.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	7.6E-09	2.7E-12	6.4E-12	--		6.1E-03	78%
								TOTAL			**0.00783**	

Exposure to Chemicals via Ingestion of Eggs - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.036	Ingestion rate of eggs relevant for young children as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.0E-06	4.2E-10	4.8E-09	--		1.5E-05	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	3.0E-06	6.2E-10	7.2E-09	--		9.0E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.4E-06	3.0E-10	3.5E-09	--		2.2E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	5.3E-04	1.1E-07	1.3E-06	--		3.6E-03	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	4.8E-08	9.9E-12	1.2E-10	--		1.3E-07	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.2E-05	2.5E-09	2.9E-08	--		2.9E-05	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.6E-05	3.3E-09	3.8E-08	--		2.2E-05	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.1E-05	2.3E-09	2.6E-08	--		2.9E-05	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.3E-06	8.9E-10	1.0E-08	--		9.3E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.8E-05	9.8E-09	1.1E-07	--		2.0E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.3E-05	2.7E-09	3.1E-08	--		4.5E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	4.1E-05	8.5E-09	9.9E-08	--		2.1E-05	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.3E-03	2.6E-07	3.0E-06	--		1.3E-03	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.2E-06	4.5E-10	5.2E-09	--		2.6E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.5E-05	3.1E-09	3.6E-08	--		3.6E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	7.6E-09	1.6E-12	1.8E-11	--		1.7E-02	78%
								TOTAL			**0.02229**	

Maximum Other Places Location assuming it could be residential in the future

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Maximum Other Places	Air Concentration - annual average (mg/m3) Maximum Other Places
Nitrogen dioxide (NO2)	2.22E-01	2.2E-04
Sulfur dioxide (SO2)	4.45E-02	4.4E-05
Hydrogen chloride (HCl)	1.78E-02	1.8E-05
Hydrogen fluoride (HF)	3.56E-03	3.6E-06
Ammonia	1.78E-02	1.8E-05
PM10	1.74E-02	1.7E-05
PM2.5	1.69E-02	1.7E-05
Cadmium (Cd)	2.37E-06	2.4E-09
Thallium (Tl)	2.07E-06	2.1E-09
Beryllium (Be)	7.47E-06	7.5E-09
Mercury (Hg)	4.45E-05	4.4E-08
Antimony (Sb)	1.86E-05	1.9E-08
Arsenic (As)	2.25E-05	2.3E-08
Lead (Pb)	6.23E-05	6.2E-08
Chromium (Cr VI assumed)	1.86E-04	1.9E-07
Cobalt (Co)	1.96E-05	2.0E-08
Copper (Cu)	1.95E-04	1.9E-07
Manganese (Mn)	5.46E-05	5.5E-08
Nickel (Ni)	3.20E-04	3.2E-07
Selenium (Se)	1.86E-04	1.9E-07
Vanadium (V)	1.08E-05	1.1E-08
Tin (Sn)	1.96E-04	2.0E-07
Dioxins and furans	8.00E-10	8.0E-13
Benzene	1.78E-02	1.8E-05

COPC	Deposition Rate - annual average (mg/m2/year) Maximum Other Places	Deposition Rate - annual average (mg/m2/year) Maximum Other Places
Cadmium (Cd)	3.38E-04	3.38E-04
Thallium (Tl)	3.00E-04	3.00E-04
Beryllium (Be)	1.07E-03	1.07E-03
Mercury (Hg)	6.38E-03	6.38E-03
Antimony (Sb)	2.55E-03	2.55E-03
Arsenic (As)	3.83E-03	3.83E-03
Lead (Pb)	8.93E-03	8.93E-03
Chromium (Cr VI assumed)	2.68E-02	2.68E-02
Cobalt (Co)	2.55E-03	2.55E-03
Copper (Cu)	2.81E-02	2.81E-02
Manganese (Mn)	7.65E-03	7.65E-03
Nickel (Ni)	4.59E-02	4.59E-02
Selenium (Se)	2.82E-02	2.82E-02
Vanadium (V)	1.28E-03	1.28E-03
Tin (Sn)	2.67E-02	2.67E-02
Dioxins and furans	7.65E-08	7.65E-08

Inhalation - gases and particulates
Maximum Other Places

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Workers, Visitors, School Students		
Exposure Time at Home (ET, hr/day)	24	Assume people may be present at other locations for a work day
Fraction Inhaled from Source (FI, unitless)	1	Assume present at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m^3)$^{-1}$	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	2.2E-04	1.1E-04	2.2E-04	--		4.0E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	4.4E-05	2.2E-05	4.4E-05	--		8.9E-04	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	1.8E-05	8.9E-06	1.8E-05	--		6.8E-04	6%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.6E-06	1.8E-06	3.6E-06	--		1.2E-04	1%
Ammonia		3.2E-01	0%	3.2E-01	1.8E-05	8.9E-06	1.8E-05	--		5.6E-05	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	2.4E-09	4.5E-10	8.9E-10	--		2.2E-04	2%
Thallium (Tl)		2.8E-03	0%	2.8E-03	2.1E-09	3.9E-10	7.8E-10	--		2.8E-07	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	7.5E-09	1.4E-09	2.8E-09	--		1.8E-04	2%
Mercury (Hg)		2.0E-04	10%	1.8E-04	4.4E-08	8.3E-09	1.7E-08	--		9.3E-05	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	1.9E-08	3.5E-09	7.0E-09	--		3.5E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	2.3E-08	4.2E-09	8.5E-09	--		8.5E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	6.2E-08	1.2E-08	2.3E-08	--		4.7E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	1.9E-07	3.5E-08	7.0E-08	--		7.0E-04	7%
Cobalt (Co)		1.0E-04	0%	1.0E-04	2.0E-08	3.7E-09	7.4E-09	--		7.4E-05	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	1.9E-07	3.7E-08	7.3E-08	--		1.5E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	5.5E-08	1.0E-08	2.0E-08	--		1.7E-04	2%
Nickel (Ni)		2.0E-05	20%	1.6E-05	3.2E-07	6.0E-08	1.2E-07	--		7.5E-03	70%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.9E-07	3.5E-08	7.0E-08	--		8.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	1.1E-08	2.0E-09	4.0E-09	--		4.0E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.0E-07	3.7E-08	7.4E-08	--		1.1E-07	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	8.0E-13	1.5E-13	3.0E-13	--		8.1E-05	1%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.8E-05	8.9E-06	1.8E-05	5.3E-8		6.6E-04	6%
							TOTAL	**5.3E-08**		**0.01068**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - Maximum Other Locations

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	3.4E-04	1.5E-03	9.9E-05
Thallium (Tl)	273973	2.5E-06	3.0E-04	1.3E-03	8.7E-05
Beryllium (Be)	273973	2.5E-06	1.1E-03	4.7E-03	3.1E-04
Mercury (Hg)	273973	2.5E-06	6.4E-03	2.8E-02	1.9E-03
Antimony (Sb)	273973	2.5E-06	2.6E-03	1.1E-02	7.4E-04
Arsenic (As)	273973	2.5E-06	3.8E-03	1.7E-02	1.1E-03
Lead (Pb)	273973	2.5E-06	8.9E-03	3.9E-02	2.6E-03
Chromium (Cr VI assumed)	273973	2.5E-06	2.7E-02	1.2E-01	7.8E-03
Cobalt (Co)	273973	2.5E-06	2.6E-03	1.1E-02	7.4E-04
Copper (Cu)	273973	2.5E-06	2.8E-02	1.2E-01	8.2E-03
Manganese (Mn)	273973	2.5E-06	7.7E-03	3.3E-02	2.2E-03
Nickel (Ni)	273973	2.5E-06	4.6E-02	2.0E-01	1.3E-02
Selenium (Se)	273973	2.5E-06	2.8E-02	1.2E-01	8.2E-03
Vanadium (V)	273973	2.5E-06	1.3E-03	5.6E-03	3.7E-04
Tin (Sn)	273973	2.5E-06	2.7E-02	1.2E-01	7.8E-03
Dioxins and furans	15.00	4.6E-02	7.7E-08	9.9E-08	6.6E-09

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum Other Places

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.5E-03	4.4E-10	1.1E-09	--		3.3E-06	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.3E-03	3.9E-10	9.4E-10	--		1.2E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	4.7E-03	1.4E-09	3.3E-09	--		2.1E-06	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.8E-02	8.3E-09	2.0E-08	--		5.5E-05	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.1E-02	3.3E-09	8.0E-09	--		9.3E-06	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.7E-02	5.0E-09	1.2E-08	--		1.2E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.9E-02	1.2E-08	2.8E-08	--		1.6E-05	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.2E-01	3.5E-08	8.4E-08	--		9.3E-05	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.1E-02	3.3E-09	8.0E-09	--		7.1E-06	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.2E-01	3.6E-08	8.8E-08	--		1.6E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.3E-02	9.9E-09	2.4E-08	--		3.4E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.0E-01	5.9E-08	1.4E-07	--		3.0E-05	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.2E-01	3.6E-08	8.8E-08	--		3.7E-05	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.6E-03	1.7E-09	4.0E-09	--		2.0E-06	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.2E-01	3.5E-08	8.3E-08	--		8.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	9.9E-08	2.9E-14	7.1E-14	--		6.7E-05	20%
								TOTAL			0.000338	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Other Places

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		1.5E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		1.3E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	4.7E-03	8.7E-11	2.1E-10	--		1.3E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.8E-02	5.2E-10	1.3E-09	--		3.5E-6	2%
Antimony (Sb)		8.6E-04		8.6E-04		1.1E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	1.7E-02	1.6E-09	3.8E-09	--		3.8E-6	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		3.9E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.2E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.1E-02	2.1E-10	5.0E-10	--		4.5E-7	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.2E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		3.3E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.0E-01	1.9E-08	4.5E-08	--		9.4E-6	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.2E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		5.6E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.2E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	9.9E-08	5.6E-14	1.3E-13	--		1.3E-4	88%
								TOTAL			**0.000144**	

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum Other Places

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.5E-03	8.5E-10	9.9E-09	--		3.1E-05	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.3E-03	7.5E-10	8.7E-09	--		1.1E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	4.7E-03	2.7E-09	3.1E-08	--		2.0E-05	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.8E-02	1.6E-08	1.9E-07	--		5.2E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.1E-02	6.4E-09	7.4E-08	--		8.7E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.7E-02	9.6E-09	1.1E-07	--		1.1E-04	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.9E-02	2.2E-08	2.6E-07	--		1.5E-04	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.2E-01	6.7E-08	7.8E-07	--		8.7E-04	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.1E-02	6.4E-09	7.4E-08	--		6.6E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.2E-01	7.0E-08	8.2E-07	--		1.5E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.3E-02	1.9E-08	2.2E-07	--		3.2E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.0E-01	1.1E-07	1.3E-06	--		2.8E-04	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.2E-01	7.0E-08	8.2E-07	--		3.4E-04	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.6E-03	3.2E-09	3.7E-08	--		1.9E-05	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.2E-01	6.7E-08	7.8E-07	--		7.8E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	9.9E-08	5.7E-14	6.6E-13	--		6.3E-04	20%
								TOTAL			**0.00315**	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Other Places

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT}$$ **(mg/kg/day)**

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		1.5E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		1.3E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	4.7E-03	3.6E-11	4.2E-10	--		2.6E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.8E-02	2.2E-10	2.5E-09	--		7.0E-6	2%
Antimony (Sb)		8.6E-04		8.6E-04		1.1E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	1.7E-02	6.5E-10	7.5E-09	--		7.5E-6	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		3.9E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.2E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.1E-02	8.6E-11	1.0E-09	--		9.0E-7	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.2E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		3.3E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.0E-01	7.7E-09	9.0E-08	--		1.9E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.2E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		5.6E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.2E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	9.9E-08	2.3E-14	2.7E-13	--		2.5E-4	88%
								TOTAL			**0.000288**	

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops

$$C_p = \frac{DR \bullet F \bullet \left[1 - e^{-k \bullet t}\right]}{Y \bullet k}$$ (mg/kg plant – wet weight)

where:
DR= Particle deposition rate for accidental release (mg/m^2/day)
F= Fraction for the surface area of plant (unitless)
k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$
$T_{0.5}$= Chemical half-life as particulate on plant (days)
t= Deposition time (days)
Y= Crop yield (kg/m^2)

Uptake via Roots from Soil

$$C_{rp} = C_s \bullet RUF$$ (mg/kg plant – wet weight)

where:
Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg)
RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations - Maximum Residential

Chemical	Half-life on plant ($T_{0.5}$)#	Loss constant (k) &	Deposition Rate (DR)	Aboveground Produce Concentration via Deposition	Root Uptake Factor (RUF)$	Soil Concentration (Cs)	Below Ground Produce Concentration
	days	per day	mg/m^2/day	mg/kg ww	unitless	mg/kg	mg/kg ww
Cadmium (Cd)	14	0.05	9.3E-07	4.6E-07	0.125	9.9E-05	1.2E-05
Thallium (Tl)	14	0.05	8.2E-07	4.1E-07	0.001	8.7E-05	8.7E-08
Beryllium (Be)	14	0.05	2.9E-06	1.5E-06	0.0025	3.1E-04	7.8E-07
Mercury (Hg)	14	0.05	1.7E-05	8.7E-06	0.225	1.9E-03	4.2E-04
Antimony (Sb)	14	0.05	7.0E-06	3.5E-06	0.05	7.4E-04	3.7E-05
Arsenic (As)	14	0.05	1.0E-05	5.2E-06	0.04	1.1E-03	4.5E-05
Lead (Pb)	14	0.05	2.4E-05	1.2E-05	0.0113	2.6E-03	2.9E-05
Chromium (Cr VI assumed)	14	0.05	7.3E-05	3.7E-05	0.00188	7.8E-03	1.5E-05
Cobalt (Co)	14	0.05	7.0E-06	3.5E-06	0.005	7.4E-04	3.7E-06
Copper (Cu)	14	0.05	7.7E-05	3.8E-05	0.1	8.2E-03	8.2E-04
Manganese (Mn)	14	0.05	2.1E-05	1.0E-05	0.0625	2.2E-03	1.4E-04
Nickel (Ni)	14	0.05	1.3E-04	6.3E-05	0.015	1.3E-02	2.0E-04
Selenium (Se)	14	0.05	7.7E-05	3.9E-05	0.00625	8.2E-03	5.1E-05
Vanadium (V)	14	0.05	3.5E-06	1.7E-06	0.00138	3.7E-04	5.1E-07
Tin (Sn)	14	0.05	7.3E-05	3.6E-05	0.0075	7.8E-03	5.8E-05
Dioxins and furans	14	0.05	2.1E-10	1.0E-10	0.000876	6.6E-09	5.8E-12

$ Root uptake factors from RAIS (soil to wet weight of plant)

& Loss constant is 1/half life

Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)				NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	4.6E-07	1.2E-05	8.7E-10	2.1E-09	--		6.5E-06	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	4.1E-07	8.7E-08	7.6E-11	1.8E-10	--		2.3E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.5E-06	7.8E-07	3.0E-10	7.3E-10	--		4.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	8.7E-06	4.2E-04	2.8E-08	6.8E-08	--		1.9E-04	61%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.5E-06	3.7E-05	3.0E-09	7.2E-09	--		8.4E-06	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.2E-06	4.5E-05	3.8E-09	9.1E-09	--		9.1E-06	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.2E-05	2.9E-05	4.0E-09	9.6E-09	--		5.5E-06	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.7E-05	1.5E-05	7.3E-09	1.8E-08	--		1.9E-05	6%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.5E-06	3.7E-06	8.4E-10	2.0E-09	--		1.8E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.8E-05	8.2E-04	5.9E-08	1.4E-07	--		2.5E-06	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.0E-05	1.4E-04	1.1E-08	2.6E-08	--		3.7E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	6.3E-05	2.0E-04	2.4E-08	5.7E-08	--		1.2E-05	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	3.9E-05	5.1E-05	9.9E-09	2.4E-08	--		1.0E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.7E-06	5.1E-07	3.3E-10	8.1E-10	--		4.0E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.6E-05	5.8E-05	1.0E-08	2.4E-08	--		2.4E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.0E-10	5.8E-12	1.8E-14	4.5E-14	--		4.2E-05	14%
									TOTAL			0.000309	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Above ground produce concentration (mg/kg wet weight)	Root crops concentrations (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	4.6E-07	1.2E-05	3.8E-10	4.4E-09	--		1.4E-05	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	4.1E-07	8.7E-08	5.7E-11	6.7E-10	--		8.4E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.5E-06	7.8E-07	2.2E-10	2.5E-09	--		1.6E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	8.7E-06	4.2E-04	1.2E-08	1.4E-07	--		3.9E-04	51%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.5E-06	3.7E-05	1.4E-09	1.7E-08	--		1.9E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.2E-06	4.5E-05	1.8E-09	2.2E-08	--		2.2E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.2E-05	2.9E-05	2.4E-09	2.8E-08	--		1.6E-05	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.7E-05	1.5E-05	5.3E-09	6.2E-08	--		6.9E-05	9%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.5E-06	3.7E-06	5.6E-10	6.6E-09	--		5.9E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.8E-05	8.2E-04	2.6E-08	3.0E-07	--		5.4E-06	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.0E-05	1.4E-04	5.0E-09	5.8E-08	--		8.3E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	6.3E-05	2.0E-04	1.4E-08	1.6E-07	--		3.3E-05	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	3.9E-05	5.1E-05	6.5E-09	7.6E-08			3.2E-05	4%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.7E-06	5.1E-07	2.5E-10	2.9E-09	--		1.4E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.6E-05	5.8E-05	6.4E-09	7.5E-08	--		7.5E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.0E-10	5.8E-12	1.4E-14	1.7E-13	--		1.6E-04	21%
									TOTAL			0.000763	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$$ (mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	4.6E-07	9.9E-05	1.0E-02	1.0E-08	OEHHA (2015)
Thallium (Tl)	4.1E-07	8.7E-05	1.7E-02	1.6E-08	
Beryllium (Be)	1.5E-06	3.1E-04	9.0E-02	3.0E-07	OEHHA (2015)
Mercury (Hg)	8.7E-06	1.9E-03	8.0E-01	1.6E-05	OEHHA (2015)
Antimony (Sb)	3.5E-06	7.4E-04	4.2E-04	3.3E-09	
Arsenic (As)	5.2E-06	1.1E-03	7.0E-02	8.3E-07	OEHHA (2015)
Lead (Pb)	1.2E-05	2.6E-03	4.0E-02	1.1E-06	OEHHA (2015)
Chromium (Cr VI assumed)	3.7E-05	7.8E-03	9.2E-03	7.6E-07	OEHHA (2003)
Cobalt (Co)	3.5E-06	7.4E-04	3.8E-02	3.0E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	3.8E-05	8.2E-03	3.8E-02	3.3E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	1.0E-05	2.2E-03	3.8E-02	9.0E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	6.3E-05	1.3E-02	2.0E-02	2.8E-06	OEHHA (2015)
Selenium (Se)	3.9E-05	8.2E-03	3.0E+00	2.6E-04	OEHHA (2015)
Vanadium (V)	1.7E-06	3.7E-04	3.8E-02	1.5E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	3.6E-05	7.8E-03	3.8E-02	3.1E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	1.0E-10	6.6E-09	1.0E+01	7.9E-10	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.059	Ingestion rate of eggs relevant for adults as per P90 from FSANZ 2017
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.0E-08	3.6E-12	8.8E-12	--		2.7E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.6E-08	5.4E-12	1.3E-11	--		1.6E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.0E-07	1.0E-10	2.5E-10	--		1.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.6E-05	5.5E-09	1.3E-08	--		3.7E-05	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.3E-09	1.2E-12	2.8E-12	--		3.2E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.3E-07	2.9E-10	7.0E-10	--		7.0E-07	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.1E-06	3.8E-10	9.3E-10	--		5.3E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	7.6E-07	2.7E-10	6.4E-10	--		7.1E-07	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.0E-07	1.0E-10	2.5E-10	--		2.2E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.3E-06	1.1E-09	2.8E-09	--		4.9E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	9.0E-07	3.1E-10	7.6E-10	--		1.1E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.8E-06	9.9E-10	2.4E-09	--		5.0E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.6E-04	9.1E-08	2.2E-07	--		9.1E-05	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.5E-07	5.2E-11	1.3E-10	--		6.3E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.1E-06	1.1E-09	2.6E-09	--		2.6E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	7.9E-10	2.8E-13	6.6E-13	--		6.3E-04	83%
								TOTAL			0.000760	

Exposure to Chemicals via Ingestion of Eggs

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.036	Ingestion rate of eggs relevant for young children as per P90 from FSANZ 2017
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.0E-08	2.1E-12	2.5E-11	--		7.8E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.6E-08	3.2E-12	3.7E-11	--		4.7E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.0E-07	6.1E-11	7.1E-10	--		4.5E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.6E-05	3.2E-09	3.8E-08	--		1.0E-04	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.3E-09	6.8E-13	7.9E-12	--		9.2E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.3E-07	1.7E-10	2.0E-09	--		2.0E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.1E-06	2.3E-10	2.6E-09	--		1.5E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	7.6E-07	1.6E-10	1.8E-09	--		2.0E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.0E-07	6.1E-11	7.2E-10	--		6.4E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.3E-06	6.8E-10	7.9E-09	--		1.4E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	9.0E-07	1.8E-10	2.2E-09	--		3.1E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.8E-06	5.8E-10	6.8E-09	--		1.4E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.6E-04	5.4E-08	6.3E-07	--		2.6E-04	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.5E-07	3.1E-11	3.6E-10	--		1.8E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.1E-06	6.4E-10	7.5E-09	--		7.5E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	7.9E-10	1.6E-13	1.9E-12	--		1.8E-03	83%
								TOTAL			0.00216	

EPA Limit modelling scenario

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Maximum Other Places	Air Concentration - annual average (mg/m3) Maximum Other Places
Nitrogen dioxide (NO2)	1.21E+00	1.2E-03
Sulfur dioxide (SO2)	1.57E+00	1.6E-03
Hydrogen chloride (HCl)	4.72E-01	4.7E-04
Hydrogen fluoride (HF)	3.15E-02	3.1E-05
Ammonia	2.36E-01	2.4E-04
PM10	2.31E-01	2.3E-04
PM2.5	2.24E-01	2.2E-04
Cadmium (Cd)	8.40E-05	8.4E-08
Thallium (Tl)	7.33E-05	7.3E-08
Beryllium (Be)	6.61E-06	6.6E-09
Mercury (Hg)	2.75E-04	2.8E-07
Antimony (Sb)	4.92E-05	4.9E-08
Arsenic (As)	5.98E-05	6.0E-08
Lead (Pb)	1.65E-04	1.7E-07
Chromium (Cr VI assumed)	4.93E-04	4.9E-07
Cobalt (Co)	5.21E-05	5.2E-08
Copper (Cu)	5.17E-04	5.2E-07
Manganese (Mn)	1.45E-04	1.4E-07
Nickel (Ni)	8.50E-04	8.5E-07
Selenium (Se)	1.64E-04	1.6E-07
Vanadium (V)	2.86E-05	2.9E-08
Tin (Sn)	1.74E-04	1.7E-07
Dioxins and furans	1.42E-09	1.4E-12
Benzene	1.57E-01	1.6E-04

COPC	Deposition Rate - annual average (mg/m2/year) Maximum Other Places	Deposition Rate - annual average (mg/m2/year) Maximum Other Places
Cadmium (Cd)	1.35E-02	1.35E-02
Thallium (Tl)	1.20E-02	1.20E-02
Beryllium (Be)	1.07E-03	1.07E-03
Mercury (Hg)	4.47E-02	4.47E-02
Antimony (Sb)	7.65E-03	7.65E-03
Arsenic (As)	1.15E-02	1.15E-02
Lead (Pb)	2.68E-02	2.68E-02
Chromium (Cr VI assumed)	8.04E-02	8.04E-02
Cobalt (Co)	7.65E-03	7.65E-03
Copper (Cu)	8.42E-02	8.42E-02
Manganese (Mn)	2.30E-02	2.30E-02
Nickel (Ni)	1.38E-01	1.38E-01
Selenium (Se)	2.82E-02	2.82E-02
Vanadium (V)	3.83E-03	3.83E-03
Tin (Sn)	2.67E-02	2.67E-02
Dioxins and furans	1.53E-07	1.53E-07

Inhalation - gases and particulates
Maximum Other Places as Residential
EPA limit modelling scenario

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m³) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m³) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m³)⁻¹	Chronic TC Air (mg/m³)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m³)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m³)	Inhalation Exposure Concentration - NonThreshold (mg/m³)	Inhalation Exposure Concentration - Threshold (mg/m³)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	1.2E-03	6.1E-04	1.2E-03	--		2.2E-02	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	1.6E-03	7.9E-04	1.6E-03	--		3.1E-02	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	4.7E-04	2.4E-04	4.7E-04	--		1.8E-02	32%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.1E-05	1.6E-05	3.1E-05	--		1.1E-03	2%
Ammonia		3.2E-01	0%	3.2E-01	2.4E-04	1.2E-04	2.4E-04	--		7.4E-04	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	8.4E-08	1.6E-08	3.1E-08	--		7.9E-03	14%
Thallium (Tl)		2.8E-03	0%	2.8E-03	7.3E-08	1.4E-08	2.7E-08	--		9.8E-06	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	6.6E-09	1.2E-09	2.5E-09	--		1.5E-04	0%
Mercury (Hg)		2.0E-04	10%	1.8E-04	2.8E-07	5.2E-08	1.0E-07	--		5.7E-04	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	4.9E-08	9.2E-09	1.8E-08	--		9.2E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	6.0E-08	1.1E-08	2.2E-08	--		2.2E-05	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	1.7E-07	3.1E-08	6.2E-08	--		1.2E-04	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	4.9E-07	9.2E-08	1.8E-07	--		1.8E-03	3%
Cobalt (Co)		1.0E-04	0%	1.0E-04	5.2E-08	9.8E-09	2.0E-08	--		2.0E-04	0%
Copper (Cu)		4.9E-01	0%	4.9E-01	5.2E-07	9.7E-08	1.9E-07	--		4.0E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	1.4E-07	2.7E-08	5.4E-08	--		4.5E-04	1%
Nickel (Ni)		2.0E-05	20%	1.6E-05	8.5E-07	1.6E-07	3.2E-07	--		2.0E-02	35%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.6E-07	3.1E-08	6.2E-08	--		7.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	2.9E-08	5.4E-09	1.1E-08	--		1.1E-04	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	1.7E-07	3.3E-08	6.5E-08	--		9.3E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.4E-12	2.7E-13	5.3E-13	--		1.4E-04	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.6E-04	7.9E-05	1.6E-04	4.7E-7		5.8E-03	10%
							TOTAL	**4.7E-07**		**0.0573**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - EPA limit modelling scenario

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	1.4E-02	5.9E-02	3.9E-03
Thallium (Tl)	273973	2.5E-06	1.2E-02	5.2E-02	3.5E-03
Beryllium (Be)	273973	2.5E-06	1.1E-03	4.7E-03	3.1E-04
Mercury (Hg)	273973	2.5E-06	4.5E-02	2.0E-01	1.3E-02
Antimony (Sb)	273973	2.5E-06	7.7E-03	3.3E-02	2.2E-03
Arsenic (As)	273973	2.5E-06	1.1E-02	5.0E-02	3.3E-03
Lead (Pb)	273973	2.5E-06	2.7E-02	1.2E-01	7.8E-03
Chromium (Cr VI assumed)	273973	2.5E-06	8.0E-02	3.5E-01	2.3E-02
Cobalt (Co)	273973	2.5E-06	7.7E-03	3.3E-02	2.2E-03
Copper (Cu)	273973	2.5E-06	8.4E-02	3.7E-01	2.5E-02
Manganese (Mn)	273973	2.5E-06	2.3E-02	1.0E-01	6.7E-03
Nickel (Ni)	273973	2.5E-06	1.4E-01	6.0E-01	4.0E-02
Selenium (Se)	273973	2.5E-06	2.8E-02	1.2E-01	8.2E-03
Vanadium (V)	273973	2.5E-06	3.8E-03	1.7E-02	1.1E-03
Tin (Sn)	273973	2.5E-06	2.7E-02	1.2E-01	7.8E-03
Dioxins and furans	15.00	4.6E-02	1.5E-07	2.0E-07	1.3E-08

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - maximum other places - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.9E-02	1.8E-08	4.2E-08	--		1.3E-04	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	5.2E-02	1.6E-08	3.7E-08	--		4.7E-05	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	4.7E-03	1.4E-09	3.3E-09	--		2.1E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.0E-01	5.8E-08	1.4E-07	--		3.9E-04	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.3E-02	9.9E-09	2.4E-08	--		2.8E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.0E-02	1.5E-08	3.6E-08	--		3.6E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.2E-01	3.5E-08	8.4E-08	--		4.8E-05	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.5E-01	1.0E-07	2.5E-07	--		2.8E-04	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.3E-02	9.9E-09	2.4E-08	--		2.1E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.7E-01	1.1E-07	2.6E-07	--		4.7E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.0E-01	3.0E-08	7.2E-08	--		1.0E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	6.0E-01	1.8E-07	4.3E-07	--		9.0E-05	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.2E-01	3.6E-08	8.8E-08	--		3.7E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.7E-02	5.0E-09	1.2E-08	--		6.0E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.2E-01	3.5E-08	8.3E-08	--		8.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.0E-07	5.9E-14	1.4E-13	--		1.3E-04	11%
								TOTAL			0.00125	

Dermal Exposure to Chemicals via Contact with Soil - maximum other places - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		5.9E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		5.2E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	4.7E-03	8.7E-11	2.1E-10	--		1.3E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.0E-01	3.6E-09	8.8E-09	--		2.4E-5	8%
Antimony (Sb)		8.6E-04		8.6E-04		3.3E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	5.0E-02	4.7E-09	1.1E-08	--		1.1E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.2E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		3.5E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	3.3E-02	6.2E-10	1.5E-09	--		1.3E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		3.7E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.0E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	6.0E-01	5.6E-08	1.4E-07	--		2.8E-5	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.2E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		1.7E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.2E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	2.0E-07	1.1E-13	2.7E-13	--		2.5E-4	79%
								TOTAL			**0.00032**	

Exposure to Chemicals via Incidental Ingestion of Soil - maximum other places - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.9E-02	3.4E-08	3.9E-07	--		1.2E-03	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	5.2E-02	3.0E-08	3.5E-07	--		4.4E-04	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	4.7E-03	2.7E-09	3.1E-08	--		2.0E-05	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.0E-01	1.1E-07	1.3E-06	--		3.6E-03	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	3.3E-02	1.9E-08	2.2E-07	--		2.6E-04	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	5.0E-02	2.9E-08	3.3E-07	--		3.3E-04	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.2E-01	6.7E-08	7.8E-07	--		4.5E-04	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.5E-01	2.0E-07	2.3E-06	--		2.6E-03	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.3E-02	1.9E-08	2.2E-07	--		2.0E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.7E-01	2.1E-07	2.5E-06	--		4.4E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.0E-01	5.7E-08	6.7E-07	--		9.6E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	6.0E-01	3.4E-07	4.0E-06	--		8.4E-04	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.2E-01	7.0E-08	8.2E-07	--		3.4E-04	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.7E-02	9.6E-09	1.1E-07	--		5.6E-05	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.2E-01	6.7E-08	7.8E-07	--		7.8E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.0E-07	1.1E-13	1.3E-12	--		1.3E-03	11%
								TOTAL			**0.0117**	

Dermal Exposure to Chemicals via Contact with Soil - maximum other places - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		5.9E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		5.2E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	4.7E-03	3.6E-11	4.2E-10	--		2.6E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	2.0E-01	1.5E-09	1.8E-08	--		4.9E-5	8%
Antimony (Sb)		8.6E-04		8.6E-04		3.3E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	5.0E-02	1.9E-09	2.3E-08	--		2.3E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.2E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		3.5E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	3.3E-02	2.6E-10	3.0E-09	--		2.7E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		3.7E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.0E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	6.0E-01	2.3E-08	2.7E-07	--		5.7E-5	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		1.2E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		1.7E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		1.2E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	2.0E-07	4.6E-14	5.4E-13	--		5.1E-4	79%
								TOTAL			0.00064	

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops	Uptake via Roots from Soil
$C_p = \frac{DR \bullet F \bullet \left[1 - e^{-k \bullet t}\right]}{Y \bullet k}$ (mg/kg plant – wet weight)	$C_{rp} = C_s \bullet RUF$ (mg/kg plant – wet weight)
where: DR= Particle deposition rate for accidental release (mg/m^2/day) F= Fraction for the surface area of plant (unitless) k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$ $T_{0.5}$= Chemical half-life as particulate on plant (days) t= Deposition time (days) Y= Crop yield (kg/m^2)	**where**: Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg) RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations - maximum other places - EPA limit modelling scenario

Chemical	Half-life on plant ($T_{0.5}$)#	Loss constant (k) &	Deposition Rate (DR)	Aboveground Produce Concentration via Deposition	Root Uptake Factor (RUF)$	Soil Concentration (Cs)	Below Ground Produce Concentration
	days	per day	mg/m^2/day	mg/kg ww	unitless	mg/kg	mg/kg ww
Cadmium (Cd)	14	0.05	3.7E-05	1.8E-05	0.125	3.9E-03	4.9E-04
Thallium (Tl)	14	0.05	3.3E-05	1.6E-05	0.001	3.5E-03	3.5E-06
Beryllium (Be)	14	0.05	2.9E-06	1.5E-06	0.0025	3.1E-04	7.8E-07
Mercury (Hg)	14	0.05	1.2E-04	6.1E-05	0.225	1.3E-02	2.9E-03
Antimony (Sb)	14	0.05	2.1E-05	1.0E-05	0.05	2.2E-03	1.1E-04
Arsenic (As)	14	0.05	3.1E-05	1.6E-05	0.04	3.3E-03	1.3E-04
Lead (Pb)	14	0.05	7.3E-05	3.7E-05	0.0113	7.8E-03	8.8E-05
Chromium (Cr VI assumed)	14	0.05	2.2E-04	1.1E-04	0.00188	2.3E-02	4.4E-05
Cobalt (Co)	14	0.05	2.1E-05	1.0E-05	0.005	2.2E-03	1.1E-05
Copper (Cu)	14	0.05	2.3E-04	1.2E-04	0.1	2.5E-02	2.5E-03
Manganese (Mn)	14	0.05	6.3E-05	3.1E-05	0.0625	6.7E-03	4.2E-04
Nickel (Ni)	14	0.05	3.8E-04	1.9E-04	0.015	4.0E-02	6.0E-04
Selenium (Se)	14	0.05	7.7E-05	3.9E-05	0.00625	8.2E-03	5.1E-05
Vanadium (V)	14	0.05	1.0E-05	5.2E-06	0.00138	1.1E-03	1.5E-06
Tin (Sn)	14	0.05	7.3E-05	3.6E-05	0.0075	7.8E-03	5.8E-05
Dioxins and furans	14	0.05	4.2E-10	2.1E-10	0.000876	1.3E-08	1.2E-11

$ Root uptake factors from RAIS (soil to wet weight of plant)

& Loss constant is 1/half life

\# Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - maximum other places - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)				NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.8E-05	4.9E-04	3.5E-08	8.4E-08	--		2.6E-04	14%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.6E-05	3.5E-06	3.1E-09	7.4E-09	--		9.2E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.5E-06	7.8E-07	3.0E-10	7.3E-10	--		4.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	6.1E-05	2.9E-03	2.0E-07	4.8E-07	--		1.3E-03	71%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.0E-05	1.1E-04	8.9E-09	2.2E-08	--		2.5E-05	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.6E-05	1.3E-04	1.1E-08	2.7E-08	--		2.7E-05	1%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.7E-05	8.8E-05	1.2E-08	2.9E-08	--		1.7E-05	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.1E-04	4.4E-05	2.2E-08	5.3E-08	--		5.8E-05	3%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.0E-05	1.1E-05	2.5E-09	6.1E-09	--		5.4E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.2E-04	2.5E-03	1.8E-07	4.3E-07	--		7.6E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.1E-05	4.2E-04	3.2E-08	7.8E-08	--		1.1E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.9E-04	6.0E-04	7.1E-08	1.7E-07	--		3.6E-05	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	3.9E-05	5.1E-05	9.9E-09	2.4E-08	--		1.0E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.2E-06	1.5E-06	1.0E-09	2.4E-09	--		1.2E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.6E-05	5.8E-05	1.0E-08	2.4E-08	--		2.4E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.1E-10	1.2E-11	3.7E-14	8.9E-14	--		8.4E-05	5%
									TOTAL			0.00187	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - maximum other places - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	10%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.8E-05	4.9E-04	1.5E-08	1.8E-07	--		5.5E-04	13%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.6E-05	3.5E-06	2.3E-09	2.7E-08	--		3.3E-05	1%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.5E-06	7.8E-07	2.2E-10	2.5E-09	--		1.6E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	6.1E-05	2.9E-03	8.3E-08	9.7E-07	--		2.7E-03	65%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.0E-05	1.1E-04	4.3E-09	5.0E-08	--		5.8E-05	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.6E-05	1.3E-04	5.5E-09	6.5E-08	--		6.5E-05	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.7E-05	8.8E-05	7.2E-09	8.4E-08	--		4.8E-05	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.1E-04	4.4E-05	1.6E-08	1.9E-07	--		2.1E-04	5%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.0E-05	1.1E-05	1.7E-09	2.0E-08	--		1.8E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.2E-04	2.5E-03	7.8E-08	9.1E-07	--		1.6E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	3.1E-05	4.2E-04	1.5E-08	1.7E-07	--		2.5E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.9E-04	6.0E-04	4.1E-08	4.8E-07	--		9.9E-05	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	3.9E-05	5.1E-05	6.5E-09	7.6E-08			3.2E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	5.2E-06	1.5E-06	7.4E-10	8.7E-09	--		4.3E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.6E-05	5.8E-05	6.4E-09	7.5E-08	--		7.5E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.1E-10	1.2E-11	2.8E-14	3.3E-13	--		3.1E-04	8%
									TOTAL			0.00414	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$$ (mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - maximum other places - EPA limit modelling scenario

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	1.8E-05	3.9E-03	1.0E-02	4.2E-07	OEHHA (2015)
Thallium (Tl)	1.6E-05	3.5E-03	1.7E-02	6.2E-07	
Beryllium (Be)	1.5E-06	3.1E-04	9.0E-02	3.0E-07	OEHHA (2015)
Mercury (Hg)	6.1E-05	1.3E-02	8.0E-01	1.1E-04	OEHHA (2015)
Antimony (Sb)	1.0E-05	2.2E-03	4.2E-04	9.9E-09	
Arsenic (As)	1.6E-05	3.3E-03	7.0E-02	2.5E-06	OEHHA (2015)
Lead (Pb)	3.7E-05	7.8E-03	4.0E-02	3.3E-06	OEHHA (2015)
Chromium (Cr VI assumed)	1.1E-04	2.3E-02	9.2E-03	2.3E-06	OEHHA (2003)
Cobalt (Co)	1.0E-05	2.2E-03	3.8E-02	9.0E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	1.2E-04	2.5E-02	3.8E-02	9.9E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	3.1E-05	6.7E-03	3.8E-02	2.7E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	1.9E-04	4.0E-02	2.0E-02	8.5E-06	OEHHA (2015)
Selenium (Se)	3.9E-05	8.2E-03	3.0E+00	2.6E-04	OEHHA (2015)
Vanadium (V)	5.2E-06	1.1E-03	3.8E-02	4.5E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	3.6E-05	7.8E-03	3.8E-02	3.1E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	2.1E-10	1.3E-08	1.0E+01	1.6E-09	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs - maximum other places - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.059	Ingestion rate of eggs relevant for adults as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	4.2E-07	1.5E-10	3.5E-10	--		1.1E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.2E-07	2.2E-10	5.2E-10	--		6.5E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.0E-07	1.0E-10	2.5E-10	--		1.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.1E-04	3.8E-08	9.3E-08	--		2.6E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	9.9E-09	3.5E-12	8.4E-12	--		9.7E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.5E-06	8.6E-10	2.1E-09	--		2.1E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.3E-06	1.2E-09	2.8E-09	--		1.6E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.3E-06	8.0E-10	1.9E-09	--		2.1E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	9.0E-07	3.1E-10	7.6E-10	--		6.7E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	9.9E-06	3.4E-09	8.3E-09	--		1.5E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.7E-06	9.4E-10	2.3E-09	--		3.2E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	8.5E-06	3.0E-09	7.2E-09	--		1.5E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.6E-04	9.1E-08	2.2E-07	--		9.1E-05	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	4.5E-07	1.6E-10	3.8E-10	--		1.9E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.1E-06	1.1E-09	2.6E-09	--		2.6E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.6E-09	5.5E-13	1.3E-12	--		1.3E-03	78%
								TOTAL			0.00162	

Exposure to Chemicals via Ingestion of Eggs - maximum other places - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.036	Ingestion rate of eggs relevant for young children as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	4.2E-07	8.6E-11	1.0E-09	--		3.1E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.2E-07	1.3E-10	1.5E-09	--		1.9E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	3.0E-07	6.1E-11	7.1E-10	--		4.5E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.1E-04	2.3E-08	2.6E-07	--		7.3E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	9.9E-09	2.0E-12	2.4E-11	--		2.8E-08	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.5E-06	5.1E-10	5.9E-09	--		5.9E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.3E-06	6.8E-10	7.9E-09	--		4.5E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.3E-06	4.7E-10	5.5E-09	--		6.1E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	9.0E-07	1.8E-10	2.2E-09	--		1.9E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	9.9E-06	2.0E-09	2.4E-08	--		4.2E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.7E-06	5.5E-10	6.5E-09	--		9.2E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	8.5E-06	1.7E-09	2.0E-08	--		4.2E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.6E-04	5.4E-08	6.3E-07	--		2.6E-04	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	4.5E-07	9.2E-11	1.1E-09	--		5.4E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.1E-06	6.4E-10	7.5E-09	--		7.5E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.6E-09	3.2E-13	3.8E-12	--		3.6E-03	78%
								TOTAL			0.00460	

Maximum Commercial/Industrial Location

Scenario 1

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Maximum from grid	Air Concentration - annual average (mg/m3) Maximum from grid
Nitrogen dioxide (NO2)	3.05E-01	3.0E-04
Sulfur dioxide (SO2)	4.44E-02	4.4E-05
Hydrogen chloride (HCl)	1.78E-02	1.8E-05
Hydrogen fluoride (HF)	3.55E-03	3.6E-06
Ammonia	1.78E-02	1.8E-05
PM10	1.74E-02	1.7E-05
PM2.5	1.69E-02	1.7E-05
Cadmium (Cd)	2.37E-06	2.4E-09
Thallium (Tl)	2.07E-06	2.1E-09
Beryllium (Be)	7.46E-06	7.5E-09
Mercury (Hg)	4.44E-05	4.4E-08
Antimony (Sb)	1.85E-05	1.9E-08
Arsenic (As)	2.25E-05	2.3E-08
Lead (Pb)	6.23E-05	6.2E-08
Chromium (Cr VI assumed)	1.86E-04	1.9E-07
Cobalt (Co)	1.96E-05	2.0E-08
Copper (Cu)	1.95E-04	1.9E-07
Manganese (Mn)	5.45E-05	5.5E-08
Nickel (Ni)	3.20E-04	3.2E-07
Selenium (Se)	1.86E-04	1.9E-07
Vanadium (V)	1.08E-05	1.1E-08
Tin (Sn)	1.96E-04	2.0E-07
Dioxins and furans	7.99E-10	8.0E-13
Benzene	1.78E-02	1.8E-05

COPC	Deposition Rate - annual average (mg/m2/year) Maximum from grid		Deposition Rate - annual average (mg/m2/year) Maximum from grid
Cadmium (Cd)	1.64E-03		1.64E-03
Thallium (Tl)	1.45E-03		1.45E-03
Beryllium (Be)	5.19E-03		5.19E-03
Mercury (Hg)	3.09E-02		3.09E-02
Antimony (Sb)	1.24E-02		1.24E-02
Arsenic (As)	1.85E-02		1.85E-02
Lead (Pb)	4.33E-02		4.33E-02
Chromium (Cr VI assumed)	1.30E-01		1.30E-01
Cobalt (Co)	1.24E-02		1.24E-02
Copper (Cu)	1.36E-01		1.36E-01
Manganese (Mn)	3.71E-02		3.71E-02
Nickel (Ni)	2.22E-01		2.22E-01
Selenium (Se)	1.37E-01		1.37E-01
Vanadium (V)	6.18E-03		6.18E-03
Tin (Sn)	1.29E-01		1.29E-01
Dioxins and furans	3.71E-07		3.71E-07

Inhalation - gases and particulates
Maximum Commercial/Industrial/Retail Location

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m^3) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m^3) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Workers		
Exposure Time at Home (ET, hr/day)	10	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	262800	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk ($(mg/m^3)^{-1}$)	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m^3)	Inhalation Exposure Concentration - NonThreshold (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	3.0E-04	3.6E-05	8.3E-05	--		1.5E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	4.4E-05	5.2E-06	1.2E-05	--		2.4E-04	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	1.8E-05	2.1E-06	4.9E-06	--		1.9E-04	6%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.6E-06	4.2E-07	9.7E-07	--		3.4E-05	1%
Ammonia		3.2E-01	0%	3.2E-01	1.8E-05	2.1E-06	4.9E-06	--		1.5E-05	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	2.4E-09	1.0E-10	2.4E-10	--		6.1E-05	2%
Thallium (Tl)		2.8E-03	0%	2.8E-03	2.1E-09	9.1E-11	2.1E-10	--		7.6E-08	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	7.5E-09	3.3E-10	7.7E-10	--		4.8E-05	2%
Mercury (Hg)		2.0E-04	10%	1.8E-04	4.4E-08	2.0E-09	4.6E-09	--		2.5E-05	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	1.9E-08	8.2E-10	1.9E-09	--		9.5E-06	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	2.3E-08	9.9E-10	2.3E-09	--		2.3E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	6.2E-08	2.7E-09	6.4E-09	--		1.3E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	1.9E-07	8.2E-09	1.9E-08	--		1.9E-04	7%
Cobalt (Co)		1.0E-04	0%	1.0E-04	2.0E-08	8.6E-10	2.0E-09	--		2.0E-05	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	1.9E-07	8.6E-09	2.0E-08	--		4.1E-08	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	5.5E-08	2.4E-09	5.6E-09	--		4.7E-05	2%
Nickel (Ni)		2.0E-05	20%	1.6E-05	3.2E-07	1.4E-08	3.3E-08	--		2.1E-03	70%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.9E-07	8.2E-09	1.9E-08	--		2.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	1.1E-08	4.7E-10	1.1E-09	--		1.1E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.0E-07	8.6E-09	2.0E-08	--		2.9E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	8.0E-13	3.5E-14	8.2E-14	--		2.2E-05	1%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.8E-05	2.1E-06	4.9E-06	1.3E-8		1.8E-04	6%
							TOTAL	**1.3E-08**		**0.00292**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - Maximum Commercial

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	1.6E-03	7.2E-03	4.8E-04
Thallium (Tl)	273973	2.5E-06	1.5E-03	6.4E-03	4.2E-04
Beryllium (Be)	273973	2.5E-06	5.2E-03	2.3E-02	1.5E-03
Mercury (Hg)	273973	2.5E-06	3.1E-02	1.4E-01	9.0E-03
Antimony (Sb)	273973	2.5E-06	1.2E-02	5.4E-02	3.6E-03
Arsenic (As)	273973	2.5E-06	1.9E-02	8.1E-02	5.4E-03
Lead (Pb)	273973	2.5E-06	4.3E-02	1.9E-01	1.3E-02
Chromium (Cr VI assumed)	273973	2.5E-06	1.3E-01	5.7E-01	3.8E-02
Cobalt (Co)	273973	2.5E-06	1.2E-02	5.4E-02	3.6E-03
Copper (Cu)	273973	2.5E-06	1.4E-01	5.9E-01	4.0E-02
Manganese (Mn)	273973	2.5E-06	3.7E-02	1.6E-01	1.1E-02
Nickel (Ni)	273973	2.5E-06	2.2E-01	9.7E-01	6.5E-02
Selenium (Se)	273973	2.5E-06	1.4E-01	6.0E-01	4.0E-02
Vanadium (V)	273973	2.5E-06	6.2E-03	2.7E-02	1.8E-03
Tin (Sn)	273973	2.5E-06	1.3E-01	5.6E-01	3.8E-02
Dioxins and furans	15.00	4.6E-02	3.7E-07	4.8E-07	3.2E-08

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum Commercial

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	25	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	Time at one work location as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.2E-03	7.2E-10	1.7E-09	--		5.3E-06	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.4E-03	6.4E-10	1.5E-09	--		1.9E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	2.3E-09	5.3E-09	--		3.3E-06	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-01	1.4E-08	3.2E-08	--		8.8E-05	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.4E-02	5.4E-09	1.3E-08	--		1.5E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.1E-02	8.2E-09	1.9E-08	--		1.9E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.9E-01	1.9E-08	4.4E-08	--		2.5E-05	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.7E-01	5.7E-08	1.3E-07	--		1.5E-04	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.4E-02	5.4E-09	1.3E-08	--		1.1E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.9E-01	6.0E-08	1.4E-07	--		2.5E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.6E-01	1.6E-08	3.8E-08	--		5.4E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.7E-01	9.8E-08	2.3E-07	--		4.8E-05	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	6.0E-08	1.4E-07	--		5.8E-05	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.7E-02	2.7E-09	6.3E-09	--		3.2E-06	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	5.7E-08	1.3E-07	--		1.3E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	4.8E-07	4.8E-14	1.1E-13	--		1.1E-04	20%
								TOTAL			0.000538	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Commercial

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT}$$ **(mg/kg/day)**

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	3800	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data: Non-Threshold Slope Factor $(mg/kg\text{-}day)^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Toxicity Data: Dermal Absorption (ABS)	Soil Concentration (mg/kg)	Daily Intake: Non-Threshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		7.2E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		6.4E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	1.7E-10	4.1E-10	--		2.5E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.4E-01	1.0E-09	2.4E-09	--		6.7E-6	2%
Antimony (Sb)		8.6E-04		8.6E-04		5.4E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	8.1E-02	3.1E-09	7.2E-09	--		7.2E-6	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.9E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		5.7E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	5.4E-02	4.1E-10	9.7E-10	--		8.6E-7	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		5.9E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.6E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	9.7E-01	3.7E-08	8.7E-08	--		1.8E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		2.7E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	4.8E-07	1.1E-13	2.6E-13	--		2.4E-4	88%
TOTAL											**0.000277**	

Exposure to Chemicals via Incidental Ingestion of Soil

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.2E-03	2.7E-09	3.1E-08	--		9.8E-05	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	6.4E-03	2.4E-09	2.8E-08	--		3.5E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	8.5E-09	1.0E-07	--		6.2E-05	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-01	5.1E-08	5.9E-07	--		1.6E-03	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.4E-02	2.0E-08	2.4E-07	--		2.8E-04	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.1E-02	3.0E-08	3.6E-07	--		3.6E-04	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.9E-01	7.1E-08	8.3E-07	--		4.7E-04	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.7E-01	2.1E-07	2.5E-06	--		2.8E-03	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.4E-02	2.0E-08	2.4E-07	--		2.1E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.9E-01	2.2E-07	2.6E-06	--		4.7E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.6E-01	6.1E-08	7.1E-07	--		1.0E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	9.7E-01	3.7E-07	4.3E-06	--		8.9E-04	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	2.2E-07	2.6E-06	--		1.1E-03	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.7E-02	1.0E-08	1.2E-07	--		5.9E-05	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	2.1E-07	2.5E-06	--		2.5E-05	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	4.8E-07	1.8E-13	2.1E-12	--		2.0E-03	20%
								TOTAL			**0.0100**	

Dermal Exposure to Chemicals via Contact with Soil

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Regulatory scenario

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		7.2E-03			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		6.4E-03			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	1.2E-10	1.3E-09	--		8.4E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.4E-01	6.9E-10	8.0E-09	--		2.2E-5	2%
Antimony (Sb)		8.6E-04		8.6E-04		5.4E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	8.1E-02	2.1E-09	2.4E-08	--		2.4E-5	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		1.9E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		5.7E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	5.4E-02	2.7E-10	3.2E-09	--		2.9E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		5.9E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.6E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	9.7E-01	2.5E-08	2.9E-07	--		6.0E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		2.7E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	4.8E-07	7.3E-14	8.6E-13	--		8.1E-4	88%
								TOTAL			0.00092	

EPA Limit modelling scenario

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Max Commercial	Air Concentration - annual average (mg/m3) Max Commercial
Nitrogen dioxide (NO2)	1.35E+00	1.4E-03
Sulfur dioxide (SO2)	1.78E+00	1.8E-03
Hydrogen chloride (HCl)	5.33E-01	5.3E-04
Hydrogen fluoride (HF)	3.55E-02	3.6E-05
Ammonia	2.66E-01	2.7E-04
PM10	2.61E-01	2.6E-04
PM2.5	2.53E-01	2.5E-04
Cadmium (Cd)	9.48E-05	9.5E-08
Thallium (Tl)	8.28E-05	8.3E-08
Beryllium (Be)	7.46E-06	7.5E-09
Mercury (Hg)	3.11E-04	3.1E-07
Antimony (Sb)	5.56E-05	5.6E-08
Arsenic (As)	6.76E-05	6.8E-08
Lead (Pb)	1.87E-04	1.9E-07
Chromium (Cr VI assumed)	5.57E-04	5.6E-07
Cobalt (Co)	5.88E-05	5.9E-08
Copper (Cu)	5.84E-04	5.8E-07
Manganese (Mn)	1.64E-04	1.6E-07
Nickel (Ni)	9.60E-04	9.6E-07
Selenium (Se)	1.86E-04	1.9E-07
Vanadium (V)	3.23E-05	3.2E-08
Tin (Sn)	1.96E-04	2.0E-07
Dioxins and furans	1.60E-09	1.6E-12
Benzene	1.78E-01	1.8E-04

COPC	Deposition Rate - annual average (mg/m2/year) Max Commercial	Deposition Rate - annual average (mg/m2/year) Max Commercial
Cadmium (Cd)	6.55E-02	6.55E-02
Thallium (Tl)	5.81E-02	5.81E-02
Beryllium (Be)	5.19E-03	5.19E-03
Mercury (Hg)	2.16E-01	2.16E-01
Antimony (Sb)	3.71E-02	3.71E-02
Arsenic (As)	5.56E-02	5.56E-02
Lead (Pb)	1.30E-01	1.30E-01
Chromium (Cr VI assumed)	3.89E-01	3.89E-01
Cobalt (Co)	3.71E-02	3.71E-02
Copper (Cu)	4.08E-01	4.08E-01
Manganese (Mn)	1.11E-01	1.11E-01
Nickel (Ni)	6.67E-01	6.67E-01
Selenium (Se)	1.37E-01	1.37E-01
Vanadium (V)	1.85E-02	1.85E-02
Tin (Sn)	1.29E-01	1.29E-01
Dioxins and furans	7.42E-07	7.42E-07

Inhalation - gases and particulates
Maximum Commercial/Industrial
EPA limit modelling scenario

$$\boldsymbol{Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}}$$ **(mg/m^3) for gases**

$$\boldsymbol{Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}}$$ **(mg/m^3) for chemicals attached to particles**

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	10	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	262800	US EPA 2009

	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
Key Chemical	**Inhalation Unit Risk** (mg/m^3)$^{-1}$	**Chronic TC Air** (mg/m^3)	**Background Intake (% Chronic TC)**	**Chronic TC Allowable for Assessment (TC-Background)** (mg/m^3)	**Estimated Concentration in Air - Maximum anywhere (Ca)** (mg/m^3)	**Inhalation Exposure Concentration -** NonThreshold (mg/m^3)	**Inhalation Exposure Concentration -** Threshold (mg/m^3)	**Non-Threshold Risk** (unitless)	**% Total Risk**	**Chronic Hazard Quotient** (unitless)	**% Total HI**
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	1.4E-03	1.6E-04	3.7E-04	--		6.6E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	1.8E-03	2.1E-04	4.9E-04	--		9.7E-03	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	5.3E-04	6.3E-05	1.5E-04	--		5.6E-03	32%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	3.6E-05	4.2E-06	9.7E-06	--		3.4E-04	2%
Ammonia		3.2E-01	0%	3.2E-01	2.7E-04	3.1E-05	7.3E-05	--		2.3E-04	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	9.5E-08	4.2E-09	9.7E-09	--		2.4E-03	14%
Thallium (Tl)		2.8E-03	0%	2.8E-03	8.3E-08	3.6E-09	8.5E-09	--		3.0E-06	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	7.5E-09	3.3E-10	7.7E-10	--		4.8E-05	0%
Mercury (Hg)		2.0E-04	10%	1.8E-04	3.1E-07	1.4E-08	3.2E-08	--		1.8E-04	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	5.6E-08	2.4E-09	5.7E-09	--		2.9E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	6.8E-08	3.0E-09	6.9E-09	--		6.9E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	1.9E-07	8.2E-09	1.9E-08	--		3.8E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	5.6E-07	2.5E-08	5.7E-08	--		5.7E-04	3%
Cobalt (Co)		1.0E-04	0%	1.0E-04	5.9E-08	2.6E-09	6.0E-09	--		6.0E-05	0%
Copper (Cu)		4.9E-01	0%	4.9E-01	5.8E-07	2.6E-08	6.0E-08	--		1.2E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	1.6E-07	7.2E-09	1.7E-08	--		1.4E-04	1%
Nickel (Ni)		2.0E-05	20%	1.6E-05	9.6E-07	4.2E-08	9.9E-08	--		6.2E-03	35%
Selenium (Se)		2.1E-02	60%	8.4E-03	1.9E-07	8.2E-09	1.9E-08	--		2.3E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	3.2E-08	1.4E-09	3.3E-09	--		3.3E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	2.0E-07	8.6E-09	2.0E-08	--		2.9E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.6E-12	7.0E-14	1.6E-13	--		4.4E-05	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	1.8E-04	2.1E-05	4.9E-05	1.3E-7		1.8E-03	10%
							TOTAL	**1.3E-07**		**0.0177**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - maximum commercial - EPA limit modelling scenario

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	6.6E-02	2.9E-01	1.9E-02
Thallium (Tl)	273973	2.5E-06	5.8E-02	2.5E-01	1.7E-02
Beryllium (Be)	273973	2.5E-06	5.2E-03	2.3E-02	1.5E-03
Mercury (Hg)	273973	2.5E-06	2.2E-01	9.5E-01	6.3E-02
Antimony (Sb)	273973	2.5E-06	3.7E-02	1.6E-01	1.1E-02
Arsenic (As)	273973	2.5E-06	5.6E-02	2.4E-01	1.6E-02
Lead (Pb)	273973	2.5E-06	1.3E-01	5.7E-01	3.8E-02
Chromium (Cr VI assumed)	273973	2.5E-06	3.9E-01	1.7E+00	1.1E-01
Cobalt (Co)	273973	2.5E-06	3.7E-02	1.6E-01	1.1E-02
Copper (Cu)	273973	2.5E-06	4.1E-01	1.8E+00	1.2E-01
Manganese (Mn)	273973	2.5E-06	1.1E-01	4.9E-01	3.2E-02
Nickel (Ni)	273973	2.5E-06	6.7E-01	2.9E+00	1.9E-01
Selenium (Se)	273973	2.5E-06	1.4E-01	6.0E-01	4.0E-02
Vanadium (V)	273973	2.5E-06	1.9E-02	8.1E-02	5.4E-03
Tin (Sn)	273973	2.5E-06	1.3E-01	5.6E-01	3.8E-02
Dioxins and furans	15.00	4.6E-02	7.4E-07	9.6E-07	6.4E-08

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - maximum commercial - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.9E-01	5.8E-08	1.3E-07	--		4.2E-04	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.5E-01	5.1E-08	1.2E-07	--		1.5E-04	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	4.6E-09	1.1E-08	--		6.7E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.5E-01	1.9E-07	4.4E-07	--		1.2E-03	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.6E-01	3.3E-08	7.6E-08	--		8.9E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.4E-01	4.9E-08	1.1E-07	--		1.1E-04	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.7E-01	1.1E-07	2.7E-07	--		1.5E-04	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.7E+00	3.4E-07	8.0E-07	--		8.9E-04	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.6E-01	3.3E-08	7.6E-08	--		6.8E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.8E+00	3.6E-07	8.4E-07	--		1.5E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.9E-01	9.8E-08	2.3E-07	--		3.3E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.9E+00	5.9E-07	1.4E-06	--		2.9E-04	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	1.2E-07	2.8E-07	--		1.2E-04	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.1E-02	1.6E-08	3.8E-08	--		1.9E-05	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	1.1E-07	2.7E-07	--		2.7E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	9.6E-07	1.9E-13	4.5E-13	--		4.3E-04	11%
								TOTAL			0.00399	

Dermal Exposure to Chemicals via Contact with Soil - maximum commercial - EPA limit modelling scenario

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \textbf{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	30	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		2.9E-01			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		2.5E-01			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	2.9E-10	6.7E-10	--		4.2E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	9.5E-01	1.2E-08	2.8E-08	--		7.8E-5	8%
Antimony (Sb)		8.6E-04		8.6E-04		1.6E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.4E-01	1.5E-08	3.6E-08	--		3.6E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		5.7E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.7E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.6E-01	2.1E-09	4.8E-09	--		4.3E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.8E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		4.9E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.9E+00	1.9E-07	4.3E-07	--		9.0E-5	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		8.1E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	9.6E-07	3.7E-13	8.6E-13	--		8.1E-4	79%
								TOTAL			**0.00102**	

Exposure to Chemicals via Incidental Ingestion of Soil - maximum commercial - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.9E-01	1.1E-07	1.3E-06	--		3.9E-03	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.5E-01	9.5E-08	1.1E-06	--		1.4E-03	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.3E-02	8.5E-09	1.0E-07	--		6.2E-05	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.5E-01	3.6E-07	4.1E-06	--		1.2E-02	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.6E-01	6.1E-08	7.1E-07	--		8.3E-04	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.4E-01	9.1E-08	1.1E-06	--		1.1E-03	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.7E-01	2.1E-07	2.5E-06	--		1.4E-03	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.7E+00	6.4E-07	7.5E-06	--		8.3E-03	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.6E-01	6.1E-08	7.1E-07	--		6.3E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.8E+00	6.7E-07	7.8E-06	--		1.4E-04	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.9E-01	1.8E-07	2.1E-06	--		3.0E-05	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.9E+00	1.1E-06	1.3E-05	--		2.7E-03	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.0E-01	2.2E-07	2.6E-06	--		1.1E-03	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.1E-02	3.0E-08	3.6E-07	--		1.8E-04	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.6E-01	2.1E-07	2.5E-06	--		2.5E-05	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	9.6E-07	3.6E-13	4.2E-12	--		4.0E-03	11%
								TOTAL			0.0373	

Dermal Exposure to Chemicals via Contact with Soil - maximum commercial - EPA limit modelling scenario

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	240	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor $(mg/kg\text{-}day)^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		2.9E-01			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		2.5E-01			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.3E-02	1.2E-10	1.3E-09	--		8.4E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	9.5E-01	4.8E-09	5.6E-08	--		1.6E-4	8%
Antimony (Sb)		8.6E-04		8.6E-04		1.6E-01			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.4E-01	6.2E-09	7.2E-08	--		7.2E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		5.7E-01			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.7E+00			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.6E-01	8.2E-10	9.6E-09	--		8.6E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		1.8E+00			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		4.9E-01			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	2.9E+00	7.4E-08	8.6E-07	--		1.8E-4	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.0E-01			--		--	
Vanadium (V)		2.0E-03		2.0E-03		8.1E-02			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		5.6E-01			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	9.6E-07	1.5E-13	1.7E-12	--		1.6E-3	79%
								TOTAL			0.00203	

Maximum Farm Location

Scenario 1

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Maximum Farm	Air Concentration - annual average (mg/m3) Maximum Farm
Nitrogen dioxide (NO2)	1.79E-01	1.8E-04
Sulfur dioxide (SO2)	2.08E-02	2.1E-05
Hydrogen chloride (HCl)	8.32E-03	8.3E-06
Hydrogen fluoride (HF)	1.66E-03	1.7E-06
Ammonia	8.32E-03	8.3E-06
PM10	8.15E-03	8.2E-06
PM2.5	7.90E-03	7.9E-06
Cadmium (Cd)	1.11E-06	1.1E-09
Thallium (Tl)	9.70E-07	9.7E-10
Beryllium (Be)	3.49E-06	3.5E-09
Mercury (Hg)	2.08E-05	2.1E-08
Antimony (Sb)	8.68E-06	8.7E-09
Arsenic (As)	1.05E-05	1.1E-08
Lead (Pb)	2.92E-05	2.9E-08
Chromium (Cr VI assumed)	8.69E-05	8.7E-08
Cobalt (Co)	9.18E-06	9.2E-09
Copper (Cu)	9.11E-05	9.1E-08
Manganese (Mn)	2.55E-05	2.6E-08
Nickel (Ni)	1.50E-04	1.5E-07
Selenium (Se)	8.69E-05	8.7E-08
Vanadium (V)	5.04E-06	5.0E-09
Tin (Sn)	9.19E-05	9.2E-08
Dioxins and furans	1.25E-10	1.2E-13
Benzene	8.32E-03	8.3E-06

COPC	Deposition Rate - annual average (mg/m2/year) Maximum Farm	Deposition Rate - annual average (mg/m2/year) Maximum Farm
Cadmium (Cd)	1.82E-04	1.82E-04
Thallium (Tl)	1.61E-04	1.61E-04
Beryllium (Be)	5.77E-04	5.77E-04
Mercury (Hg)	3.44E-03	3.44E-03
Antimony (Sb)	1.37E-03	1.37E-03
Arsenic (As)	2.06E-03	2.06E-03
Lead (Pb)	4.81E-03	4.81E-03
Chromium (Cr VI assumed)	1.44E-02	1.44E-02
Cobalt (Co)	1.37E-03	1.37E-03
Copper (Cu)	1.51E-02	1.51E-02
Manganese (Mn)	4.12E-03	4.12E-03
Nickel (Ni)	2.47E-02	2.47E-02
Selenium (Se)	1.52E-02	1.52E-02
Vanadium (V)	6.87E-04	6.87E-04
Tin (Sn)	1.44E-02	1.44E-02
Dioxins and furans	4.12E-08	4.12E-08

Inhalation - gases and particulates
Maximum Farm

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ (mg/m³) for gases

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ (mg/m³) for chemicals attached to particles

Parameters Relevant to Quantification of Community Exposures - Residents		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

Key Chemical	Toxicity Data				Concentration	Daily Exposure		Calculated Risk			
	Inhalation Unit Risk (mg/m³)⁻¹	Chronic TC Air (mg/m³)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m³)	Estimated Concentration in Air - Maximum anywhere (Ca) (mg/m³)	Inhalation Exposure Concentration - NonThreshold (mg/m³)	Inhalation Exposure Concentration - Threshold (mg/m³)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	1.8E-04	9.0E-05	1.8E-04	--		3.2E-03	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	2.1E-05	1.0E-05	2.1E-05	--		4.2E-04	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	8.3E-06	4.2E-06	8.3E-06	--		3.2E-04	6%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	1.7E-06	8.3E-07	1.7E-06	--		5.7E-05	1%
Ammonia		3.2E-01	0%	3.2E-01	8.3E-06	4.2E-06	8.3E-06	--		2.6E-05	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	1.1E-09	2.1E-10	4.2E-10	--		1.0E-04	2%
Thallium (Tl)		2.8E-03	0%	2.8E-03	9.7E-10	1.8E-10	3.6E-10	--		1.3E-07	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	3.5E-09	6.6E-10	1.3E-09	--		8.2E-05	2%
Mercury (Hg)		2.0E-04	10%	1.8E-04	2.1E-08	3.9E-09	7.8E-09	--		4.3E-05	1%
Antimony (Sb)		2.0E-04	0%	2.0E-04	8.7E-09	1.6E-09	3.3E-09	--		1.6E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	1.1E-08	2.0E-09	4.0E-09	--		4.0E-06	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	2.9E-08	5.5E-09	1.1E-08	--		2.2E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	8.7E-08	1.6E-08	3.3E-08	--		3.3E-04	7%
Cobalt (Co)		1.0E-04	0%	1.0E-04	9.2E-09	1.7E-09	3.4E-09	--		3.4E-05	1%
Copper (Cu)		4.9E-01	0%	4.9E-01	9.1E-08	1.7E-08	3.4E-08	--		7.0E-08	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	2.6E-08	4.8E-09	9.6E-09	--		8.0E-05	2%
Nickel (Ni)		2.0E-05	20%	1.6E-05	1.5E-07	2.8E-08	5.6E-08	--		3.5E-03	71%
Selenium (Se)		2.1E-02	60%	8.4E-03	8.7E-08	1.6E-08	3.3E-08	--		3.9E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	5.0E-09	9.4E-10	1.9E-09	--		1.9E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	9.2E-08	1.7E-08	3.4E-08	--		4.9E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	1.2E-13	2.3E-14	4.7E-14	--		1.3E-05	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	8.3E-06	4.2E-06	8.3E-06	2.5E-8		3.1E-04	6%
							TOTAL	2.5E-08		0.00497	

Calculation of Concentrations in Soil

$$C_S = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - Maximum farm

Chemical	Half-life in soil years	Degradation constant (k) per year	Deposition Rate (DR) mg/m^2/year	Surface Concentration in Soil mg/kg	Agricultural Concentration in Soil mg/kg
Cadmium (Cd)	273973	2.5E-06	1.8E-04	8.0E-04	5.3E-05
Thallium (Tl)	273973	2.5E-06	1.6E-04	7.1E-04	4.7E-05
Beryllium (Be)	273973	2.5E-06	5.8E-04	2.5E-03	1.7E-04
Mercury (Hg)	273973	2.5E-06	3.4E-03	1.5E-02	1.0E-03
Antimony (Sb)	273973	2.5E-06	1.4E-03	6.0E-03	4.0E-04
Arsenic (As)	273973	2.5E-06	2.1E-03	9.0E-03	6.0E-04
Lead (Pb)	273973	2.5E-06	4.8E-03	2.1E-02	1.4E-03
Chromium (Cr VI assumed)	273973	2.5E-06	1.4E-02	6.3E-02	4.2E-03
Cobalt (Co)	273973	2.5E-06	1.4E-03	6.0E-03	4.0E-04
Copper (Cu)	273973	2.5E-06	1.5E-02	6.6E-02	4.4E-03
Manganese (Mn)	273973	2.5E-06	4.1E-03	1.8E-02	1.2E-03
Nickel (Ni)	273973	2.5E-06	2.5E-02	1.1E-01	7.2E-03
Selenium (Se)	273973	2.5E-06	1.5E-02	6.6E-02	4.4E-03
Vanadium (V)	273973	2.5E-06	6.9E-04	3.0E-03	2.0E-04
Tin (Sn)	273973	2.5E-06	1.4E-02	6.3E-02	4.2E-03
Dioxins and furans	15.00	4.6E-02	4.1E-08	5.4E-08	3.6E-09

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum farm

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	8.0E-04	2.4E-10	5.7E-10	--		1.8E-06	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	7.1E-04	2.1E-10	5.0E-10	--		6.3E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.5E-03	7.5E-10	1.8E-09	--		1.1E-06	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.5E-02	4.4E-09	1.1E-08	--		3.0E-05	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	6.0E-03	1.8E-09	4.3E-09	--		5.0E-06	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	9.0E-03	2.7E-09	6.4E-09	--		6.4E-06	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	2.1E-02	6.2E-09	1.5E-08	--		8.6E-06	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	6.3E-02	1.9E-08	4.5E-08	--		5.0E-05	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	6.0E-03	1.8E-09	4.3E-09	--		3.8E-06	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	6.6E-02	2.0E-08	4.7E-08	--		8.4E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.8E-02	5.3E-09	1.3E-08	--		1.8E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.1E-01	3.2E-08	7.7E-08	--		1.6E-05	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.6E-02	2.0E-08	4.7E-08	--		2.0E-05	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	3.0E-03	8.9E-10	2.1E-09	--		1.1E-06	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	6.3E-02	1.9E-08	4.5E-08	--		4.5E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	5.4E-08	1.6E-14	3.8E-14	--		3.6E-05	20%
								TOTAL			0.000182	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Farm

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		8.0E-04			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		7.1E-04			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.5E-03	4.7E-11	1.1E-10	--		7.1E-8	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.5E-02	2.8E-10	6.8E-10	--		1.9E-6	2%
Antimony (Sb)		8.6E-04		8.6E-04		6.0E-03			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	9.0E-03	8.4E-10	2.0E-09	--		2.0E-6	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		2.1E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		6.3E-02			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	6.0E-03	1.1E-10	2.7E-10	--		2.4E-7	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		6.6E-02			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.8E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	1.1E-01	1.0E-08	2.4E-08	--		5.1E-6	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.6E-02			--		--	
Vanadium (V)		2.0E-03		2.0E-03		3.0E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		6.3E-02			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	5.4E-08	3.0E-14	7.2E-14	--		6.8E-5	88%
							TOTAL				0.0000776	

Exposure to Chemicals via Incidental Ingestion of Soil - Maximum Farm

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	8.0E-04	4.6E-10	5.3E-09	--		1.7E-05	1%
Thallium (Tl)		8.0E-04		8.0E-04	100%	7.1E-04	4.0E-10	4.7E-09	--		5.9E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.5E-03	1.4E-09	1.7E-08	--		1.1E-05	1%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.5E-02	8.6E-09	1.0E-07	--		2.8E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	6.0E-03	3.4E-09	4.0E-08	--		4.7E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	9.0E-03	5.2E-09	6.0E-08	--		6.0E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	2.1E-02	1.2E-08	1.4E-07	--		8.0E-05	5%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	6.3E-02	3.6E-08	4.2E-07	--		4.7E-04	28%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	6.0E-03	3.4E-09	4.0E-08	--		3.6E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	6.6E-02	3.8E-08	4.4E-07	--		7.9E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.8E-02	1.0E-08	1.2E-07	--		1.7E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.1E-01	6.2E-08	7.2E-07	--		1.5E-04	9%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.6E-02	3.8E-08	4.4E-07	--		1.8E-04	11%
Vanadium (V)		2.0E-03		2.0E-03	100%	3.0E-03	1.7E-09	2.0E-08	--		1.0E-05	1%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	6.3E-02	3.6E-08	4.2E-07	--		4.2E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	5.4E-08	3.1E-14	3.6E-13	--		3.4E-04	20%
								TOTAL			0.00170	

Dermal Exposure to Chemicals via Contact with Soil - Maximum Farm

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \qquad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		8.0E-04			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		7.1E-04			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.5E-03	1.9E-11	2.3E-10	--		1.4E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.5E-02	1.2E-10	1.4E-09	--		3.8E-6	2%
Antimony (Sb)		8.6E-04		8.6E-04		6.0E-03			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	9.0E-03	3.5E-10	4.1E-09	--		4.1E-6	3%
Lead (Pb)		3.5E-03	50%	1.8E-03		2.1E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		6.3E-02			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	6.0E-03	4.6E-11	5.4E-10	--		4.8E-7	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		6.6E-02			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		1.8E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	1.1E-01	4.2E-09	4.9E-08	--		1.0E-5	7%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.6E-02			--		--	
Vanadium (V)		2.0E-03		2.0E-03		3.0E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		6.3E-02			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	5.4E-08	1.2E-14	1.4E-13	--		1.4E-4	88%

TOTAL		**0.000155**

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops	Uptake via Roots from Soil
$C_p = \frac{DR \bullet F \bullet \left[1 - e^{-k \bullet t}\right]}{Y \bullet k}$ (mg/kg plant – wet weight)	$C_{rp} = C_s \bullet RUF$ (mg/kg plant – wet weight)
where: DR= Particle deposition rate for accidental release (mg/m^2/day) F= Fraction for the surface area of plant (unitless) k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$ $T_{0.5}$= Chemical half-life as particulate on plant (days) t= Deposition time (days) Y= Crop yield (kg/m^2)	**where**: Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg) RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations - Maximum Farm

Chemical	Half-life on plant ($T_{0.5}$)#	Loss constant (k) &	Deposition Rate (DR)	Aboveground Produce Concentration via Deposition	Root Uptake Factor (RUF)$	Soil Concentration (Cs)	Below Ground Produce Concentration
	days	per day	mg/m^2/day	mg/kg ww	unitless	mg/kg	mg/kg ww
Cadmium (Cd)	14	0.05	5.0E-07	2.5E-07	0.125	5.3E-05	6.6E-06
Thallium (Tl)	14	0.05	4.4E-07	2.2E-07	0.001	4.7E-05	4.7E-08
Beryllium (Be)	14	0.05	1.6E-06	7.9E-07	0.0025	1.7E-04	4.2E-07
Mercury (Hg)	14	0.05	9.4E-06	4.7E-06	0.225	1.0E-03	2.3E-04
Antimony (Sb)	14	0.05	3.8E-06	1.9E-06	0.05	4.0E-04	2.0E-05
Arsenic (As)	14	0.05	5.6E-06	2.8E-06	0.04	6.0E-04	2.4E-05
Lead (Pb)	14	0.05	1.3E-05	6.6E-06	0.0113	1.4E-03	1.6E-05
Chromium (Cr VI assumed)	14	0.05	4.0E-05	2.0E-05	0.00188	4.2E-03	7.9E-06
Cobalt (Co)	14	0.05	3.8E-06	1.9E-06	0.005	4.0E-04	2.0E-06
Copper (Cu)	14	0.05	4.1E-05	2.1E-05	0.1	4.4E-03	4.4E-04
Manganese (Mn)	14	0.05	1.1E-05	5.6E-06	0.0625	1.2E-03	7.5E-05
Nickel (Ni)	14	0.05	6.8E-05	3.4E-05	0.015	7.2E-03	1.1E-04
Selenium (Se)	14	0.05	4.2E-05	2.1E-05	0.00625	4.4E-03	2.8E-05
Vanadium (V)	14	0.05	1.9E-06	9.4E-07	0.00138	2.0E-04	2.8E-07
Tin (Sn)	14	0.05	3.9E-05	2.0E-05	0.0075	4.2E-03	3.1E-05
Dioxins and furans	14	0.05	1.1E-10	5.6E-11	0.000876	3.6E-09	3.1E-12

$ Root uptake factors from RAIS (soil to wet weight of plant)

& Loss constant is 1/half life

Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - Maximum Farm

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	35%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)^-1	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Above ground produce concentration (mg/kg wet weight)	Root crops concentrations (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.5E-07	6.6E-06	1.6E-09	3.9E-09	--		1.2E-05	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.2E-07	4.7E-08	1.4E-10	3.5E-10	--		4.3E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.9E-07	4.2E-07	5.7E-10	1.4E-09	--		8.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	4.7E-06	2.3E-04	5.3E-08	1.3E-07	--		3.6E-04	61%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.9E-06	2.0E-05	5.6E-09	1.4E-08	--		1.6E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.8E-06	2.4E-05	7.1E-09	1.7E-08	--		1.7E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	6.6E-06	1.6E-05	7.5E-09	1.8E-08	--		1.0E-05	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.0E-05	7.9E-06	1.4E-08	3.3E-08	--		3.7E-05	6%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.9E-06	2.0E-06	1.6E-09	3.8E-09	--		3.4E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.1E-05	4.4E-04	1.1E-07	2.7E-07	--		4.8E-06	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.6E-06	7.5E-05	2.0E-08	4.9E-08	--		7.0E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.4E-05	1.1E-04	4.5E-08	1.1E-07	--		2.2E-05	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	2.8E-05	1.9E-08	4.5E-08	--		1.9E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	9.4E-07	2.8E-07	6.3E-10	1.5E-09	--		7.6E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.0E-05	3.1E-05	1.9E-08	4.6E-08	--		4.6E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	5.6E-11	3.1E-12	3.5E-14	8.4E-14	--		7.9E-05	14%
									TOTAL			0.000582	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - Maximum Farm

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	35%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)				NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.5E-07	6.6E-06	7.1E-10	8.3E-09	--		2.6E-05	2%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.2E-07	4.7E-08	1.1E-10	1.3E-09	--		1.6E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.9E-07	4.2E-07	4.1E-10	4.8E-09	--		3.0E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	4.7E-06	2.3E-04	2.2E-08	2.6E-07	--		7.3E-04	51%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.9E-06	2.0E-05	2.7E-09	3.1E-08	--		3.6E-05	3%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.8E-06	2.4E-05	3.5E-09	4.1E-08	--		4.1E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	6.6E-06	1.6E-05	4.5E-09	5.3E-08	--		3.0E-05	2%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.0E-05	7.9E-06	1.0E-08	1.2E-07	--		1.3E-04	9%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.9E-06	2.0E-06	1.1E-09	1.2E-08	--		1.1E-05	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.1E-05	4.4E-04	4.9E-08	5.7E-07	--		1.0E-05	1%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.6E-06	7.5E-05	9.4E-09	1.1E-07	--		1.6E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.4E-05	1.1E-04	2.6E-08	3.0E-07	--		6.2E-05	4%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	2.8E-05	1.2E-08	1.4E-07			5.9E-05	4%
Vanadium (V)		2.0E-03		2.0E-03	100%	9.4E-07	2.8E-07	4.7E-10	5.4E-09	--		2.7E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.0E-05	3.1E-05	1.2E-08	1.4E-07	--		1.4E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	5.6E-11	3.1E-12	2.7E-14	3.1E-13	--		3.0E-04	21%
									TOTAL			0.001437	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$$ (mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - Maximum Farm

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	2.5E-07	5.3E-05	1.0E-02	5.6E-09	OEHHA (2015)
Thallium (Tl)	2.2E-07	4.7E-05	1.7E-02	8.4E-09	
Beryllium (Be)	7.9E-07	1.7E-04	9.0E-02	1.6E-07	OEHHA (2015)
Mercury (Hg)	4.7E-06	1.0E-03	8.0E-01	8.5E-06	OEHHA (2015)
Antimony (Sb)	1.9E-06	4.0E-04	4.2E-04	1.8E-09	
Arsenic (As)	2.8E-06	6.0E-04	7.0E-02	4.4E-07	OEHHA (2015)
Lead (Pb)	6.6E-06	1.4E-03	4.0E-02	5.9E-07	OEHHA (2015)
Chromium (Cr VI assumed)	2.0E-05	4.2E-03	9.2E-03	4.1E-07	OEHHA (2003)
Cobalt (Co)	1.9E-06	4.0E-04	3.8E-02	1.6E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	2.1E-05	4.4E-03	3.8E-02	1.8E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	5.6E-06	1.2E-03	3.8E-02	4.8E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	3.4E-05	7.2E-03	2.0E-02	1.5E-06	OEHHA (2015)
Selenium (Se)	2.1E-05	4.4E-03	3.0E+00	1.4E-04	OEHHA (2015)
Vanadium (V)	9.4E-07	2.0E-04	3.8E-02	8.0E-08	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	2.0E-05	4.2E-03	3.8E-02	1.7E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	5.6E-11	3.6E-09	1.0E+01	4.2E-10	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs - Maximum Farm

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.059	Ingestion rate of eggs relevant for adults as per P90 from FSANZ 2017
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Egg concentration (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.6E-09	2.0E-12	4.7E-12	--		1.5E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	8.4E-09	2.9E-12	7.0E-12	--		8.8E-09	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-07	5.6E-11	1.3E-10	--		8.4E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	8.5E-06	3.0E-09	7.1E-09	--		2.0E-05	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.8E-09	6.2E-13	1.5E-12	--		1.7E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	4.4E-07	1.6E-10	3.7E-10	--		3.7E-07	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.9E-07	2.1E-10	5.0E-10	--		2.9E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	4.1E-07	1.4E-10	3.4E-10	--		3.8E-07	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.6E-07	5.6E-11	1.4E-10	--		1.2E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.8E-06	6.2E-10	1.5E-09	--		2.7E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.8E-07	1.7E-10	4.1E-10	--		5.8E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.5E-06	5.3E-10	1.3E-09	--		2.7E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-04	4.9E-08	1.2E-07	--		4.9E-05	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.0E-08	2.8E-11	6.8E-11	--		3.4E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	5.9E-10	1.4E-09	--		1.4E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	4.2E-10	1.5E-13	3.6E-13	--		3.4E-04	83%
								TOTAL			0.000409	

Exposure to Chemicals via Ingestion of Eggs - Maximum Farm

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.036	Ingestion rate of eggs relevant for young children as per P90 from FSANZ 2017
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.6E-09	1.2E-12	1.3E-11	--		4.2E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	8.4E-09	1.7E-12	2.0E-11	--		2.5E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-07	3.3E-11	3.8E-10	--		2.4E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	8.5E-06	1.7E-09	2.0E-08	--		5.6E-05	5%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.8E-09	3.7E-13	4.3E-12	--		5.0E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	4.4E-07	9.1E-11	1.1E-09	--		1.1E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.9E-07	1.2E-10	1.4E-09	--		8.1E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	4.1E-07	8.4E-11	9.8E-10	--		1.1E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.6E-07	3.3E-11	3.9E-10	--		3.4E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.8E-06	3.6E-10	4.2E-09	--		7.6E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.8E-07	9.9E-11	1.2E-09	--		1.7E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.5E-06	3.1E-10	3.7E-09	--		7.6E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-04	2.9E-08	3.4E-07	--		1.4E-04	12%
Vanadium (V)		2.0E-03		2.0E-03	100%	8.0E-08	1.7E-11	1.9E-10	--		9.7E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	3.5E-10	4.0E-09	--		4.0E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	4.2E-10	8.7E-14	1.0E-12	--		9.6E-04	83%
								TOTAL			0.00116	

Calculation of Concentrations in Homegrown Beef

Uptake in to beef meat

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_B$$ (mg/kg beef – wet weight)

where:
FI = Fraction of grain/crop ingested by cattle each day (unitless)
IRc = Ingestion rate of grain/crop by cattle each day (kg/day)
C = Concentration of chemical in grain/crop eaten by cattle (mg/kg)
IRs = Ingestion rate of soil by cattle each day (kg/day)
Cs = Concentration in soil the cattle ingest (mg/kg)
B = Bioavailability of soil ingested by cattle (%)
TFE = Transfer factor from ingestion to beef (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of pasture consumed by cattle is grown in the same soil
IRc (ingestion rate of crops)	kg/day	9	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.5	USEPA (2005) (NSW DPI recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - Maximum Farm

Chemical	Concentration in crops ingested by cattle mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to beef day/kg	Beef Concentration mg/kg ww	
Cadmium (Cd)	2.5E-07	5.3E-05	2.0E-04	5.8E-09	OEHHA (2015)
Thallium (Tl)	2.2E-07	4.7E-05	4.0E-02	1.0E-06	
Beryllium (Be)	7.9E-07	1.7E-04	3.0E-04	2.7E-08	OEHHA (2015)
Mercury (Hg)	4.7E-06	1.0E-03	4.0E-04	2.2E-07	OEHHA (2015)
Antimony (Sb)	1.9E-06	4.0E-04	1.0E-03	2.2E-07	
Arsenic (As)	2.8E-06	6.0E-04	2.0E-03	6.5E-07	OEHHA (2015)
Lead (Pb)	6.6E-06	1.4E-03	3.0E-04	2.3E-07	OEHHA (2015)
Chromium (Cr VI assumed)	2.0E-05	4.2E-03	5.5E-03	1.3E-05	
Cobalt (Co)	1.9E-06	4.0E-04	2.0E-02	4.3E-06	
Copper (Cu)	2.1E-05	4.4E-03	1.0E-02	2.4E-05	
Manganese (Mn)	5.6E-06	1.2E-03	4.0E-04	2.6E-07	
Nickel (Ni)	3.4E-05	7.2E-03	3.0E-04	1.2E-06	OEHHA (2015)
Selenium (Se)	2.1E-05	4.4E-03	4.0E-02	9.6E-05	OEHHA (2015)
Vanadium (V)	9.4E-07	2.0E-04	2.5E-03	2.7E-07	
Tin (Sn)	2.0E-05	4.2E-03	1.0E-03	2.3E-06	
Dioxins and furans	5.6E-11	3.6E-09	7.0E-01	1.6E-09	OEHHA (2015)

Transfer factors from OEHHA (2015) as noted, and then from RAIS (accessed in 2019)

Exposure to Chemicals via Ingestion of Beef - Maximum Farm

$$\text{Daily chemical intake} = C_B \times \frac{IR_B \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Beef (IRB) (kg/day)	0.16	Ingestion rate of beef for adults as per P90 from FSANZ 2017
Fraction ingested that is homegrown (%)	100%	Assume 35% beef intakes from home-sourced meat
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Beef concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.8E-09	5.5E-12	1.3E-11	--		4.1E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.0E-06	9.7E-10	2.3E-09	--		2.9E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.7E-08	2.6E-11	6.3E-11	--		3.9E-08	
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.2E-07	2.1E-10	5.0E-10	--		1.4E-06	0%
Antimony (Sb)		8.6E-04		8.6E-04	100%	2.2E-07	2.1E-10	5.0E-10	--		5.8E-07	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	6.5E-07	6.2E-10	1.5E-09	--		1.5E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	2.3E-07	2.2E-10	5.2E-10	--		3.0E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.3E-05	1.2E-08	2.9E-08	--		3.2E-05	1%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.3E-06	4.1E-09	9.9E-09	--		8.9E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.4E-05	2.3E-08	5.5E-08	--		9.8E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.6E-07	2.5E-10	6.0E-10	--		8.5E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.2E-06	1.1E-09	2.7E-09	--		5.6E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	9.6E-05	9.1E-08	2.2E-07	--		9.1E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.7E-07	2.6E-10	6.2E-10	--		3.1E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.3E-06	2.1E-09	5.2E-09	--		5.2E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.6E-09	1.5E-12	3.7E-12	--		3.5E-03	96%
								TOTAL			**0.00361**	

Exposure to Chemicals via Ingestion of Beef - Maximum Farm

$$\text{Daily chemical intake} = C_B \times \frac{IR_B \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate of Beef (IRB) (kg/day)	0.085	Ingestion rate of beef by children aged 2-6 years (P90 value) FSANZ (2017)
Fraction ingested that is homegrown (%)	100%	Assume 35% beef intakes from home-sourced meat
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Beef concentration (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	5.8E-09	2.8E-12	3.3E-11	--		1.0E-07	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	1.0E-06	5.0E-10	5.8E-09	--		7.2E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.7E-08	1.3E-11	1.6E-10	--		9.7E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.2E-07	1.1E-10	1.2E-09	--		3.4E-06	0%
Antimony (Sb)		8.6E-04		8.6E-04	100%	2.2E-07	1.1E-10	1.2E-09	--		1.4E-06	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	6.5E-07	3.2E-10	3.7E-09	--		3.7E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	2.3E-07	1.1E-10	1.3E-09	--		7.4E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.3E-05	6.1E-09	7.1E-08	--		7.9E-05	1%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.3E-06	2.1E-09	2.5E-08	--		2.2E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.4E-05	1.2E-08	1.4E-07	--		2.4E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.6E-07	1.3E-10	1.5E-09	--		2.1E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.2E-06	5.7E-10	6.6E-09	--		1.4E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	9.6E-05	4.7E-08	5.4E-07	--		2.3E-04	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.7E-07	1.3E-10	1.5E-09	--		7.7E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.3E-06	1.1E-09	1.3E-08	--		1.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.6E-09	7.8E-13	9.1E-12	--		8.6E-03	96%
								TOTAL			0.00895	

Calculation of Concentrations in Dairy Milk

Uptake in to milk (dairy cows)

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_B$$ (mg/kg beef – wet weight)

where:
FI = Fraction of grain/crop ingested by cattle each day (unitless)
IRc = Ingestion rate of grain/crop by cattle each day (kg/day)
C = Concentration of chemical in grain/crop eaten by cattle (mg/kg)
IRs = Ingestion rate of soil by cattle each day (kg/day)
Cs = Concentration in soil the cattle ingest (mg/kg)
B = Bioavailability of soil ingested by cattle (%)
TFE = Transfer factor from ingestion to milk (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of pasture consumed by cattle is grown in the same soil
IRc (ingestion rate of crops)	kg/day	22	Assumed ingestion rate from OEHHA 2015 for lactating cattle (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.5	USEPA (2005) (NSW DPI recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - Maximum Farm

Chemical	Concentration in crops ingested by cattle mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to milk day/kg	Milk Concentration mg/kg ww	
Cadmium (Cd)	2.5E-07	5.3E-05	5.0E-06	1.6E-10	OEHHA (2015)
Thallium (Tl)	2.2E-07	4.7E-05	2.0E-03	5.7E-08	
Beryllium (Be)	7.9E-07	1.7E-04	9.0E-07	9.1E-11	OEHHA (2015)
Mercury (Hg)	4.7E-06	1.0E-03	7.0E-05	4.2E-08	OEHHA (2015)
Antimony (Sb)	1.9E-06	4.0E-04	1.0E-04	2.4E-08	
Arsenic (As)	2.8E-06	6.0E-04	5.0E-05	1.8E-08	OEHHA (2015)
Lead (Pb)	6.6E-06	1.4E-03	6.0E-05	5.1E-08	OEHHA (2015)
Chromium (Cr VI assumed)	2.0E-05	4.2E-03	9.0E-06	2.3E-08	OEHHA (2015)
Cobalt (Co)	1.9E-06	4.0E-04	2.0E-03	4.8E-07	
Copper (Cu)	2.1E-05	4.4E-03	1.5E-03	4.0E-06	
Manganese (Mn)	5.6E-06	1.2E-03	3.5E-04	2.5E-07	
Nickel (Ni)	3.4E-05	7.2E-03	3.0E-05	1.3E-07	OEHHA (2015)
Selenium (Se)	2.1E-05	4.4E-03	9.0E-03	2.4E-05	OEHHA (2015)
Vanadium (V)	9.4E-07	2.0E-04	2.0E-05	2.4E-09	
Tin (Sn)	2.0E-05	4.2E-03	1.0E-03	2.5E-06	
Dioxins and furans	5.6E-11	3.6E-09	2.0E-02	6.1E-11	OEHHA (2015)

Transfer factors from OEHHA (2015) as noted, and then from RAIS (accessed in 2019)

Exposure to Chemicals via Ingestion of Milk - Maximum Farm

$$\text{Daily chemical intake} = C_M \times \frac{IR_M \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Milk (IRM) (kg/day)	1.295	Ingestion rate of cows milk for adults (P90 value from FSANZ 2017)
Fraction ingested that is homegrown (%)	100%	Assume all milk consumed is from the dairy farm
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Milk concentration (mg/kg wet weight)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)			NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.6E-10	1.2E-12	3.0E-12	--		9.3E-09	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	5.7E-08	4.4E-10	1.1E-09	--		1.3E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	9.1E-11	7.0E-13	1.7E-12	--		1.1E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	4.2E-08	3.2E-10	7.8E-10	--		2.2E-06	0%
Antimony (Sb)		8.6E-04		8.6E-04	100%	2.4E-08	1.9E-10	4.5E-10	--		5.2E-07	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.8E-08	1.4E-10	3.4E-10	--		3.4E-07	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.1E-08	3.9E-10	9.4E-10	--		5.4E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.3E-08	1.8E-10	4.2E-10	--		4.7E-07	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.8E-07	3.7E-09	8.9E-09	--		8.0E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.0E-06	3.1E-08	7.4E-08	--		1.3E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.5E-07	1.9E-09	4.7E-09	--		6.7E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.3E-07	1.0E-09	2.4E-09	--		5.0E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.4E-05	1.8E-07	4.4E-07	--		1.9E-04	15%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.4E-09	1.9E-11	4.5E-11	--		2.2E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.5E-06	1.9E-08	4.7E-08	--		4.7E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	6.1E-11	4.6E-13	1.1E-12	--		1.1E-03	84%
								TOTAL			0.00126	

Exposure to Chemicals via Ingestion of Milk - Maximum Farm

$$\text{Daily chemical intake} = C_M \times \frac{IR_M \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate of Milk (IRM) (kg/day)	1.097	Ingestion rate of cows milk for children aged 2-6 years (P90 value from FSANZ 2017)
Fraction ingested that is homegrown (%)	100%	Assume all milk consumed is from the dairy farm
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability	Milk concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	(%)	(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.6E-10	1.0E-12	1.2E-11	--		3.7E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	5.7E-08	3.6E-10	4.2E-09	--		5.2E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	9.1E-11	5.7E-13	6.7E-12	--		4.2E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	4.2E-08	2.7E-10	3.1E-09	--		8.6E-06	0%
Antimony (Sb)		8.6E-04		8.6E-04	100%	2.4E-08	1.5E-10	1.8E-09	--		2.1E-06	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.8E-08	1.1E-10	1.3E-09	--		1.3E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.1E-08	3.2E-10	3.7E-09	--		2.1E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.3E-08	1.4E-10	1.7E-09	--		1.9E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.8E-07	3.0E-09	3.5E-08	--		3.2E-05	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.0E-06	2.5E-08	2.9E-07	--		5.2E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.5E-07	1.6E-09	1.9E-08	--		2.7E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.3E-07	8.2E-10	9.5E-09	--		2.0E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.4E-05	1.5E-07	1.8E-06	--		7.3E-04	15%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.4E-09	1.5E-11	1.8E-10	--		8.8E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.5E-06	1.6E-08	1.8E-07	--		1.8E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	6.1E-11	3.8E-13	4.4E-12	--		4.2E-03	84%
								TOTAL			0.0050	

EPA Limit modelling scenario

Predicted ground level concentrations - chronic exposures

COPC	Air Concentration - annual average (ug/m3) Maximum FARM	Air Concentration - annual average (mg/m3) Maximum FARM
Nitrogen dioxide (NO2)	7.96E-01	8.0E-04
Sulfur dioxide (SO2)	8.32E-01	8.3E-04
Hydrogen chloride (HCl)	2.50E-01	2.5E-04
Hydrogen fluoride (HF)	1.66E-02	1.7E-05
Ammonia	1.25E-01	1.2E-04
PM10	1.22E-01	1.2E-04
PM2.5	1.19E-01	1.2E-04
Cadmium (Cd)	4.49E-04	4.5E-07
Thallium (Tl)	3.88E-05	3.9E-08
Beryllium (Be)	3.49E-06	3.5E-09
Mercury (Hg)	1.46E-04	1.5E-07
Antimony (Sb)	2.60E-05	2.6E-08
Arsenic (As)	3.16E-05	3.2E-08
Lead (Pb)	8.75E-05	8.7E-08
Chromium (Cr VI assumed)	2.61E-04	2.6E-07
Cobalt (Co)	2.75E-05	2.8E-08
Copper (Cu)	2.73E-04	2.7E-07
Manganese (Mn)	7.66E-05	7.7E-08
Nickel (Ni)	4.49E-04	4.5E-07
Selenium (Se)	8.69E-05	8.7E-08
Vanadium (V)	1.51E-05	1.5E-08
Tin (Sn)	9.19E-05	9.2E-08
Dioxins and furans	7.49E-10	7.5E-13
Benzene	8.32E-02	8.3E-05

COPC	Deposition Rate - annual average (mg/m2/year) Maximum FARM	Deposition Rate - annual average (mg/m2/year) Maximum FARM
Cadmium (Cd)	7.28E-03	7.28E-03
Thallium (Tl)	6.46E-03	6.46E-03
Beryllium (Be)	5.77E-04	5.77E-04
Mercury (Hg)	2.41E-02	2.41E-02
Antimony (Sb)	4.12E-03	4.12E-03
Arsenic (As)	6.18E-03	6.18E-03
Lead (Pb)	1.44E-02	1.44E-02
Chromium (Cr VI assumed)	4.33E-02	4.33E-02
Cobalt (Co)	4.12E-03	4.12E-03
Copper (Cu)	4.54E-02	4.54E-02
Manganese (Mn)	1.24E-02	1.24E-02
Nickel (Ni)	7.42E-02	7.42E-02
Selenium (Se)	1.52E-02	1.52E-02
Vanadium (V)	2.06E-03	2.06E-03
Tin (Sn)	1.44E-02	1.44E-02
Dioxins and furans	8.25E-08	8.25E-08

Inhalation - gases and particulates
Maximum Farm
EPA limit modelling scenario

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * EF * ED}{AT}$$ **(mg/m^3) for gases**

$$Inhalation\ Exposure\ Concentration = Ca * \frac{ET * FI * DRF * EF * ED}{AT}$$ **(mg/m^3) for chemicals attached to particles**

Parameters Relevant to Quantification of Community Exposures		
Exposure Time at Home (ET, hr/day)	24	Assume residents at home or on property 24 hours per day
Fraction Inhaled from Source (FI, unitless)	1	Assume resident at the same property
Dust lung retention factor (unitless)	0.375	Percentage of respirable dust that is small enough to reach and be retained in the lungs (NEPM 1999 amended 2013) - NA for gasses
Exposure Frequency - normal conditions (EF, days/yr)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	35	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, hours)	613200	US EPA 2009
Averaging Time - Threshold (Atn, hours)	306600	US EPA 2009

	Toxicity Data				**Concentration**	**Daily Exposure**		**Calculated Risk**			
Key Chemical	**Inhalation Unit Risk** (mg/m^3)$^{-1}$	**Chronic TC Air** (mg/m^3)	**Background Intake (% Chronic TC)**	**Chronic TC Allowable for Assessment (TC-Background)** (mg/m^3)	**Estimated Concentration in Air - Maximum anywhere (Ca)** (mg/m^3)	**Inhalation Exposure Concentration -** NonThreshold (mg/m^3)	**Inhalation Exposure Concentration -** Threshold (mg/m^3)	**Non-Threshold Risk** (unitless)	**% Total Risk**	**Chronic Hazard Quotient** (unitless)	**% Total HI**
Nitrogen dioxide (NO2)		5.6E-02	0%	5.6E-02	8.0E-04	4.0E-04	8.0E-04	--		1.4E-02	
Sulfur dioxide (SO2)		5.0E-02	0%	5.0E-02	8.3E-04	4.2E-04	8.3E-04	--		1.7E-02	
Hydrogen chloride (HCl)		2.6E-02	0%	2.6E-02	2.5E-04	1.2E-04	2.5E-04	--		9.6E-03	14%
Hydrogen fluoride (HF)		2.9E-02	0%	2.9E-02	1.7E-05	8.3E-06	1.7E-05	--		5.7E-04	1%
Ammonia		3.2E-01	0%	3.2E-01	1.2E-04	6.2E-05	1.2E-04	--		3.9E-04	1%
Cadmium (Cd)		5.0E-06	20%	4.0E-06	4.5E-07	8.4E-08	1.7E-07	--		4.2E-02	62%
Thallium (Tl)		2.8E-03	0%	2.8E-03	3.9E-08	7.3E-09	1.5E-08	--		5.2E-06	0%
Beryllium (Be)		2.0E-05	20%	1.6E-05	3.5E-09	6.6E-10	1.3E-09	--		8.2E-05	0%
Mercury (Hg)		2.0E-04	10%	1.8E-04	1.5E-07	2.7E-08	5.5E-08	--		3.0E-04	0%
Antimony (Sb)		2.0E-04	0%	2.0E-04	2.6E-08	4.9E-09	9.8E-09	--		4.9E-05	0%
Arsenic (As)		1.0E-03	0%	1.0E-03	3.2E-08	5.9E-09	1.2E-08	--		1.2E-05	0%
Lead (Pb)		5.0E-04	0%	5.0E-04	8.7E-08	1.6E-08	3.3E-08	--		6.6E-05	0%
Chromium (Cr VI assumed)		1.0E-04	0%	1.0E-04	2.6E-07	4.9E-08	9.8E-08	--		9.8E-04	1%
Cobalt (Co)		1.0E-04	0%	1.0E-04	2.8E-08	5.2E-09	1.0E-08	--		1.0E-04	0%
Copper (Cu)		4.9E-01	0%	4.9E-01	2.7E-07	5.1E-08	1.0E-07	--		2.1E-07	0%
Manganese (Mn)		1.5E-04	20%	1.2E-04	7.7E-08	1.4E-08	2.9E-08	--		2.4E-04	0%
Nickel (Ni)		2.0E-05	20%	1.6E-05	4.5E-07	8.4E-08	1.7E-07	--		1.1E-02	15%
Selenium (Se)		2.1E-02	60%	8.4E-03	8.7E-08	1.6E-08	3.3E-08	--		3.9E-06	0%
Vanadium (V)		1.0E-04	0%	1.0E-04	1.5E-08	2.8E-09	5.7E-09	--		5.7E-05	0%
Tin (Sn)		7.0E-01	0%	7.0E-01	9.2E-08	1.7E-08	3.4E-08	--		4.9E-08	0%
Dioxins and furans		8.1E-09	54%	3.7E-09	7.5E-13	1.4E-13	2.8E-13	--		7.6E-05	0%
Benzene	6.0E-03	3.0E-02	10%	2.7E-02	8.3E-05	4.2E-05	8.3E-05	2.5E-7		3.1E-03	5%
							TOTAL	**2.5E-07**		**0.0683**	

Calculation of Concentrations in Soil

$$C_s = \frac{DR \bullet \left[1 - e^{-k \bullet t}\right]}{d \bullet \rho \bullet k} \bullet 1000$$ **(mg/kg)** ref: Stevens B. (1991)

where:

DR=	Particle deposition rate (mg/m^2/year)
K =	Chemical-specific soil-loss constant (1/year) = ln(2)/T0.5
T0.5 =	Chemical half-life in soil (years)
t =	Accumulation time (years)
d =	Soil mixing depth (m)
ρ =	Soil bulk-density (g/m^3)
1000 =	Conversion from g to kg

General Parameters		Surface (for direct contact)	Depth (for agricultural pathways)	
Soil bulk density (p)	g/m^3	1600000	1600000	Default for fill materials
General mixing depth (d)	m	0.01	0.15	As per OEHHA (2015) guidance
Duration of deposition (T)	years	70	70	As per OEHHA (2015) guidance

Chemical-specific Inputs and calculations - maximum farm - EPA limit modelling scenario

Chemical	Half-life in soil	Degradation constant (k)	Deposition Rate (DR)	Surface Concentration in Soil	Agricultural Concentration in Soil
	years	per year	mg/m^2/year	mg/kg	mg/kg
Cadmium (Cd)	273973	2.5E-06	7.3E-03	3.2E-02	2.1E-03
Thallium (Tl)	273973	2.5E-06	6.5E-03	2.8E-02	1.9E-03
Beryllium (Be)	273973	2.5E-06	5.8E-04	2.5E-03	1.7E-04
Mercury (Hg)	273973	2.5E-06	2.4E-02	1.1E-01	7.0E-03
Antimony (Sb)	273973	2.5E-06	4.1E-03	1.8E-02	1.2E-03
Arsenic (As)	273973	2.5E-06	6.2E-03	2.7E-02	1.8E-03
Lead (Pb)	273973	2.5E-06	1.4E-02	6.3E-02	4.2E-03
Chromium (Cr VI assumed)	273973	2.5E-06	4.3E-02	1.9E-01	1.3E-02
Cobalt (Co)	273973	2.5E-06	4.1E-03	1.8E-02	1.2E-03
Copper (Cu)	273973	2.5E-06	4.5E-02	2.0E-01	1.3E-02
Manganese (Mn)	273973	2.5E-06	1.2E-02	5.4E-02	3.6E-03
Nickel (Ni)	273973	2.5E-06	7.4E-02	3.2E-01	2.2E-02
Selenium (Se)	273973	2.5E-06	1.5E-02	6.6E-02	4.4E-03
Vanadium (V)	273973	2.5E-06	2.1E-03	9.0E-03	6.0E-04
Tin (Sn)	273973	2.5E-06	1.4E-02	6.3E-02	4.2E-03
Dioxins and furans	15.00	4.6E-02	8.2E-08	1.1E-07	7.1E-09

Half-life in soil for dioxins: 9-15 years in surface soils; 25-100 years in subsurface soils (ATSDR 1998, DEH 2004)
Half-life in soil for metals: OEHHA 2015

Exposure to Chemicals via Incidental Ingestion of Soil - maximum farm - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (IRs, mg/day)	50	As per NEPM 2013
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	3.2E-02	9.4E-09	2.3E-08	--		7.1E-05	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.8E-02	8.4E-09	2.0E-08	--		2.5E-05	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.5E-03	7.5E-10	1.8E-09	--		1.1E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.1E-01	3.1E-08	7.5E-08	--		2.1E-04	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.8E-02	5.3E-09	1.3E-08	--		1.5E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.7E-02	8.0E-09	1.9E-08	--		1.9E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	6.3E-02	1.9E-08	4.5E-08	--		2.6E-05	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.9E-01	5.6E-08	1.4E-07	--		1.5E-04	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.8E-02	5.3E-09	1.3E-08	--		1.2E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.0E-01	5.9E-08	1.4E-07	--		2.5E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.4E-02	1.6E-08	3.9E-08	--		5.5E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.2E-01	9.6E-08	2.3E-07	--		4.8E-05	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.6E-02	2.0E-08	4.7E-08	--		2.0E-05	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	9.0E-03	2.7E-09	6.4E-09	--		3.2E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	6.3E-02	1.9E-08	4.5E-08	--		4.5E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.1E-07	3.2E-14	7.7E-14	--		7.2E-05	11%
								TOTAL			**0.000675**	

Dermal Exposure to Chemicals via Contact with Soil - maximum farm - EPA limit modelling scenario

$$\textit{Daily Chemical Intake}_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Adults		
Surface Area (SAs, cm^2)	6300	Exposed skin surface area for adults as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)	(mg/kg)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04		3.2E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		2.8E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.5E-03	4.7E-11	1.1E-10	--		7.1E-8	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.1E-01	2.0E-09	4.7E-09	--		1.3E-5	8%
Antimony (Sb)		8.6E-04		8.6E-04		1.8E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.7E-02	2.5E-09	6.1E-09	--		6.1E-6	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		6.3E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.9E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.8E-02	3.4E-10	8.1E-10	--		7.2E-7	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		2.0E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		5.4E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	3.2E-01	3.0E-08	7.3E-08	--		1.5E-5	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.6E-02			--		--	
Vanadium (V)		2.0E-03		2.0E-03		9.0E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		6.3E-02			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	1.1E-07	6.0E-14	1.4E-13	--		1.4E-4	79%
								TOTAL			0.000172	

Exposure to Chemicals via Incidental Ingestion of Soil - maximum farm - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IS} = C_S \bullet \frac{IR_S \bullet FI \bullet CF \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Ingestion Rate (IRs, mg/day)	100	Assumed daily soil ingestion rate for young children, enHealth (2012)
Fraction Ingested from Source (FI, unitless)	100%	All of daily soil intake occurs from site
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	3.2E-02	1.8E-08	2.1E-07	--		6.6E-04	11%
Thallium (Tl)		8.0E-04		8.0E-04	100%	2.8E-02	1.6E-08	1.9E-07	--		2.4E-04	4%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.5E-03	1.4E-09	1.7E-08	--		1.1E-05	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.1E-01	6.0E-08	7.0E-07	--		1.9E-03	31%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.8E-02	1.0E-08	1.2E-07	--		1.4E-04	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.7E-02	1.5E-08	1.8E-07	--		1.8E-04	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	6.3E-02	3.6E-08	4.2E-07	--		2.4E-04	4%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.9E-01	1.1E-07	1.3E-06	--		1.4E-03	22%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.8E-02	1.0E-08	1.2E-07	--		1.1E-04	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.0E-01	1.1E-07	1.3E-06	--		2.4E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.4E-02	3.1E-08	3.6E-07	--		5.2E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.2E-01	1.9E-07	2.2E-06	--		4.5E-04	7%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	6.6E-02	3.8E-08	4.4E-07	--		1.8E-04	3%
Vanadium (V)		2.0E-03		2.0E-03	100%	9.0E-03	5.2E-09	6.0E-08	--		3.0E-05	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	6.3E-02	3.6E-08	4.2E-07	--		4.2E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.1E-07	6.1E-14	7.1E-13	--		6.8E-04	11%
								TOTAL			0.00630	

Dermal Exposure to Chemicals via Contact with Soil - maximum farm - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{DS} = C_S \bullet \frac{SA_S \bullet AF \bullet FE \bullet ABS \bullet CF \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young Children		
Surface Area (SAs, cm^2)	2700	Exposed skin surface area for young children as per NEPM (2013)
Adherence Factor (AF, mg/cm^2)	0.5	Default as per NEPM (2013)
Fraction of Day Exposed	1	Assume skin is washed after 24 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Soil Concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Absorption (ABS)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04		3.2E-02			--		--	
Thallium (Tl)		8.0E-04		8.0E-04		2.8E-02			--		--	
Beryllium (Be)		2.0E-03	20%	1.6E-03	0.001	2.5E-03	1.9E-11	2.3E-10	--		1.4E-7	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	0.001	1.1E-01	8.1E-10	9.5E-09	--		2.6E-5	8%
Antimony (Sb)		8.6E-04		8.6E-04		1.8E-02			--		--	
Arsenic (As)		2.0E-03	50%	1.0E-03	0.005	2.7E-02	1.0E-09	1.2E-08	--		1.2E-5	4%
Lead (Pb)		3.5E-03	50%	1.8E-03		6.3E-02			--		--	
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04		1.9E-01			--		--	
Cobalt (Co)		1.4E-03	20%	1.1E-03	0.001	1.8E-02	1.4E-10	1.6E-09	--		1.4E-6	0%
Copper (Cu)		1.4E-01	60%	5.6E-02		2.0E-01			--		--	
Manganese (Mn)		1.4E-01	50%	7.0E-02		5.4E-02			--		--	
Nickel (Ni)		1.2E-02	60%	4.8E-03	0.005	3.2E-01	1.3E-08	1.5E-07	--		3.0E-5	9%
Selenium (Se)		6.0E-03	60%	2.4E-03		6.6E-02			--		--	
Vanadium (V)		2.0E-03		2.0E-03		9.0E-03			--		--	
Tin (Sn)		2.0E-01	50%	1.0E-01		6.3E-02			--		--	
Dioxins and furans		2.3E-09	54%	1.1E-09	0.03	1.1E-07	2.5E-14	2.9E-13	--		2.7E-4	79%
								TOTAL			0.000344	

Calculation of Concentrations in Plants

ref: Stevens B. (1991)

Uptake Due to Deposition in Aboveground Crops	Uptake via Roots from Soil
$C_p = \frac{DR \bullet F \bullet \left[1 - e^{-k \bullet t}\right]}{Y \bullet k}$ (mg/kg plant – wet weight) where: DR= Particle deposition rate for accidental release (mg/m^2/day) F= Fraction for the surface area of plant (unitless) k= Chemical-specific soil-loss constant (1/years) = ln(2)/$T_{0.5}$ $T_{0.5}$= Chemical half-life as particulate on plant (days) t= Deposition time (days) Y= Crop yield (kg/m^2)	$C_{rp} = C_s \bullet RUF$ (mg/kg plant – wet weight) **where**: Cs = Concentration of persistent chemical in soil assuming 15cm mixing depth within gardens, calculated using Soil Equation for each chemical assessed (mg/kg) RUF = Root uptake factor which differs for each Chemical (unitless)

General Parameters	Units	Value
Crop		Edible crops
Crop Yield (Y)	kg/m^2	2
Deposition Time (t)	days	70
Plant Interception fraction (F)	unitless	0.051

Chemical-specific Inputs and calculations - maximum farm - EPA limit modelling scenario

Chemical	Half-life on plant ($T_{0.5}$)#	Loss constant (k) &	Deposition Rate (DR)	Aboveground Produce Concentration via Deposition	Root Uptake Factor (RUF)$	Soil Concentration (Cs)	Below Ground Produce Concentration
	days	per day	mg/m^2/day	mg/kg ww	unitless	mg/kg	mg/kg ww
Cadmium (Cd)	14	0.05	2.0E-05	1.0E-05	0.125	2.1E-03	2.7E-04
Thallium (Tl)	14	0.05	1.8E-05	8.8E-06	0.001	1.9E-03	1.9E-06
Beryllium (Be)	14	0.05	1.6E-06	7.9E-07	0.0025	1.7E-04	4.2E-07
Mercury (Hg)	14	0.05	6.6E-05	3.3E-05	0.225	7.0E-03	1.6E-03
Antimony (Sb)	14	0.05	1.1E-05	5.6E-06	0.05	1.2E-03	6.0E-05
Arsenic (As)	14	0.05	1.7E-05	8.5E-06	0.04	1.8E-03	7.2E-05
Lead (Pb)	14	0.05	4.0E-05	2.0E-05	0.0113	4.2E-03	4.8E-05
Chromium (Cr VI assumed)	14	0.05	1.2E-04	5.9E-05	0.00188	1.3E-02	2.4E-05
Cobalt (Co)	14	0.05	1.1E-05	5.6E-06	0.005	1.2E-03	6.0E-06
Copper (Cu)	14	0.05	1.2E-04	6.2E-05	0.1	1.3E-02	1.3E-03
Manganese (Mn)	14	0.05	3.4E-05	1.7E-05	0.0625	3.6E-03	2.3E-04
Nickel (Ni)	14	0.05	2.0E-04	1.0E-04	0.015	2.2E-02	3.2E-04
Selenium (Se)	14	0.05	4.2E-05	2.1E-05	0.00625	4.4E-03	2.8E-05
Vanadium (V)	14	0.05	5.6E-06	2.8E-06	0.00138	6.0E-04	8.3E-07
Tin (Sn)	14	0.05	3.9E-05	2.0E-05	0.0075	4.2E-03	3.1E-05
Dioxins and furans	14	0.05	2.3E-10	1.1E-10	0.000876	7.1E-09	6.3E-12

$ Root uptake factors from RAIS (soil to wet weight of plant)

& Loss constant is 1/half life

Half life on plant taken from Stevens 1991 which notes that particles deposit onto the surface of plants but then over time are lost due to weathering (wind, rain etc) - the half life for the amount of time these particles remain on the surface of the plant (and so may be present in the produce) is 14 days

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT}$$ (mg/kg/day)

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Produce (IRp) (kg/day)	0.4	Total fruit and vegetable consumption rate for adults as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	73%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	27%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	35%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Above ground produce concentration	Root crops concentrations	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.0E-05	2.7E-04	6.5E-08	1.6E-07	--		4.9E-04	14%
Thallium (Tl)		8.0E-04		8.0E-04	100%	8.8E-06	1.9E-06	5.8E-09	1.4E-08	--		1.7E-05	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.9E-07	4.2E-07	5.7E-10	1.4E-09	--		8.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.3E-05	1.6E-03	3.7E-07	9.0E-07	--		2.5E-03	71%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.6E-06	6.0E-05	1.7E-08	4.1E-08	--		4.7E-05	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.5E-06	7.2E-05	2.1E-08	5.1E-08	--		5.1E-05	1%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	2.0E-05	4.8E-05	2.3E-08	5.4E-08	--		3.1E-05	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.9E-05	2.4E-05	4.1E-08	9.9E-08	--		1.1E-04	3%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.6E-06	6.0E-06	4.8E-09	1.1E-08	--		1.0E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	6.2E-05	1.3E-03	3.3E-07	8.0E-07	--		1.4E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.7E-05	2.3E-04	6.1E-08	1.5E-07	--		2.1E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.0E-04	3.2E-04	1.3E-07	3.2E-07	--		6.7E-05	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	2.8E-05	1.9E-08	4.5E-08	--		1.9E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.8E-06	8.3E-07	1.9E-09	4.6E-09	--		2.3E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.0E-05	3.1E-05	1.9E-08	4.6E-08	--		4.6E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.1E-10	6.3E-12	7.0E-14	1.7E-13	--		1.6E-04	5%
									TOTAL			0.00353	

Exposure to Chemicals via Ingestion of Homegrown Fruit and Vegetables - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_A \times \frac{IR_P \times \%A \times FI \times ME \times EF \times ED}{BW \times AT} + C_R \times \frac{IR_P \times \%R \times FI \times ME \times ED \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Produce (IRp) (kg/day)	0.28	Total fruit and vegetable consumption rate for children as per NEPM (2013)
Proportion of total intake from aboveground crops (%A	84%	Proportions as per NEPM (2013)
Proportion of total intake from root crops (%R)	16%	Proportions as per NEPM (2013)
Fraction ingested that is homegrown (%)	35%	Relevant to urban areas as per NEPM (2013)
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor $(mg/kg\text{-}day)^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Above ground produce concentration (mg/kg wet weight)	Root crops concentrations (mg/kg wet weight)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.0E-05	2.7E-04	2.8E-08	3.3E-07	--		1.0E-03	13%
Thallium (Tl)		8.0E-04		8.0E-04	100%	8.8E-06	1.9E-06	4.3E-09	5.0E-08	--		6.3E-05	1%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	7.9E-07	4.2E-07	4.1E-10	4.8E-09	--		3.0E-06	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.3E-05	1.6E-03	1.6E-07	1.8E-06	--		5.1E-03	65%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.6E-06	6.0E-05	8.0E-09	9.4E-08	--		1.1E-04	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	8.5E-06	7.2E-05	1.0E-08	1.2E-07	--		1.2E-04	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	2.0E-05	4.8E-05	1.4E-08	1.6E-07	--		9.0E-05	1%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.9E-05	2.4E-05	3.0E-08	3.5E-07	--		3.9E-04	5%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	5.6E-06	6.0E-06	3.2E-09	3.7E-08	--		3.3E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	6.2E-05	1.3E-03	1.5E-07	1.7E-06	--		3.1E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.7E-05	2.3E-04	2.8E-08	3.3E-07	--		4.7E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.0E-04	3.2E-04	7.7E-08	9.0E-07	--		1.9E-04	2%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	2.8E-05	1.2E-08	1.4E-07			5.9E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.8E-06	8.3E-07	1.4E-09	1.6E-08	--		8.2E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.0E-05	3.1E-05	1.2E-08	1.4E-07	--		1.4E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.1E-10	6.3E-12	5.4E-14	6.3E-13	--		5.9E-04	8%
									TOTAL			**0.00781**	

Calculation of Concentrations in Eggs

Uptake in to chicken eggs

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_E$$

(mg/kg egg – wet weight)

where:
FI = Fraction of pasture/crop ingested by chickens each day (unitless)
IRc = Ingestion rate of pasture/crop by chicken each day (kg/day)
C = Concentration of chemical in grain/crop eaten by chicken (mg/kg)
IRs = Ingestion rate of soil by chickens each day (kg/day)
Cs = Concentration in soil the chickens ingest (mg/kg)
B = Bioavailability of soil ingested by chickens (%)
TFE = Transfer factor from ingestion to eggs (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of crops consumed by chickens is grown in the same soil
IRc (ingestion rate of crops)	kg/day	0.12	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.01	USEPA (2005) (Ag Victoria recommendation)
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - maximum farm - EPA limit modelling scenario

Chemical	Concentration in crops ingested by chickens mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to eggs day/kg	Egg Concentration mg/kg ww	
Cadmium (Cd)	1.0E-05	2.1E-03	1.0E-02	2.2E-07	OEHHA (2015)
Thallium (Tl)	8.8E-06	1.9E-03	1.7E-02	3.3E-07	
Beryllium (Be)	7.9E-07	1.7E-04	9.0E-02	1.6E-07	OEHHA (2015)
Mercury (Hg)	3.3E-05	7.0E-03	8.0E-01	5.9E-05	OEHHA (2015)
Antimony (Sb)	5.6E-06	1.2E-03	4.2E-04	5.3E-09	
Arsenic (As)	8.5E-06	1.8E-03	7.0E-02	1.3E-06	OEHHA (2015)
Lead (Pb)	2.0E-05	4.2E-03	4.0E-02	1.8E-06	OEHHA (2015)
Chromium (Cr VI assumed)	5.9E-05	1.3E-02	9.2E-03	1.2E-06	OEHHA (2003)
Cobalt (Co)	5.6E-06	1.2E-03	3.8E-02	4.8E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Copper (Cu)	6.2E-05	1.3E-02	3.8E-02	5.3E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Manganese (Mn)	1.7E-05	3.6E-03	3.8E-02	1.4E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Nickel (Ni)	1.0E-04	2.2E-02	2.0E-02	4.6E-06	OEHHA (2015)
Selenium (Se)	2.1E-05	4.4E-03	3.0E+00	1.4E-04	OEHHA (2015)
Vanadium (V)	2.8E-06	6.0E-04	3.8E-02	2.4E-07	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Tin (Sn)	2.0E-05	4.2E-03	3.8E-02	1.7E-06	Geometric mean transfer factor for metals, transfer to eggs (Leeman et al 2007)
Dioxins and furans	1.1E-10	7.1E-09	1.0E+01	8.5E-10	OEHHA (2015)

Transfer factors from OEHHA 2015 unless otherwise noted

Exposure to Chemicals via Ingestion of Eggs - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Eggs (IRE) (kg/day)	0.059	Ingestion rate of eggs relevant for adults as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.2E-07	7.8E-11	1.9E-10	--		5.9E-07	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	3.3E-07	1.2E-10	2.8E-10	--		3.5E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-07	5.6E-11	1.3E-10	--		8.4E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	5.9E-05	2.1E-08	5.0E-08	--		1.4E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.3E-09	1.9E-12	4.5E-12	--		5.2E-09	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.3E-06	4.7E-10	1.1E-09	--		1.1E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.8E-06	6.2E-10	1.5E-09	--		8.6E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.2E-06	4.3E-10	1.0E-09	--		1.1E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.8E-07	1.7E-10	4.1E-10	--		3.6E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.3E-06	1.9E-09	4.5E-09	--		8.0E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.4E-06	5.1E-10	1.2E-09	--		1.7E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	4.6E-06	1.6E-09	3.9E-09	--		8.0E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-04	4.9E-08	1.2E-07	--		4.9E-05	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.4E-07	8.4E-11	2.0E-10	--		1.0E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	5.9E-10	1.4E-09	--		1.4E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	8.5E-10	3.0E-13	7.2E-13	--		6.8E-04	78%
								TOTAL			0.00087	

Exposure to Chemicals via Ingestion of Eggs - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_E \times \frac{IR_E \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Young children		
Ingestion Rate of Eggs (IRE) (kg/day)	0.036	Ingestion rate of eggs relevant for young children as per enHealth (2012)
Fraction ingested that is homegrown (%)	100%	Assume all eggs consumed in urban area are from backyard chickens
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Days at home (normal conditions), as per NEPM (1999 amended 2013)
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Egg concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.2E-07	4.6E-11	5.4E-10	--		1.7E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	3.3E-07	6.9E-11	8.0E-10	--		1.0E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.6E-07	3.3E-11	3.8E-10	--		2.4E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	5.9E-05	1.2E-08	1.4E-07	--		4.0E-04	16%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.3E-09	1.1E-12	1.3E-11	--		1.5E-08	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.3E-06	2.7E-10	3.2E-09	--		3.2E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.8E-06	3.7E-10	4.3E-09	--		2.4E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.2E-06	2.5E-10	2.9E-09	--		3.3E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	4.8E-07	9.9E-11	1.2E-09	--		1.0E-06	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	5.3E-06	1.1E-09	1.3E-08	--		2.3E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.4E-06	3.0E-10	3.5E-09	--		5.0E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	4.6E-06	9.4E-10	1.1E-08	--		2.3E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	1.4E-04	2.9E-08	3.4E-07	--		1.4E-04	6%
Vanadium (V)		2.0E-03		2.0E-03	100%	2.4E-07	5.0E-11	5.8E-10	--		2.9E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	3.5E-10	4.0E-09	--		4.0E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	8.5E-10	1.7E-13	2.0E-12	--		1.9E-03	78%
								TOTAL			0.00248	

Calculation of Concentrations in Homegrown Beef

Uptake in to beef meat

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_B$$ (mg/kg beef – wet weight)

where:
FI = Fraction of grain/crop ingested by cattle each day (unitless)
IRc = Ingestion rate of grain/crop by cattle each day (kg/day)
C = Concentration of chemical in grain/crop eaten by cattle (mg/kg)
IRs = Ingestion rate of soil by cattle each day (kg/day)
Cs = Concentration in soil the cattle ingest (mg/kg)
B = Bioavailability of soil ingested by cattle (%)
TFE = Transfer factor from ingestion to beef (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of pasture consumed by cattle is grown in the same soil
IRc (ingestion rate of crops)	kg dw/day	9	Assumed ingestion rate from OEHHA 2015 (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	0.45	OEHHA (2015) Table 5.4 (soil ingestion = 5% of pasture ingestion (as dry weight))
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - maximum farm - EPA limit modelling scenario

Chemical	Concentration in crops ingested by cattle mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to beef day/kg	Beef Concentration mg/kg ww	
Cadmium (Cd)	1.0E-05	2.1E-03	2.0E-04	2.1E-07	OEHHA (2015)
Thallium (Tl)	8.8E-06	1.9E-03	4.0E-02	3.7E-05	
Beryllium (Be)	7.9E-07	1.7E-04	3.0E-04	2.5E-08	OEHHA (2015)
Mercury (Hg)	3.3E-05	7.0E-03	4.0E-04	1.4E-06	OEHHA (2015)
Antimony (Sb)	5.6E-06	1.2E-03	1.0E-03	5.9E-07	
Arsenic (As)	8.5E-06	1.8E-03	2.0E-03	1.8E-06	OEHHA (2015)
Lead (Pb)	2.0E-05	4.2E-03	3.0E-04	6.2E-07	OEHHA (2015)
Chromium (Cr VI assumed)	5.9E-05	1.3E-02	5.5E-03	3.4E-05	
Cobalt (Co)	5.6E-06	1.2E-03	2.0E-02	1.2E-05	
Copper (Cu)	6.2E-05	1.3E-02	1.0E-02	6.5E-05	
Manganese (Mn)	1.7E-05	3.6E-03	4.0E-04	7.1E-07	
Nickel (Ni)	1.0E-04	2.2E-02	3.0E-04	3.2E-06	OEHHA (2015)
Selenium (Se)	2.1E-05	4.4E-03	4.0E-02	8.7E-05	OEHHA (2015)
Vanadium (V)	2.8E-06	6.0E-04	2.5E-03	7.4E-07	
Tin (Sn)	2.0E-05	4.2E-03	1.0E-03	2.1E-06	
Dioxins and furans	1.1E-10	7.1E-09	7.0E-01	3.0E-09	OEHHA (2015)

Transfer factors from OEHHA (2015) as noted, and then from RAIS (accessed in 2019)

Exposure to Chemicals via Ingestion of Beef - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_B \times \frac{IR_B \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Beef (IRB) (kg/day)	0.16	Ingestion rate of beef for adults >19 years (enHealth 2012, noted to be the same as P90 from FSANZ 2017)
Fraction ingested that is homegrown (%)	100%	Assume 35% beef intakes from home-sourced meat
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Beef concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.1E-07	2.0E-10	4.8E-10	--		1.5E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	3.7E-05	3.5E-08	8.5E-08	--		1.1E-04	2%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.5E-08	2.4E-11	5.7E-11	--		3.6E-08	
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-06	1.3E-09	3.2E-09	--		8.8E-06	0%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.9E-07	5.6E-10	1.4E-09	--		1.6E-06	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.8E-06	1.7E-09	4.1E-09	--		4.1E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	6.2E-07	5.9E-10	1.4E-09	--		8.1E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.4E-05	3.2E-08	7.8E-08	--		8.7E-05	1%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.2E-05	1.1E-08	2.7E-08	--		2.4E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	6.5E-05	6.2E-08	1.5E-07	--		2.7E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	7.1E-07	6.7E-10	1.6E-09	--		2.3E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.2E-06	3.0E-09	7.3E-09	--		1.5E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	8.7E-05	8.3E-08	2.0E-07	--		8.3E-05	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	7.4E-07	7.0E-10	1.7E-09	--		8.5E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.1E-06	2.0E-09	4.7E-09	--		4.7E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.0E-09	2.8E-12	6.8E-12	--		6.4E-03	95%
								TOTAL			0.00672	

Exposure to Chemicals via Ingestion of Beef - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_B \times \frac{IR_B \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate of Beef (IRB) (kg/day)	0.085	Ingestion rate of beef by children aged 2-6 years (P90 value) FSANZ (2017)
Fraction ingested that is homegrown (%)	100%	Assume 35% beef intakes from home-sourced meat
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Beef concentration (mg/kg wet weight)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)			NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.1E-07	1.0E-10	1.2E-09	--		3.7E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	3.7E-05	1.8E-08	2.1E-07	--		2.6E-04	2%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.5E-08	1.2E-11	1.4E-10	--		8.8E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-06	6.7E-10	7.8E-09	--		2.2E-05	0%
Antimony (Sb)		8.6E-04		8.6E-04	100%	5.9E-07	2.9E-10	3.4E-09	--		3.9E-06	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.8E-06	8.6E-10	1.0E-08	--		1.0E-05	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	6.2E-07	3.0E-10	3.5E-09	--		2.0E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	3.4E-05	1.7E-08	1.9E-07	--		2.2E-04	1%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.2E-05	5.7E-09	6.7E-08	--		6.0E-05	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	6.5E-05	3.2E-08	3.7E-07	--		6.6E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	7.1E-07	3.4E-10	4.0E-09	--		5.7E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.2E-06	1.6E-09	1.8E-08	--		3.8E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	8.7E-05	4.2E-08	4.9E-07	--		2.1E-04	1%
Vanadium (V)		2.0E-03		2.0E-03	100%	7.4E-07	3.6E-10	4.2E-09	--		2.1E-06	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	2.1E-06	1.0E-09	1.2E-08	--		1.2E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.0E-09	1.4E-12	1.7E-11	--		1.6E-02	95%
								TOTAL			0.0167	

Calculation of Concentrations in Dairy Milk

Uptake in to milk (dairy cows)

$$C_E = (FI \times IR_C \times C + IR_S \times C_S \times B) \times TF_B$$ (mg/kg beef – wet weight)

where:
FI = Fraction of grain/crop ingested by cattle each day (unitless)
IRc = Ingestion rate of grain/crop by cattle each day (kg/day)
C = Concentration of chemical in grain/crop eaten by cattle (mg/kg)
IRs = Ingestion rate of soil by cattle each day (kg/day)
Cs = Concentration in soil the cattle ingest (mg/kg)
B = Bioavailability of soil ingested by cattle (%)
TFE = Transfer factor from ingestion to milk (day/kg)

General Parameters	Units	Value	
FI (fraction of crops ingested from property)		1	Assume 100% of pasture consumed by cattle is grown in the same soil
IRc (ingestion rate of crops)	kg (dw)/day	22	Assumed ingestion rate from OEHHA 2015 for lactating cattle (assume concentration the same as predicted for aboveground crops)
IRs (ingestion rate of soil)	kg/day	1.1	OEHHA (2015) Table 5.4 (soil ingestion = 5% of pasture ingestion (as dry weight))
B (bioavailability)	%	100%	

Chemical-specific Inputs and calculations - maximum farm - EPA limit modelling scenario

Chemical	Concentration in crops ingested by cattle mg/kg ww	Soil Concentration - Agriculture (Cs) mg/kg	Transfer factor to milk day/kg	Milk Concentration mg/kg ww	
Cadmium (Cd)	1.0E-05	2.1E-03	5.0E-06	1.3E-08	OEHHA (2015)
Thallium (Tl)	8.8E-06	1.9E-03	2.0E-03	4.5E-06	
Beryllium (Be)	7.9E-07	1.7E-04	9.0E-07	1.8E-10	OEHHA (2015)
Mercury (Hg)	3.3E-05	7.0E-03	7.0E-05	5.9E-07	OEHHA (2015)
Antimony (Sb)	5.6E-06	1.2E-03	1.0E-04	1.4E-07	
Arsenic (As)	8.5E-06	1.8E-03	5.0E-05	1.1E-07	OEHHA (2015)
Lead (Pb)	2.0E-05	4.2E-03	6.0E-05	3.0E-07	OEHHA (2015)
Chromium (Cr VI assumed)	5.9E-05	1.3E-02	9.0E-06	1.4E-07	OEHHA (2015)
Cobalt (Co)	5.6E-06	1.2E-03	2.0E-03	2.9E-06	
Copper (Cu)	6.2E-05	1.3E-02	1.5E-03	2.4E-05	
Manganese (Mn)	1.7E-05	3.6E-03	3.5E-04	1.5E-06	
Nickel (Ni)	1.0E-04	2.2E-02	3.0E-05	7.8E-07	OEHHA (2015)
Selenium (Se)	2.1E-05	4.4E-03	9.0E-03	4.8E-05	OEHHA (2015)
Vanadium (V)	2.8E-06	6.0E-04	2.0E-05	1.4E-08	
Tin (Sn)	2.0E-05	4.2E-03	1.0E-03	5.0E-06	
Dioxins and furans	1.1E-10	7.1E-09	2.0E-02	2.1E-10	OEHHA (2015)

Transfer factors from OEHHA (2015) as noted, and then from RAIS (accessed in 2019)

Exposure to Chemicals via Ingestion of Milk - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_M \times \frac{IR_M \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate of Milk (IRM) (kg/day)	1.295	Ingestion rate of cows milk for adults (P90 value from FSANZ 2017)
Fraction ingested that is homegrown (%)	100%	Assume all milk consumed is from the dairy farm
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	29	Time at one residence as adult as per enHealth 2002 and NEPM 1999
Body Weight (BW, kg)	70	For male and females combined (enHealth 2012)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10585	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Milk concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.3E-08	9.8E-11	2.4E-10	--		7.4E-07	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	4.5E-06	3.5E-08	8.4E-08	--		1.0E-04	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.8E-10	1.4E-12	3.4E-12	--		2.1E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	5.9E-07	4.5E-09	1.1E-08	--		3.0E-05	1%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.4E-07	1.1E-09	2.7E-09	--		3.1E-06	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.1E-07	8.3E-10	2.0E-09	--		2.0E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.0E-07	2.3E-09	5.6E-09	--		3.2E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.4E-07	1.0E-09	2.5E-09	--		2.8E-06	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	2.9E-06	2.2E-08	5.4E-08	--		4.8E-05	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.4E-05	1.8E-07	4.4E-07	--		7.9E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.5E-06	1.2E-08	2.8E-08	--		4.0E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.8E-07	6.0E-09	1.4E-08	--		3.0E-06	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	4.8E-05	3.7E-07	8.9E-07	--		3.7E-04	9%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.4E-08	1.1E-10	2.7E-10	--		1.3E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.0E-06	3.9E-08	9.3E-08	--		9.3E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.1E-10	1.6E-12	3.8E-12	--		3.6E-03	86%
								TOTAL			0.00419	

Exposure to Chemicals via Ingestion of Milk - maximum farm - EPA limit modelling scenario

$$\text{Daily chemical intake} = C_M \times \frac{IR_M \times FI \times ME \times EF \times ED}{BW \times AT} \quad \text{(mg/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate of Milk (IRM) (kg/day)	1.097	Ingestion rate of cows milk for children aged 2-6 years (P90 value from FSANZ 2017)
Fraction ingested that is homegrown (%)	100%	Assume all milk consumed is from the dairy farm
Matrix effect (unitless)	1	Assume chemicals ingested in produce is 100% bioavailable
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	USEPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Milk concentration	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/kg wet weight)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.3E-08	8.0E-11	9.3E-10	--		2.9E-06	0%
Thallium (Tl)		8.0E-04		8.0E-04	100%	4.5E-06	2.8E-08	3.3E-07	--		4.1E-04	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	1.8E-10	1.1E-12	1.3E-11	--		8.3E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	5.9E-07	3.7E-09	4.3E-08	--		1.2E-04	1%
Antimony (Sb)		8.6E-04		8.6E-04	100%	1.4E-07	9.1E-10	1.1E-08	--		1.2E-05	0%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.1E-07	6.8E-10	7.9E-09	--		7.9E-06	0%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.0E-07	1.9E-09	2.2E-08	--		1.3E-05	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.4E-07	8.6E-10	1.0E-08	--		1.1E-05	0%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	2.9E-06	1.8E-08	2.1E-07	--		1.9E-04	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.4E-05	1.5E-07	1.7E-06	--		3.1E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.5E-06	9.5E-09	1.1E-07	--		1.6E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.8E-07	4.9E-09	5.7E-08	--		1.2E-05	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	4.8E-05	3.0E-07	3.5E-06	--		1.5E-03	9%
Vanadium (V)		2.0E-03		2.0E-03	100%	1.4E-08	9.1E-11	1.1E-09	--		5.3E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	5.0E-06	3.2E-08	3.7E-07	--		3.7E-06	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	2.1E-10	1.3E-12	1.5E-11	--		1.4E-02	86%
								TOTAL			0.0166	

Rainwater Tanks

Scenario 1 – Residential

Calculation of Concentrations in Rainwater tank

$$CW = DM/(VR*Kd*\rho) \quad \text{(mg/L)}$$

where:

DM =	Mass of dust deposited on roof each year (mg) = DR x Area
DR =	Deposition rate from model (mg/m2/year)
Area =	Area of roof (m2)
VR =	Volume of water collected from roof over year (L) = R x Area x Rc/1000
R =	Rainfall each year (mm)
ρ =	Soil bulk-density (g/m^3)
Rc =	Runoff coefficient (unitless)
Kd =	Soil-water partition coefficient (cm3/g)
1000 =	Conversion from mm to m

General Parameters			
Average rainfaill	mm/year	874	mean for all years (1887 - 2020) for Prospect Reservoir (067019)
Roof area	m2	200	4 bedroom australian home
Runoff coefficient	-	0.7	assumes 30% water loss in capture into tank
Volume of rainwater	m3/year	122.36	calculated
Volume of rainwater	L/year	122360	
Bulk density of deposited dust	g/cm3	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Chemical-specific Inputs and calculations - maximum residential scenario 1

\ Chemical	PM10 Deposition Rate (DR) mg/m^2/year	Mass deposited each year (DM) mg	Kd (cm3/g)	Particulate Concentration in water mg/L	Dissolved Concentration in water mg/L
Cadmium (Cd)	3.78E-04	0.0756	75.0	6.2E-07	1.6E-08
Thallium (Tl)	3.35E-04	0.067	29	5.5E-07	3.8E-08
Beryllium (Be)	1.20E-03	0.240	790	2.0E-06	5.0E-09
Mercury (Hg)	7.13E-03	1.427	790	1.2E-05	3.0E-08
Antimony (Sb)	2.85E-03	0.571	45	4.7E-06	2.1E-07
Arsenic (As)	4.28E-03	0.856	29	7.0E-06	4.8E-07
Lead (Pb)	9.99E-03	1.997	900	1.6E-05	3.6E-08
Chromium (Cr VI assumed)	3.00E-02	5.992	19	4.9E-05	5.2E-06
Cobalt (Co)	2.85E-03	0.571	45	4.7E-06	2.1E-07
Copper (Cu)	3.14E-02	6.277	35	5.1E-05	2.9E-06
Manganese (Mn)	8.56E-03	1.712	65	1.4E-05	4.3E-07
Nickel (Ni)	5.14E-02	10.271	65	8.4E-05	2.6E-06
Selenium (Se)	3.15E-02	6.303	5	5.2E-05	2.1E-05
Vanadium (V)	1.43E-03	0.285	1000	2.3E-06	4.7E-09
Tin (Sn)	2.98E-02	5.962	250	4.9E-05	3.9E-07
Dioxins and furans	8.56E-08	0.0000171	38900	1.4E-10	7.2E-15

Kd sourced from RAIS except for dioxins
sourced from USEPA HHRAP Database for dioxins (https://archive.epa.gov/epawaste/hazard/tsd/td/web/html/risk.html)

Exposure to Chemicals via Incidental Ingestion of Water - Maximum Residential Scenario 1

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (Irw, L/day)	2	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Concentration in Water (Cw) (mg/L)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.6E-08	2.0E-10	4.7E-10	--		1.5E-06	0%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	3.8E-08	4.6E-10	1.1E-09	--		1.3E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.0E-09	6.1E-11	1.4E-10	--		8.9E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.0E-08	3.6E-10	8.4E-10	--		2.3E-06	1%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	2.1E-07	2.5E-09	5.9E-09	--		6.9E-06	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	4.8E-07	5.9E-09	1.4E-08	--		1.4E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.6E-08	4.4E-10	1.0E-09	--		5.9E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	5.2E-06	6.3E-08	1.5E-07	--		1.6E-04	36%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	2.1E-07	2.5E-09	5.9E-09	--		5.3E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.9E-06	3.6E-08	8.4E-08	--		1.5E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.3E-07	5.3E-09	1.2E-08	--		1.8E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.6E-06	3.2E-08	7.4E-08	--		1.5E-05	3%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	2.5E-07	5.9E-07	--		2.5E-04	54%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	4.7E-09	5.7E-11	1.3E-10	--		6.7E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.9E-07	4.8E-09	1.1E-08	--		1.1E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	7.2E-15	8.8E-17	2.1E-16	--		1.9E-07	0%
TOTAL											**0.000458**	

Dermal Exposure to Chemicals via Contact with Water - Maximum Residential Scenario 1

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Adults		
Surface Area (Saw, cm2)	20000	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	0.58	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Toxicity Data: Dermal Permeability (Kp) (cm/hr)	Concentration in Water (Cw) (mg/L)	DAevent (mg/cm2 per event)	Daily Intake: Non-Threshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	1.6E-08	9.56E-15	1.2E-12	2.7E-12	--		8.5E-09	0%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	3.8E-08	2.19E-14	2.7E-12	6.3E-12	--		7.8E-09	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	5.0E-09	2.88E-15	3.5E-13	8.2E-13	--		5.1E-10	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	3.0E-08	1.71E-14	2.1E-12	4.9E-12	--		1.4E-08	0%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	2.1E-07	1.20E-13	1.5E-11	3.4E-11	--		4.0E-08	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	4.8E-07	2.80E-13	3.4E-11	8.0E-11	--		8.0E-08	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	3.6E-08	2.10E-15	2.6E-13	6.0E-13	--		3.4E-10	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	5.2E-06	5.98E-12	7.3E-10	1.7E-09	--		1.9E-06	43%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	2.1E-07	4.81E-14	5.9E-12	1.4E-11	--		1.2E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	2.9E-06	1.70E-12	2.1E-10	4.9E-10	--		8.7E-09	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	4.3E-07	2.50E-13	3.1E-11	7.1E-11	--		1.0E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	2.6E-06	3.00E-13	3.7E-11	8.6E-11	--		1.8E-08	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	2.1E-05	1.19E-11	1.5E-09	3.4E-09	--		1.4E-06	32%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	4.7E-09	2.70E-15	3.3E-13	7.7E-13	--		3.9E-10	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	3.9E-07	2.26E-13	2.8E-11	6.5E-11	--		6.5E-10	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	7.2E-15	3.34E-18	4.1E-16	9.5E-16	--		9.0E-07	20%
												0.00000441	

Exposure to Chemicals via Incidental Ingestion of Water - Maximum Residential Scenario 1

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate (Irw, L/day)	0.4	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/L)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	1.6E-08	3.8E-11	4.4E-10	--		1.4E-06	0%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	3.8E-08	8.6E-11	1.0E-09	--		1.3E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.0E-09	1.1E-11	1.3E-10	--		8.3E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	3.0E-08	6.7E-11	7.9E-10	--		2.2E-06	1%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	2.1E-07	4.7E-10	5.5E-09	--		6.4E-06	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	4.8E-07	1.1E-09	1.3E-08	--		1.3E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	3.6E-08	8.3E-11	9.7E-10	--		5.5E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	50%	5.2E-06	1.2E-08	1.4E-07	--		1.5E-04	36%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	2.1E-07	4.7E-10	5.5E-09	--		4.9E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	2.9E-06	6.7E-09	7.8E-08	--		1.4E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	4.3E-07	9.8E-10	1.1E-08	--		1.6E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	2.6E-06	5.9E-09	6.9E-08	--		1.4E-05	3%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	4.7E-08	5.5E-07	--		2.3E-04	54%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	4.7E-09	1.1E-11	1.2E-10	--		6.2E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.9E-07	8.9E-10	1.0E-08	--		1.0E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	7.2E-15	1.6E-17	1.9E-16	--		1.8E-07	0%

TOTAL		0.000428

Dermal Exposure to Chemicals via Contact with Water - Maximum Residential Scenario 1

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Children		
Surface Area (Saw, cm2)	6100	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	1	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Toxicity Data: Dermal Permeability (Kp) (cm/hr)	Concentration in Water (Cw) (mg/L)	DAevent (mg/cm2 per event)	Daily Intake: Non-Threshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	1.6E-08	1.65E-14	5.7E-13	6.7E-12	--		2.1E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	3.8E-08	3.78E-14	1.3E-12	1.5E-11	--		1.9E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	5.0E-09	4.96E-15	1.7E-13	2.0E-12	--		1.3E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	3.0E-08	2.95E-14	1.0E-12	1.2E-11	--		3.3E-08	0%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	2.1E-07	2.07E-13	7.2E-12	8.4E-11	--		9.8E-08	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	4.8E-07	4.82E-13	1.7E-11	2.0E-10	--		2.0E-07	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	3.6E-08	3.63E-15	1.3E-13	1.5E-12	--		8.4E-10	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	5.2E-06	1.03E-11	3.6E-10	4.2E-09	--		4.7E-06	43%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	2.1E-07	8.29E-14	2.9E-12	3.4E-11	--		3.0E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	2.9E-06	2.93E-12	1.0E-10	1.2E-09	--		2.1E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	4.3E-07	4.30E-13	1.5E-11	1.8E-10	--		2.5E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	2.6E-06	5.17E-13	1.8E-11	2.1E-10	--		4.4E-08	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	2.1E-05	2.06E-11	7.2E-10	8.4E-09	--		3.5E-06	32%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	4.7E-09	4.66E-15	1.6E-13	1.9E-12	--		9.5E-10	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	3.9E-07	3.90E-13	1.4E-11	1.6E-10	--		1.6E-09	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	7.2E-15	5.75E-18	2.0E-16	2.3E-15	--		2.2E-06	20%
												0.0000108	

EPA Limit modelling scenario – Residential

Calculation of Concentrations in Rainwater tank

$$CW = DM/(VR*Kd*\rho) \quad \text{(mg/L)}$$

where:

DM =	Mass of dust deposited on roof each year (mg) = DR x Area
DR =	Deposition rate from model (mg/m2/year)
Area =	Area of roof (m2)
VR =	Volume of water collected from roof over year (L) = R x Area x Rc/1000
R =	Rainfall each year (mm)
ρ =	Soil bulk-density (g/m^3)
Rc =	Runoff coefficient (unitless)
Kd =	Soil-water partition coefficient (cm3/g)
1000 =	Conversion from mm to m

General Parameters

Average rainfaill	mm/year	874	mean for all years (1887 - 2020) for Prospect Reservoir (067019)
Roof area	m2	200	4 bedroom australian home
Runoff coefficient	-	0.7	assumes 30% water loss in capture into tank
Volume of rainwater	m3/year	122.36	calculated
Volume of rainwater	L/year	122360	
Bulk density of deposited dust	g/cm3	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Chemical-specific Inputs and calculations - maximum residential - EPA limit modelling scenario

Chemical	PM10 Deposition Rate (DR) mg/m^2/year	PM10 Mass deposited each year (DM) mg	Kd (cm3/g)	Particulate Concentration in water mg/L	Dissolved Concentration in water mg/L
Cadmium (Cd)	1.51E-02	3.0	75.0	2.5E-05	6.6E-07
Thallium (Tl)	1.34E-02	2.7	29	2.2E-05	1.5E-06
Beryllium (Be)	1.20E-03	0.2	790	2.0E-06	5.0E-09
Mercury (Hg)	4.99E-02	10.0	790	8.2E-05	2.1E-07
Antimony (Sb)	8.56E-03	1.7	45	1.4E-05	6.2E-07
Arsenic (As)	1.28E-02	2.6	29	2.1E-05	1.4E-06
Lead (Pb)	3.00E-02	6.0	900	4.9E-05	1.1E-07
Chromium (Cr VI assumed)	8.99E-02	18.0	19	1.5E-04	1.5E-05
Cobalt (Co)	8.56E-03	1.7	45	1.4E-05	6.2E-07
Copper (Cu)	9.42E-02	18.8	35	1.5E-04	8.8E-06
Manganese (Mn)	2.57E-02	5.1	65	4.2E-05	1.3E-06
Nickel (Ni)	1.54E-01	30.8	65	2.5E-04	7.7E-06
Selenium (Se)	3.15E-02	6.3	5	5.2E-05	2.1E-05
Vanadium (V)	4.28E-03	0.9	1000	7.0E-06	1.4E-08
Tin (Sn)	2.98E-02	6.0	250	4.9E-05	3.9E-07
Dioxins and furans	1.71E-07	0.0	38900	2.8E-10	1.4E-14

Exposure to Chemicals via Incidental Ingestion of Water - maximum residential - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (Irw, L/day)	2	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/L)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	6.6E-07	8.1E-09	1.9E-08	--		5.9E-05	6%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	1.5E-06	1.9E-08	4.3E-08	--		5.4E-05	5%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.0E-09	6.1E-11	1.4E-10	--		8.9E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.1E-07	2.5E-09	5.9E-09	--		1.6E-05	2%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	6.2E-07	7.6E-09	1.8E-08	--		2.1E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.4E-06	1.8E-08	4.1E-08	--		4.1E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.1E-07	1.3E-09	3.1E-09	--		1.8E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	1.5E-05	1.9E-07	4.4E-07	--		4.9E-04	49%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	6.2E-07	7.6E-09	1.8E-08	--		1.6E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	8.8E-06	1.1E-07	2.5E-07	--		4.5E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.3E-06	1.6E-08	3.7E-08	--		5.3E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.7E-06	9.5E-08	2.2E-07	--		4.6E-05	5%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	2.5E-07	5.9E-07	--		2.5E-04	25%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	1.4E-08	1.7E-10	4.0E-10	--		2.0E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.9E-07	4.8E-09	1.1E-08	--		1.1E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.4E-14	1.8E-16	4.1E-16	--		3.9E-07	0%
TOTAL											0.00100	

Dermal Exposure to Chemicals via Contact with Water - maximum residential - EPA limit modelling scenario

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Adults		
Surface Area (Saw, cm2)	20000	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	0.58	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (Kp) (cm/hr)	(mg/L)	(mg/cm2 per event)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	6.6E-07	3.82E-13	4.7E-11	1.1E-10	--		3.4E-07	3%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	1.5E-06	8.77E-13	1.1E-10	2.5E-10	--		3.1E-07	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	5.0E-09	2.88E-15	3.5E-13	8.2E-13	--		5.1E-10	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	2.1E-07	1.20E-13	1.5E-11	3.4E-11	--		9.5E-08	1%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	6.2E-07	3.61E-13	4.4E-11	1.0E-10	--		1.2E-07	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	1.4E-06	8.39E-13	1.0E-10	2.4E-10	--		2.4E-07	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	1.1E-07	6.31E-15	7.7E-13	1.8E-12	--		1.0E-09	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	1.5E-05	1.79E-11	2.2E-09	5.1E-09	--		5.7E-06	56%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	6.2E-07	1.44E-13	1.8E-11	4.1E-11	--		3.7E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	8.8E-06	5.10E-12	6.2E-10	1.5E-09	--		2.6E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	1.3E-06	7.49E-13	9.2E-11	2.1E-10	--		3.1E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	7.7E-06	8.99E-13	1.1E-10	2.6E-10	--		5.4E-08	1%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	2.1E-05	1.19E-11	1.5E-09	3.4E-09	--		1.4E-06	14%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	1.4E-08	8.11E-15	9.9E-13	2.3E-12	--		1.2E-09	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	3.9E-07	2.26E-13	2.8E-11	6.5E-11	--		6.5E-10	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	1.4E-14	6.68E-18	8.2E-16	1.9E-15	--		1.8E-06	18%
												0.0000102	

Exposure to Chemicals via Incidental Ingestion of Water - maximum residential - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate (Irw, L/day)	0.4	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	6.6E-07	1.5E-09	1.8E-08	--		5.5E-05	6%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	1.5E-06	3.5E-09	4.0E-08	--		5.0E-05	5%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	5.0E-09	1.1E-11	1.3E-10	--		8.3E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	2.1E-07	4.7E-10	5.5E-09	--		1.5E-05	2%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	6.2E-07	1.4E-09	1.7E-08	--		1.9E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	1.4E-06	3.3E-09	3.9E-08	--		3.9E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.1E-07	2.5E-10	2.9E-09	--		1.7E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	50%	1.5E-05	3.5E-08	4.1E-07	--		4.6E-04	49%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	6.2E-07	1.4E-09	1.7E-08	--		1.5E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	8.8E-06	2.0E-08	2.3E-07	--		4.2E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.3E-06	3.0E-09	3.4E-08	--		4.9E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	7.7E-06	1.8E-08	2.1E-07	--		4.3E-05	5%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	2.1E-05	4.7E-08	5.5E-07	--		2.3E-04	25%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	1.4E-08	3.2E-11	3.7E-10	--		1.9E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	3.9E-07	8.9E-10	1.0E-08	--		1.0E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	1.4E-14	3.3E-17	3.8E-16	--		3.6E-07	0%
								TOTAL			0.00093	

Dermal Exposure to Chemicals via Contact with Water - maximum residential - EPA limit modelling scenario

$$DA_{event} = K_p \times C_w \times t_{event}$$ **mg/cm2 per event (for inorganics)**

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$ **mg/kg bw/day**

Parameters Relevant to Quantification of Exposure to Children		
Surface Area (Saw, cm2)	6100	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	1	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (Kp) (cm/hr)	(mg/L)	(mg/cm2 per event)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	6.6E-07	6.59E-13	2.3E-11	2.7E-10	--		8.4E-07	3%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	1.5E-06	1.51E-12	5.3E-11	6.1E-10	--		7.7E-07	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	5.0E-09	4.96E-15	1.7E-13	2.0E-12	--		1.3E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	2.1E-07	2.07E-13	7.2E-12	8.4E-11	--		2.3E-07	1%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	6.2E-07	6.22E-13	2.2E-11	2.5E-10	--		2.9E-07	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	1.4E-06	1.45E-12	5.0E-11	5.9E-10	--		5.9E-07	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	1.1E-07	1.09E-14	3.8E-13	4.4E-12	--		2.5E-09	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	1.5E-05	3.09E-11	1.1E-09	1.3E-08	--		1.4E-05	56%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	6.2E-07	2.49E-13	8.7E-12	1.0E-10	--		9.0E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	8.8E-06	8.79E-12	3.1E-10	3.6E-09	--		6.4E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	1.3E-06	1.29E-12	4.5E-11	5.3E-10	--		7.5E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	7.7E-06	1.55E-12	5.4E-11	6.3E-10	--		1.3E-07	1%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	2.1E-05	2.06E-11	7.2E-10	8.4E-09	--		3.5E-06	14%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	1.4E-08	1.40E-14	4.9E-13	5.7E-12	--		2.8E-09	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	3.9E-07	3.90E-13	1.4E-11	1.6E-10	--		1.6E-09	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	1.4E-14	1.15E-17	4.0E-16	4.7E-15	--		4.4E-06	18%
												0.0000249	

Scenario 1 – Commercial/Industrial

Calculation of Concentrations in Rainwater tank

CW = DM/(VR*Kd*ρ) **(mg/L)**

where:

DM =	Mass of dust deposited on roof each year (mg) = DR x Area
DR =	Deposition rate from model (mg/m2/year)
Area =	Area of roof (m2)
VR =	Volume of water collected from roof over year (L) = R x Area x Rc/1000
R =	Rainfall each year (mm)
ρ =	Soil bulk-density (g/m^3)
Rc =	Runoff coefficient (unitless)
Kd =	Soil-water partition coefficient (cm3/g)
1000 =	Conversion from mm to m

General Parameters			
Average rainfaill	mm/year	874	mean for all years (1887 - 2020) for Prospect Reservoir (067019)
Roof area	m2	200	4 bedroom australian home
Runoff coefficient	-	0.7	assumes 30% water loss in capture into tank
Volume of rainwater	m3/year	122.36	calculated
Volume of rainwater	L/year	122360	
Bulk density of deposited dust	g/cm3	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Chemical-specific Inputs and calculations - maximum commercial scenario 1

Chemical	PM10 Deposition Rate (DR) mg/m^2/year	Mass deposited each year (DM) mg	Kd (cm3/g)	Particulate Concentration in water mg/L	Dissolved Concentration in water mg/L
Cadmium (Cd)	1.64E-03	0.3	75.0	2.7E-06	7.1E-08
Thallium (Tl)	1.45E-03	0.3	29	2.4E-06	1.6E-07
Beryllium (Be)	5.19E-03	1.0	790	8.5E-06	2.1E-08
Mercury (Hg)	3.09E-02	6.2	790	5.1E-05	1.3E-07
Antimony (Sb)	1.24E-02	2.5	45	2.0E-05	9.0E-07
Arsenic (As)	1.85E-02	3.7	29	3.0E-05	2.1E-06
Lead (Pb)	4.33E-02	8.7	900	7.1E-05	1.6E-07
Chromium (Cr VI assumed)	1.30E-01	26.0	19	2.1E-04	2.2E-05
Cobalt (Co)	1.24E-02	2.5	45	2.0E-05	9.0E-07
Copper (Cu)	1.36E-01	27.2	35	2.2E-04	1.3E-05
Manganese (Mn)	3.71E-02	7.4	65	6.1E-05	1.9E-06
Nickel (Ni)	2.22E-01	44.5	65	3.6E-04	1.1E-05
Selenium (Se)	1.37E-01	27.3	5	2.2E-04	8.9E-05
Vanadium (V)	6.18E-03	1.2	1000	1.0E-05	2.0E-08
Tin (Sn)	1.29E-01	25.8	250	2.1E-04	1.7E-06
Dioxins and furans	3.71E-07	0.0	38900	6.1E-10	3.1E-14

Exposure to Chemicals via Incidental Ingestion of Water - maximum commercial scenario 1

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (Irw, L/day)	2	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Year 1

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/L)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.1E-08	8.7E-10	2.0E-09	--		6.4E-06	0%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	1.6E-07	2.0E-09	4.7E-09	--		5.8E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.1E-08	2.6E-10	6.1E-10	--		3.8E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.3E-07	1.6E-09	3.7E-09	--		1.0E-05	1%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	9.0E-07	1.1E-08	2.6E-08	--		3.0E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.1E-06	2.6E-08	6.0E-08	--		6.0E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.6E-07	1.9E-09	4.5E-09	--		2.6E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.2E-05	2.7E-07	6.4E-07	--		7.1E-04	36%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	9.0E-07	1.1E-08	2.6E-08	--		2.3E-05	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.3E-05	1.6E-07	3.6E-07	--		6.5E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.9E-06	2.3E-08	5.3E-08	--		7.6E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.1E-05	1.4E-07	3.2E-07	--		6.7E-05	3%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	8.9E-05	1.1E-06	2.6E-06	--		1.1E-03	54%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	2.0E-08	2.5E-10	5.8E-10	--		2.9E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	2.1E-08	4.8E-08	--		4.8E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.1E-14	3.8E-16	8.9E-16	--		8.4E-07	0%
								TOTAL			0.00198	

Dermal Exposure to Chemicals via Contact with Water - maximum commercial scenario 1

$$DA_{event} = K_p \times C_w \times t_{event}$$ **mg/cm2 per event (for inorganics)**

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$ **mg/kg bw/day**

Parameters Relevant to Quantification of Exposure to Adults		
Surface Area (Saw, cm2)	20000	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	0.58	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Permeability (Kp)			Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/cm2 per event)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	7.1E-08	4.14E-14	5.1E-12	1.2E-11	--		3.7E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	1.6E-07	9.50E-14	1.2E-11	2.7E-11	--		3.4E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.1E-08	1.25E-14	1.5E-12	3.6E-12	--		2.2E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	1.3E-07	7.42E-14	9.1E-12	2.1E-11	--		5.9E-08	0%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	9.0E-07	5.21E-13	6.4E-11	1.5E-10	--		1.7E-07	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	2.1E-06	1.21E-12	1.5E-10	3.5E-10	--		3.5E-07	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	1.6E-07	9.11E-15	1.1E-12	2.6E-12	--		1.5E-09	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	2.2E-05	2.59E-11	3.2E-09	7.4E-09	--		8.2E-06	43%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	9.0E-07	2.08E-13	2.6E-11	6.0E-11	--		5.3E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	1.3E-05	7.37E-12	9.0E-10	2.1E-09	--		3.8E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	1.9E-06	1.08E-12	1.3E-10	3.1E-10	--		4.4E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	1.1E-05	1.30E-12	1.6E-10	3.7E-10	--		7.7E-08	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	8.9E-05	5.18E-11	6.3E-09	1.5E-08	--		6.2E-06	32%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	2.0E-08	1.17E-14	1.4E-12	3.3E-12	--		1.7E-09	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.7E-06	9.79E-13	1.2E-10	2.8E-10	--		2.8E-09	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	3.1E-14	1.45E-17	1.8E-15	4.1E-15	--		3.9E-06	20%
												0.0000191	

Exposure to Chemicals via Incidental Ingestion of Water - maximum commercial scenario 1

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate (Irw, L/day)	0.4	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.1E-08	1.6E-10	1.9E-09	--		5.9E-06	0%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	1.6E-07	3.7E-10	4.4E-09	--		5.5E-06	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.1E-08	4.9E-11	5.7E-10	--		3.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.3E-07	2.9E-10	3.4E-09	--		9.5E-06	1%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	9.0E-07	2.1E-09	2.4E-08	--		2.8E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.1E-06	4.8E-09	5.6E-08	--		5.6E-05	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.6E-07	3.6E-10	4.2E-09	--		2.4E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	50%	2.2E-05	5.1E-08	6.0E-07	--		6.6E-04	36%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	9.0E-07	2.1E-09	2.4E-08	--		2.1E-05	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.3E-05	2.9E-08	3.4E-07	--		6.0E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	1.9E-06	4.3E-09	5.0E-08	--		7.1E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.1E-05	2.6E-08	3.0E-07	--		6.2E-05	3%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	8.9E-05	2.0E-07	2.4E-06	--		9.9E-04	54%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	2.0E-08	4.6E-11	5.4E-10	--		2.7E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	3.9E-09	4.5E-08	--		4.5E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.1E-14	7.1E-17	8.3E-16	--		7.9E-07	0%

TOTAL		**0.00185**

Dermal Exposure to Chemicals via Contact with Water - maximum commercial scenario 1

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Children		
Surface Area (Saw, cm2)	6100	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	1	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Year 1

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (Kp) (cm/hr)	(mg/L)	(mg/cm2 per event)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	7.1E-08	7.14E-14	2.5E-12	2.9E-11	--		9.1E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	1.6E-07	1.64E-13	5.7E-12	6.7E-11	--		8.3E-08	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.1E-08	2.15E-14	7.5E-13	8.7E-12	--		5.5E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	1.3E-07	1.28E-13	4.5E-12	5.2E-11	--		1.4E-07	0%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	9.0E-07	8.98E-13	3.1E-11	3.7E-10	--		4.2E-07	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	2.1E-06	2.09E-12	7.3E-11	8.5E-10	--		8.5E-07	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	1.6E-07	1.57E-14	5.5E-13	6.4E-12	--		3.7E-09	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	2.2E-05	4.47E-11	1.6E-09	1.8E-08	--		2.0E-05	43%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	9.0E-07	3.59E-13	1.3E-11	1.5E-10	--		1.3E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	1.3E-05	1.27E-11	4.4E-10	5.2E-09	--		9.2E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	1.9E-06	1.86E-12	6.5E-11	7.6E-10	--		1.1E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	1.1E-05	2.24E-12	7.8E-11	9.1E-10	--		1.9E-07	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	8.9E-05	8.93E-11	3.1E-09	3.6E-08	--		1.5E-05	32%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	2.0E-08	2.02E-14	7.0E-13	8.2E-12	--		4.1E-09	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.7E-06	1.69E-12	5.9E-11	6.9E-10	--		6.9E-09	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	3.1E-14	2.49E-17	8.7E-16	1.0E-14	--		9.6E-06	20%
												0.0000469	

EPA Limit modelling scenario – Commercial/Industrial

Calculation of Concentrations in Rainwater tank

CW = DM/(VR*Kd*ρ) **(mg/L)**

where:

DM =	Mass of dust deposited on roof each year (mg) = DR x Area
DR =	Deposition rate from model (mg/m2/year)
Area =	Area of roof (m2)
VR =	Volume of water collected from roof over year (L) = R x Area x Rc/1000
R =	Rainfall each year (mm)
ρ =	Soil bulk-density (g/m^3)
Rc =	Runoff coefficient (unitless)
Kd =	Soil-water partition coefficient (cm3/g)
1000 =	Conversion from mm to m

General Parameters			
Average rainfaill	mm/year	874	mean for all years (1887 - 2020) for Prospect Reservoir (067019)
Roof area	m2	200	4 bedroom australian home
Runoff coefficient	-	0.7	assumes 30% water loss in capture into tank
Volume of rainwater	m3/year	122.36	calculated
Volume of rainwater	L/year	122360	
Bulk density of deposited dust	g/cm3	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Chemical-specific Inputs and calculations - Grid Commercial - EPA limit modelling scenario

Chemical	PM10 Deposition Rate (DR) mg/m^2/year	PM10 Mass deposited each year (DM) mg	Kd (cm3/g)	Particulate Concentration in water mg/L	Dissolved Concentration in water mg/L
Cadmium (Cd)	6.55E-02	13.1	75.0	1.1E-04	2.9E-06
Thallium (Tl)	5.81E-02	11.6	29	9.5E-05	6.5E-06
Beryllium (Be)	5.19E-03	1.0	790	8.5E-06	2.1E-08
Mercury (Hg)	2.16E-01	43.3	790	3.5E-04	9.0E-07
Antimony (Sb)	3.71E-02	7.4	45	6.1E-05	2.7E-06
Arsenic (As)	5.56E-02	11.1	29	9.1E-05	6.3E-06
Lead (Pb)	1.30E-01	26.0	900	2.1E-04	4.7E-07
Chromium (Cr VI assumed)	3.89E-01	77.9	19	6.4E-04	6.7E-05
Cobalt (Co)	3.71E-02	7.4	45	6.1E-05	2.7E-06
Copper (Cu)	4.08E-01	81.6	35	6.7E-04	3.8E-05
Manganese (Mn)	1.11E-01	22.2	65	1.8E-04	5.6E-06
Nickel (Ni)	6.67E-01	133.5	65	1.1E-03	3.4E-05
Selenium (Se)	1.37E-01	27.3	5	2.2E-04	8.9E-05
Vanadium (V)	1.85E-02	3.7	1000	3.0E-05	6.1E-08
Tin (Sn)	1.29E-01	25.8	250	2.1E-04	1.7E-06
Dioxins and furans	7.42E-07	0.0	38900	1.2E-09	6.2E-14

Exposure to Chemicals via Incidental Ingestion of Water - maximum commercial - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (Irw, L/day)	2	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/L)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.9E-06	3.5E-08	8.2E-08	--		2.5E-04	6%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	6.5E-06	8.0E-08	1.9E-07	--		2.3E-04	5%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.1E-08	2.6E-10	6.1E-10	--		3.8E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.0E-07	1.1E-08	2.6E-08	--		7.1E-05	2%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	2.7E-06	3.3E-08	7.7E-08	--		8.9E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	6.3E-06	7.7E-08	1.8E-07	--		1.8E-04	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.7E-07	5.8E-09	1.3E-08	--		7.7E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	6.7E-05	8.2E-07	1.9E-06	--		2.1E-03	49%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	2.7E-06	3.3E-08	7.7E-08	--		6.9E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.8E-05	4.7E-07	1.1E-06	--		1.9E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.6E-06	6.9E-08	1.6E-07	--		2.3E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.4E-05	4.1E-07	9.6E-07	--		2.0E-04	5%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	8.9E-05	1.1E-06	2.6E-06	--		1.1E-03	25%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	6.1E-08	7.4E-10	1.7E-09	--		8.7E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	2.1E-08	4.8E-08	--		4.8E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	6.2E-14	7.6E-16	1.8E-15	--		1.7E-06	0%
								TOTAL	0.00E+00		0.00432	

Dermal Exposure to Chemicals via Contact with Water - maximum commercial - EPA limit modelling scenario

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Adults		
Surface Area (Saw, cm2)	20000	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	0.58	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Toxicity Data: Dermal Permeability (Kp) (cm/hr)	Concentration in Water (Cw) (mg/L)	DAevent (mg/cm2 per event)	Daily Intake: Non-Threshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	2.9E-06	1.66E-12	2.0E-10	4.7E-10	--		1.5E-06	3%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	6.5E-06	3.80E-12	4.7E-10	1.1E-09	--		1.4E-06	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.1E-08	1.25E-14	1.5E-12	3.6E-12	--		2.2E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	9.0E-07	5.19E-13	6.4E-11	1.5E-10	--		4.1E-07	1%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	2.7E-06	1.56E-12	1.9E-10	4.5E-10	--		5.2E-07	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	6.3E-06	3.64E-12	4.5E-10	1.0E-09	--		1.0E-06	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	4.7E-07	2.73E-14	3.3E-12	7.8E-12	--		4.5E-09	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	6.7E-05	7.77E-11	9.5E-09	2.2E-08	--		2.5E-05	56%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	2.7E-06	6.25E-13	7.7E-11	1.8E-10	--		1.6E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	3.8E-05	2.21E-11	2.7E-09	6.3E-09	--		1.1E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	5.6E-06	3.25E-12	4.0E-10	9.3E-10	--		1.3E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	3.4E-05	3.89E-12	4.8E-10	1.1E-09	--		2.3E-07	1%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	8.9E-05	5.18E-11	6.3E-09	1.5E-08	--		6.2E-06	14%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	6.1E-08	3.52E-14	4.3E-12	1.0E-11	--		5.0E-09	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.7E-06	9.79E-13	1.2E-10	2.8E-10	--		2.8E-09	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	6.2E-14	2.89E-17	3.5E-15	8.3E-15	--		7.8E-06	18%
												0.0000440	

Exposure to Chemicals via Incidental Ingestion of Water - maximum commercial - EPA limit modelling scenario

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate (Irw, L/day)	0.4	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data: Non-Threshold Slope Factor $(mg/kg-day)^{-1}$	Toxicity Data: Threshold TDI (mg/kg/day)	Toxicity Data: Background Intake (% TDI)	Toxicity Data: TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Bioavailability (%)	Concentration in Water (Cw) (mg/L)	Daily Intake: NonThreshold (mg/kg/day)	Daily Intake: Threshold (mg/kg/day)	Calculated Risk: Non-Threshold Risk (unitless)	Calculated Risk: % Total Risk	Calculated Risk: Chronic Hazard Quotient (unitless)	Calculated Risk: % Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	2.9E-06	6.5E-09	7.6E-08	--		2.4E-04	6%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	6.5E-06	1.5E-08	1.7E-07	--		2.2E-04	5%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.1E-08	4.9E-11	5.7E-10	--		3.6E-07	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	9.0E-07	2.0E-09	2.4E-08	--		6.6E-05	2%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	2.7E-06	6.2E-09	7.2E-08	--		8.4E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	6.3E-06	1.4E-08	1.7E-07	--		1.7E-04	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	4.7E-07	1.1E-09	1.3E-08	--		7.2E-06	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	50%	6.7E-05	1.5E-07	1.8E-06	--		2.0E-03	49%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	2.7E-06	6.2E-09	7.2E-08	--		6.4E-05	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	3.8E-05	8.7E-08	1.0E-06	--		1.8E-05	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	5.6E-06	1.3E-08	1.5E-07	--		2.1E-06	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.4E-05	7.7E-08	9.0E-07	--		1.9E-04	5%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	8.9E-05	2.0E-07	2.4E-06	--		9.9E-04	25%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	6.1E-08	1.4E-10	1.6E-09	--		8.1E-07	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.7E-06	3.9E-09	4.5E-08	--		4.5E-07	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	6.2E-14	1.4E-16	1.7E-15	--		1.6E-06	0%
TOTAL											0.00403	

Dermal Exposure to Chemicals via Contact with Water - maximum commercial - EPA limit modelling scenario

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Children		
Surface Area (Saw, cm2)	6100	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	1	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (Kp) (cm/hr)	(mg/L)	(mg/cm2 per event)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	2.9E-06	2.86E-12	1.0E-10	1.2E-09	--		3.6E-06	3%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	6.5E-06	6.55E-12	2.3E-10	2.7E-09	--		3.3E-06	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.1E-08	2.15E-14	7.5E-13	8.7E-12	--		5.5E-09	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	9.0E-07	8.95E-13	3.1E-11	3.6E-10	--		1.0E-06	1%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	2.7E-06	2.69E-12	9.4E-11	1.1E-09	--		1.3E-06	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	6.3E-06	6.27E-12	2.2E-10	2.5E-09	--		2.5E-06	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	4.7E-07	4.71E-14	1.6E-12	1.9E-11	--		1.1E-08	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	6.7E-05	1.34E-10	4.7E-09	5.4E-08	--		6.1E-05	56%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	2.7E-06	1.08E-12	3.8E-11	4.4E-10	--		3.9E-07	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	3.8E-05	3.81E-11	1.3E-09	1.5E-08	--		2.8E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	5.6E-06	5.59E-12	2.0E-10	2.3E-09	--		3.3E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	3.4E-05	6.71E-12	2.3E-10	2.7E-09	--		5.7E-07	1%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	8.9E-05	8.93E-11	3.1E-09	3.6E-08	--		1.5E-05	14%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	6.1E-08	6.06E-14	2.1E-12	2.5E-11	--		1.2E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.7E-06	1.69E-12	5.9E-11	6.9E-10	--		6.9E-09	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	6.2E-14	4.99E-17	1.7E-15	2.0E-14	--		1.9E-05	18%
												0.000108	

Scenario 1 – Farm

Calculation of Concentrations in Rainwater tank

$$CW = DM/(VR*Kd*\rho) \quad \text{(mg/L)}$$

where:

DM =	Mass of dust deposited on roof each year (mg) = DR x Area
DR =	Deposition rate from model (mg/m2/year)
Area =	Area of roof (m2)
VR =	Volume of water collected from roof over year (L) = R x Area x Rc/1000
R =	Rainfall each year (mm)
ρ =	Soil bulk-density (g/m^3)
Rc =	Runoff coefficient (unitless)
Kd =	Soil-water partition coefficient (cm3/g)
1000 =	Conversion from mm to m

General Parameters			
Average rainfaill	mm/year	874	mean for all years (1887 - 2020) for Prospect Reservoir (067019)
Roof area	m2	200	4 bedroom australian home
Runoff coefficient	-	0.7	assumes 30% water loss in capture into tank
Volume of rainwater	m3/year	122.36	calculated
Volume of rainwater	L/year	122360	
Bulk density of deposited dust	g/cm3	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Chemical-specific Inputs and calculations - maximum farm scenario 1

Chemical	PM10 Deposition Rate (DR) mg/m^2/year	Mass deposited each year (DM) mg	Kd (cm3/g)	Particulate Concentration in water mg/L	Dissolved Concentration in water mg/L
Cadmium (Cd)	1.82E-04	0.0364	75.0	3.0E-07	7.9E-09
Thallium (Tl)	1.61E-04	0.032	29	2.6E-07	1.8E-08
Beryllium (Be)	5.77E-04	0.115	790	9.4E-07	2.4E-09
Mercury (Hg)	3.44E-03	0.687	790	5.6E-06	1.4E-08
Antimony (Sb)	1.37E-03	0.275	45	2.2E-06	1.0E-07
Arsenic (As)	2.06E-03	0.412	29	3.4E-06	2.3E-07
Lead (Pb)	4.81E-03	0.962	900	7.9E-06	1.7E-08
Chromium (Cr VI assumed)	1.44E-02	2.886	19	2.4E-05	2.5E-06
Cobalt (Co)	1.37E-03	0.275	45	2.2E-06	1.0E-07
Copper (Cu)	1.51E-02	3.024	35	2.5E-05	1.4E-06
Manganese (Mn)	4.12E-03	0.825	65	6.7E-06	2.1E-07
Nickel (Ni)	2.47E-02	4.948	65	4.0E-05	1.2E-06
Selenium (Se)	1.52E-02	3.036	5	2.5E-05	9.9E-06
Vanadium (V)	6.87E-04	0.137	1000	1.1E-06	2.2E-09
Tin (Sn)	1.44E-02	2.872	250	2.3E-05	1.9E-07
Dioxins and furans	4.12E-08	0.0000082	38900	6.7E-11	3.5E-15

Kd sourced from RAIS except for dioxins
sourced from USEPA HHRAP Database for dioxins (https://archive.epa.gov/epawaste/hazard/tsd/td/web/html/risk.html)

Exposure to Chemicals via Incidental Ingestion of Water - Maximum Farm Scenario 1

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (Irw, L/day)	2	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/L)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.9E-09	9.7E-11	2.3E-10	--		7.1E-07	0%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	1.8E-08	2.2E-10	5.2E-10	--		6.5E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.4E-09	2.9E-11	6.8E-11	--		4.3E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-08	1.7E-10	4.1E-10	--		1.1E-06	1%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	1.0E-07	1.2E-09	2.9E-09	--		3.3E-06	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.3E-07	2.8E-09	6.6E-09	--		6.6E-06	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.7E-08	2.1E-10	5.0E-10	--		2.9E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	2.5E-06	3.0E-08	7.1E-08	--		7.9E-05	36%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.0E-07	1.2E-09	2.9E-09	--		2.5E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.4E-06	1.7E-08	4.0E-08	--		7.2E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.1E-07	2.5E-09	5.9E-09	--		8.5E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.2E-06	1.5E-08	3.6E-08	--		7.4E-06	3%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	9.9E-06	1.2E-07	2.8E-07	--		1.2E-04	54%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	2.2E-09	2.8E-11	6.4E-11	--		3.2E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.9E-07	2.3E-09	5.4E-09	--		5.4E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.5E-15	4.2E-17	9.9E-17	--		9.4E-08	0%
								TOTAL			**0.000221**	

Dermal Exposure to Chemicals via Contact with Water - Maximum Farm Scenario 1

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Adults		
Surface Area (Saw, cm2)	20000	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	0.58	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (Kp) (cm/hr)	(mg/L)	(mg/cm2 per event)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	7.9E-09	4.60E-15	5.6E-13	1.3E-12	--		4.1E-09	0%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	1.8E-08	1.06E-14	1.3E-12	3.0E-12	--		3.8E-09	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.4E-09	1.39E-15	1.7E-13	4.0E-13	--		2.5E-10	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	1.4E-08	8.25E-15	1.0E-12	2.4E-12	--		6.5E-09	0%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	1.0E-07	5.79E-14	7.1E-12	1.7E-11	--		1.9E-08	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	2.3E-07	1.35E-13	1.7E-11	3.9E-11	--		3.9E-08	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	1.7E-08	1.01E-15	1.2E-13	2.9E-13	--		1.7E-10	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	2.5E-06	2.88E-12	3.5E-10	8.2E-10	--		9.1E-07	43%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	1.0E-07	2.32E-14	2.8E-12	6.6E-12	--		5.9E-09	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	1.4E-06	8.19E-13	1.0E-10	2.3E-10	--		4.2E-09	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	2.1E-07	1.20E-13	1.5E-11	3.4E-11	--		4.9E-10	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	1.2E-06	1.44E-13	1.8E-11	4.1E-11	--		8.6E-09	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	9.9E-06	5.76E-12	7.0E-10	1.6E-09	--		6.9E-07	32%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	2.2E-09	1.30E-15	1.6E-13	3.7E-13	--		1.9E-10	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.9E-07	1.09E-13	1.3E-11	3.1E-11	--		3.1E-10	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	3.5E-15	1.61E-18	2.0E-16	4.6E-16	--		4.3E-07	20%
												0.00000213	

Exposure to Chemicals via Incidental Ingestion of Water - Maximum Farm Scenario 1

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate (Irw, L/day)	0.4	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	7.9E-09	1.8E-11	2.1E-10	--		6.6E-07	0%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	1.8E-08	4.2E-11	4.9E-10	--		6.1E-07	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.4E-09	5.5E-12	6.4E-11	--		4.0E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.4E-08	3.2E-11	3.8E-10	--		1.1E-06	1%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	1.0E-07	2.3E-10	2.7E-09	--		3.1E-06	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	2.3E-07	5.3E-10	6.2E-09	--		6.2E-06	3%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	1.7E-08	4.0E-11	4.7E-10	--		2.7E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	50%	2.5E-06	5.7E-09	6.6E-08	--		7.4E-05	36%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	1.0E-07	2.3E-10	2.7E-09	--		2.4E-06	1%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	1.4E-06	3.2E-09	3.8E-08	--		6.7E-07	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	2.1E-07	4.7E-10	5.5E-09	--		7.9E-08	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	1.2E-06	2.8E-09	3.3E-08	--		6.9E-06	3%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	9.9E-06	2.3E-08	2.6E-07	--		1.1E-04	54%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	2.2E-09	5.1E-12	6.0E-11	--		3.0E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.9E-07	4.3E-10	5.0E-09	--		5.0E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	3.5E-15	7.9E-18	9.2E-17	--		8.7E-08	0%

TOTAL		**0.000206**

Dermal Exposure to Chemicals via Contact with Water - Maximum Farm Scenario 1

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Children		
Surface Area (Saw, cm2)	6100	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	1	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Permeability (Kp)			Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day)$^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/cm2 per event)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	7.9E-09	7.94E-15	2.8E-13	3.2E-12	--		1.0E-08	0%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	1.8E-08	1.82E-14	6.3E-13	7.4E-12	--		9.3E-09	0%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.4E-09	2.39E-15	8.3E-14	9.7E-13	--		6.1E-10	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	1.4E-08	1.42E-14	5.0E-13	5.8E-12	--		1.6E-08	0%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	1.0E-07	9.98E-14	3.5E-12	4.1E-11	--		4.7E-08	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	2.3E-07	2.32E-13	8.1E-12	9.5E-11	--		9.5E-08	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	1.7E-08	1.75E-15	6.1E-14	7.1E-13	--		4.1E-10	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	2.5E-06	4.97E-12	1.7E-10	2.0E-09	--		2.2E-06	43%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	1.0E-07	3.99E-14	1.4E-12	1.6E-11	--		1.5E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	1.4E-06	1.41E-12	4.9E-11	5.7E-10	--		1.0E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	2.1E-07	2.07E-13	7.2E-12	8.4E-11	--		1.2E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	1.2E-06	2.49E-13	8.7E-12	1.0E-10	--		2.1E-08	0%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	9.9E-06	9.92E-12	3.5E-10	4.0E-09	--		1.7E-06	32%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	2.2E-09	2.25E-15	7.8E-14	9.1E-13	--		4.6E-10	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.9E-07	1.88E-13	6.5E-12	7.6E-11	--		7.6E-10	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	3.5E-15	2.77E-18	9.7E-17	1.1E-15	--		1.1E-06	20%
												0.0000052	

EPA Limit modelling scenario – Farm

Calculation of Concentrations in Rainwater tank

CW = DM/(VR*Kd*ρ) **(mg/L)**

where:

DM =	Mass of dust deposited on roof each year (mg) = DR x Area
DR =	Deposition rate from model (mg/m2/year)
Area =	Area of roof (m2)
VR =	Volume of water collected from roof over year (L) = R x Area x Rc/1000
R =	Rainfall each year (mm)
ρ =	Soil bulk-density (g/m^3)
Rc =	Runoff coefficient (unitless)
Kd =	Soil-water partition coefficient (cm3/g)
1000 =	Conversion from mm to m

General Parameters

Average rainfaill	mm/year	874	mean for all years (1887 - 2020) for Prospect Reservoir (067019)
Roof area	m2	200	4 bedroom australian home
Runoff coefficient	-	0.7	assumes 30% water loss in capture into tank
Volume of rainwater	m3/year	122.36	calculated
Volume of rainwater	L/year	122360	
Bulk density of deposited dust	g/cm3	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Chemical-specific Inputs and calculations - maximum farm EPA Limit Modelling Scenario

Chemical	PM10 Deposition Rate (DR) mg/m^2/year	Mass deposited each year (DM) mg	Kd (cm3/g)	Particulate Concentration in water mg/L	Dissolved Concentration in water mg/L
Cadmium (Cd)	7.28E-03	1.5	75.0	1.2E-05	3.2E-07
Thallium (Tl)	6.46E-03	1.3	29	1.1E-05	7.3E-07
Beryllium (Be)	5.77E-04	0.1	790	9.4E-07	2.4E-09
Mercury (Hg)	2.41E-02	4.8	790	3.9E-05	1.0E-07
Antimony (Sb)	4.12E-03	0.8	45	6.7E-06	3.0E-07
Arsenic (As)	6.18E-03	1.2	29	1.0E-05	7.0E-07
Lead (Pb)	1.44E-02	2.9	900	2.4E-05	5.2E-08
Chromium (Cr VI assumed)	4.33E-02	8.7	19	7.1E-05	7.4E-06
Cobalt (Co)	4.12E-03	0.8	45	6.7E-06	3.0E-07
Copper (Cu)	4.54E-02	9.1	35	7.4E-05	4.2E-06
Manganese (Mn)	1.24E-02	2.5	65	2.0E-05	6.2E-07
Nickel (Ni)	7.42E-02	14.8	65	1.2E-04	3.7E-06
Selenium (Se)	1.52E-02	3.0	5	2.5E-05	9.9E-06
Vanadium (V)	2.06E-03	0.4	1000	3.4E-06	6.7E-09
Tin (Sn)	1.44E-02	2.9	250	2.3E-05	1.9E-07
Dioxins and furans	8.25E-08	0.0	38900	1.3E-10	6.9E-15

Exposure to Chemicals via Incidental Ingestion of Water - maximum farm - EPA Limit Modelling Scenario

$$Daily\ Chemical\ Intake_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate (Irw, L/day)	2	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)			NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)		(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	3.2E-07	3.9E-09	9.1E-09	--		2.8E-05	6%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	7.3E-07	8.9E-09	2.1E-08	--		2.6E-05	5%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.4E-09	2.9E-11	6.8E-11	--		4.3E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.0E-07	1.2E-09	2.8E-09	--		7.9E-06	2%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	3.0E-07	3.7E-09	8.6E-09	--		1.0E-05	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	7.0E-07	8.5E-09	2.0E-08	--		2.0E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.2E-08	6.4E-10	1.5E-09	--		8.6E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	100%	7.4E-06	9.1E-08	2.1E-07	--		2.4E-04	49%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.0E-07	3.7E-09	8.6E-09	--		7.6E-06	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.2E-06	5.2E-08	1.2E-07	--		2.2E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	6.2E-07	7.6E-09	1.8E-08	--		2.5E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.7E-06	4.6E-08	1.1E-07	--		2.2E-05	5%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	9.9E-06	1.2E-07	2.8E-07	--		1.2E-04	25%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	6.7E-09	8.3E-11	1.9E-10	--		9.6E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.9E-07	2.3E-09	5.4E-09	--		5.4E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	6.9E-15	8.5E-17	2.0E-16	--		1.9E-07	0%
								TOTAL			**0.00048**	

Exposure to Chemicals via Incidental Ingestion of Water - maximum farm - EPA Limit Modelling Scenario

$$\textit{Daily Chemical Intake}_{IW} = C_W \bullet \frac{IR_W \bullet FI \bullet B \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(L/kg/day)}$$

Parameters Relevant to Quantification of Exposure by Children		
Ingestion Rate (Irw, L/day)	0.4	Water intakes from all sources (incl. food and bathing) enHealth 2012
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Bioavailability (%)	Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day)$^{-1}$	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		(mg/L)	NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
Cadmium (Cd)		8.0E-04	60%	3.2E-04	100%	3.2E-07	7.3E-10	8.5E-09	--		2.6E-05	6%
Thallium (Tl)		8.0E-04	0%	8.0E-04	100%	7.3E-07	1.7E-09	1.9E-08	--		2.4E-05	5%
Beryllium (Be)		2.0E-03	20%	1.6E-03	100%	2.4E-09	5.5E-12	6.4E-11	--		4.0E-08	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	100%	1.0E-07	2.3E-10	2.7E-09	--		7.4E-06	2%
Antimony (Sb)		8.6E-04	0%	8.6E-04	100%	3.0E-07	6.8E-10	8.0E-09	--		9.3E-06	2%
Arsenic (As)		2.0E-03	50%	1.0E-03	100%	7.0E-07	1.6E-09	1.9E-08	--		1.9E-05	4%
Lead (Pb)		3.5E-03	50%	1.8E-03	100%	5.2E-08	1.2E-10	1.4E-09	--		8.0E-07	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	50%	7.4E-06	1.7E-08	2.0E-07	--		2.2E-04	49%
Cobalt (Co)		1.4E-03	20%	1.1E-03	100%	3.0E-07	6.8E-10	8.0E-09	--		7.1E-06	2%
Copper (Cu)		1.4E-01	60%	5.6E-02	100%	4.2E-06	9.7E-09	1.1E-07	--		2.0E-06	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	100%	6.2E-07	1.4E-09	1.7E-08	--		2.4E-07	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	100%	3.7E-06	8.5E-09	1.0E-07	--		2.1E-05	5%
Selenium (Se)		6.0E-03	60%	2.4E-03	100%	9.9E-06	2.3E-08	2.6E-07	--		1.1E-04	25%
Vanadium (V)		2.0E-03	0%	2.0E-03	100%	6.7E-09	1.5E-11	1.8E-10	--		9.0E-08	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	100%	1.9E-07	4.3E-10	5.0E-09	--		5.0E-08	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	100%	6.9E-15	1.6E-17	1.8E-16	--		1.7E-07	0%

TOTAL		**0.00045**

Dermal Exposure to Chemicals via Contact with Water - maximum farm - EPA Limit Modelling Scenario

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Adults		
Surface Area (Saw, cm2)	20000	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	0.58	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Permeability (Kp)			Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/cm2 per event)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	3.2E-07	1.84E-13	2.3E-11	5.3E-11	--		1.6E-07	3%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	7.3E-07	4.22E-13	5.2E-11	1.2E-10	--		1.5E-07	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.4E-09	1.39E-15	1.7E-13	4.0E-13	--		2.5E-10	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	1.0E-07	5.77E-14	7.1E-12	1.6E-11	--		4.6E-08	1%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	3.0E-07	1.74E-13	2.1E-11	5.0E-11	--		5.8E-08	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	7.0E-07	4.04E-13	5.0E-11	1.2E-10	--		1.2E-07	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	5.2E-08	3.04E-15	3.7E-13	8.7E-13	--		5.0E-10	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	7.4E-06	8.64E-12	1.1E-09	2.5E-09	--		2.7E-06	56%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	3.0E-07	6.95E-14	8.5E-12	2.0E-11	--		1.8E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	4.2E-06	2.46E-12	3.0E-10	7.0E-10	--		1.3E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	6.2E-07	3.61E-13	4.4E-11	1.0E-10	--		1.5E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	3.7E-06	4.33E-13	5.3E-11	1.2E-10	--		2.6E-08	1%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	9.9E-06	5.76E-12	7.0E-10	1.6E-09	--		6.9E-07	14%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	6.7E-09	3.91E-15	4.8E-13	1.1E-12	--		5.6E-10	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.9E-07	1.09E-13	1.3E-11	3.1E-11	--		3.1E-10	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	6.9E-15	3.22E-18	3.9E-16	9.2E-16	--		8.7E-07	18%
												0.0000049	

Dermal Exposure to Chemicals via Contact with Water - maximum farm - EPA Limit Modelling Scenario

$$DA_{event} = K_p \times C_w \times t_{event}$$

mg/cm2 per event (for inorganics)

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

mg/kg bw/day

Parameters Relevant to Quantification of Exposure to Children		
Surface Area (Saw, cm2)	6100	Whole body as per enHealth (2012)
Exposure Time per event (tevent, hr/event)	1	Reasonable maximum time spent showering or wet each day (ESEPA)
Conversion Factor (CF, L/cm3)	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Event Frequency (EV, events/day)	1	Assumed relevant to exposure being evaluated
Exposure Frequency (EF, days/yr)	365	Exposure occurs every day
Exposure Duration (ED, years)	6	Duration as young child
Body Weight (BW, kg)	15	Representative weight as per NEPM (2013)
Averaging Time - NonThreshold (Atc, days)	25550	US EPA 1989 and CSMS 1996
Averaging Time - Threshold (Atn, days)	2190	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	DAevent	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Permeability (Kp)			Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/cm2 per event)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
Cadmium (Cd)		8.0E-04	60%	3.2E-04	1.00E-3	3.2E-07	3.17E-13	1.1E-11	1.3E-10	--		4.0E-07	3%
Thallium (Tl)		8.0E-04		8.0E-04	1.00E-3	7.3E-07	7.28E-13	2.5E-11	3.0E-10	--		3.7E-07	3%
Beryllium (Be)		2.0E-03	20%	1.6E-03	1.00E-3	2.4E-09	2.39E-15	8.3E-14	9.7E-13	--		6.1E-10	0%
Mercury (Hg)		6.0E-04	40%	3.6E-04	1.00E-3	1.0E-07	9.95E-14	3.5E-12	4.0E-11	--		1.1E-07	1%
Antimony (Sb)		8.6E-04		8.6E-04	1.00E-3	3.0E-07	3.00E-13	1.0E-11	1.2E-10	--		1.4E-07	1%
Arsenic (As)		2.0E-03	50%	1.0E-03	1.00E-3	7.0E-07	6.97E-13	2.4E-11	2.8E-10	--		2.8E-07	2%
Lead (Pb)		3.5E-03	50%	1.8E-03	1.00E-4	5.2E-08	5.24E-15	1.8E-13	2.1E-12	--		1.2E-09	0%
Chromium (Cr VI assumed)		1.0E-03	10%	9.0E-04	2.00E-3	7.4E-06	1.49E-11	5.2E-10	6.1E-09	--		6.7E-06	56%
Cobalt (Co)		1.4E-03	20%	1.1E-03	4.00E-4	3.0E-07	1.20E-13	4.2E-12	4.9E-11	--		4.4E-08	0%
Copper (Cu)		1.4E-01	60%	5.6E-02	1.00E-3	4.2E-06	4.24E-12	1.5E-10	1.7E-09	--		3.1E-08	0%
Manganese (Mn)		1.4E-01	50%	7.0E-02	1.00E-3	6.2E-07	6.22E-13	2.2E-11	2.5E-10	--		3.6E-09	0%
Nickel (Ni)		1.2E-02	60%	4.8E-03	2.00E-4	3.7E-06	7.46E-13	2.6E-11	3.0E-10	--		6.3E-08	1%
Selenium (Se)		6.0E-03	60%	2.4E-03	1.00E-3	9.9E-06	9.92E-12	3.5E-10	4.0E-09	--		1.7E-06	14%
Vanadium (V)		2.0E-03		2.0E-03	1.00E-3	6.7E-09	6.74E-15	2.3E-13	2.7E-12	--		1.4E-09	0%
Tin (Sn)		2.0E-01	50%	1.0E-01	1.00E-3	1.9E-07	1.88E-13	6.5E-12	7.6E-11	--		7.6E-10	0%
Dioxins and furans		2.3E-09	54%	1.1E-09	8.00E-1	6.9E-15	5.54E-18	1.9E-16	2.3E-15	--		2.1E-06	18%
												0.0000120	

Prospect Reservoir

Scenario 1 and EPA Limit Modelling Scenario

Calculation of Concentrations in Prospect Reservoir

Dissolved C_W = DM/(V*Kd*ρ) **(mg/L)**

where:

DM =	Mass of dust deposited in across the dam and catchment each year (mg) = DR x Area
DR =	Deposition rate from model (mg/m²/year) (includes wet and dry deposition)
Area =	Area of relevant areas - reservoir surface and ground surface in catchment (m²)
V =	Volume of water - calculation assumes dust mixes in the water in the reservoir
ρ =	Soil bulk-density (g/m³)
Kd =	Soil-water partition coefficient (cm3/g)

Parameters relevant for direct deposition onto the water in the dam			
Area of reservoir	m²	5200000	Prospect Reservoir covers 5.2 km2
Depth of reservoir	m	24	Prospect Reservoir is approximately 24 m deep
Volume of reservoir	m³	124800000	
Volume of reservoir	L	1.248E+11	convert from m3 to L
Bulk density of deposited dust	g/cm³	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Parameters relevant for deposition onto ground and washoff into reservoir			
Area of catchment around reservoir	m²	4800000	Catchment around Reservoir covers 4.8 km2 to makeup to to total of 10km2 for whole area
Runoff coefficient	-	0.7	assumes only 70% of what falls onto ground washes off to reservoir. Same value as assumed for wash off from roof to calculate concentrations in rainwater tank. This value is assumed to be conservative due to capture by vegetation etc.
Bulk density of deposited dust	g/cm3	0.5	assumed for loose deposited dust on roof (similar to upper end measured for powders)

Chemical-specific Inputs and calculations - Prospect Reservoir Scenario 1

Chemical	Deposition Rate (DR) - land	Deposition Rate (DR) - water	Mass deposited to land and washed off	Mass deposited directly to water	Total mass mixed into dam each year (DM)	Kd	Particulate Concentration in water	Dissolved Concentration in water
	mg/m²/year	mg/m²/year	mg/year	mg/year	mg	(cm3/g)	mg/L	mg/L
Cadmium (Cd)	4.69E-03	1.17E-03	15759	6097	21856	75.0	1.8E-07	4.7E-09
Thallium (Tl)	4.16E-03	1.04E-03	13975	5407	19382	29	1.6E-07	1.1E-08
Beryllium (Be)	1.49E-02	3.72E-03	49954	19327	69281	790	5.6E-07	1.4E-09
Mercury (Hg)	8.85E-02	2.21E-02	297343	115043	412386	790	3.3E-06	8.4E-09
Antimony (Sb)	3.54E-02	8.85E-03	118937	46017	164954	45	1.3E-06	5.9E-08
Arsenic (As)	5.31E-02	1.33E-02	178406	69026	247432	29	2.0E-06	1.4E-07
Lead (Pb)	1.24E-01	3.10E-02	416280	161061	577341	900	4.6E-06	1.0E-08
Chromium (Cr VI assumed)	3.72E-01	9.29E-02	1248840	483182	1732022	19	1.4E-05	1.5E-06
Cobalt (Co)	3.54E-02	8.85E-03	118937	46017	164954	45	1.3E-06	5.9E-08
Copper (Cu)	3.89E-01	9.73E-02	1308309	506191	1814499	35	1.5E-05	8.3E-07
Manganese (Mn)	1.06E-01	2.65E-02	356811	138052	494863	65	4.0E-06	1.2E-07
Nickel (Ni)	6.37E-01	1.59E-01	2140869	828312	2969181	65	2.4E-05	7.3E-07
Selenium (Se)	3.91E-01	9.77E-02	1313643	508255	1821898	5	1.5E-05	5.8E-06
Vanadium (V)	1.77E-02	4.42E-03	59469	23009	82477	1000	6.6E-07	1.3E-09
Tin (Sn)	3.70E-01	9.25E-02	1242635	480781	1723417	250	1.4E-05	1.1E-07
Dioxins and furans	1.06E-06	2.65E-07	3.568	1.381	4.949	38900	4.0E-11	2.0E-15

Chemical-specific Inputs and calculations - Prospect Reservoir EPA Limit Modelling Scenario

Chemical	Deposition Rate (DR) - land	Deposition Rate (DR) - water	Mass deposited to land and washed off	Mass deposited directly to water	Total mass mixed into dam each year (DM)	Kd	Particulate Concentration in water	Dissolved Concentration in water
	mg/m²/year	mg/m²/year	mg/year	mg/year	mg	(cm3/g)	mg/L	mg/L
Cadmium (Cd)	1.88E-01	4.69E-02	630367	243892	874259	75.0	7.0E-06	1.9E-07
Thallium (Tl)	1.66E-01	4.16E-02	559005	216282	775286	29	6.2E-06	4.3E-07
Beryllium (Be)	1.49E-02	3.72E-03	49954	19327	69281	790	5.6E-07	1.4E-09
Mercury (Hg)	6.19E-01	1.55E-01	2081400	805304	2886704	790	2.3E-05	5.9E-08
Antimony (Sb)	1.06E-01	2.65E-02	356811	138052	494863	45	4.0E-06	1.8E-07
Arsenic (As)	1.59E-01	3.98E-02	535217	207078	742295	29	5.9E-06	4.1E-07
Lead (Pb)	3.72E-01	9.29E-02	1248840	483182	1732022	900	1.4E-05	3.1E-08
Chromium (Cr VI assumed)	1.12E+00	2.79E-01	3746520	1449546	5196066	19	4.2E-05	4.4E-06
Cobalt (Co)	1.06E-01	2.65E-02	356811	138052	494863	45	4.0E-06	1.8E-07
Copper (Cu)	1.17E+00	2.92E-01	3924926	1518572	5443498	35	4.4E-05	2.5E-06
Manganese (Mn)	3.19E-01	7.96E-02	1070434	414156	1484590	65	1.2E-05	3.7E-07
Nickel (Ni)	1.91E+00	4.78E-01	6422606	2484937	8907542	65	7.1E-05	2.2E-06
Selenium (Se)	3.91E-01	9.77E-02	1313643	508255	1821898	5	1.5E-05	5.8E-06
Vanadium (V)	5.31E-02	1.33E-02	178406	69026	247432	1000	2.0E-06	4.0E-09
Tin (Sn)	3.70E-01	9.25E-02	1242635	480781	1723417	250	1.4E-05	1.1E-07
Dioxins and furans	1.06E-06	2.65E-07	3.568	1.381	4.949	38900	4.0E-11	2.0E-15