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Attention: Peter Stacey

Seaview wastewater treatment plant odour deodoriser – human health risk assessment

1 Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Air Quality Consulting NZ (AQCNZ) to perform a focused human health risk assessment (HHRA) to inform AQCNZ's air quality assessment (AQA) performed for Wellington Water Limited's (WWL) Seaview wastewater treatment plant located in Lower Hutt, Wellington, New Zealand (the "site").

WWL is seeking a resource consent to authorise the operation of up to four deodorises as a tool to suppress odour generation during maintenance activities when the treatment plant has the potential to generate odours. To support an air discharge consent application to the Greater Wellington Regional Council, WWL has engaged AQCNZ to perform an AQA to assess the potential effects associated with discharges to air from the deodorises. This HHRA was performed to provide human health risk assessment information to support AQCNZ's air quality assessment.

It is understood that the proposed deodorisers (up to four operating at the same time) will generate a constant stream of very fine water aerosols between 20-50 µm in diameter, containing low concentrations of the following odour-neutralising agents that will be mixed with water at a ratio of 1 part neutraliser to 500 parts water prior to being dispersed by the deodoriser:

- Hi Chem – Disinfectant Reodorant (HPC)
- Oda-Ban Concentrate (biOx International)
- Odour Neutraliser PLUS (biOx International).

The following safety data sheets (SDS) for the proposed neutralisers are provided in Appendix A of AQCNZ's AQA report:

- HCP 2020. Hi Chem – Disinfectant Reodorant, Safety Data Sheet. October 2020
- biOx International 2020. Oda-Ban Concentrate, Safety Data Sheet, 7 April 2020
- biOx International 2020. Odour Neutraliser PLUS, Safety Data Sheet, 7 April 2020.

2 Objectives

The overall objective of this HHRA is to assess the potential health risks to offsite sensitive populations (residents, recreational users and offsite commercial workers) that have the potential to be exposed to aerosols generated by the deodorisers during maintenance activities at the wastewater treatment plant.

This HHRA has focused on impacts to community health for populations located outside the site boundary and has not addressed risks to workers involved in operation of the deodorisers on the site. Workers

involved in operation of the deodorisers would be managed under the New Zealand *Health and Safety at Work Act 2015* and associated regulations and instruments.

This assessment has relied upon the information provided to enRiskS (described in AQCNZ's report) up to 14 October 2024 and has only considered exposure (via inhalation of aerosols) to the four chemicals described in the SDS (as listed in **Table 1**).

3 Methodology

In general, New Zealand has limited detailed guidance in relation to the assessment of risks to community health from environmental exposures resultant from the operation of industrial facilities such as the deodoriser at the wastewater treatment plant. Therefore, this HHRA has been undertaken in accordance with the following guidance from New Zealand, Australia and the United States:

- enHealth, Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012)
- Ministry for the Environment (MfE) Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health (MfE 2011)
- Ministry for the Environment (MfE) Contaminated land management guidelines No 1, reporting on contaminated sites in New Zealand (MfE 2021)
- NEPM, National Environmental Protection Measure – Assessment of Site Contamination referred to as NEPM (2013), including:
    - Schedule B1 Investigation Levels for Soil and Groundwater (NEPC 1999 amended 2013a)
    - Schedule B4 Guideline on Health Risk Assessment Methodology (NEPC 1999 amended 2013b)
    - Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 1999 amended 2013c).
- United States Environmental Protection Agency (USEPA) Risk Assessment Guidance (USEPA 2009).

The HHRA framework and key steps for undertaking a HHRA comprise of:

- Issue identification: which identifies the key chemicals, offsite sensitive human populations and exposure pathways that need to be evaluated in the assessment (**Section 4**).
- Hazard identification: which relates to the toxicity or hazards posed by exposure to the key chemicals evaluated, with quantitative dose-response values identified for each chemical evaluated (**Section 5**)
- Exposure assessment: which relates to who may be exposed to the key chemicals and how (via inhalation), with quantitative values adopted to characterise exposure (**Section 6**)
- Risk characterisation: where the above elements are combined to provide a quantitative assessment of potential risks to human health (**Section 7**).

4 Issue identification

4.1 Key chemicals

The individual chemicals that are described in the odour neutraliser SDS are summarised in **Table 1**. A quantitative assessment of exposure to these chemicals by offsite sensitive human populations is undertaken in this HHRA.

Table 1: Key chemicals listed in the odour neutraliser SDS

Chemical name	CAS No.	Proportion
Hi Chem – Disinfectant Reodorant		
Benzalkonium chloride	8001-54-5	<10%
Non-hazardous ingredients	-	Balance
Oda-Ban Concentrate		
Non-hazardous ingredients	-	100%
Odour Neutraliser PLUS		
Sodium chlorite	7758-19-2	1-2%
Potassium persulphate	7727-21-1	<0.1%
Dodecyldimethylamine oxide (surfactant)	1643-20-5	<1.0 %
Non-hazardous ingredients	-	Balance

Environment Protection Authority (EPA) New Zealand (NZ) (2022)[1] states that the disclosure of 'non-hazardous' confidential ingredient names in an SDS is not required for those ingredients that do not have a prescribed workplace exposure standard (as defined in the Health and Safety Work (Hazardous Substances) Regulations 2017[2]) and are classified within the following Globally Harmonised System (GHS) for the classification and labelling of chemicals health hazard categories (UN 2023).

The GHS provides characteristics and cut-off values or concentrations limits for substances and mixtures for which information is required to be included in a SDS, which include the following:

- acute toxicity – category 5 (oral, dermal and inhalation) (i.e. where toxicity/effects occur at concentrations >1%)
- skin and/or eye irritation – category 3 (i.e. where toxicity/effects occur at concentrations >1%)
- specific target organ toxicity – single exposure category 4 (i.e. where toxicity/effects occur at concentrations >1%)
- aspiration hazard – category 2 (where toxicity/effects occur at concentrations >1%).

It is noted that it is not possible to assess the products or parts of products listed as non-hazardous. Assessing potential risks to human health requires an understanding of the specific chemicals and the potential for adverse effects to occur as a result of exposure. It is assumed that the toxicity of the non-hazardous chemicals in the products evaluated is higher (less toxic) than the chemicals evaluated in this assessment (i.e. listed on the SDSs).

[1] https://www.epa.govt.nz/assets/Uploads/Documents/Hazardous-Substances/EPA-Notices/Hazardous-Substances-Safety-Data-Sheets-Notice-2017-EPA-Consolidation-30-September-2022.pdf

[2] https://www.legislation.govt.nz/regulation/public/2017/0131/latest/DLM7309401.html

4.2 Offsite sensitive populations

Figure 1 illustrates the location of the site (and typical location of the deodoriser on the site) and offsite sensitive populations that comprise:

- Owhiti Urupā: located approximately 100 m to the north of the site boundary and comprises a cemetery that is zoned 'Community Iwi' in the Hutt City District Plan
- recreational facility: located approximately 300 m to the northeast of the site and comprises an indoor recreational facility
- Wellington Top 10 Holiday Park: located approximately 450 m to the northeast of the site and comprises a recreational facility for holiday makers
- residential area: located 400 m to the north of the site and comprises the nearest low-density residential area
- nearby commercial properties located adjacent to the site boundary.

These areas are all located in the direction where the hourly average wind speeds are recorded to be the highest as measured by WWL's automatic weather station (data measured between 15 December 2023 to 20 August 2024) (refer to Section 3.1 of AQCNZ's AQA report). Since windspeed can have a significant impact on the potential for transporting fine aerosols from the deodorisers, assessment of the offsite populations to the north/northeast is appropriate for this HHRA. Therefore, potential health risks for the populations to the north/northeast will be protective for offsite populations in different directions from the site.

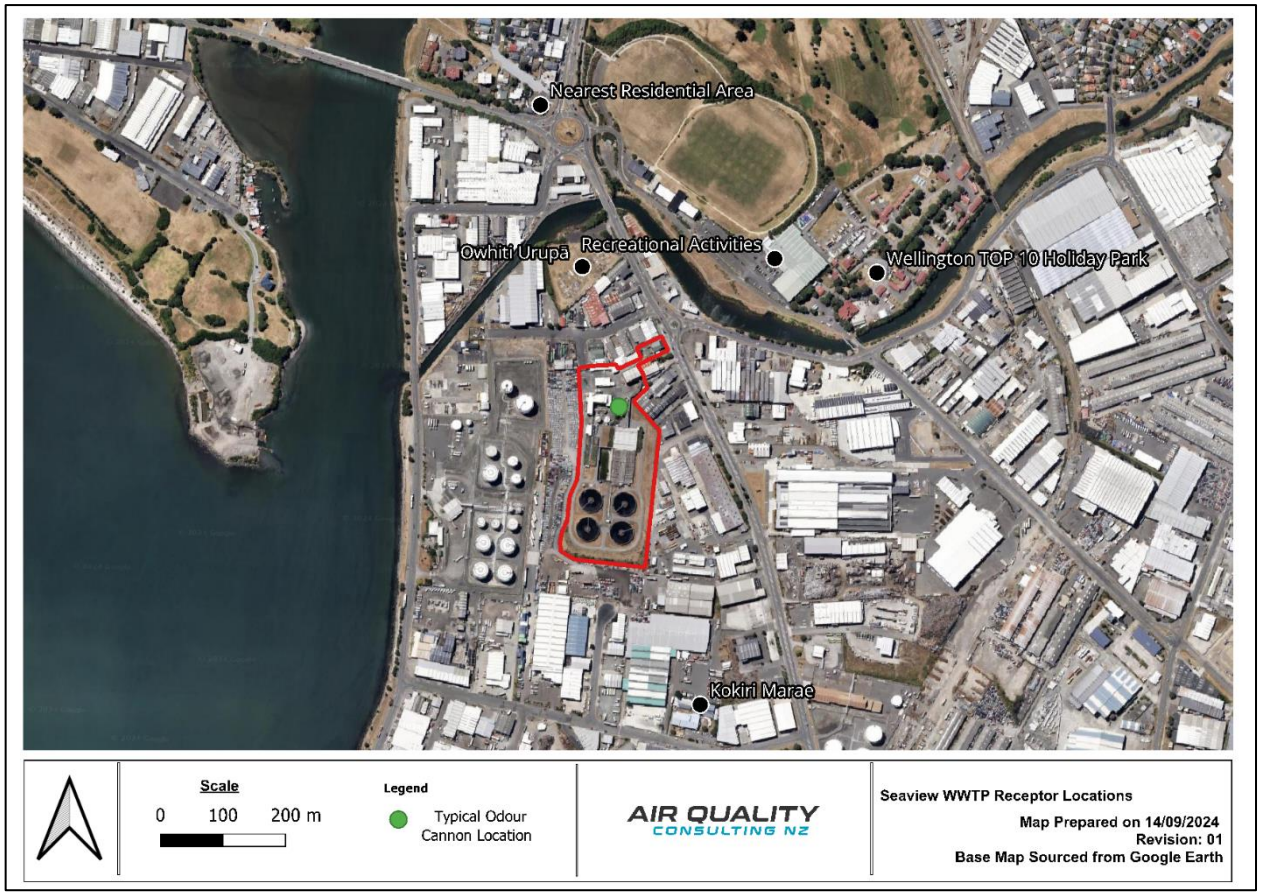

Figure 1: location of the site (red outline) and nearest offsite sensitive populations

The exposure pathway of concern for this HHRA comprises the inhalation of aerosols that contain concentrations of the key chemicals listed in **Table 1**.

When particulates are inhaled and not exhaled, they will either:

1. reach the lungs (alveoli)
2. be swallowed and enter the gastrointestinal tract, or
3. will be gradually removed from the respiratory tract via mucus lining.

The potential for these processes to occur will depend on the particle diameter. Particles that are ≤50 µm are referred to as inspirable particles. Particles that are inspirable but not respirable will not reach the alveoli (in the lungs) but instead they are removed via mucus lining (enHealth 2012). Particles <2.5 µm are considered to represent the respirable fraction (that will reach the alveoli) and particles <10-2.5 µm represent the respirable and thoracic fraction (enHealth 2012). Aerosols emitted from the deodorisers are reported to have particle diameters ranging between 20-50 µm[3], therefore the majority of these particles are unlikely to be inhaled and reach the alveoli. This HHRA has assumed that 100% of aerosols are inhaled and deposited into the lungs (alveoli) which is a conservative assumption given that these particles are unlikely to be inhaled and reach the alveoli. The conservative assumption, however, accounts for the deposition of larger aerosols in the upper airway and swallowing or ingestion of these aerosols.

5 Toxicity assessment

A human health toxicity summary for the key chemicals listed in **Table 1** is provided in **Table 2**. These data and information were obtained from the supplied SDS, peer-reviewed literature and the following New Zealand and international agencies:

- European Chemicals Agency (ECHA)
- Hazardous Substances Data Bank (HSDB database)
- International Agency for Research on Cancer (IARC)
- National Health and Medical Research Council (NHMRC)
- National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (now referred to as Australian Industrial Chemicals Introduction Scheme (AICIS)
- New Zealand Environmental Protection Authority (NZ EPA) Chemical Classification and Information Database (CCID)
- Organisation for Economic Co-Operation and Development (OECD)
- Safe Work Australia (SWA)
- United States Environmental Protection Agency (USEPA)
- Worksafe New Zealand.

It should be recognised that the acute and chronic health effects summarised in **Table 2** assume that the chemical is present in an undiluted form. Therefore, these effects will overestimate exposure to the offsite recreational users and residents who will be exposed to the chemicals in aerosol in which the chemical has been significantly diluted and will comprise between <0.1% and <10% of the odour neutraliser product (refer to **Table 1**). These concentrations will be further diluted prior to use in the deodorisers at 1 part neutraliser to 500 parts of water.

[3] The AQCNZ modelling assumed that the aerosol particles behaved similar to PM_{10} particles which is likely to overestimate the distance aerosols will travel given they have a larger diameter (20-50 µm).

Table 2: Chemical profiles

Category	Description	Reference
Benzalkonium chloride (CAS No. 8001-54-5)		
Acute health effects	Health effects from exposure to this compound are principally associated with acute exposures in occupational environments. Hazardous in case of skin contact (irritant), eye contact (irritant), ingestion, or inhalation. Hazardous in case of skin contact (corrosive) and eye contact (corrosive). Causes severe skin burns and eye damage. The amount of tissue damage depends on the length of contact. Eye contact can result in corneal damage or blindness. Severe over-exposure can produce lung damage, choking, unconsciousness or death. Inflammation of the eye is characterised by redness, watering and itching. Skin inflammation is characterised by itching, scaling, reddening or occasionally blistering.	NZ EPA (2024) USEPA (2006)
Chronic health effects	May be toxic to kidneys, liver, heart, gastrointestinal tract, cardiovascular system and central nervous system. Possible reproductive system toxin. Repeated or prolonged exposure of the eyes to a low level of dust can produce eye irritation. Repeated skin exposure can produce local skin destruction or dermatitis. Repeated inhalation of dust can produce varying degrees of respiratory irritation or lung damage.	USEPA (2006)
Classifications	Not assessed by IARC. USEPA classified as not carcinogenic or mutagenic.	IARC[1] USEPA (2006)
Guidelines	**Inhalation**: short-, intermediate- and long-term no observed adverse effect level (NOAEL) (inhalation) of 3 mg/kg/day from an oral development study in rabbits (laboured breathing). Inhalation absorption is assumed to be equivalent to oral absorption (100%). An oral toxicity reference value (TRV) 0.03 mg/kg/day can be derived by dividing the NOAEL by safety factor of 100 (10x for interspecies variation, 10x intraspecies variation[3]). An inhalation TRV of 0.105 mg/m^3 is derived via route-to-route extrapolation assuming a body weight of 70 kg and a breathing rate of 20 m^3/day. **Dermal:** intermediate-term dermal NOAEL of 20 mg/kg/day based on a 21-day dermal toxicity study in rats for a 4% active ingredient formulated product. **Incidental oral**: short- and intermediate-term NOAEL of 10 mg/kg/day from a rat development toxicity study. Worksafe New Zealand and Work Safe Australia do not provide a workplace exposure standards.	USEPA (2006)
Background exposure	Used for a range of domestic, agricultural and commercial purposes such as fabric softeners, shampoo/conditioner, body lotions, residential and commercial pools, pulp paper products and wood preservation.	Pereira and Tagkopoulos (2019)
Sodium chlorite (CAS No. 7758-19-2)		
Acute health effects	Sodium chlorite is rapidly absorbed following oral administration and is also absorbed through the skin. Health effects from exposure to this compound are principally associated with acute exposures in occupational environments. Can cause severe skin burns (irritation) and eye damage (irritation). Not known to be a skin sensitiser. Has moderate acute oral toxicity and high acute dermal toxicity. In a solution at 31% concentration in water, the compound is not irritating or exhibits evidence of skin sensitisation.	NZ EPA (2024) NICNAS (2014) ECHA (2023)
Chronic health effects	Not considered to be toxic to the reproductive or developmental systems. May cause damage to kidneys through prolonged or repeat exposure.	NICNAS (2014)
Classifications	Classified by IARC as Group 3, not classifiable as to its carcinogenicity in humans (evaluation year 1990). Not considered to be carcinogenic or mutagenic.	IARC[1]
Guidelines	**Inhalation**: A no observed adverse effect concentration (NOAEC) of 1.74 mg/m^3 based on an oral exposure two-generational study in rats measuring the effect on fertility. An inhalation TRV of 0.0174 mg/m^3 can be derived by dividing the NOAEL by safety factor of 100 (10x for interspecies variation, 10x intraspecies variation[3]). **Oral**: NOAEL of 4 mg/kg/day based on a two-generational rat study.	EHCA (2023) NHMRC (2011 updated 2022)

Category	Description	Reference
	Dermal: NOAEL of 40 mg/kg/day based on a two-generational rat study, calculated via route-to-route extrapolation assuming 10% dermal absorption. The Australian Drinking Water Standard for chlorite is 0.8 mg/L, based on a no-effect level of 2.9 mg/kg/day from a two-generation rat study, with a safety factor of 100 (10 for intraspecies differences, and 10 for intraspecies differences). The NZ Drinking Water Standard for chlorite is also 0.8 mg/L. Worksafe New Zealand and Work Safe Australia do not provide a workplace exposure standards.	
Background exposure	Sodium chlorite is used in washing and cleaning products, and in the manufacture of textiles.	ECHA (2023)
Potassium persulphate (CAS No. 7727-21-1)		
Acute health effects	Persulphate salts rapidly dissociate in water, and ingested potassium ions will be readily taken up in the gastrointestinal tract however the persulphate ions is poorly absorbed. The main critical effects to human health are associated with skin and respiratory sensitisation and irritation. Can cause skin irritation and allergic reaction, and eye irritation. May cause allergy, irritation or asthma symptoms or breathing difficulties if inhaled. Persulfate salts have low acute dermal and inhalation toxicity. Acute inhalation studies with potassium persulphate in rats indicated median lethal concentration (LC50) values greater than the maximum attainable concentration of 42.9 mg/L. Persulfate salts have moderate acute toxicity via the oral route.	NZ EPA (2024) NICNAS (2016)
Chronic health effects	Persulfates have low repeat dose toxicity via the oral and inhalation routes. Based on limited data for ammonium persulphate (that has very similar physical/chemical/toxicological properties), potassium persulfate is not considered to be toxic to reproduction or development. Pulmonary function tests conducted on employees of a persulfate production factory indicated no adverse effects on pulmonary function (including long-term observations) at concentrations of 0.5 mg/m^3.	NICNAS (2016) OECD (2005)
Classifications	Not assessed by IARC. Not considered to be mutagenic or carcinogenic.	NICNAS (2016)
Guidelines	**Oral**: NOAEL of 131.5 mg/kg/day based on a 28-day repeat dose oral (dietary) toxicity study conducted on male rats. **Inhalation**: NOAEC of 10.3 mg/m^3 based on a 90-day repeat dose inhalation toxicity study (dust aerosol concentrations) using ammonium persulfate on rats. An inhalation TRV of 0.0103 mg/m^3 can be derived by dividing the NOAEL by safety factor of 100 (10x for interspecies variation, 10x intraspecies variation[3]). Safe Work Australia provides a workplace exposure time weighted average (TWA) standard of 0.01 mg/m^3 (peak limitation). Worksafe New Zealand does not provide a workplace exposure standard.	OECD (2005) Safe Work Australia (2022)
Background exposure	Potassium persulphate is used as a bleaching, oxidising and colouring agent for uses such as hair and textiles colouring.	NICNAS (2016)
Dodecyldimethylamine oxide (CAS No. 1643-20-5)		
Acute health effects	Causes severe skin burns (irritation) and eye damage (irritation). Instillation of a 30% solution into the eyes of rabbits was reported to be slightly irritating. A LD50 of >20 g/kg per undiluted formulation containing 0.3% active dodecylidmethylamine oxide is reported in a rat oral toxicity study. No adverse effects were observed at the highest test concentration. A LC50 of 5.3 mg/L was reported in a 4 hour rat inhalation toxicity study exposing rats to liquid droplet aerosol formulation containing 0.3% active dodecylidmethylamine oxide. No adverse effects observed at the highest test concentration.	ECHA HSDB USEPA (2020)
Chronic health effects	No evidence of reproductive toxicity or fertility effects in a study in a rat dietary study over two generations.	OECD (2006)
Classifications	Not assessed by IARC. Not considered to be mutagenic or carcinogenic.	OECD (2006) HSDB[2]
Guidelines	Developmental NOAEL of >40 mg/kg/day based on a multi-generational rat dietary study where no macroscopic or histopathological changes were	OECD (2006)

Category	Description	Reference
	observed. An oral TRV of 0.4 mg/kg/day can be derived by dividing the NOAEL by safety factor of 100 (10x for interspecies variation, 10x intraspecies variation[3]). An inhalation TRV of 1.4 mg/m^3 is derived via route-to-route extrapolation assuming a body weight of 70 kg and a breathing rate of 20 m^3/day. Worksafe New Zealand and Work Safe Australia do not provide a workplace exposure standards.	
Background exposure	Used in washing, cleaning, cosmetics and personal care products such as hair mousse, foaming hand soap, foaming face wash and carpet cleaner foam/spray.	ECHA

Notes for Table 2:
1. IARC: https://monographs.iarc.who.int/list-of-classifications
2. HSDB: https://pubchem.ncbi.nlm.nih.gov/source/11933
3. Safety factors adopted consistent with methodology adopted in the Australian Drinking Water Guidelines (NHMRC 2011 updated 2022).

A summary of the inhalation TRVs used to assess potential health risks to offsite sensitive populations is provided in **Table 3**. These inhalation TRVs are based on toxicity studies that assessed chronic exposure that either considered multi-generational or repeat dose exposure. This HHRA has conservatively allocated 10% of the inhalation TRV to background exposure given the reported use of the key chemicals in a variety of domestic and personal care products.

Table 3: Summary of toxicity reference values

Chemical name	Inhalation toxicity reference value (mg/m^3)	Reference	Background exposure allocation	Reference
Benzalkonium chloride	0.105	USEPA (2006)	10%	Pereira and Tagkopoulos (2019)
Sodium chlorite	0.0174	EHCA (2023)	10%	EHCA (2023)
Potassium persulphate	0.0103	OECD (2005)	10%	NICNAS (2016)
Dodecyldimethylamine oxide	1.4	OECD (2006)	10%	ECHA

6 Exposure assessment

6.1 General

The assessment presented has addressed potential worst-case exposure to the key chemicals in aerosol spray and exposure has been calculated for a ***Reasonable Maximum Exposure (RME)*** scenario estimated by using intake variables and chemical concentrations that define the highest exposure that is reasonably likely to occur. The RME is likely to provide a conservative or overestimate of total exposure and therefore health risk.

The quantification of exposure has involved consideration of the following:

- Identification of relevant ***exposure parameters*** for the inhalation pathway and potentially exposed populations. The magnitude of the exposure is a function of a number of variables (termed exposure parameters), which describe the physical, and behavioural parameters relevant to the potentially exposed population. Exposure parameters which are considered representative have been selected. Where available, additional exposure data have been obtained from New Zealand sources (MfE 2011).
- Estimation of the ***chemical concentration*** in aerosol spray relevant to the offsite populations and inhalation pathway. This has involved the use of the maximum 1-hour average offsite concentrations modelled to the nearest sensitive population (i.e., the Owhiti Urupā located approximately 100 m to the north), and the maximum offsite concentration modelled to the site boundary, as reported in Section 4.1 of the AQCNZ's report.

Since the assessment of chronic health risks to offsite populations is the focus of this HHRA, the maximum 1-hour average concentrations were converted to an annual average exposure concentration in accordance with the Ontario MfE (2004) guidelines.

A summary of the maximum 1-hour average concentrations, and the converted maximum annual average concentrations, is provided in **Table 4** and **Table 5**.

Table 4: Maximum 1-hr and annual average concentrations modelled to nearest sensitive receptor

Chemical name	Maximum 1-hour average concentration (mg/m^3)	Converted maximum annual average concentration (mg/m^3)[1]
Benzalkonium chloride	4.7×10^{-2}	3.7×10^{-3}
Sodium chlorite	9.2×10^{-3}	7.4×10^{-4}
Potassium persulphate	4.0×10^{-4}	3.2×10^{-5}
Dodecyldimethylamine oxide	4.8×10^{-3}	3.8×10^{-4}

Notes for Table 4:

1. The maximum 1-hour average concentration was converted to a maximum annual average by dividing the 1-hour average concentration by 12.5 in accordance with Ontario MfE (2004) guidelines (refer to Table A).

Table 5: Maximum 1-hr and annual average concentrations modelled to the site boundary

Chemical name	Maximum 1-hour average concentration (mg/m^3)	Converted maximum annual average concentration (mg/m^3)[1]
Benzalkonium chloride	108.8×10^{-2}	8.7×10^{-3}
Sodium chlorite	21.6×10^{-3}	1.7×10^{-3}
Potassium persulphate	1.2×10^{-4}	9.6×10^{-5}
Dodecyldimethylamine oxide	10.8×10^{-3}	8.6×10^{-4}

Notes for Table 5:

1. The maximum 1-hour average concentration was converted to a maximum annual average by dividing the 1-hour average concentration by 12.5 in accordance with Ontario MfE (2004) guidelines (refer to Table A).

6.2 Exposure assumptions

Intakes via inhalation have been assessed on the basis of the following equation, where an inhalation exposure concentration is calculated (enHealth 2012; NEPC 1999 amended 2013c). The exposure parameters adopted are presented in **Table 6** and included in the risk calculations in **Attachment A**.

$$\text{Inhalation exposure concentration } \left(\frac{mg}{m^3}\right) = C_a \times \frac{ET \times EF \times ED}{AT}$$

Table 6: Summary of adopted exposure parameters

Parameter		Offsite recreational users	Offsite residents	Offsite commercial workers
Ca	Concentration in air at the point of exposure (mg/m^3)	Represents the maximum annual average concentration modelled by AQCNZ at the nearest recreational facility (Owhiti Urupā). Refer to **Table 4**.	Represents the maximum annual average concentration modelled by AQCNZ at the nearest recreational facility (Owhiti Urupā). Refer to **Table 4**. This assumption is conservative given the nearest residential area is located 400 m from the site boundary where the aerosol concentrations will be lower than at Owhiti Urupā.	Represents the maximum annual average concentration modelled by AQCNZ at the site boundary. Refer to **Table 5**.
ET	Exposure time (hours/day)	2 hours per day as per ASC NEPM (NEPC 1999 amended 2013c) for recreational land use (no guidance provided in MfE 2011)	24 hours per day as per MfE (2011) for residential land use	8 hours per day as per MfE (2011) for commercial land use
EF	Exposure Frequency (days/year)	200 days per year as per MfE (2011) for recreational land use	350 days per year as per MfE (2011) for residential land use	230 days per year as per MfE (2011) for commercial land use
ED	Exposure Duration (years)	14 years as per MfE (2011) for recreational land use	20 years as per MfE (2011) for residential land use	20 years as per MfE (2011) for commercial land use
AT	Averaging Time (hours)	Threshold: ED x 365 days x 24 hours as per MfE (MfE 2011), enHealth (enHealth 2012) and USEPA (USEPA 2009)		

The calculation of inhalation exposures is not dependent on age or body weight consistent with USEPA (2009) guidance. Therefore, risk estimates are not calculated separately for children and adults, rather as a person who is exposed to an aerosol concentration for an assumed period of time.

7 Risk characterisation

7.1 Approach

The quantification of potential exposure and risks to human health associated with the presence of chemicals where a threshold dose-response approach is appropriate has been undertaken by comparing the estimated intake (or exposure concentration) with the threshold values adopted that represent a tolerable intake (or concentration), with consideration for background intakes[4]. The calculated ratio is termed a Hazard Index (HI), which is the sum of all ratios (termed Hazard Quotients (HQ)) over all relevant pathways of exposure. These are calculated using the following equations for inhalation exposures:

$$\text{Hazard Quotient (HQ) (inhalation)} = \frac{\text{Exposure concentration}}{\text{(TRV - background)}}$$

$$\text{Hazard Index (HI)} = \sum_{\text{All pathways/chemicals}} \text{HQ}$$

The interpretation of an acceptable HI needs to recognise an inherent degree of conservatism that is built into the establishment of appropriate TRVs adopted (using many uncertainty factors) and the exposure assessment. Hence, in reviewing and interpreting the calculated HI the following is noted:

- A HI 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 outlined in MfE (2011).
- A HI 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.

7.2 Calculated risks

The quantification of risk in relation to potential inhalation exposures to the key chemicals requires the calculation of a threshold HI. The calculated risks relevant to exposures for offsite commercial workers, recreational users and residents are presented in **Table 7**.

Appendix A presents the calculations undertaken to quantify potential exposures and risks associated with exposure to key chemicals within the aerosol spray.

Table 7: Calculated risks

Exposure pathway and population group	Hazard Index
Inhalation by recreational users	0.004
Inhalation by residents	0.09
Inhalation by offsite commercial workers	0.05
Acceptable risk/HI/RI	**≤ 1**

[4] Background intakes are intakes of a chemical that are derived from sources other than the contamination being assessed. This may include dietary intakes and intakes from domestic/personal products, drinking water or urban air.

Based on the calculated risks presented in **Table 7**, the following is concluded:

- potential health risks to offsite recreational users are low and acceptable in accordance with New Zealand guidelines
- potential health risks to offsite residents are low and acceptable in accordance with New Zealand guidelines
- potential health risks to offsite commercial workers are low and acceptable in accordance with New Zealand guidelines.

7.3 Uncertainty assessment

7.3.1 General

Uncertainty in any assessment refers to a lack of knowledge (that could be better refined through the collection of additional data or conduct of additional studies) and is an important aspect of the risk assessment process. An assessment of uncertainty is a qualitative process relating to the selection and rejection of specific data, estimates or scenarios within the risk assessment. In general, to compensate for uncertainty, conservative assumptions are often made that result in an overestimate rather than an underestimate of risk.

7.3.2 Toxicity information

In general, the available scientific information is insufficient to provide a thorough understanding of all of the potential toxic properties of chemicals to which humans may be exposed. It is necessary, therefore, to extrapolate these properties from data obtained under other conditions of exposure and involving experimental laboratory animals. The majority of the toxicological knowledge of chemicals comes from experiments with laboratory animals, although there may be interspecies differences in chemical absorption, metabolism, excretion and toxic response. There may also be uncertainties concerning the relevance of animal studies using exposure routes that differ from human exposure routes. In addition, the necessity to extrapolate results of short-term or sub-chronic animal studies to humans exposed over a lifetime has inherent uncertainty.

Overall, the toxicological data presented are considered to be current and adequate for the assessment of risks to human health associated with the potential exposure to the key chemicals identified at the site. The uncertainties inherent in the toxicological values adopted are considered likely to result in an overestimation of actual risk assessed for long-term or chronic exposures.

7.3.3 Exposure assessment

The quantification of exposure has assumed the following conservative assumptions, which are intended to provide a worst-case or conservative assessment of potential exposure and risk:

- the predicted aerosol concentrations will be present at a constant concentration over the assumed exposure duration, whereas realistically, aerosol spray emitted from the onsite deodorisers will only be present during periods when the wastewater treatment plant is undergoing maintenance activities
- risk estimates for the offsite residents (approximately 400 m from the site) assumed exposure to the same air concentration that was predicted to occur to the nearest recreational area (100 m from the site). Therefore, risk estimates calculated for the offsite residents will be overestimated considering the aerosol air concentration will reduce with distance from the recreational area
- risk estimates for the offsite residents and commercial workers assumed that the aerosol concentrations represent an indoor air concentration where a resident is present 20 hours per day and a commercial worker is present 8 hours per day. This is likely to overestimate concentrations

because less aerosol spray will enter residential dwellings and commercial buildings via open windows and doors

- the air quality modelling performed by AQCNZ incorporated a number of conservative assumptions that have the potential to overestimate the predicted air concentrations such as:
    - all four deodorisers will be operating at the same time
    - all four deodorisers will be located in the same location to give a concentrated discharge rate. This is unlikely as the deodorisers are likely to be spread around the site a varying distances
    - all four deodorisers will operate continuously i.e. every hour of the day for the entire modelling period
    - the Oda-ban deodoriser has no hazardous compounds (refer to **Table 1**), if this was to be used, or even partially used, predicted concentrations would be lower
    - the aerosol behaves like particles that are 10 µm, whereas the aerosols have size range of between 20 – 50 µm. This would result in the model overpredicting the distance in which the aerosol may travel.

8 Conclusions

Environmental Risk Sciences Pty Ltd (enRiskS) was engaged by Air Quality Consulting NZ (AQCNZ) to perform a HHRA to inform AQCNZ's air quality assessment performed for WWL's Seaview wastewater treatment plant located in Lower Hutt, Wellington, New Zealand. The air quality assessment has been prepared to support an air discharge consent application to the Greater Wellington Regional Council for the use of four deodorises on the site to manage odours generated from the wastewater treatment plant during maintenance activities.

This HHRA assessed the potential risks to the nearest offsite sensitive populations (recreational users, residents and offsite commercial workers) from exposure to the following chemicals (present in the odour neutralising agents) in aerosol spray that will be emitted during operation of the deodorisers:

- benzalkonium chloride
- sodium chlorite
- potassium persulphate
- dodecyldimethylamine oxide

The predicted air concentrations, of the above listed chemicals, modelled by AQCNZ were used to assess potential health risks to the offsite sensitive populations in accordance with New Zealand and relevant international HHRA guidance.

Based on the calculated risks and identified uncertainties presented in this HHRA, the following is concluded:

- potential health risks to offsite recreational users are low and acceptable in accordance with New Zealand guidelines
- potential health risks to offsite residents are low and acceptable in accordance with New Zealand guidelines
- potential health risks to offsite commercial workers are low and acceptable in accordance with New Zealand guidelines.

9 Limitations

Environmental Risk Sciences Pty Ltd has prepared this report for the use of Air Quality Consulting NZ 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 objective and methodology and for the purpose outlined in **Section 1** of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences Pty Ltd 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 provided for use in this assessment was false.

This report was prepared in October and November 2024 and is based on the information provided and reviewed at that time. Environmental Risk Sciences Pty Ltd 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.

10 Closure

If you require any additional information, please do not hesitate to contact me on +61 2 9614 0297.

Yours sincerely,

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Attachment A: Risk calculations

Inhalation of volatiles

$$\text{Inhalation exposure concentration} = C_a \times \frac{ET \times FI \times EF \times ED}{AT} \quad (mg/m^3)$$

Parameters relevant to quantification of exposure by nearest recreational users (Owhiti Urupa)		
Exposure Time Indoors (ET, hr/day)	2	Recreational exposure appropriate for a cemetery (Owhiti Urupa)
Fraction Inhaled from Contaminated Source (FI, unitless)	1	
Exposure Frequency (EF, days/yr)	200	Default park/recreation scenario (MfE 2011)
Exposure Duration (ED, years)	14	Default park/recreation scenario (MfE 2011)
Averaging Time - Threshold (Atn, hours)	122640	ED x 365 x 24 (MfE, 2011)

Key Chemical	Toxicity Data			Concentration	Daily Exposure		
	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air (Ca) (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Chronic Hazard Quotient (unitless)	% Total HI
Benzalkonium chloride	1.1E-01	10%	9.5E-02	3.7E-03	1.7E-04	1.81E-03	44%
Sodium chlorite	1.7E-02	10%	1.6E-02	7.4E-04	3.4E-05	2.15E-03	52%
Potassium persulphate	1.0E-02	10%	9.3E-03	3.2E-05	1.5E-06	1.58E-04	4%
Dodecyldimethylamine oxide	1.4E+00	10%	1.3E+00	3.8E-04	1.8E-05	1.39E-05	0%
					TOTAL	**0.004**	

Inhalation of volatiles

$$\text{Inhalation exposure concentration} = C_a \times \frac{ET \times FI \times EF \times ED}{AT} \quad (mg/m^3)$$

Parameters relevant to quantification of exposure by residents		
Exposure Time Indoors (ET, hr/day)	24	Default for residental land use (MfE 2011)
Fraction Inhaled from Contaminated Source (FI, unitless)	1	
Exposure Frequency (EF, days/yr)	350	Default for residental land use (MfE 2011)
Exposure Duration (ED, years)	20	Default for residental land use (MfE 2011)
Averaging Time - Threshold (Atn, hours)	175200	ED x 365 x 24 (MfE, 2011)

Key Chemical	Toxicity Data			Concentration	Daily Exposure		
	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air (Ca) (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Chronic Hazard Quotient (unitless)	% Total HI
Benzalkonium chloride	1.1E-01	10%	9.5E-02	3.7E-03	3.6E-03	3.80E-02	44%
Sodium chlorite	1.7E-02	10%	1.6E-02	7.4E-04	7.1E-04	4.51E-02	52%
Potassium persulphate	1.0E-02	10%	9.3E-03	3.2E-05	3.1E-05	3.31E-03	4%
Dodecyldimethylamine oxide	1.4E+00	10%	1.3E+00	3.8E-04	3.7E-04	2.92E-04	0%
					TOTAL	**0.087**	

Inhalation of volatiles

$$\text{Inhalation exposure concentration} = C_a \times \frac{ET \times FI \times EF \times ED}{AT} \quad (mg/m^3)$$

Parameters relevant to quantification of exposure by commercial workers		
Exposure Time Indoors (ET, hr/day)	8	Default for commercial land use (MfE 2011)
Fraction Inhaled from Contaminated Source (FI, unitless)	1	
Exposure Frequency (EF, days/yr)	230	Default for commercial land use (MfE 2011)
Exposure Duration (ED, years)	20	Default for commercial land use (MfE 2011)
Averaging Time - Threshold (Atn, hours)	175200	ED x 365 x 24 (MfE, 2011)

Key Chemical	Toxicity Data			Concentration	Daily Exposure		
	Chronic TC Air (mg/m^3)	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) (mg/m^3)	Estimated Concentration in Air (Ca) (mg/m^3)	Inhalation Exposure Concentration - Threshold (mg/m^3)	Chronic Hazard Quotient (unitless)	% Total HI
Benzalkonium chloride	1.1E-01	10%	9.5E-02	8.7E-03	1.8E-03	1.93E-02	43%
Sodium chlorite	1.7E-02	10%	1.6E-02	1.7E-03	3.6E-04	2.32E-02	52%
Potassium persulphate	1.0E-02	10%	9.3E-03	9.6E-05	2.0E-05	2.18E-03	5%
Dodecyldimethylamine oxide	1.4E+00	10%	1.3E+00	8.6E-04	1.8E-04	1.44E-04	0%
				TOTAL		**0.045**	