Appendix M:

Quantitative Microbiological Risk Assessment

Quantitative Health Risk Assessment for Wet-Weather Wastewater Discharges into City Rivers and Poverty Bay, Gisborne

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Executive Summary

This Quantitative Microbiological Risk Assessment (QMRA) assesses (1) enteric illness risks related to contact recreation and consumption of harvested shellfish and (2) acute febrile illness (respiratory) risks associated with potential inhalation of spray droplets, following wastewater overflows[1] into Gisborne city rivers and Tūranganui-a-Kiwa/Poverty Bay.

The pathogens considered in the QMRA were *Salmonella*; noroviruses, adenovirus and enteroviruses, and the parasites associated with cryptosporidiosis, giardiasis and ascariasis. Typical concentrations of pathogens in untreated wastewater were used to assess risks associated with ingestion of potentially polluted water and inhalation of aerosolised pathogens, e.g. during water-skiing. In addition to recreational exposure, risks associated with consumption of raw shellfish were assessed. Dilutions following the discharge of wastewater overflows into Gisborne city rivers and Tūranganui-a-Kiwa/Poverty Bay were predicted[2] at these sites and used to assess risks in the QMRA.

Overflows currently occur on average approximately three times per year as a result of excessive stormwater ingress into the wastewater network during heavy rainfall events. Improvements to stormwater and wastewater networks, including private drainage, will be carried out as part of the Gisborne District Council (GDC) operational and capital works programmes, including the Drainwise Programme. The aim of these improvements is to substantially reduce stormwater ingress to the wastewater network and implement other drainage improvements so that the wastewater network does not overflow in rainfall events up to the 2-year annual recurrence interval (ARI) event[3]. However larger rainfall events (for example the 10-year ARI), will continue to cause overflows.

Particularly important in this study is the description of risks before and after improvements to stormwater and wastewater networks. Three scenarios were thus investigated in this QMRA: wastewater overflows during conditions of 2-year current, 10-year current and 10-year future annual recurrence interval (ARI) rainfalls. The 2-year future ARI rainfall event was not assessed as the Gisborne District Council's (GDC) Drainwise Programme is designed to ensure that the network does not overflow in this magnitude event.

A precautionary approach was adopted. This was achieved by accounting for very high influent virus concentrations that occur during on-going but undetected viral illness

[1] Note that this assessment relates to wet weather overflows caused by rainfall.
[2] In the three-dimensional hydrodynamic modeling conducted by MetOcean which captured 8 river flow, tidal flow and wind conditions.
[3] A rainfall event of a magnitude that occurs on average only once every two years.

outbreaks in the community; assuming the wastewater overflow is not diluted by stormwater; reporting children's illness risk as opposed to the generally lower adults' risk; including a dilution-only scenario that does not include solar ultraviolet-based inactivation of viruses; and applying a bioaccumulation factor to shellfish.

Fourteen exposure sites were considered in this QMRA report; Site 1 (farthest horizontal distance to discharge along the Centennial Marine drive shoreline), Site 2, 3 and 5 (along the Kaiti Beach Road shoreline), Site 4 (close to Wainui Road and the outlet of the discharge into the Poverty Bay), Site 9 (along the Te Oneroa walkway shoreline), Sites 10,12,12 and 13 (sites further away from the shoreline into the Poverty Bay), Site 14 (on the Waikanae River). Other sites included in the QMRA and closest to the overflow discharge are Sites 6 (on the Waimata River), 7 (close to Oak Street) and 8 (close to Peel Street).

The key results are:

Enteric Illness Risks (Swimming)

- During the two current scenarios (2-Yr Current and 10-Yr Current ARI), overall predicted enteric illness risks among 100 individuals (children) who swim at 5 out of the 14 exposure sites were below the NOAEL (no observable adverse effect level). Low enteric illness risks were predicted to be associated with recreation at the other exposure sites (i.e. Sites 1, 2, 4, 6, 7, 8, 9, 11 and 12). Particularly low enteric illness risks were predicted to be associated with recreation at Site 1, during southeasterly winds.
- During the 10-Yr Future ARI scenarios (i.e. after implementation of GDC's Drainwise programme with concomitant stormwater inflow reduction and drainage improvements), overall predicted enteric illness risks among 100 children engaging in recreation at all 14 of the exposure sites were below the NOAEL.

Acute Febrile Respiratory Illness Risk (Inhalation)

- During the two current scenarios (2-Yr Current and 10-Yr Current ARI), overall predicted acute febrile respiratory illness risks among 100 individuals (children) who swim at 4 out of the 14 exposure sites were below the NOAEL (no observable adverse effect level). Low enteric illness risks were predicted to be associated with recreation at the other exposure sites (i.e. Sites 1, 2, 4, 6, 7, 8, 9,10,11 and 12). Particularly low enteric illness risks were predicted to be associated with recreation at Site 1, during southeasterly winds.

- During the 10-Yr Future ARI scenarios (i.e. after implementation of GDC's Drainwise programme with concomitant stormwater inflow reduction and drainage improvements), overall predicted respiratory illness risks among 100 children engaging in recreation at all 14 of the exposure sites were below the NOAEL.

Enteric Illness Risk (Shellfish consumption)

- Low to high risks are associated with consumption of raw shellfish harvested at most of the exposure sites (13 out of 14 sites) during the 2-Yr Current ARI and the 10-Yr Current ARI scenarios.
- Following stormwater inflow reductions reductions and drainage improvements (in the 10-Yr Future ARI scenario), overall predicted risks associated with raw shellfish consumption predominantly ranged from low to moderate. For instance, at Sites 6, 7 and 8, which are the closest to the discharge location, enteric health risk will reduce from high (in the 2-Yr Current and 10-Yr Current ARI) to moderate risk (in the 10-Yr Future ARI scenario) following stormwater inflow reductions reductions and drainage improvements. The most notable improvement is predicted at Site 4 (10-Yr Future ARI scenario); the risks associated with raw shellfish consumption will be reduced from high risk (currently) to below the NOAEL in six out of the eight tested river flow, tidal flow and wind conditions.
- While the QMRA modelling in this study focused only on the effect of reduction of stormwater inflows in the 10-Yr Future ARI scenario, other proposed improvements such as reduction in the frequencies of the overflow (from approximately three per year currently to less than one every two years) will also further reduce overall health risk.

From a health risk perspective, results of this QMRA thus indicate that the proposed future changes delivered through GDC's Drainwise Programme result in a significant improvement over existing conditions.

The QMRA results herein presented are for attributable risk, i.e., the increment in risk associated with the overflow discharges only. That is, the results do not account for the continuous discharge of treated wastewater from the WWTP outfall in Tūranganui-a-Kiwa/Poverty Bay nor urban and rural stormwater runoff, which will add to the potential health risks from overflows. Hence, while the results suggest that the enteric risk associated with ingestion during recreational water use is below the NOAEL at some sites, the risks may be higher than NOAEL when the continuous discharge from the WWTP and other sources are considered. Health risks associated with continuous discharges from the WWTP will be addressed in a second QMRA. In the meantime, as a key way of managing all risk associated with overflows (both recreation and shellfish gathering),

regulatory authorities should continue to advise that members of the public avoid the use of these sites for recreational purposes and shellfish harvesting days after an overflow event or heavy rainfall.

1. Introduction

Streamlined Environmental was contracted to provide a health risk assessment associated with wastewater overflows (a mixture of raw wastewater[4] and stormwater[5]) into Gisborne city rivers during large rainfall events. These overflows are caused by excessive ingress of stormwater into the wastewater network, primarily associated with private property drainage issues. Currently the network overflows approximately three times per year (on average).

Quantitative Microbial Risk Assessment (QMRA) is an integral part of assessing the effects of wastewater discharges and is used here to inform the risks to human health associated with contact recreation and consumption of harvested raw shellfish. QMRA is also used here to identify further improvements, where applicable, that may be required to minimise risks.

Particularly important in this study is the description of risks before and after improvements to stormwater and wastewater networks, including private drainage, which will be carried out as part of the Gisborne District Council (GDC) operational and capital works programmes, including the Drainwise Programme. The aim of these improvements is to substantially reduce stormwater ingress to the wastewater network and implement other drainage improvements so that the wastewater network does not overflow in rainfall events up to the 2-year annual recurrence interval (ARI) event[6]. However larger rainfall events (for example the 10-year ARI), will continue to cause overflows.

It is important to note that this QMRA focuses only on attributable risk, i.e., the increment in risk associated with occasional wastewater overflow discharges that may occur during heavy rainfall. Overflows occur on top of a continuous daily discharge of treated wastewater from the Gisborne Wastewater Treatment Plant (WWTP) outfall located in Tūranganui-a-Kiwa/Poverty Bay[7] and contaminants carried in stormwater/river flows from urban and upstream rural catchments. Health risks accounting for continuous discharge of treated wastewater will be addressed in a future QMRA.

[4] Wastewater is any water that has been used by some human domestic or industrial activity and, because of that, now contains waste products while sewage is a suspension of water and solid waste, transported by sewers to be disposed of or processed.
[5] Stormwater is the rainfall that is not absorbed by the ground. Urban stormwater runoff is generally directed into a separate drainage network that conveys and discharges stormwater to Gisborne's rivers and coastal waters. However, parts of Gisborne are not serviced by a stormwater network. In these areas, stormwater is usually directed to ground soakage.
[6] A rainfall event of a magnitude that occurs on average only once every two years.
[7] We note that Council is currently upgrading the WWTP to install clarification and UV treatment. This will substantially reduce risks from this source.

2. Quantitative Microbial Health Risk Assessment

2.1 Overview

QMRA is a framework that applies information and data incorporated into mathematical models to assess the potential spread of pathogens through environmental exposures and to characterize the nature of associated adverse outcomes. While quantitative risk assessment was initially designed to assess risks of exposure to various hazards, particularly chemicals, it has since been modified to incorporate risks related to exposure to microbial pathogens (NRC 1983). Risk is the combination of the likelihood of identified hazards causing harm in exposed populations in a specified time frame and the severity of the consequences (Hrudey, Hrudey, and Pollard 2006).

Typically, four steps are involved in QMRA (Haas, Rose, and Gerba 1999):

- hazard identification;
- exposure assessment;
- dose-response analysis, and;
- risk characterization.

2.2 Hazard Identification

A number of pathogens have been identified in untreated wastewater in New Zealand (Jacangelo et al. 2003; McBride 2007). These infectious agents, typically present in high concentrations, present significant public health risks (Lodder et al. 2010; Okoh, Sibanda, and Gusha 2010, Hai et al. 2014). These include: protozoans, which can cause life-threatening diseases including giardiasis, cryptosporidiosis, dysentery and amoebic meningoencephalitis (Bitton 2010); viruses, which can cause paralysis, meningitis, respiratory disease, encephalitis, congenital heart anomalies and upper respiratory and gastrointestinal illness (Melnick, Gerba, and Wallis 1978; Toze 1997; Okoh, Sibanda, and Gusha 2010); and bacteria, consisting of the enteropathogenic and opportunistic bacteria which cause gastrointestinal diseases such as cholera, dysentery, salmonellosis, typhoid and paratyphoid fever (Toze 1997; Cabral 2010).

For environmental waters impacted by wastewater overflows in the Tūranganui-a-Kiwa/Poverty Bay environment, the ideal gastrointestinal pathogens considered for human risk assessment are members of the bacterial genus *Salmonella*; noroviruses and enteroviruses; and the parasites associated with cryptosporidiosis, giardiasis and ascariasis. Norovirus, enterovirus and adenovirus have been used as representative viruses for previous studies in New Zealand (Dada 2018a; 2018b; Dada 2019; McBride 2007, 2011, 2012, 2016). While norovirus and enterovirus are significant contributors to

enteric infections, adenovirus can cause respiratory illnesses via inhalation of aerosols from contaminated water during swimming, skiing and other water-related recreational activities. *Salmonella*, Giardia, *Cryptosporidium* and *Ascaris lumbricoides* have also been used as reference pathogens in previous QMRAs (Amha et al 2015; Bastos et al 2008; Dada 2019; McBride et al 2013; Fidjeland 2010; Henao-Herreño et al 2017; Hamilton et al 2018; McCuin and Clancy 2006; Stevens et al 2017). Other technical reasons warranting the choice of reference pathogens are detailed in Appendix 1.

2.3 Exposure Assessment

During heavy rainfall, stormwater enters the wastewater network through a range of mechanisms. These include inflow: the direct entry of stormwater from roofs and overland flow into the wastewater network; and infiltration: groundwater entry through cracks in the pipe network. Many of these issues arise on private property and are associated with poor or aged private drainage systems.

Where the volume of stormwater inflow and infiltration causes the capacity of the wastewater network to be exceeded, the system surcharges and overflows from either formal (manually operated constructed relief valves) or informal (e.g. wastewater manholes, private household gulley traps) overflow points. To avoid the latter, and associated public health risks, GDC opens overflow relief valves to discharge overflows at controlled points once it is determined that overflows are likely to occur.

Over the years, GDC has implemented a range of infrastructure and management improvements to progressively reduce overflows and to manage those that do occur to limit the discharge (in all but extreme rainfall) to two primary and two secondary overflow points. These locations are shown in Figure 1. The mixture of stormwater and wastewater mixes with river water in the Taruheru and Waimata Rivers and eventually disperses within Tūranganui-a-Kiwa/Poverty Bay.

GDC is continuing to implement drainage improvements via its Drainwise programme, with the aim of removing a substantial proportion of the stormwater from the wastewater network. When this is achieved, overflow frequencies should be reduced such that the wastewater network does not overflow in rainfall events up to the 2-year ARI

Exposure assessment involves identification of human populations that could be affected by pathogens. In order to assess the potential level of exposure, the following were considered:

- proximity of the site to discharge outlet;

- exposure pathways that allow the pathogen to reach people and cause infection (through the air, through ingesting polluted water, consuming shellfish, etc.);
- range (minimum, maximum and median) of pathogen concentrations in treated effluent;
- discharge volume of untreated wastewater;
- environmental fate of microbial contaminants in the marine receiving environment, considering the effects of dilution;
- how much water a child[8] will ingest over a period of time during a particular recreational activity; and
- amount, frequency, length of time of exposure, and doses for an exposure.

The main individuals at risk of exposure to pathogens in the receiving environment (marine and river sites) due to wastewater overflows from the Gisborne wastewater network are those that engage in any sort of contact recreation at, or those who consume raw shellfish collected from, sites potentially impacted by the overflows.

2.3.1 Exposure assessment sites

In consultation with science staff at GDC, 14 key sites in Gisborne's rivers and Tūranganui-a-Kiwa/Poverty Bay for recreational water contact and for harvesting of shellfish were identified. These sites could be potentially impacted as a result of discharge of wastewater overflow (see Figure 1). The selected exposures sites are: Site 1 (farthest horizontal distance to discharge along the Centennial Marine drive shoreline), Site 2, 3 and 5 (along the Kaiti Beach Road shoreline), Site 4 (close to Wainui Road and the outlet of the discharge into the Poverty Bay), Site 9 (along the Te Oneroa walkway shoreline), Sites 10,12,12 and 13 (sites further away from the shoreline into the Poverty Bay), Site 14 (on the Waikanae River). Other sites included in the QMRA and closest to the overflow discharge are Sites 6 (on the Waimata River), 7 (close to Oak Street) and 8 (close to Peel Street).

Pathogen concentrations at sites 4, 6, 7 and 8 would be generally higher compared to the other distant sites (1, 2, 3, 5, 9, 10, 11, 12 and 13) where generally higher dilutions occur. Details of the dilutions occurring at all sites are reported in the MetOcean hydrodynamic report (Brett Beamsley[9]).

[8] A child is considered to be the worst-case risk because studies show that ingestion rates for children are twice as much as for adults (e.g. Dufour et al 2006) as reported in McBride (2017) QMRA for Bell Island WWTP outfall.
[9] Scour event modelling: Poverty Bay. Report Prepared for Gisborne District Council. Feb 2019

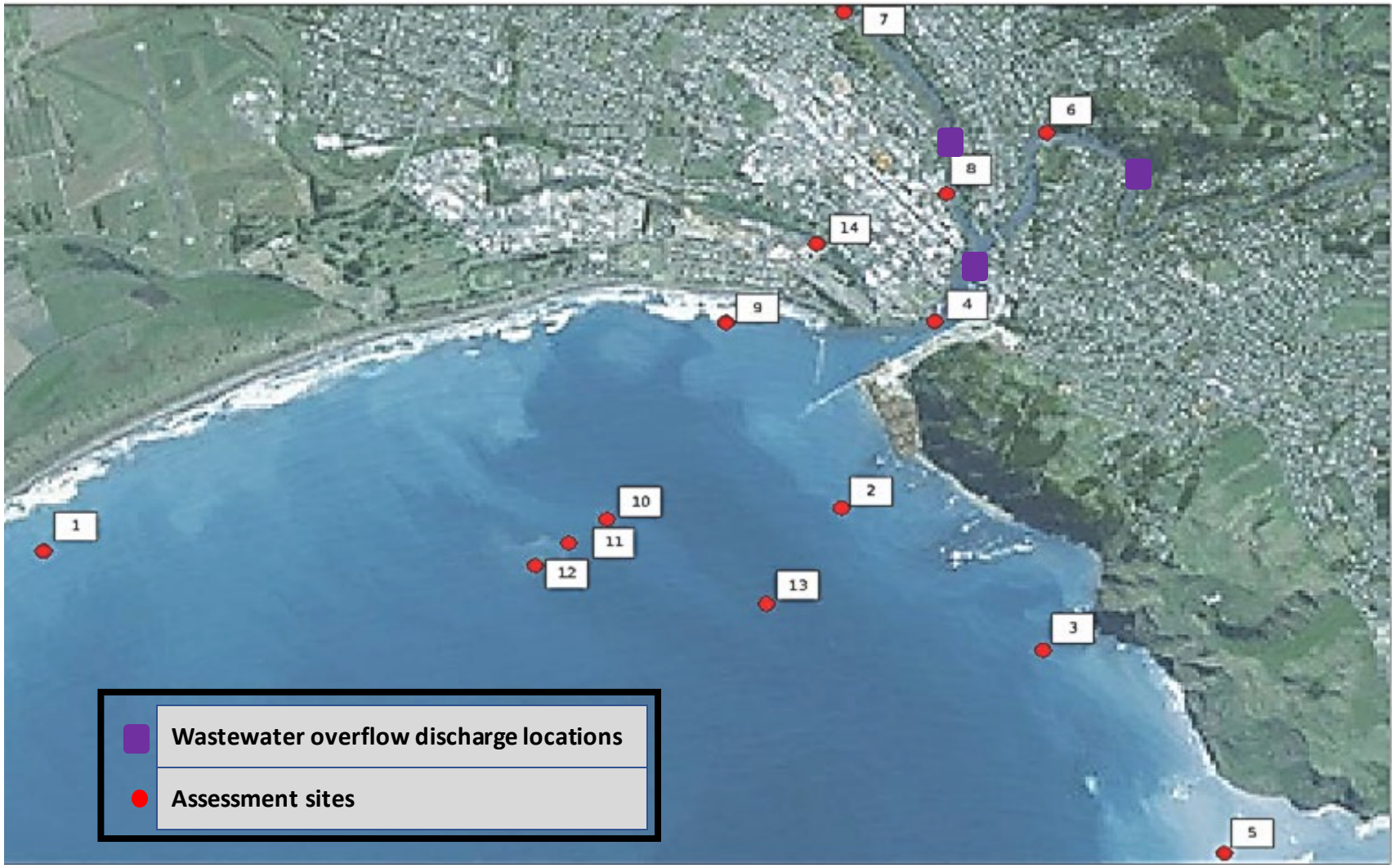

Figure 1 Wastewater overflow discharge locations and assessment sites used in this QMRA. Sites 6, 7, 8 and 14 are freshwater sites while all other sites are marine.

2.3.2 Dilution of the wastewater overflow

MetOcean used three-dimensional hydrodynamic modelling to estimate dispersion and dilution in Poverty Bay of wastewater overflow discharged from the outfalls in Figure 1 under a range of weather/oceanographic scenarios (Table 1). Each simulation is unique in terms of initial tidal state, wind and rainfall. 2-year and 10-year annual recurrence interval (ARI) rainfalls were modelled. Both the existing and future (following the implementation of drainage improvements) were modelled[10]. River forcing in the MetOcean model varied depending on whether the 2-year or the 10-year ARI rainfall was being simulated[11]. For each ARI rainfall, discharges were modelled under two different tides (mean high water spring [MHWS] and mean low water spring [MLWS]) and four winds. Details are presented in a separate MetOcean report.

MetOcean's model provided time series data of water column pathogen concentrations following the discharge (time-step 15 min up to 2.5 days after a wastewater overflow event). The pathogen concentrations yielded by the model reflect the fate of microbial contaminants following dilution in the river/marine receiving environment. An in-depth discussion of the dilution has been presented in the MetOcean report[12]. Most sites experienced wastewater plume dilution after 6 hours of >10,000, with the notable exception of Sites 4 and 9, which had lower dilutions of 3,170 and 5,390, respectively. After 24 and 48 hours, the minimum dilution at all sites is either static or increases (Table 2).

[10] Note that the future 2-year ARI event was not modelled as the network is not predicted to overflow in this event following stormwater inflow reduction and drainage improvements

[11] As above, no future 2-year event was modelled as the aim of the Drainwise programme is to remove sufficient stormwater such that the wastewater network will not overflow in a 2-year event.

[12] MetOcean Draft Report on Scour event modelling: Poverty Bay

Table 1 Model scenarios applied in this QMRA model.

Scenario	Code	Description
2-Year Current ARI	2yrs_current_NW15_MHWS 2yrs_current_NW15_MLWS 2yrs_current_NW25_MHWS 2yrs_current_NW25_MLWS 2yrs_current_SE15_MHWS 2yrs_current_SE15_MLWS 2yrs_current_SE25_MHWS 2yrs_current_SE25_MLWS	2yrs_current_ARI northeast and southeast winds (15 and 25 $m.s^{-1}$) MHSW and MLWS no improvement in sewage network
10-Year Current ARI	10yrs_current_NW15_MHWS 10yrs_current_NW15_MLWS 10yrs_current_NW25_MHWS 10yrs_current_NW25_MLWS 10yrs_current_SE15_MHWS 10yrs_current_SE15_MLWS 10yrs_current_SE25_MHWS 10yrs_current_SE25_MLWS	10yrs_current_ARI northeast and southeast winds (15 and 25 $m.s^{-1}$) MHSW and MLWS no improvement in sewage network
10-Year Future ARI	10yrs_future_NW15_MHWS 10yrs_future_NW15_MLWS 10yrs_future_NW25_MHWS 10yrs_future_NW25_MLWS 10yrs_future_SE15_MHWS 10yrs_future_SE15_MLWS 10yrs_future_SE25_MHWS 10yrs_future_SE25_MLWS	10yrs_current_ARI northeast and southeast winds (15 and 25 $m.s^{-1}$) MHSW and MLWS upgrades and improvement in sewage network that reduce intensities of overflow events

Table 2 Dilutions from MetOcean hydrodynamic model.

Descriptor	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
Dilution (6 hours all scenarios)														
Minimum	7,970	15,200	36,322	3,190	38,667	30,700	10,000	10,100	5,450	21,400	14,200	9,840	19,600	0
Median	3,721,150	590,000	839,000	6,433	202,000	38,400	10,400	10,400	8,602	270,000	162,000	139,000	639,500	0
Maximum	2E+27	5E+16	1E+25	16,300	1E+36	47,200	10800	10800	2E+24	9E+13	5E+12	7E+09	2E+15	0
Dilution (24 hours all scenarios)														
Minimum	8,130	13,600	28,200	3,170	24,500	44,800	10,000	10,100	5,390	19,700	12,900	10,700	17,300	0
Median	73,500	77,350	136,000	7,704	259,500	45,900	10,400	10,400	10,750	53,900	43,700	35,100	74,000	0
Maximum	5E+07	2E+07	4E+07	2E+04	1E+35	5E+04	1E+04	1E+04	4E+06	7E+06	2E+06	1E+06	8E+06	0
Dilution (48 hours all scenarios)														
Minimum	8,650	31,000	24,700	9,030	23,100	0	0	0	13,600	21,000	16,900	14,200	24,900	0
Median	844,500	120,000	113,300	5,310,000	400,000	0	0	0	330,000	113,750	83,425	37,800	100,573	0
Maximum	2E+07	4E+06	5E+06	6E+09	2E+09	0	0	0	7E+07	9E+06	7E+06	7E+06	8E+06	0

2.3.3 Wastewater overflow pathogen concentrations

GDC conducted a limited microbiological analysis of the WWTP influent samples (enumeration was conducted by DNAture NZ in 2019). Published New Zealand QMRAs have also documented a range of pathogen concentrations that are typical of raw wastewater in New Zealand (McBride 2007, 2011; 2012; 2016a,b). Other studies (e.g. McBride et al 2013) have also documented pathogen concentrations in stormwater. As stormwater ingress into the wastewater network i.e. wet-weather overflows, dilution and reduction of the pathogen concentrations will occur in the resulting mixture of wastewater and stormwater. Although GDC has advised that Gisborne's wastewater overflows are expected to be at 75-88.3% stormwater[13], as a conservative approach, we have assumed in this QMRA that the content discharged is 100% raw wastewater (

Table 3).

Table 3 Raw WWTP overflow pathogen concentrations (cells per L) applied in this QMRA.

Pathogen	Minimum	Median	Maximum	Assessment of risks associated with
Adenovirus	2,000	5,000	30,000,000	Contact recreation (CR)
Enterovirus	500	4,000	50,000,000	Contact recreation (CR) Shellfish gathering (SG)
Norovirus	100	10,000	10,000,000	Contact recreation (CR) Shellfish gathering (SG)
Cryptosporidium	1	100	5,000	Contact recreation (CR) Shellfish gathering (SG)
Giardia	1	50	10,000	Contact recreation (CR) Shellfish gathering (SG)
Salmonella	1	500	3,000	Contact recreation (CR) Shellfish gathering (SG)
Ascaris (Helminths)	1	50	800	Contact recreation (CR) Shellfish gathering (SG)

(*Sources of reference pathogen concentrations in raw wastewater: GDC-DNAture 2019 pathogen monitoring study, Other QMRAs e.g. McBride 2007, 2011; 2012; 2016a,b; McBride et al 2013, Soller et al 2010, EPA, 1991 and 1992). Pathogen concentrations were bounded in hockey-stick distributions that are strongly right skewed with a hinge at the 95th percentile, in line with previous New Zealand QMRAs (e.g. Dada 2018a; 2018b; McBride 2007, 2011; 2012; 2016; Stewart et al 2017).

[13] Gisborne's wastewater network is sized to carry 4 to 6 times normal wastewater flows. Hence, overflows are expected to be at least 75% stormwater.

To estimate final concentrations of pathogens at each of the exposure sites[14], dilution factors (time-series) from hydrodynamic modelling conducted by MetOcean were multiplied by QMRA pathogen concentrations fitted to a "hockey-stick"[15] distribution. This approach has been explained and justified in a previous stormwater QMRA (McBride et al 2013).

2.3.4 Predicting exposure doses

Typically, the dose of the pathogen that an individual ingests, inhales or comes into contact with is used as input to the dose-response models to predict the probability of infection or illness. The wastewater pathogen concentrations (as described in Section 2.3.3) and the ingestion rates for the water users (adults and children, in the case of swimming or other contact recreation, Figure 2) were used to convert pathogen concentrations in the receiving environment into doses. Water ingestion rates applied in the QMRA were based on previous studies that have applied biochemical procedures to trace a decomposition product of chlorine-stabilizing chloroisocyanurate which passes through the surveyed swimmers' bodies unmetabolized (Dufour, Evans, Behymer, & Cantu, 2006; McBride, 2016). Details of these dose-response models are presented in Appendices 2 and 3.

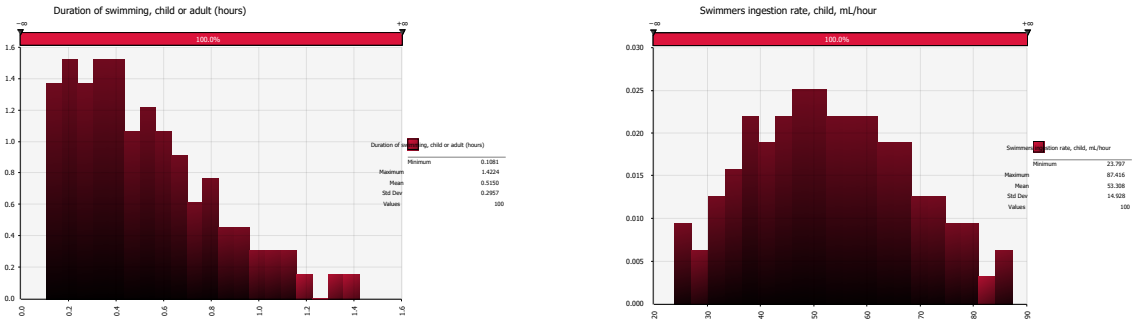

Figure 2 Duration of swimming and swimmers' ingestion rates applied in this QMRA.

In order to assess risks due to consumption of raw harvested shellfish, ingestion rates used were informed by estimates of daily intake of 98 consumers of mussels, oysters, scallops, pipi and tuatua in the 1997 National Nutrition Survey, as reported in previous

[14] After dilution in the receiving environment.

[15] In accordance with previous QMRA reports (e.g. McBride 2016a,b reports for Warkworth WWTP QMRA and Snells Beach QMRA), minimum, median and maximum virus concentrations were bounded in the hockey-stick distribution in a way that the resulting data are strongly right skewed with a hinge at the 95%ile. The RiskGeneral function was used to generate the random draws from the right-skewed distribution of virus concentrations. This, therefore, presents in the same population the generally predominant lower virus concentrations (i.e. having higher probabilities) alongside the extreme concentrations (which could be said to be rare but substantial). In this way, the QMRA aligns with the Resource Management Act, which defines an "effect" to include considerations for instances of rare (i.e. low probability of occurrence) but elevated virus concentrations. These "low probability events with high potential impact" are effectively captured in the hockey-stick distribution.

New Zealand QMRAs e.g. McBride (2005, 2016). We followed previous QMRA reports (e.g. McBride 2016 a, b) and assessed risks due to ingestion of raw shellfish tissue using bivalve molluscs as the vector. This is because bivalve molluscs are very common and accessible in New Zealand waters, are very frequently consumed raw, and because they are known to 'bioaccumulate' pathogens. Bioaccumulation is represented by the additional multiplier effect called the pathogen bioaccumulative factor (PBAF, see Table 4) applied in our model (Bellou, Kokkinos, and Vantarakis 2013; Hanley 2015; Hassard et al. 2017).

2.3.5 Dose-response models

Dose-response models estimate the risk of a response (for example, infection or illness) given a known dose of a pathogen. Dose-response models are mathematical functions which describe the dose-response relationship for specific pathogens, transmission routes and hosts. Additional dose-response details are presented in Appendices 2 and 3.

2.3.6 Risk characterization

Information from the previous steps is incorporated into Monte Carlo simulations to determine the likelihood of illness from exposure to pathogens. The Monte Carlo simulation is a randomization method that applies multiple random sampling from distributions assigned to key input variables in a model. Typically, in a Monte Carlo model run, 100 individuals who do not have prior knowledge of existing contamination in the water are 'exposed' to potentially infectious water on a given day and this exposure is repeated 1,000 times. Therefore, the total number of exposures is 100,000. The result of the analysis is a full range of possible risks, including average and worst-case scenarios, associated with exposure to pathogens during the identified recreational activities or following consumption of raw shellfish. Monte Carlo simulations were undertaken using @Risk software (Palisade, NY).

QMRA results are reported both in terms of infection and illness. We note, however, that not all individuals that become infected eventually become ill. Although pathogen dose-response models in literature were determined based on infection endpoint, illness endpoint was estimated simply using a uniform probability for illness as was done in several previous QMRAs (e.g. McBride 2011, 2017). We applied infection/illness ratios of 0.60 and 0.5 for noroviruses and adenoviruses (McBride 2016). Due to the relative unavailability of dose-response and morbidity data for Enterovirus, *Salmonella*, *Cryptosporidium* and Helminths, we used a precautionary approach, that is, every individual who contracted infections as a result of these pathogens also became ill, which is achieved by applying an infection/illness ratio of 1. This is in line with methods applied in previous New Zealand QMRAs e.g. McBride 2011, 2016a,b).

Table 4 Distributions and inputs for the QMRA.

Parameter	QMRA Statistics applied	Comments
Duration of swim (hours)	Minimum = 0.1 Median = 0.25 Maximum = 2	For child or adult (McBride 2007, 2011; 2012; 2016)
Swimmers water ingestion rate, mL per hour	Minimum = 20 Median =50 Maximum = 100	PERT distribution for a child rate. Typically, adult rate is half the child rate (Dufour et al, 2006)
Water inhalation rate, mL per hour	Minimum = 10 Median =25 Maximum = 50	PERT distribution for an adult, assumed as half of child rate (McBride 2007, 2011; 2012; 2016)
Dose response parameters	Adenovirus Type 4 (simple binomial model, r = 0.4142) Prob(illness/infection)=0.5	Dada 2018a; 2018b; McBride 2007, 2011; 2012; 2016; Stewart et al 2017, Soller et al 2010a,b
	Enterovirus (beta-binomial model, α = 1.3, β =75) Prob(illness/infection)=1	Dada 2018a; 2018b; McBride 2007, 2011; 2012; 2016; Stewart et al 2017, Soller et al 2010a,b
	Norovirus (beta-binomial model, α = 0.04, β =0.055) Prob(illness/infection)=0.6	Dada 2018a; 2018b; McBride 2007, 2011; 2012; 2016; Stewart et al 2017, Soller et al 2010
	Cryptosporidium LT2ESWTR Bayesian dose-response model (r=0.09) Prob(illness/infection)=1	See USEPA, 2006; Messner et al. (2001)
	Giardia dose-response model (r=0.0199) Prob(illness/infection)=1	See Rose et al. (1991)
	Salmonella (conservative beta-Poisson model, α = 0.2767 and β = 21.159) Prob(illness/infection)=1	Unlike the typical beta-Poisson model with model parameters α = 0.3126 and β = 2884, this approach was more conservative, in line with Marjala et al (2005).
	Helminths (exponential model dose-response using at a worst-case single hit approach, r=1. Prob(illness/infection)=1	Navarro et al 2009, Kundu et al 2014
Shellfish size	α = 2.2046 β = 75.072 γ = -0.903	Loglogistic distribution between 5g and 800g, based on estimates of daily intake of consumers of raw shellfish (see McBride 2005, McBride 2007, 2011; 2012; 2016, Russel et al 1999)

Pathogen bioaccumulation factor (PBAF)	Mean = 49.9 Standard deviation = 20.93	Normal distributions around mean. Pathogen dose upon consumption of 100 grams of shellfish is a product of the PBAF and the number of pathogens in an equivalent volume of water (see Burkhardt & Calci 2000, McBride 2007, 2011; 2012; 2016)

We report the predicted risk as the IIR (individual illness risk), which is calculated as the total number of infection cases divided by the total number of exposures, expressed as a percentage. The IIR is then compared with thresholds defined in the New Zealand "Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas" (MfE/MoH 2003). Depending on the risk being examined, the applicable NZ thresholds differ.

In the case of risk due to enteric illnesses as a result of ingestion of polluted water while swimming or consumption of raw shellfish, the following thresholds apply:

- high illness risk (>10% GI illness);
- moderate illness risk (5-10% GI illness);
- low illness risk (1-5% GI illness);
- NOAEL (<1%). The 1% IIR threshold, also referred to as the 'no observable adverse effects level (NOAEL), is the widely-accepted threshold when assessing the effect of wastewater discharge on recreational health risk (Dada 2018a; 2018b; McBride 2016a,b, 2017; Stewart et al 2017).

When the IIR is greater than 1%, the discharge is expected to be associated with some health risks. For instance, when IIR is less than 1%, there is a probability of less than one case of enteric infection in every 100 exposures. If IIR falls between 1 and 5%, this means a maximum of 5 cases of infection in 100 exposures. An IIR above 5% presents an even greater chance of infection (1 in 20 to 1 in 10 cases of gastroenteritis for a single exposure[16]). An IIR above 10% presents a greater than 10% chance of illness per single exposure.

In the case of acute febrile illness risk due to inhalation of polluted water, comparatively lower thresholds apply:

- high illness risk (>3.9% AFRI illness);
- moderate illness risk (1.9-3.9% AFRI illness);
- low illness risk (0.3-<1.9% AFRI illness);

[16] MfE (2003) Ministry of Health Guideline values for microbiological quality of freshwater recreational waters.

- NOAEL (<0.3%).

3. Results

3.1 Ingestion during recreational water use

Table 5 presents predictions of IIR among 100 individuals who ingest water while swimming at any of the 14 sites exposed to wastewater overflows during varying river flow, tidal flow and wind conditions. "Overall" enteric illness results are presented in Table 5, where the overall IIR per site is defined as the maximum IIR reported from all of the six reference pathogens (enterovirus, norovirus, *Cryptosporidium*, Giardia, *helminths-Ascaris* and *Salmonella*). See Appendix 4 for results for each individual pathogen.

During the two current scenarios (2-Yr Current and 10-Yr Current ARI), overall predicted enteric illness risks among 100 individuals (children) who swim at 5 out of the 14 exposure sites were below the NOAEL (Table 5). Low enteric illness risks were predicted to be associated with recreation at Sites 1, 2, 4, 6, 7, 8, 9, 11 and 12 (Table 5). Particularly low enteric illness risks were predicted to be associated with recreation at Site 1 during southeasterly winds (Table 5).

At Site 1 (the farthest horizontally from the discharge), IIR during the 2-Yr Current and 10-Yr Current ARI scenarios was generally below the NOAEL under northwesterly winds, which drive the overflow plume away from the shoreline and into the Bay where further dilution occurs. On the other hand, under southeasterly winds, low risks were predicted to be associated with recreation at Site 1.

During the 10-Yr Future ARI scenarios (that is, after the substantial stormwater inflow reduction and other drainage improvements), overall predicted enteric and respiratory illness risks among 100 children engaging in recreation at any of the 14 exposure sites were below the NOAEL (Table 5 and Table 6).

The MetOcean dilution modelling showed that the wastewater overflow plume does not reach Site 14 (on the Waikanae River), enteric illness risks for this site are predicted to be less than the NOAEL.

3.2 Inhalation during recreational water use

Table 6 presents predictions of IIR among 100 individuals who inhale water containing aerosolized adenoviruses at any of the 14 sites exposed to untreated wastewater overflows. As discussed in Section 3.1, these QMRA results are for attributable risk, i.e., the increment in risk associated with the overflow discharges only.

During the two current scenarios (2-Yr Current and 10-Yr Current ARI), predicted acute febrile respiratory illness risks among 100 children were below the NOAEL at 4 out of the 14 sites (Table 6). Low enteric illness risks were predicted to be associated with recreation at the other exposure sites (i.e. Sites 1, 2, 4, 6, 7, 8, 9,10,11 and 12). Particularly low enteric illness risks were predicted to be associated with recreation at Site 1, during southeasterly winds (Table 6).

During the 10-Yr Future ARI scenarios (that is, after stormwater reductions/drainage improvements), overall predicted respiratory illness risks among 100 children who engage in recreational activities at any of the 14 exposure sites were below the NOAEL (Table 6).

3.3 Consumption of raw harvested shellfish

Table 7 presents predictions of overall IIR among 100 individuals who consume raw shellfish that were harvested from any of the exposure sites impacted by untreated stormwater discharge during varying river flow, tidal flow and wind conditions. Results of predicted IIR for each individual pathogen are presented in Appendix 4.

Low to high risks are associated with consumption of raw shellfish harvested at most of the exposure sites (13 out of 14 sites) during the 2-Yr Current ARI and the 10-Yr Current ARI scenarios. The MetOcean dilution modelling showed that the wastewater overflow plume does not reach Site 14, attributable risks for this site are predicted to be less than the NOAEL.

At Site 1, low risks are associated with consumption of raw harvested shellfish during the 2-Yr Current and 10-Yr Current ARI scenarios under northwesterly winds. The northwesterly winds drive the stormwater discharge plume away from the shoreline and into the bay where further dilution occurs. On the other hand, under southeasterly winds, generally high risks were predicted to be associated with consumption of raw shellfish harvested at Site 1.

QMRA results for the 2-Yr Current and 10-Yr Current ARI scenarios suggest that shellfish harvested at most of the sites (13 out of 14) may be impacted by wastewater overflows (Table 7). The proposed stormwater inflow reductions and drainage improvements (10-Yr Future ARI scenario) will reduce the risks associated with raw shellfish consumption at the exposure sites. For instance, enteric health risk at 9 out of the 14 considered sites will reduce from high to low risk following stormwater inflow reductions. At Sites 6, 7 and 8, which are the closest to the discharge location, enteric health risk will reduce from high to moderate risk following stormwater inflow reductions reductions and drainage improvements (10-Yr Future ARI scenario). The most notable improvement is predicted at Site 4 (10-Yr Future ARI scenario); the risks associated with raw shellfish consumption

will be reduced from high risk to below the “no observable adverse effect level” (NOAEL) in six out of the eight tested river flow, tidal flow and wind conditions.

Table 5. Overall Child Individual's Illness Risk (%) associated with swimming at one of the 14 exposure sites containing pathogens during the 2-Yr Current ARI, 10-Yr Current ARI and 10-Yr Future ARI stormwater discharge scenarios [12-hr after overflow].

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL
10yrs_current_NW15_MLWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	Low	Low	NOAEL	NOAEL
10yrs_future_NW15_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_NW15_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_NW15_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_future_NW15_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_NW25_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_NW25_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	Low	NOAEL	NOAEL	NOAEL
10yrs_future_NW25_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_NW25_MLWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_NW25_MLWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	NOAEL
10yrs_future_NW25_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE15_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL
10yrs_current_SE15_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL
10yrs_future_SE15_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE15_MLWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_SE15_MLWS	Low	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_future_SE15_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE25_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_SE25_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_future_SE25_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE25_MLWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_SE25_MLWS	Low	Low	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	Low	Low	NOAEL	NOAEL
10yrs_future_SE25_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL

IIR> 10%	High illness risk
IIR (5-10%)	Moderate illness risk
IIR (1-4.99%)	Low illness risk
IIR <1%	NOAEL

*enteric illness risk due to ingestion

Table 6. Overall Individual's Illness Risk (%) associated with inhalation of aerosolized pathogens at the vicinity of any of the 14 exposure sites receiving wastewater overflows during the 2-Yr Current ARI, 10-Yr Current ARI and 10-Yr Future ARI stormwater discharge scenarios [12-hr after overflow].

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL
10yrs_current_NW15_MLWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL
10yrs_future_NW15_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_NW15_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_NW15_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL
10yrs_future_NW15_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_NW25_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_NW25_MHWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_future_NW25_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_NW25_MLWS	NOAEL	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_NW25_MLWS	NOAEL	Low	NOAEL	Low	NOAEL	NOAEL	Low	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	NOAEL
10yrs_future_NW25_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE15_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	Low	NOAEL	NOAEL	NOAEL
10yrs_current_SE15_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	Low	NOAEL	NOAEL	NOAEL
10yrs_future_SE15_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE15_MLWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	Low	NOAEL	NOAEL	NOAEL
10yrs_current_SE15_MLWS	Low	NOAEL	NOAEL	Low	NOAEL	Low	Low	Low	Low	NOAEL	Low	NOAEL	NOAEL	NOAEL
10yrs_future_SE15_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE25_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_SE25_MHWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_future_SE25_MHWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
2yrs_current_SE25_MLWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL
10yrs_current_SE25_MLWS	Low	NOAEL	NOAEL	Low	NOAEL	NOAEL	Low	Low	Low	NOAEL	Low	Low	NOAEL	NOAEL
10yrs_future_SE25_MLWS	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL	NOAEL

IIR> 3.9%	High AFR illness risk
IIR (1.9-3.9%)	Moderate AFR illness risk
IIR (0.3-<1.9%)	Low AFR illness risk
IIR <0.3%	NOAEL

*Acute Febrile Resipitarory Illness (AFRI) due to inhalation

Table 7. Overall Individual's Illness Risk (%) associated with consumption of raw shellfish collected from one of the 14 exposure sites during the 2-Yr Current ARI, 10-Yr Current ARI and 10-Yr Future ARI stormwater discharge scenarios [12-hr after discharge]

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	NOAEL	High	High	High	High	High	High	High	High	High	High	High	High	NOAEL
10yrs_current_NW15_MLWS	Low	High	High	High	High	High	High	High	High	High	High	High	High	NOAEL
10yrs_future_NW15_MLWS	Low	Low	Low	NOAEL	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	NOAEL
2yrs_current_NW15_MHWS	NOAEL	High	High	High	High	High	High	High	High	High	High	High	High	NOAEL
10yrs_current_NW15_MHWS	Low	High	High	High	High	High	High	High	High	High	High	High	High	NOAEL
10yrs_future_NW15_MHWS	Low	Low	Low	NOAEL	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	NOAEL
2yrs_current_NW25_MHWS	Low	High	High	High	High	High	High	High	Low	Low	Low	Low	Low	NOAEL
10yrs_current_NW25_MHWS	Low	High	High	High	High	High	High	High	High	High	High	Moderate	High	NOAEL
10yrs_future_NW25_MHWS	NOAEL	Low	Low	Moderate	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	NOAEL
2yrs_current_NW25_MLWS	Low	High	High	High	High	High	High	High	Low	Low	Low	Low	Low	NOAEL
10yrs_current_NW25_MLWS	Low	High	High	High	High	High	High	High	High	High	High	Moderate	High	NOAEL
10yrs_future_NW25_MLWS	NOAEL	Low	Low	Low	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	NOAEL
2yrs_current_SE15_MHWS	High	Moderate	Low	High	NOAEL	High	High	High	High	High	High	High	High	NOAEL
10yrs_current_SE15_MHWS	High	Moderate	Moderate	High	Low	High	High	High	High	High	High	High	High	NOAEL
10yrs_future_SE15_MHWS	Low	Low	Low	NOAEL	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	NOAEL
2yrs_current_SE15_MLWS	High	Moderate	Low	High	NOAEL	High	High	High	High	High	High	High	High	NOAEL
10yrs_current_SE15_MLWS	High	Moderate	Moderate	High	Moderate	High	High	High	High	High	High	High	High	NOAEL
10yrs_future_SE15_MLWS	Low	Low	Low	NOAEL	Low	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	NOAEL
2yrs_current_SE25_MHWS	High	NOAEL	NOAEL	High	NOAEL	High	High	High	High	High	High	High	Moderate	NOAEL
10yrs_current_SE25_MHWS	High	High	Moderate	High	NOAEL	High	High	High	High	High	High	High	High	NOAEL
10yrs_future_SE25_MHWS	Moderate	Moderate	Low	NOAEL	NOAEL	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	NOAEL
2yrs_current_SE25_MLWS	High	NOAEL	NOAEL	High	NOAEL	High	High	High	High	Moderate	Moderate	Moderate	Moderate	NOAEL
10yrs_current_SE25_MLWS	High	High	Moderate	High	NOAEL	High	High	High	High	High	High	High	High	NOAEL
10yrs_future_SE25_MLWS	Low	Low	Low	NOAEL	NOAEL	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	NOAEL

From a health risk perspective, it is important to note that following the reduction of stormwater inflows and other drainage improvements, overflow frequency will be substantially reduced from approximately three per year currently to less than one every two years. Therefore, while an overflow event will still give rise to low public health risk, the frequency of these events will be significantly less. This reduces overall health risk substantially from the current scenario to the future (post improvements) situation.

4. Discussion

Results from this QMRA show that proposed stormwater inflow reduction and drainage improvements (10-Yr Future ARI scenario) will generally reduce the illness risks associated with ingestion or inhalation of water from low risk to below the "no observable adverse effect level" (NOAEL). Also, the reduction of stormwater inflows in the wastewater network during the 10-Yr Future ARI scenario will generally reduce the risks associated with raw shellfish consumption from high risk to low/moderate risk. While the QMRA modelling in this study focused only on the effect of reduction of stormwater inflows in the 10-Yr Future ARI scenario, other improvements such as reduction in the frequencies of the overflow (from approximately three per year currently to less than one every two years) will further reduce overall health risk by reducing the likelihood/frequency of exposure. From a health risk perspective, results of this QMRA thus indicate that the proposed future changes delivered through GDC's Drainwise programme (i.e. 10-Yr Future ARI scenario) is a significant improvement over existing conditions (i.e. 2-Yr and 10-Yr Current ARI scenarios).

It is important to note that the QMRA results for attributable risk, i.e., the increment in risk associated with the overflow discharges only. That is, the QMRA does not account for the continuous discharge of treated wastewater from the WWTP, or other sources, which will add to health risk associated with wastewater overflows. Hence, while the results suggest that the enteric risk associated with ingestion during recreational water use is below the NOAEL at some sites, the risks may be higher than NOAEL when the continuous discharge from the WWTP is considered. To compensate for possible underestimation of risks, we have taken a conservative approach in the QMRA, as mentioned previously in Section 2.3 and discussed further, below.

Additional health risks associated with continuous discharges from the WWTP will be addressed in a future QMRA. In the meantime, as a key way of managing all risk associated with overflows (both recreation and shell fish gathering), regulatory authorities should continue to advise that members of the public avoid the use of these sites for recreational purposes and shell fish harvesting days after a stormwater event or heavy rainfall.

We view this QMRA as being conservative for several reasons:

(1) We assumed that the overflow is entirely raw wastewater, thus neglecting the anticipated significant component of stormwater[17] in the overflow, which would dilute pathogen concentrations.

[17] Stormwater pathogen concentrations generally tend to be lower than raw wastewater pathogen concentrations.

(2) We fitted pathogen concentrations to the hockey-stick distribution, which allows for consideration of very high influent virus concentrations that occasionally occur during illness outbreaks in the community. While these high concentrations are rare, they have a high potential impact on the estimated risks.

(3) We report the children's illness risk as opposed to the generally lower adults' risk.

(4) We included a dilution-only scenario which does not include solar ultraviolet-based inactivation of viruses[18], to capture risks posed to early-morning recreational water users. This scenario can be considered worst-case, in which risks may be significantly overstated.

(5) We applied the bioaccumulation factor to assess risk associated with ingestion of raw shellfish tissue. Also, we assumed that consumption of shellfish is instantaneous (i.e. without depuration). While depuration of oysters after harvesting and adequate refrigeration before consumption are key steps that commercial harvesters take to reduce health risks, these steps are not routinely taken by consumers of recreational shellfish. Hence consideration of depuration was not included in this QMRA. This explains why risks from raw shellfish consumption are always calculated to be rather higher than risks associated with swimming in or near to the shellfish-harvesting waters.

5. Conclusion

Results of this QMRA show that during the two current scenarios (2-Yr Current and 10-Yr Current ARI), overall predicted enteric and respiratory illness risks among 100 individuals (children) who swim at most of the exposure sites are low.

During the 10-Yr Future ARI scenarios (that is, after improvements with concomitant reduction of stormwater inflows in the wastewater network), overall predicted enteric and respiratory illness risks among 100 children engaging in recreation at any of the 14 exposure sites are below the NOAEL. The proposed reductions in stormwater ingress into the wastewater network (10-Yr Future ARI scenario) therefore reduces risks associated with ingestion or inhalation of water at the exposure sites.

[18] The reason for the exclusion of solar radiation-based inactivation is supported by arguments in published literature (e.g. see Silverman 2013, Linden et al 2007; Jin & Flury 2002). The effectiveness of sunlight inactivation of waterborne viruses depends on complex and variable environmental factors (e.g. the intensity and spectrum of sunlight), characteristics of the water containing the virus particles (e.g. pH, DO, ionic strength, source and concentration of photosensitizers), and peculiarities of the virus particles (e.g. virus structures, genome type and prevalence of sites susceptible to photo-transformation; protein capsid composition and structure). These uncertainties present a core challenge in accurately modelling virus inactivation rates. It is thus difficult to simply compare or apply experimental UV irradiation values across different studies (Silverman 2013). For these reasons, it is not possible to reliably predict mechanisms or rates of inactivation of viruses of public health concern based on current knowledge of bacteriophage inactivation. Despite the uncertainties associated with estimating the actual rates of UV inactivation that would take place in the receiving environment, it is certain that ultraviolet inactivation will occur. MetOcean's approach to exclude solar radiation-based ultraviolet inactivation from the hydrodynamic module that produced dilution factors for this QMRA is thus, a highly conservative approach, from a public health protection perspective. Consequently, the reported risks from this QMRA include the worst-case scenario and may be overstated.

The proposed reductions in stormwater ingress into the wastewater network will also reduce the risks associated with raw shellfish consumption at the exposure sites from high and moderate risk (currently) to low risk. However, even after the stormwater network improvements, there will continue to be low risks associated with consumption of raw shellfish harvested at some sites. While the QMRA modelling in this study focused only on the effect of reduction of stormwater inflows in the 10-Yr Future ARI scenario, other proposed improvements such as reduction in the frequencies of the overflow (from approximately three per year currently to less than one every two years) will further reduce overall health risk by reducing the likelihood/frequency of exposure.

From a health risk perspective, results of this QMRA thus indicate that the proposed future changes delivered through GDC's Drainwise programme is a significant improvement over existing conditions.

6. References

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Appendix 1 Additional notes on choice of QMRA reference pathogens

We selected norovirus as the first representative viral pathogen for this QMRA because:

1. Noroviruses are host-specific, present mostly in human waste. This makes them ideal candidates for tracking primary sources of human-related faecal contamination in the environment (Ahmed et al., 2010; Mara and Sleigh, 2010).
2. Human noroviruses are now the most common cause of gastroenteritis outbreaks in children in developed countries worldwide, implicated in >90% of nonbacterial and ≈50% of all-cause epidemic gastroenteritis worldwide (Lopman et al. 2016; Lofranco 2017). They are unquestionably the most common viral cause of gastroenteritis[19] for which dose-response data are available (Mara and Sleigh, 2010; Teunis et al., 2008, CDC 2015, Farkas et al 2017).
3. As with other enteric viruses, they are often symptomatic or pauci-symptomatic[20]; they can even present a high risk of morbidity and mortality in vulnerable (high-risk) populations such as young children, elderly individuals and immunocompromised patients (Prevost et al., 2015).
4. Noroviruses often present higher illness risks than other viruses ((Vergara, Rose, and Gin 2016). Also, noroviruses have a much lower ID_{50} (the minimum dose of norovirus pathogens that can cause infection in 50% of exposed and susceptible subjects) than other viruses. Dose-response relationships suggest that a single norovirus particle can cause infections in more than 40% of susceptible individuals, a rate much higher than other viruses (McBride, 2011).
5. Norovirus outbreaks can occur throughout the year, but have been reported to occur more frequently during the colder winter seasons in temperate climates (Lofranco 2017; CDC 2014; Maunula, Miettinen, and Von Bonsdorff 2005; Ahmed, Lopman, and Levy 2013). A similar observation was made in the scoping and surrogate study on virus concentration at Mangere WWTP influent, New Zealand (Simpson et al 2003).

We selected enterovirus as a second representative viral pathogen for this QMRA because:

1. Enterovirus, one of the largest genera of viruses classified within the Picornaviridae family, represents a significant burden to public health globally (Lofranco 2017).
2. Enteroviruses target either intestinal or upper respiratory tract cells resulting in an upper respiratory tract infection or gastrointestinal illness. Enterovirus types can cause a wide spectrum of diseases within humans and present a broad range of symptoms.
3. Enteroviruses are also transmissible via sewage contaminated waters (Lofranco 2017; Health Canada 2012).
4. Although human enterovirus outbreaks can occur throughout the year depending on the strain, in temperate climates, enterovirus infections are most prevalent during summer months (Sedmak, Bina, and MacDonald 2003; Costan-Longares et al. 2008; PHAC 2015).

[19] norovirus mainly affects children under the age of three
[20] i.e. presenting few symptoms.

We selected adenovirus as the third representative viral pathogen for this QMRA because:

1. Adenovirus, a double-stranded DNA virus, is often detected in these same environments as noroviruses and enteroviruses (Choi and Jiang 2005; Sassoubre, Nelson, and Boehm 2012). However, compared to other viruses, it has been reported to have prolonged survival time and increased resistance to disinfection e.g. UV treatments (Albinana-Gimenez et al. 2009; Wyer et al. 2012; Kundu, McBride, and Wuertz 2013; Hewitt et al. 2013).
2. This pathogenic virus has a low infectious dose and is thus of great importance in public health (Donzelli et al. 2015). Human adenoviruses (HAdVs) cause numerous symptomatic and asymptomatic infections affecting the respiratory tract, the eyes, and the gastrointestinal tract (Carducci et al. 2016). They can be excreted in the faeces, urine, and respiratory secretions and transmitted via contact with the eyes, the faecal-oral route, or inhalation (Bambic et al. 2015)..
3. HAdVs have a number of features that justify their use as index pathogens for air in occupational settings possibly contaminated by faecally-excreted pathogens (Donzelli et al. 2015).

We selected *Salmonella* as a representative bacteria pathogen for this QMRA because:

1. Possesses unique abilities to survive very long time in water environments (Winfield et al 2003). It can persist in environmental median for up to 180 days or longer (Holley, Arrus, Ominski, Tenuta, & Blank, 2006).
2. Possesses unique abilities to survive in seawater and seafood because of the relatively high salt conditions in the receiving environment (Johnson et al 2003).
3. Several outbreaks and contaminations have been related to *Salmonella* in wastewater through its discharge into the marine environment (Lemarchand et al 2003, Harakeh et al 2006).
4. It is very heterogeneous as its serotypes have adapted to a wide variety of host-specific environments including humans.
5. *Salmonella* can be detected throughout the year, with densities and serotype diversity typically higher during summer months than winter months (Haley, Cole, & Lipp, 2009).

We selected Cryptosporidium and Giardia as representative protozoan pathogens for this QMRA because:

1. These species have been implicated in many waterborne disease outbreaks both in New Zealand and globally
2. Dose-response models are available for the pathogen, it can infect a significant proportion of the exposed population at low doses (Medema et al., 1996; Teunis et al., 2005; USEPA, 2010).

3. *Cryptosporidium* and *giardia* are frequently isolated from livestock manure, and their respective oocysts and cysts can survive for extended periods of time in the environment (USEPA, 2010) and may be washed into the sewerage system during storm water conditions.

We selected Ascaris as a representative helminth pathogen for this QMRA because:

1. These species have been implicated in many waterborne disease outbreaks globally. Although we note that in many countries with good sanitation systems (e.g., Australia, New Zealand) helminth infections are not endemic in humans and helminths may not be commonly detected in raw sewage (Grant et al., 2012; Irwin et al., 2017). However, because of the potential for overland flow to introduce helminths from animal sources, helminth was also included as a reference pathogen in this health risk assessment.

Appendix 2 Additional notes on dose-response characterization

Dose-response model for virus pathogens

A rich discussion on dose-response functions already exists in published literature (e.g. See McBride 2011, 2016a, Vergara et al 2016, USEPA 2010, WHO 2016). Dose-infection curves for the viral pathogens used have been established from clinical test results of subsets of volunteers challenged with laboratory-prepared aliquots of viral suspensions at varying serial dilutions of known mean[21] doses of viruses (Haas et al 1999). These were based primarily on two assumptions. This first assumption is the 'single-hit' hypothesis, which is that a single viral pathogen would evade the host defence mechanisms and reach its potential infection site, establish itself and then cause infection. The second assumption is based on a Poisson distribution of the viral pathogens in the laboratory-prepared viral aliquot, which better reflects a random, well-mixed population. These assumptions can be described with probability distributions.

When the probability of ingesting a dose of pathogens is Poisson-distributed and all of the ingested pathogens have an equal probability of initiating infection, the exponential dose-response model is appropriate:

$$P_{\inf(d;r)} = 1 - e^{-rd} \qquad \text{....eqn(1)}$$

where $P_{\inf}$ is the probability of infection, d is dose (number of pathogens), e represents the standard exponential constant, 2.7183, and r is a parameter of the distribution equal to the probability that an individual pathogen initiates infection.

When the probability of ingesting pathogens is Poisson-distributed and the probability that individual pathogens initiate infection is beta-distributed, the beta-Poisson model is appropriate:

$$P_{\inf(d;\alpha,\beta)} = 1 - {}_1Fe_1(\alpha, \alpha+\beta, -d) \qquad \text{....eqn(2)}$$

where α and β are parameters of the Beta distribution and ${}_1F_1$ denotes a confluent hypergeometric function. A commonly used approximation to the beta-Poisson may be used when β >> 1 and β >> α, which is usually so in most cases. This approximation is:

$$P_{\inf(d;\alpha,\beta)} = 1 - (1 + \frac{d}{\beta})^{-\alpha} \qquad \text{....eqn(3)}$$

where $P_{\inf}$ is the probability of infection, d = mean dose, α and β are 'nonnegative shape' and location parameters, respectively. This approximation however is inadequate for noroviruses because the fitted α and β parameters *(i.e* β = 0.055, $\alpha = 0.04$*)* do not comply with the condition β >> 1 and β >> α , hence the push for the use of the much-more-difficult-to-evaluate hypergeometric equation (2) (as argued in McBride 2011).

One approach to QMRA is to use individual exposure per exposure occasion to represent a group visiting a polluted beach. This approach often produces unrealistic risk profiles. A very robust QMRA approach is to expose multiple people on each exposure occasion. In this case, it is possible

[21] Doses in individuals' challenges are not measured, instead the average dose given to each member of a group is known.

to assign individual doses, thus eliminating the need for the Poisson averaging. Hence, for the constant r, the simple one-parameter exponential model is easily replaced by the simple bionomial model:

$$P_{inf} = 1 - (1 - r)^{i} \quad \text{....eqn(4)}$$

where I is the individual dose. Similarly, the two-parameter beta-Poisson model (eqn 2) becomes replaced with the beta-bionomial model, below, which is easily executed using the natural logarithm of the gamma function in Excel[22]:

$$P_{inf} = 1 - [B(\alpha, \beta + i) / B(\alpha, \beta))] \quad \text{....eqn(5)}$$

where P(i) is probability of infection, β is a standard beta function (Abramowitz and Stegun, 1964; Teunis et al., 2008), *α* and β are shape and location parameters and *i* represents a dose received by an individual.

Cryptosporidium dose-response model

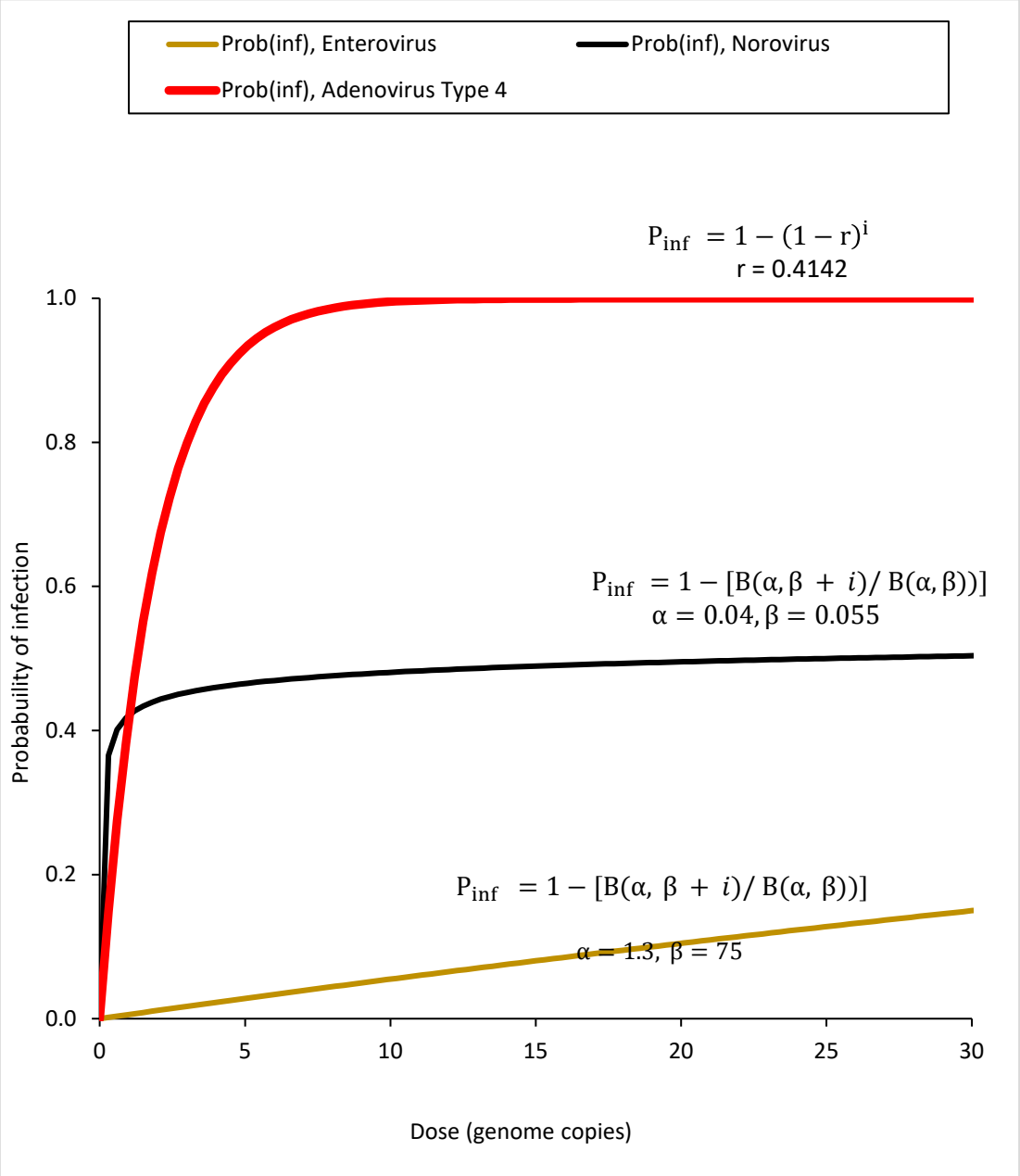
The dose-response model for *Cryptosporidium* applied in this QMRA is based on analysis for the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (USEPA, 2006). In the experimental dose-response studies, human subjects challenged with the pathogen responded differently depending on the strain of *Cryptosporidium parvum* used for the challenge (Messner, Chappell, & Okhuysen, 2001; Okhuysen et al., 2002). Consequently, Messner et al. (2001) applied the LT2ESWTR *Cryptosporidium* dose-response model built on Bayesian analyses of individual and combined data sets for different isolates and outbreak data. The LT2ESWTR dose-response model is exponential with model parameter r = 0.09.

Salmonella dose-response model

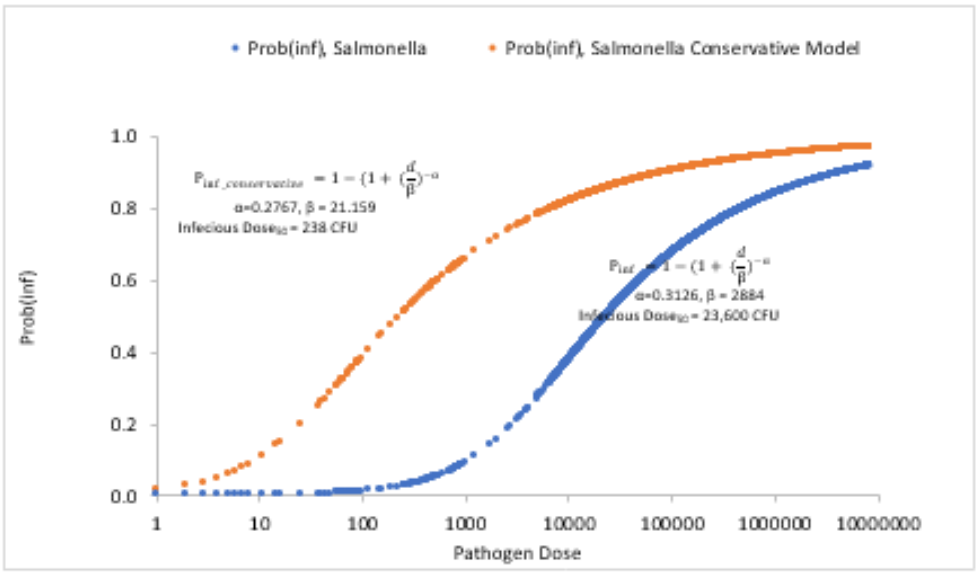
Salmonella occurrence and infectivity differs widely with serotype. Considering the range of serotypes that could reasonably occur in recreational water, it was thus necessary in this QMRA to select an appropriate dose-response model which apparently represents the overall incidence of infection among individuals who get exposed to them. For this purpose, two published *Salmonella* dose response models exists that are based on infection due to multiple serotypes of *Salmonella* (the beta-Poisson model, as in Haas et al., (1999b) and the Gompertz-log model, as in Olivieri and Seto (2007). In the beta-Poisson model, parameters α = 0.3126 and β = 2884 were applied. In the log-Gompertz model (for an illness endpoint), a range of values for the model parameters were applied consistent with previous studies. These took on a range of values of dose response parameter ln (a) which are uniformly distributed between 29 and 50, and b = 2.148. This QMRA applied the beta-Poisson model, as in Haas et al., 1999 and USEPA (2010). In this QMRA, Unlike the typical beta-Poisson model with model parameters α = 0.3126 and β = 2884, a more conservative beta-Poisson model with model parameters α = 0.2767 and β = 21.159 was used , in line with WHO (2002).

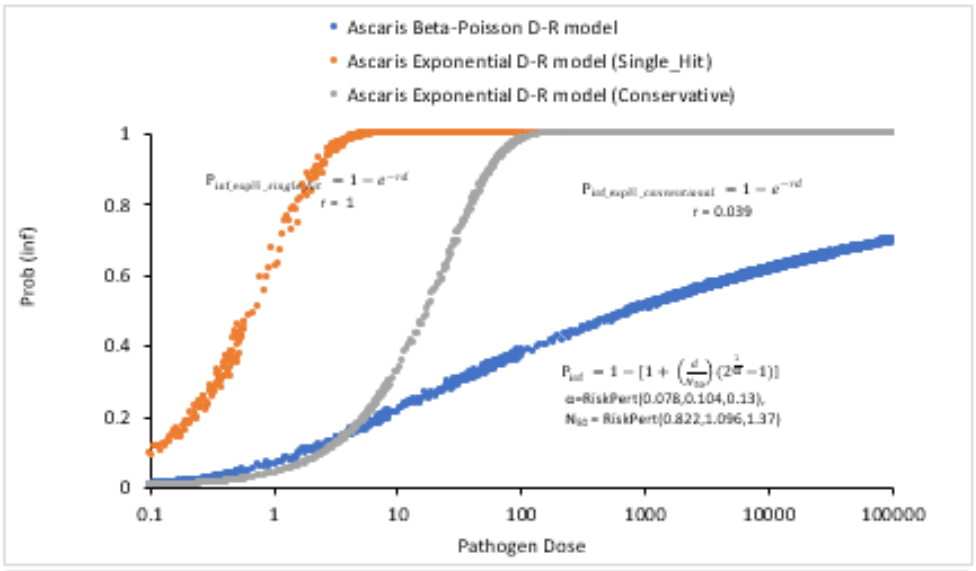
[22] Prob of infectin $= 1 - \text{EXP}\{\text{GAMMALN}(\beta + i) + \text{GAMMALN}(\alpha + \beta) - [\text{GAMMALN}(\alpha + \beta + i) + \text{GAMMALN}(\beta)]\}$ (as in McBride 2011)

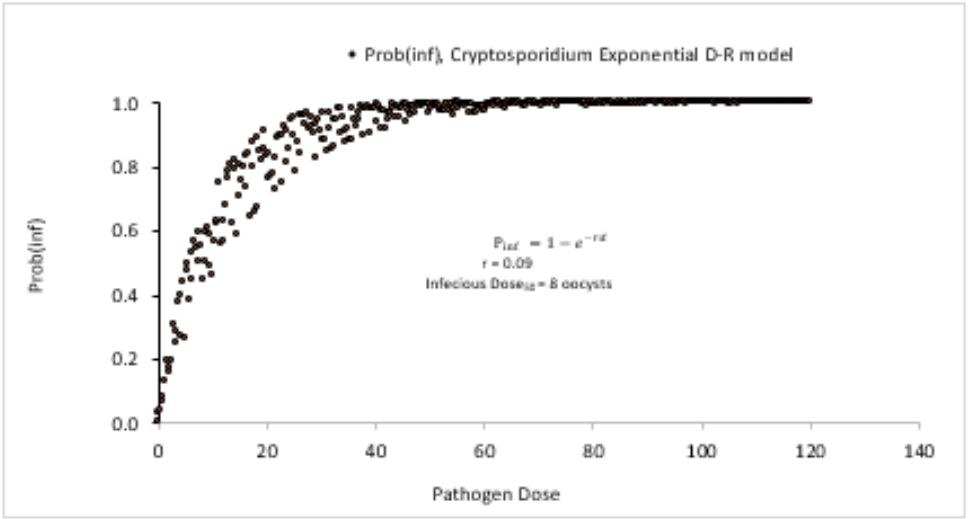
Appendix 3 Dose-response curves applied in this QMRA



Plots of individual dose response curve for adenovirus type 4, enterovirus and norovirus used in this QMRA. Included in each plot is the dose-response model applied, the model parameters and the infectious dose$_{50}$ i.e. the amount of pathogen (measured in specified units of microorganisms) required to cause an infection in the 50% of exposed host population.







Plots of individual dose response curve for adenovirus type 4, enterovirus and norovirus used in this QMRA. Included in each plot is the dose-response model applied, the model parameters and the infectious dose$_{50}$ i.e. the amount of pathogen (measured in specified units of microorganisms) required to cause an infection in the 50% of exposed host population.

Appendix 4 Individual Pathogen IIRs associated with Contact Recreation (CR) and Shellfish gathering (SG)

Enterovirus-SG

IIR> 10%	High illness risk
IIR (5-10%)	Moderate illness risk
IIR (1-4.99%)	Low illness risk
IIR <1%	NOAEL

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	0.29	5.08	5.00	8.20	4.96	5.40	7.18	7.35	7.46	4.99	5.35	5.68	5.03	<0.1
10yrs_current_NW15_MLWS	2.93	5.11	5.03	8.63	4.99	5.43	7.21	7.38	7.49	5.02	5.38	5.71	5.06	<0.1
10yrs_future_NW15_MLWS	0.84	2.53	2.25	<0.1	2.36	4.18	4.21	4.15	0.95	1.34	1.96	2.25	1.98	<0.1
2yrs_current_NW15_MHWS	0.33	4.87	4.88	8.23	5.11	5.36	7.14	7.12	7.34	5.13	5.44	5.87	4.90	<0.1
10yrs_current_NW15_MHWS	2.13	4.90	4.91	8.60	5.14	5.40	7.16	7.20	7.61	5.16	5.47	5.94	4.93	<0.1
10yrs_future_NW15_MHWS	0.87	2.29	2.83	<0.1	2.99	4.19	4.26	4.32	3.41	1.27	1.99	2.60	2.14	<0.1
2yrs_current_NW25_MHWS	1.35	5.19	4.95	8.69	5.00	5.56	7.19	7.14	1.23	1.52	1.68	1.69	2.56	<0.1
10yrs_current_NW25_MHWS	1.38	5.22	5.21	11.27	5.18	5.59	7.22	7.17	5.84	5.89	6.05	4.68	5.44	<0.1
10yrs_future_NW25_MHWS	0.21	3.71	3.45	4.22	3.12	4.27	4.34	4.12	1.28	2.91	2.87	1.94	3.12	<0.1
2yrs_current_NW25_MLWS	1.28	5.16	4.87	8.81	4.92	5.34	7.11	7.22	1.33	1.76	1.46	1.69	2.37	<0.1
10yrs_current_NW25_MLWS	1.31	5.25	5.23	11.30	5.22	5.37	7.19	7.25	5.55	5.95	6.09	3.96	5.35	<0.1
10yrs_future_NW25_MLWS	0.15	3.29	2.86	2.80	3.08	4.19	4.30	4.23	1.55	2.10	2.35	1.32	2.85	<0.1
2yrs_current_SE15_MHWS	6.83	4.68	3.59	7.80	<0.1	5.40	7.22	7.17	7.66	5.00	5.39	5.44	4.89	<0.1
10yrs_current_SE15_MHWS	7.16	4.75	4.11	8.80	3.81	5.43	7.32	7.20	7.86	5.03	5.42	5.47	4.92	<0.1
10yrs_future_SE15_MHWS	3.51	3.30	2.51	<0.1	2.58	4.22	4.25	4.26	1.41	2.70	2.96	3.21	3.25	<0.1
2yrs_current_SE15_MLWS	6.76	4.60	3.64	7.98	<0.1	5.39	7.16	7.28	7.37	5.12	5.15	5.31	5.03	<0.1
10yrs_current_SE15_MLWS	7.07	4.79	4.25	8.69	3.94	5.42	7.21	7.31	7.80	5.15	5.18	5.34	5.06	<0.1
10yrs_future_SE15_MLWS	2.90	3.13	2.84	<0.1	2.50	4.05	4.17	4.19	1.34	3.00	3.19	3.50	3.21	<0.1
2yrs_current_SE25_MHWS	6.56	0.57	0.32	7.53	<0.1	5.21	7.48	7.29	7.86	4.95	5.06	4.97	4.62	<0.1
10yrs_current_SE25_MHWS	7.45	5.24	4.25	10.61	0.11	5.44	7.51	7.32	8.78	5.46	5.43	5.62	5.43	<0.1
10yrs_future_SE25_MHWS	3.87	4.00	2.98	<0.1	<0.1	4.27	4.19	4.14	2.18	4.14	4.18	4.16	4.05	<0.1
2yrs_current_SE25_MLWS	6.74	0.73	0.45	7.49	0.16	5.32	7.19	7.05	7.68	4.78	4.80	4.63	4.24	<0.1
10yrs_current_SE25_MLWS	7.50	5.26	4.36	10.60	0.19	5.36	7.22	7.19	8.54	5.63	5.59	5.57	5.49	<0.1
10yrs_future_SE25_MLWS	3.68	3.77	2.74	<0.1	<0.1	4.10	4.46	4.13	2.04	4.15	4.09	4.09	3.96	<0.1

Norovirus-SG

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	0.57	11.14	10.31	19.21	10.32	13.08	18.19	18.17	18.32	11.25	12.86	14.48	10.43	<0.1
10yrs_current_NW15_MLWS	2.62	11.17	10.34	19.36	10.35	13.17	18.22	18.20	18.72	11.28	12.89	14.51	10.46	<0.1
10yrs_future_NW15_MLWS	1.10	2.16	1.98	<0.1	1.98	6.56	6.89	6.78	1.01	1.25	1.60	1.73	1.73	<0.1
2yrs_current_NW15_MHWS	0.57	11.40	10.74	19.21	10.75	13.08	18.00	18.00	18.60	11.53	12.97	14.69	10.80	<0.1
10yrs_current_NW15_MHWS	1.97	11.43	10.77	19.56	10.78	13.11	18.03	18.19	18.63	11.56	13.00	15.12	10.83	<0.1
10yrs_future_NW15_MHWS	1.02	1.84	2.51	<0.1	2.51	6.60	6.81	6.81	4.07	1.21	1.70	2.20	1.90	<0.1
2yrs_current_NW25_MHWS	1.14	12.61	11.32	19.50	11.26	12.93	18.16	18.18	1.18	1.40	1.49	1.50	2.23	<0.1
10yrs_current_NW25_MHWS	1.17	12.64	12.06	20.76	12.10	12.96	18.29	18.21	14.88	15.33	15.36	8.70	12.99	<0.1
10yrs_future_NW25_MHWS	0.44	4.02	3.60	7.28	3.31	6.77	6.83	6.84	1.18	2.86	2.95	1.82	3.13	<0.1
2yrs_current_NW25_MLWS	1.18	12.60	11.26	19.47	11.05	12.89	18.12	18.06	1.15	1.39	1.39	1.38	2.21	<0.1
10yrs_current_NW25_MLWS	1.21	12.63	11.77	20.57	11.61	13.06	18.27	18.09	14.40	15.13	15.46	5.63	12.66	<0.1
10yrs_future_NW25_MLWS	0.36	3.00	2.90	2.53	3.07	6.63	6.85	6.87	1.35	1.81	1.86	1.20	2.81	<0.1
2yrs_current_SE15_MHWS	17.63	9.08	3.81	18.84	<0.1	12.88	18.31	18.12	18.54	11.14	12.91	13.29	10.29	<0.1
10yrs_current_SE15_MHWS	18.11	9.38	6.00	19.52	4.53	12.97	18.34	18.15	18.89	11.17	12.94	13.32	10.32	<0.1
10yrs_future_SE15_MHWS	3.85	3.50	2.38	<0.1	2.10	6.76	6.81	6.68	1.26	2.63	2.81	3.17	3.49	<0.1
2yrs_current_SE15_MLWS	17.38	9.54	4.44	18.85	<0.1	13.08	18.25	18.08	18.39	11.25	12.79	13.12	10.68	<0.1
10yrs_current_SE15_MLWS	18.19	9.54	6.99	19.47	5.92	13.11	18.28	18.20	18.80	11.28	12.82	13.15	10.71	<0.1
10yrs_future_SE15_MLWS	2.64	3.16	2.67	<0.1	2.28	6.74	6.80	6.83	1.29	2.81	3.33	3.84	3.00	<0.1
2yrs_current_SE25_MHWS	17.24	0.77	0.48	18.49	0.21	13.07	18.18	18.13	18.74	11.04	11.62	11.60	8.57	<0.1
10yrs_current_SE25_MHWS	18.60	12.04	7.04	20.35	0.24	13.10	18.21	18.16	19.47	13.65	13.78	13.90	13.04	<0.1
10yrs_future_SE25_MHWS	5.26	5.49	2.89	<0.1	<0.1	6.70	6.77	6.80	1.94	6.24	6.45	6.55	5.88	<0.1
2yrs_current_SE25_MLWS	17.56	0.82	0.66	18.51	0.40	13.02	18.09	18.21	18.68	9.17	9.25	8.96	7.07	<0.1
10yrs_current_SE25_MLWS	18.50	12.23	7.13	20.43	0.43	13.05	18.14	18.24	19.66	13.98	14.21	14.21	13.60	<0.1
10yrs_future_SE25_MLWS	5.00	4.64	2.53	<0.1	<0.1	6.75	6.85	6.83	1.72	6.02	6.02	6.26	5.09	<0.1

Cryptosporidium-SG

IIR> 10%	High illness risk
IIR (5-10%)	Moderate illness risk
IIR (1-4.99%)	Low illness risk
IIR <1%	NOAEL

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	0.11	0.14	0.60	<0.1	0.16	0.49	0.49	0.46	0.12	0.13	0.18	<0.1	<0.1
10yrs_current_NW15_MLWS	<0.1	0.14	0.17	0.70	0.12	0.17	0.52	0.52	0.49	0.15	0.16	0.21	0.11	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	0.61	<0.1	0.13	0.47	0.41	0.48	<0.1	0.13	0.22	0.11	<0.1
10yrs_current_NW15_MHWS	<0.1	0.12	<0.1	0.67	0.12	0.13	0.49	0.50	0.52	<0.1	0.16	0.22	0.14	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	0.15	0.11	0.68	<0.1	0.14	0.39	0.45	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	0.18	0.13	1.28	0.10	0.15	0.43	0.48	0.21	0.23	0.23	<0.1	0.16	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	0.14	0.12	0.67	0.10	0.17	0.49	0.45	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	0.17	0.14	1.20	0.13	0.20	0.52	0.48	0.21	0.23	0.25	<0.1	0.13	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	0.38	<0.1	<0.1	0.56	<0.1	0.16	0.43	0.44	0.56	0.11	0.13	0.17	<0.1	<0.1
10yrs_current_SE15_MHWS	0.41	<0.1	<0.1	0.82	<0.1	0.19	0.48	0.47	0.58	0.14	0.16	0.20	<0.1	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	0.36	<0.1	<0.1	0.55	<0.1	0.14	0.45	0.45	0.56	<0.1	0.15	0.13	<0.1	<0.1
10yrs_current_SE15_MLWS	0.47	<0.1	<0.1	0.78	<0.1	0.15	0.45	0.48	0.59	0.12	0.18	0.16	<0.1	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	0.37	<0.1	<0.1	0.48	<0.1	0.17	0.46	0.43	0.57	<0.1	0.12	0.13	<0.1	<0.1
10yrs_current_SE25_MHWS	0.53	0.14	<0.1	1.16	<0.1	0.20	0.49	0.46	0.72	0.18	0.18	0.21	0.13	<0.1
10yrs_future_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MLWS	0.36	<0.1	<0.1	0.53	<0.1	0.14	0.43	0.44	0.54	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MLWS	0.47	0.13	<0.1	1.10	<0.1	0.16	0.46	0.48	0.79	0.15	0.22	0.15	0.18	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Giardia-SG

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	0.29	<0.1	<0.1	0.23	0.22	0.22	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	0.35	<0.1	0.11	0.26	0.25	0.23	0.12	0.13	<0.1	<0.1	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	0.29	<0.1	<0.1	0.28	0.20	0.19	<0.1	<0.1	0.14	<0.1	<0.1
10yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	0.32	<0.1	<0.1	0.31	0.27	0.32	<0.1	<0.1	0.17	<0.1	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	0.31	<0.1	<0.1	0.16	0.20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	0.12	<0.1	0.58	<0.1	<0.1	0.21	0.23	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	0.31	<0.1	<0.1	0.26	0.24	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	0.12	<0.1	0.55	<0.1	<0.1	0.29	0.27	<0.1	0.12	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	0.13	<0.1	<0.1	0.30	<0.1	<0.1	0.19	0.18	0.27	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MHWS	0.16	0.13	<0.1	0.49	<0.1	<0.1	0.22	0.21	0.30	<0.1	0.12	0.11	<0.1	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	0.15	<0.1	<0.1	0.19	<0.1	<0.1	0.22	0.15	0.19	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MLWS	0.24	<0.1	<0.1	0.40	<0.1	<0.1	0.25	0.17	0.23	<0.1	<0.1	0.11	<0.1	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	0.16	<0.1	<0.1	0.28	<0.1	<0.1	0.13	0.15	0.29	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MHWS	0.23	<0.1	<0.1	0.53	<0.1	<0.1	0.21	0.18	0.32	0.11	0.11	<0.1	<0.1	<0.1
10yrs_future_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MLWS	0.17	<0.1	<0.1	0.26	<0.1	<0.1	0.24	0.16	0.25	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MLWS	0.26	0.12	<0.1	0.47	<0.1	0.11	0.27	0.20	0.39	<0.1	<0.1	<0.1	0.11	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Salmonella-SG

IIR> 10%	High illness risk
IIR (5-10%)	Moderate illness risk
IIR (1-4.99%)	Low illness risk
IIR <1%	NOAEL

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	0.16	<0.1	<0.1	0.11	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	0.19	<0.1	<0.1	0.14	0.14	0.16	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	0.15	<0.1	<0.1	0.13	0.12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	0.16	<0.1	<0.1	0.16	0.18	0.12	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	0.26	<0.1	<0.1	0.11	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	0.26	<0.1	<0.1	0.16	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	0.24	<0.1	<0.1	0.12	0.13	0.16	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	0.13	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MLWS	0.12	<0.1	<0.1	0.15	<0.1	<0.1	0.16	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	0.11	<0.1	0.16	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	0.21	<0.1	<0.1	0.13	<0.1	0.19	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MLWS	0.16	<0.1	<0.1	0.22	<0.1	<0.1	0.14	0.12	0.20	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Helminths-SG

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	0.45	0.39	2.92	0.46	<0.1	<0.1	<0.1	2.38	0.39	0.67	0.84	0.48	<0.1
10yrs_current_NW15_MLWS	<0.1	0.48	0.42	3.20	0.49	<0.1	<0.1	<0.1	2.41	0.42	0.70	0.87	0.51	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	0.44	0.52	2.96	0.51	<0.1	<0.1	<0.1	2.38	0.53	0.61	0.92	0.41	<0.1
10yrs_current_NW15_MHWS	<0.1	0.47	0.55	3.30	0.54	<0.1	<0.1	<0.1	2.41	0.56	0.64	1.13	0.44	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	0.59	0.59	3.28	0.51	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	0.62	0.62	5.44	0.64	<0.1	<0.1	<0.1	0.95	1.01	1.08	0.40	0.60	<0.1
10yrs_future_NW25_MHWS	<0.1	0.13	<0.1	0.27	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	0.62	0.49	3.18	0.45	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	0.65	0.55	5.95	0.57	<0.1	<0.1	<0.1	0.78	1.00	1.06	0.22	0.52	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	1.46	0.33	0.13	2.49	<0.1	<0.1	<0.1	<0.1	2.61	0.50	0.76	0.66	0.44	<0.1
10yrs_current_SE15_MHWS	1.99	0.39	0.19	3.51	0.12	<0.1	<0.1	<0.1	2.63	0.53	0.79	0.69	0.47	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	1.92	0.40	0.13	2.43	<0.1	<0.1	<0.1	<0.1	2.08	0.45	0.54	0.69	0.60	<0.1
10yrs_current_SE15_MLWS	2.00	0.43	0.16	3.53	0.19	<0.1	<0.1	<0.1	2.45	0.48	0.57	0.72	0.63	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	1.50	<0.1	<0.1	2.41	<0.1	<0.1	<0.1	<0.1	2.43	0.46	0.46	0.52	0.32	<0.1
10yrs_current_SE25_MHWS	2.11	0.49	0.17	4.83	<0.1	<0.1	<0.1	<0.1	3.37	0.72	0.81	0.74	0.70	<0.1
10yrs_future_SE25_MHWS	0.17	0.17	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.17	0.25	0.16	0.14	<0.1
2yrs_current_SE25_MLWS	1.65	<0.1	<0.1	2.51	<0.1	<0.1	<0.1	<0.1	2.34	0.26	0.29	0.33	0.23	<0.1
10yrs_current_SE25_MLWS	2.13	0.59	0.19	5.10	<0.1	<0.1	<0.1	<0.1	3.51	0.87	0.85	0.83	0.79	<0.1
10yrs_future_SE25_MLWS	0.13	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.21	0.13	0.16	0.13	<0.1

Enterovirus-CR

IIR> 10%	High illness risk
IIR (5-10%)	Moderate illness risk
IIR (1-4.99%)	Low illness risk
IIR <1%	NOAEL

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	0.370	0.190	1.510	0.290	0.550	1.150	1.140	1.310	0.330	0.400	0.570	0.290	<0.1
10yrs_current_NW15_MLWS	<0.1	0.400	0.250	1.540	0.320	0.580	1.180	1.170	1.340	0.360	0.490	0.600	0.320	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	0.220	0.230	0.270	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	0.420	0.290	1.350	0.320	0.580	1.020	1.210	1.310	0.450	0.460	0.590	0.380	<0.1
10yrs_current_NW15_MHWS	<0.1	0.450	0.320	1.720	0.350	0.610	1.080	1.240	1.410	0.480	0.490	0.680	0.410	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	0.150	<0.1	0.150	0.110	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	0.440	0.410	1.520	0.360	0.480	1.120	1.110	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	0.560	0.430	2.430	0.390	0.510	1.130	1.200	0.760	0.730	0.530	0.290	0.510	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	0.150	<0.1	0.150	0.120	0.150	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	0.440	0.440	1.840	0.300	0.580	1.080	1.010	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	0.500	0.470	2.190	0.380	0.610	1.180	1.110	0.490	0.660	0.780	0.140	0.440	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.190	0.110	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	0.840	0.180	<0.1	1.340	<0.1	0.440	1.080	1.310	1.340	0.370	0.450	0.520	0.330	<0.1
10yrs_current_SE15_MHWS	1.190	0.230	0.120	1.590	<0.1	0.460	1.180	1.340	1.370	0.400	0.480	0.550	0.360	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	0.120	<0.1	0.260	<0.1	<0.1	0.110	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	1.070	0.280	<0.1	1.470	<0.1	0.460	1.270	1.130	1.310	0.370	0.420	0.550	0.300	<0.1
10yrs_current_SE15_MLWS	1.200	0.340	0.170	1.650	<0.1	0.490	1.300	1.270	1.370	0.400	0.450	0.580	0.330	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	0.110	0.150	0.190	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	0.790	<0.1	<0.1	1.100	<0.1	0.520	1.140	1.210	1.290	0.320	0.360	0.320	0.240	<0.1
10yrs_current_SE25_MHWS	1.370	0.460	0.200	2.050	<0.1	0.550	1.170	1.240	1.590	0.480	0.470	0.550	0.420	<0.1
10yrs_future_SE25_MHWS	0.110	0.140	<0.1	<0.1	<0.1	0.160	0.160	0.210	<0.1	0.190	0.160	0.110	0.200	<0.1
2yrs_current_SE25_MLWS	0.970	<0.1	<0.1	1.270	<0.1	0.430	1.220	1.020	1.200	0.210	0.280	0.280	0.130	<0.1
10yrs_current_SE25_MLWS	1.250	0.450	0.210	2.130	<0.1	0.460	1.250	1.220	1.750	0.600	0.620	0.760	0.560	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	0.220	0.130	0.180	<0.1	0.170	0.130	0.200	<0.1	<0.1

Norovirus-CR

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	0.740	0.690	1.480	0.760	0.890	1.210	1.280	1.310	0.800	0.920	1.100	0.790	<0.1
10yrs_current_NW15_MLWS	<0.1	0.770	0.720	1.510	0.790	0.950	1.240	1.310	1.350	0.830	1.020	1.130	0.820	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	0.450	0.440	0.450	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	0.770	0.640	1.200	0.730	1.010	1.230	1.140	1.410	0.690	0.880	0.880	0.630	<0.1
10yrs_current_NW15_MHWS	0.110	0.800	0.650	1.480	0.760	1.040	1.260	1.420	1.560	0.760	0.910	0.970	0.660	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	0.160	0.360	0.470	0.350	0.250	<0.1	<0.1	<0.1	0.140	<0.1
2yrs_current_NW25_MHWS	<0.1	0.780	0.760	1.430	0.880	1.050	1.290	1.220	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	0.810	0.880	2.080	0.910	1.080	1.320	1.280	1.090	0.930	1.080	0.520	0.760	<0.1
10yrs_future_NW25_MHWS	<0.1	0.230	0.150	0.500	0.260	0.320	0.370	0.480	<0.1	0.130	0.180	<0.1	0.120	<0.1
2yrs_current_NW25_MLWS	<0.1	0.850	0.790	1.500	0.770	0.800	1.250	1.210	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	0.860	0.820	1.800	0.920	0.830	1.310	1.270	0.920	0.930	1.040	0.370	0.870	<0.1
10yrs_future_NW25_MLWS	<0.1	0.190	0.130	<0.1	0.140	0.440	0.400	0.500	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	1.040	0.690	0.260	1.270	<0.1	0.960	1.170	1.390	1.140	0.860	0.930	1.040	0.740	<0.1
10yrs_current_SE15_MHWS	1.240	0.720	0.400	1.450	0.180	0.990	1.310	1.420	1.300	0.890	0.960	1.070	0.770	<0.1
10yrs_future_SE15_MHWS	0.220	0.220	<0.1	<0.1	<0.1	0.390	0.450	0.480	<0.1	<0.1	0.190	0.140	0.160	<0.1
2yrs_current_SE15_MLWS	1.250	0.730	0.260	1.480	<0.1	0.980	1.380	1.250	1.390	0.810	0.820	0.820	0.720	<0.1
10yrs_current_SE15_MLWS	1.350	0.760	0.610	1.510	0.420	1.010	1.410	1.280	1.420	0.840	0.850	0.850	0.750	<0.1
10yrs_future_SE15_MLWS	0.120	0.200	0.220	<0.1	<0.1	0.480	0.500	0.420	<0.1	0.110	0.160	0.250	0.140	<0.1
2yrs_current_SE25_MHWS	1.030	<0.1	<0.1	1.290	<0.1	1.030	1.420	1.220	1.420	0.720	0.750	0.830	0.450	<0.1
10yrs_current_SE25_MHWS	1.300	0.820	0.450	1.690	<0.1	1.060	1.450	1.250	1.470	0.920	0.890	0.860	0.890	<0.1
10yrs_future_SE25_MHWS	0.300	0.360	<0.1	<0.1	<0.1	0.410	0.370	0.510	<0.1	0.410	0.500	0.490	0.360	<0.1
2yrs_current_SE25_MLWS	1.140	<0.1	<0.1	1.290	<0.1	0.860	1.150	1.240	1.370	0.580	0.650	0.670	0.440	<0.1
10yrs_current_SE25_MLWS	1.280	1.070	0.490	1.890	<0.1	0.880	1.180	1.270	1.500	0.960	1.040	1.200	0.900	<0.1
10yrs_future_SE25_MLWS	0.310	0.330	<0.1	<0.1	<0.1	0.450	0.460	0.510	<0.1	0.350	0.330	0.450	0.280	<0.1

Cryptosporidium-CR

IIR> 10%	High illness risk
IIR (5-10%)	Moderate illness risk
IIR (1-4.99%)	Low illness risk
IIR <1%	NOAEL

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Helminths-CR

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	0.15	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	0.16	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MLWS	<0.1	<0.1	<0.1	0.14	<0.1	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Salmonella-CR

IIR> 10%	High illness risk
IIR (5-10%)	Moderate illness risk
IIR (1-4.99%)	Low illness risk
IIR <1%	NOAEL

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Adenovirus-CR

IIR> 3.9%	High AFR illness risk
IIR (1.9-3.9%)	Moderate AFR illness risk
IIR (0.3-<1.9%)	Low AFR illness risk
IIR <0.3%	NOAEL

*Acute Febrile Resipitarory Illness (AFRI) due to inhalation

Scenario/Exposure site	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
2yrs_current_NW15_MLWS	<0.1	0.13	0.11	0.91	0.11	0.27	0.63	0.56	0.72	0.14	0.20	0.35	0.17	<0.1
10yrs_current_NW15_MLWS	<0.1	0.16	0.14	0.94	0.14	0.33	0.66	0.57	0.75	0.17	0.27	0.38	0.20	<0.1
10yrs_future_NW15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW15_MHWS	<0.1	0.22	0.15	0.74	0.17	0.31	0.51	0.73	0.72	0.25	0.26	0.26	0.15	<0.1
10yrs_current_NW15_MHWS	<0.1	0.25	0.18	0.96	0.20	0.34	0.67	0.76	0.81	0.28	0.29	0.35	0.18	<0.1
10yrs_future_NW15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MHWS	<0.1	0.23	0.22	0.86	0.15	0.31	0.64	0.54	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MHWS	<0.1	0.24	0.26	1.39	0.18	0.34	0.67	0.66	0.42	0.37	0.27	0.16	0.20	<0.1
10yrs_future_NW25_MHWS	<0.1	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_NW25_MLWS	<0.1	0.23	0.26	0.90	0.16	0.17	0.52	0.56	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
10yrs_current_NW25_MLWS	<0.1	0.31	0.29	1.27	0.24	0.24	0.61	0.67	0.23	0.28	0.36	<0.1	0.23	<0.1
10yrs_future_NW25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MHWS	0.46	0.14	<0.1	0.71	<0.1	0.25	0.54	0.66	0.68	0.17	0.30	0.25	0.14	<0.1
10yrs_current_SE15_MHWS	0.55	0.17	<0.1	0.91	<0.1	0.28	0.55	0.69	0.71	0.20	0.33	0.28	0.17	<0.1
10yrs_future_SE15_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE15_MLWS	0.56	0.15	<0.1	0.86	<0.1	0.29	0.69	0.57	0.77	0.22	0.30	0.21	0.11	<0.1
10yrs_current_SE15_MLWS	0.66	0.18	<0.1	0.91	<0.1	0.32	0.72	0.72	0.80	0.25	0.33	0.24	0.16	<0.1
10yrs_future_SE15_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MHWS	0.46	<0.1	<0.1	0.58	<0.1	0.25	0.60	0.54	0.80	0.13	0.20	0.18	<0.1	<0.1
10yrs_current_SE25_MHWS	0.71	0.27	<0.1	1.23	<0.1	0.29	0.67	0.57	0.95	0.17	0.23	0.23	0.20	<0.1
10yrs_future_SE25_MHWS	<0.1	<0.1	<0.1	<0.1	<0.1	0.12	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
2yrs_current_SE25_MLWS	0.54	<0.1	<0.1	0.62	<0.1	0.20	0.58	0.58	0.75	0.12	0.12	0.17	<0.1	<0.1
10yrs_current_SE25_MLWS	0.63	0.26	<0.1	1.27	<0.1	0.23	0.61	0.60	0.94	0.27	0.33	0.45	0.29	<0.1
10yrs_future_SE25_MLWS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1