Under The Resource Management Act 1991

In the matter of an application for resource consent to discharge wastewater overflows from Queenstown Lakes District Council's wastewater network

Statement of Evidence of Neale Alan Hudson 18 October 2019

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Statement of Evidence of Neale Alan Hudson

1 Introduction

Qualification and experience

1.1 My full name is Neale Alan Hudson. I am an Environmental Chemist at the National Institute of Water and Atmospheric Research Limited (**NIWA**), and my current role is Manager - Freshwater and Estuaries.

1.2 I have a PhD in Environmental Chemistry from Queensland University of Technology, and more than 30 years' experience in the areas of emission processes, water quality, waste management and environmental management.

1.3 I was the first author of Hudson (2019).[1] I have been involved in the general area of microbial risk assessment for more than ten years, and have contributed directly to several Quantitative Microbial Risk Assessment studies.[2] In 2017 and 2018 I was lead consultant in the area of health risk assessment for the Nelson Regional Services Business Unit, who applied for resource consent for aberrant discharges from the sewer network in Nelson.[3]

Purpose and scope of evidence

1.4 My role and involvement in the project has been in the area of human health risk assessment:

(a) Investigating the risks to human health arising from potential exposure to pathogenic organisms (principally viruses);

(b) I also explored available water quality data, information regarding the location of sewer overflows, and the likelihood of these discharges entering surface water; and

(c) My third area of assessment was related to the response activities arising from, or following discharge of, untreated wastewater from the sewer network.

1.5 The findings of these assessments were summarised in Hudson (2019).

1.6 During a visit to Queenstown for a hui with stakeholders for this proposal on 26 and 27 September 2018, I undertook a limited reconnaissance of the Queenstown area to familiarise myself with the terrain, the proximity of sewer pipes to surface waters in stream corridors, and a limited length of the sewer lines that run along the lake foreshore. Part of the sewer network is shown in Figure 1, and the blue arrow indicates a pump station in Queenstown Basin area. The proximity of several pump stations to the waterline (e.g. one indicated with the blue arrow), was of particular interest. Information obtained from this informal site inspection is reflected in this evidence.

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1 This report was submitted as Appendix D – Public Health Assessment to the AEE. Refer Appendix One for full references.

2 McBride and Hudson 2016; Hudson and McBride 2017b; Hudson et al. 2019.

3 Hudson and McBride 2017a; Hudson and Wadhwa 2017a; Hudson and Wadhwa 2017b.

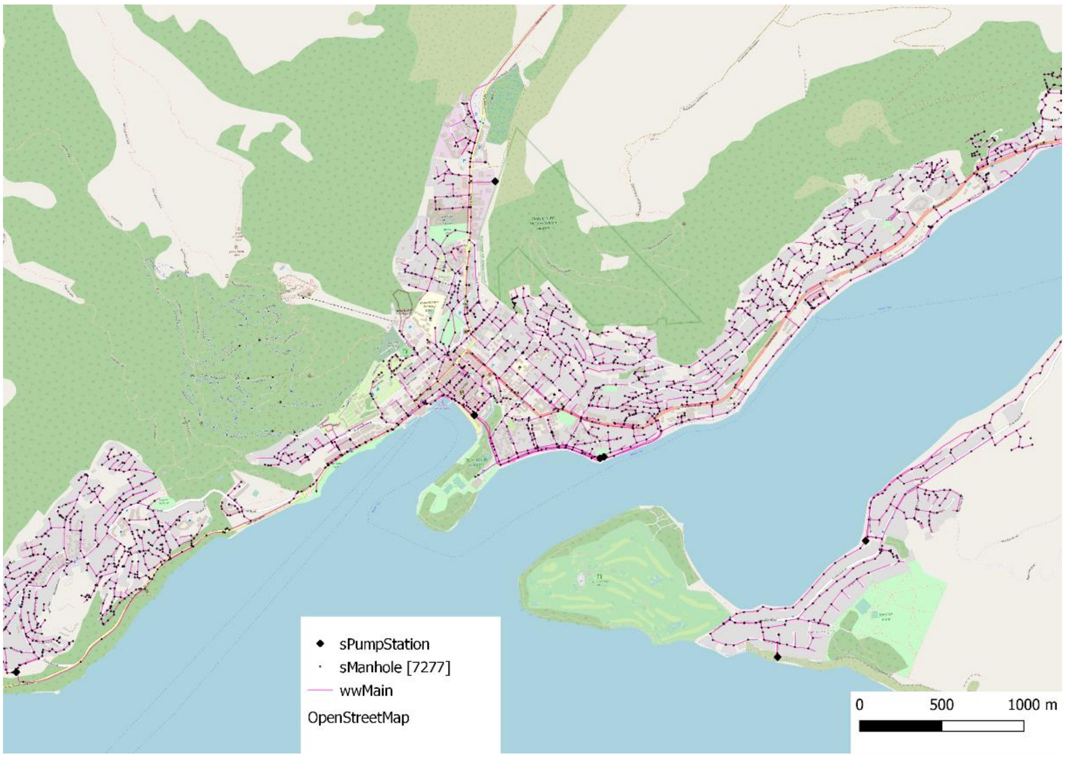

Figure 1: Part of the sewer network in the Queenstown Basin area. The sewer lines are shown as unbroken red lines, manholes as small black dots and pump stations as black diamonds.

1.7 I have also been actively involved in preparing the Wastewater Overflow Response Procedures (**WORP**).

1.8 The purpose of my evidence is to:

(a) Briefly describe the process used for human health risk assessment (Section 3), indicating why a Quantitative Microbial Risk Assessment cannot be undertaken for overflow discharges from the QLDC sewer network, and describing how health risk may be minimised in these and other circumstances. The principal tool for minimising human health risks following an unplanned discharge is an emergency response plan;

(b) After briefly reviewing emergency response principles (Section 4), I comment on the QLDC WORP (attached as Appendix One to Ms Moogan's evidence) in Section 5, and indicate why I consider it to be appropriate for the task required;

(c) I respond to submissions that relate to human health and environmental risks in Section 6, where I provide additional information and evidence to reinforce the approach previously proposed, and where specific criticisms are addressed. I specifically address an apparent misconception - that QLDC intends to deliberately discharge untreated sewage at will. This is totally incorrect - the consent seeks to formalise relatively rare, entirely uncontrollable events by ensuring that the response to these events is rapid, specific and minimises human and environment health risks;

(d) My response to the ORC Section 42A report is provided in Section 7, where I review aspects of the QLDC unplanned discharge data, specifically the number, location and frequency of discharges. After considering the size of the QLDC network, the numbers of locations where discharge is possible, and spatial distribution of known discharges, I conclude that the frequency is low;

(e) I also briefly describe the vastly different size of these unplanned discharges, relative to lake volumes and discharge in large rivers. This is not done to justify unplanned discharges – rather it is done to allay fears that these unplanned discharges will, in themselves, lead to eutrophication.

Expert Witness Code of Conduct

1.9 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Practice Note 2014. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

2 Executive summary

2.1 Modern wastewater treatment plants and associated infrastructure (sewers, access points and pump stations) were developed to reduce exposure of humans to a range of potentially pathogenic organisms. When wastewater systems fail and untreated wastewater enters the environment, human health risk exists.

2.2 Despite high standards of construction, operation and maintenance, sewer systems are vulnerable to the actions of humans, weather events and wear and tear. Separately or in concert these factors lead to failure, during which events untreated wastewater may be discharged to land or water. A failsafe sewer system is yet to be developed, so periodic unplanned discharge of sewage (and associated human health risks) should be anticipated.

2.3 It would be possible to estimate the risk of infection and illness to humans using techniques such as Quantitative Microbial Risk Assessment, if information was available regarding the concentration of pathogens in wastewater, the volumes of wastewater discharged, and the subsequent dilution and ultimate fate of the wastewater. However, the data and information required for a Quantitative Microbial Risk Assessment does not currently exist for the Queenstown Lakes District.

2.4 While it might be desirable to know the risk (and inherent uncertainty in the estimate), such knowledge does not in itself allow the potential human health risks to be managed or avoided. Reducing health risks requires an appropriate emergency response, which may involve removal of the hazardous material, warning the public so that they can avoid the hazard, or estimating the spatial extent and duration of contamination through monitoring.

2.5 Absence of quantitative information does not mean that human health cannot be protected following an unplanned discharge of untreated wastewater. Protecting human health is highly dependent on the efficacy of a suitable emergency response plan that is implemented following an unplanned discharge.

2.6 Key elements of an effective emergency response plan include:

(a) Rapid response following notification of an unplanned discharge event that includes an initial inspection. This inspection must be thorough enough to ensure that the subsequent response is effective;

(b) Where necessary, an incident controller is appointed to direct and coordinate subsequent actions;

(c) Teams deployed to the unplanned discharge site should be appropriately equipped to contain the discharge, recover hazardous materials for subsequent treatment, repair and restore service. The public should be excluded from the site, and where discharge to water has occurred, signage warning potential recreational users should be erected;

(d) Where contamination of water that may be abstracted and treated for drinking water supply has occurred, abstraction may be stopped and consumers warned;

(e) In parallel, where discharge to water is likely or has happened, a monitoring programme will be developed so that the spatial extent of contamination may be assessed, and the level of contamination estimated. The monitoring may also be used to determine when the human health risk has receded by continuing monitoring over time. Other water quality variables and measurement techniques may be used to support monitoring based on measurement of Faecal Indicator Bacteria such as *Escherichia coli* (*E. coli)*;

(f) Formal review of information and incident reporting once the emergency has been resolved will allow the response plan to be improved.

2.7 I have reviewed the QLDC WORP (attached as Appendix One in Ms Moogan's evidence). I consider that it addresses requirements identified above and includes additional elements likely to increase the efficacy of the response. I note that key aspects of the response require stringent response times. Key information is collected to enable the efficacy of the response to be assessed. Separate reports to regulatory and health protection agencies are also required.

2.8 The frequency and duration of unplanned discharges and the severity of the consequences of these unplanned discharges may be reduced by upgrading the sewer network, increasing pump capacity and on-site emergency containment and storage, and inclusion of more sophisticated real-time monitoring and warning systems.

2.9 Having considered the unplanned nature of these discharge events, the likely health risks, and having reviewed the emergency response plan and the QLDC capital improvement plan, I am satisfied that the response plan will adequately protect recreational water users, consumers of potable water, as well as communities considerable distances from the likely discharge sites.

2.10 Having reviewed the public submissions on the resource consent application, I recognise that the local community:

(a) is particularly concerned with the health risks arising from these unplanned discharge events; and

(b) in some cases has the view that QLDC deliberately chooses to discharge untreated sewage to surface waters with no consideration of the health, cultural, aesthetic or environmental consequences.

2.11 I agree with submitters that ideally no unplanned discharge of wastewater would occur. Unfortunately, unknown and unpredictable factors out of QLDC's control cause unplanned discharges. In these circumstances, it is essential to have a robust, comprehensive emergency response plan and tested procedures in place.

2.12 I consider that the WORP and other processes (e.g. related to capital expenditure) that QLDC have embarked on are adequate to reduce human health risk to acceptable levels.

3 Microbial risk assessment

3.1 Many organisms have the potential to cause infection and illness in humans. Realisation of the health consequences of exposure of humans to untreated human wastes led to the development of what we regard as conventional wastewater management systems (comprising sewers, pump stations and wastewater treatment plants). In addition to efficiently conveying human wastes to suitable treatment plants, sewers effectively minimise exposure of humans to potentially pathogenic organisms. When these systems fail however, untreated wastewater can come into contact with people.

3.2 Risk assessment is applied to a diverse range of activities, including exposure to hazardous or potentially hazardous materials. Exposure to pathogenic microbial contaminants falls into this category. Several definitions need to be considered:

(a) **Hazard** - anything that has the potential to cause harm. In this case, the hazard is an unplanned wastewater discharge;

(b) **Risk** - the chance, high or low, that somebody may be harmed by the hazard. Risk is sometimes defined as chance + hazard + exposure + consequence;

(c) **Risk assessment** - the process of evaluating risks to individual health and safety arising from the hazards. It is a systematic examination of all aspects of an activity that considers:

(i) what could cause injury or harm;

(ii) whether the hazards could be eliminated; and

(iii) if risks cannot be eliminated, what preventive or protective measures are, or should be, in place to control the risks.

3.3 By its nature risk is probabilistic and thus relies on quantitative information. Provided adequate data and information exist, risks may be determined through a quantitative process, allowing the magnitude of risk, as well as the uncertainty and variability of the hazard to be estimated. Relatively recently, techniques have been developed to allow the human health risks associated with pathogenic microorganisms to be estimated using a process known as Quantitative Microbial Risk Assessment (QMRA).

3.4 Figure 2 identifies the information required to undertake a QMRA in any area. Items in red are not available for areas in the Queenstown Lakes District where discharge from reticulated sewers may occur. Absence of key data and information therefore makes it impossible to accurately predict the human health risk associated with an accidental or unplanned discharge using techniques such as QMRA. It also makes it impossible to estimate in advance the likely spatial extent or severity of contamination – the length of river that is contaminated, or the extent of lake surface or volume of a lake that contains pathogenic organisms at concentrations that pose measurable risk.

3.5 Although the absence of key information and data makes conduct of a formal **Quantitative** Microbial Risk Assessment impossible, we are still able to consider human health risks associated with an unplanned discharge. We know that the hazards related to untreated wastewater are linked to viral and microbial pathogens and parasites, and that risk arises from exposure to and ingestion of these pathogens. A general risk assessment process thereafter directs us to focus on the preventive or protective measures that must be in place to control the risks. Rather than make risk assessment and management impossible, absence of quantitative information obliges the agency responsible for wastewater treatment to implement a suitably precautionary **response** to an unplanned sewage discharge.

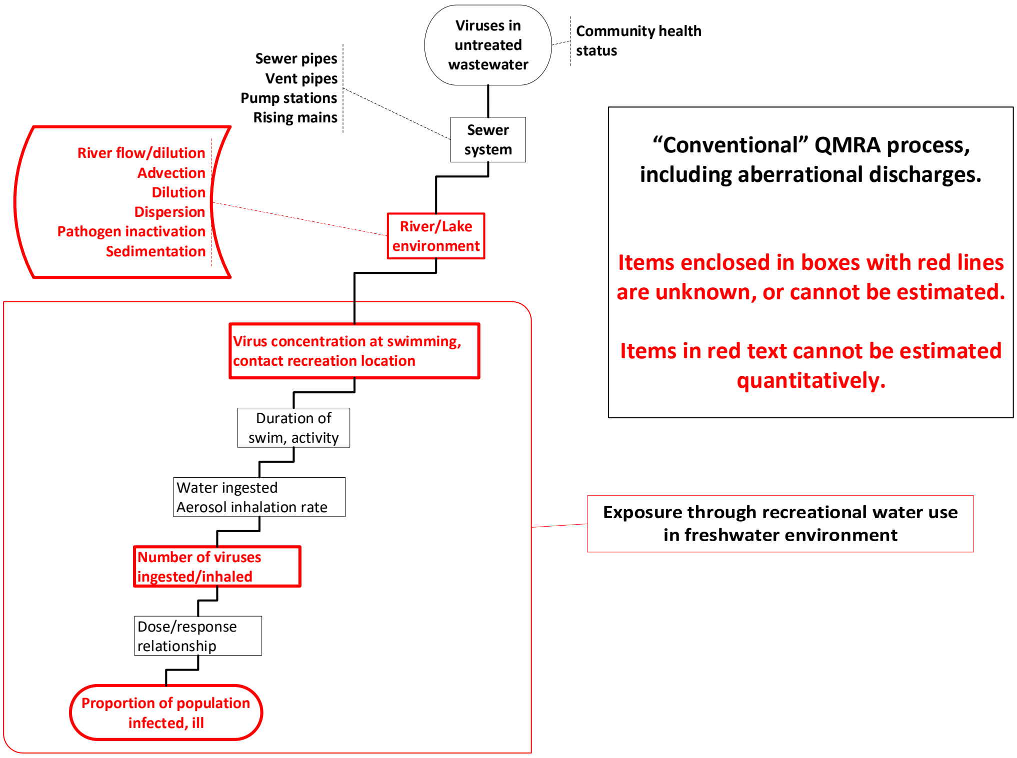

Figure 2: Process followed to relate human health risk to pathogen-contaminated surface waters. Items in red are not available, making a quantitative health risk assessment unachievable.

3.6 Mr Glasner's evidence explains the causes of overflow discharges, how such discharges are caused by events beyond QLDC's control and why the volume, frequency, duration and location of such discharges is unpredictable.

3.7 My evidence is not implying that absence of these data or information indicates dereliction of duty or poor management by QLDC. Rather, I consider that having access to these data and information does not automatically provide assurance that the risks arising from unplanned discharges will be managed adequately. Even if perfect knowledge of the volumes, concentrations of pathogens and fate of contaminated water were known, this knowledge would not protect the community from infection and illness on its own. It is the response to the unplanned discharge and the associated pathogens that is likely to protect the community from infection and illness. Absence of quantitative information prevents the magnitude and likelihood of risk to be predicted, but this does not mean that possible risks cannot be managed.

3.8 Ultimately, if an overflow does occur, then the only way to avoid or minimise adverse human health consequences is to eliminate or reduce exposure of humans to contaminated materials. Eliminating or reducing exposure will largely depend on the adequacy of the emergency response implemented by QLDC.

3.9 Implementation of a fit-for-purpose, robust monitoring programme customised for each unplanned discharge event will demonstrate the efficacy of the response plan, and will allow the spatial extent and duration of potentially hazardous conditions to be determined and managed.

4 Emergency response

4.1 Following discharge of untreated wastewater to surface waters, for infection or illness to occur pathogenic organisms must be:

(a) present in the materials; and

(b) ingested by the individual, for example by swallowing contaminated water, consuming contaminated food, inhaling an aerosol generated from the contaminated water, or by touching fomites and transferring pathogens to the mouth.

4.2 Previously I defined risk as chance + hazard + **exposure** + consequence. Should the **exposure factor(s)** leading to infection or illness risk be minimised or eliminated, the illness risk is also likely to be reduced substantially or eliminated. In other words, human health protection ultimately depends on the response to the unplanned discharge. The exposure factor(s) can be minimised or eliminated by:

(a) repairing the leak as quickly as possible to limit the volume of wastewater discharged;

(b) containing, removing and disposing the contaminated material appropriately if appropriate; and

(c) notifying the community that may potentially be exposed to contaminated water; erecting warning signs, implementing an appropriate monitoring programme.

4.3 Each discharge event and the context within which the discharge occurs is likely to be unique and will require a tailored response. Although some elements of a response are likely to be common to all discharges, other elements will need to be unique or less common because they will target the unique or uncommon circumstances for specific discharge events.

4.4 Considerable guidance regarding developing an appropriate emergency response plan is provided in the New Zealand "*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas*" (MfE/MoH 2003). Although the response actions in the Guidelines are triggered if measured concentrations of Faecal Indicator Bacteria (**FIB**) exceed defined thresholds, rather than as a consequence of identified wastewater discharges, the principles are entirely transferable. Sections that should be considered when developing a response plan include Section H (particularly pages H28 – H31), and Section I. Relevant sections of the guidelines are included as **Appendix Two**.

4.5 The identified pages in Section H detail the actions recommended in response to exceedance of FIB concentration thresholds. These include:

(a) informing the Medical Officer of Health and other councils (if appropriate);

(b) implementing additional (more frequent) sampling; and

(c) undertaking a catchment inspection to determine the source(s) of the contaminants.

4.6 Section I of the Guidelines (pages I1 – I7) focuses on public education and information regarding microbial risks arising from contact recreation generally, and actions roles and responsibilities in creating public awareness.

4.7 The management/response plan should include immediate reaction (signage, public notification), as well as sampling as a part of an overall monitoring plan. The signage and public notification will minimise risk to recreational users, and the sampling will help determine when waters may be considered safe for recreational use. Several agencies are generally involved in these response activities, guided in part by the Ministry for Environment/Ministry of Health recreational water quality guidelines, as well as other emergency response plans, such as the WORP presented in Appendix One of Ms Moogan's evidence.

4.8 Provided adequate steps are taken to reduce the likelihood and size of a wastewater discharge event, and that a robust plan exists to respond adequately to a discharge events of this nature, their impact may be reduced substantially and the overall risk to human health minimised.

4.9 The location and duration of these discharges is shown relative to water intakes in Figure 6 and Figure 7 for areas where overflow data exist.

4.10 This assessment of risk recognises that the risk of infection and illness may be relatively large in some circumstances (e.g., where the unplanned discharge is close to the freshwater body), but also recognises that an appropriate response (where exposure of the public to the discharge is minimised, and where abstraction of water intended for treatment and supply is suspended should a possibility of contamination exist), reduces the overall risk of illness and risk very substantially.

4.11 If there is no contact between human receptors and pathogens, there is no possibility of infection or illness, i.e. the risk is zero. The response plan produced by QLDC in association with their contractors seeks to achieve this target. This is discussed in Section 5 of my evidence.

5 QLDC overflow response protocol

5.1 The evidence of Ms Moogan describes QLDC's WORP and attaches a draft of QLDC's that document. Key aspects of the WORP include:

(a) Service delivery is largely provided through contractors. As consolidation of these services is proposed, the number of steps between identification of a problem and notification of the relevant contractor may reduce and this is likely to improve response times;

(b) If the discharge has entered water, signage is erected, and samples are collected;

(c) Additional monitoring commences immediately once a discharge event occurs. The location of sampling sites for this event-response monitoring has two objectives:

(i) Determining the spatial extent of the contaminant plume (to guide the public notification response); and

(ii) Determining the duration of the contamination event and response (eg for how long should signage be displayed).

(d) Signage remains in place until the thresholds in the "Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas" (MfE/MoH 2003) are met. The response plan requires the development of a sampling programme that is designed to meet the specific circumstances created by each unplanned discharge. The monitoring programme design addresses the extent of river reach or lake shoreline that is to be covered by initial and subsequent sample collection, as well as sampling frequency. Sufficient samples will be analysed over time to demonstrate that a low risk of faecal contamination exists. This will also account for natural variability in contaminant concentrations and uncertainty in laboratory assessment methods;

(e) Identification of who collects the samples and the requirement that the person should trained for the purpose. The method of sample collection is extremely important for microbiological monitoring, as is sample storage following collection. The location and number of sample points will be determined by a competent person. Record keeping, chain of custody, prompt submission of the samples to a laboratory, and time for receipt of results are identified as performance indicators;

(f) Identification of a maximum response time in terms of a contractor arriving on site for an initial inspection (one hour), and a maximum time for restoration of wastewater services (four hours). In FY 2018/19 median response and restoration times were 17 minutes and 151 minutes respectively. Although this performance appears to easily meet the required target, it would be useful to also report the total number of responses, as well as the number of responses that exceeded the specified timeframes;

(g) Other performance indicators for QLDC wastewater contractors include a maximum of three dry weather overflows per 1,000 wastewater connections. In FY 2018/19, the annual number of dry weather overflows was 3.2 per 1,000 wastewater connections;

(h) Protecting human health by safeguarding water supplies receives specific and careful attention in the WORP. Avoiding entry of contaminated water into the distribution system is a specific target;

(i) Similarly, the WORP considers the human health risk to water supplies in adjacent districts, downstream of the QLDC area. Notification of downstream councils is included in the notification plan;

(j) Although I consider the risk to downstream consumers to be very small (given the relatively small volume likely to be discharged, the massive dilution, and the natural attenuation that will happen during downstream transport), notification will ensure that an adequately precautionary response may be made by the downstream authorities.

5.2 Although I am not a wastewater or hydraulics engineer, I agree that the causes of uncontrolled overflows, and the location of these discharges are out of the control of QLDC and may not be predicted, and I consider that robust contingency planning is in place.

6 Submissions

6.1 I was provided two summaries of the submissions, prepared by ORC and Beca on behalf of QLDC. I also read each submission individually to identify consistent themes, specifically those related to public health risk.

General objections to deliberate or intentional discharges of wastewater

6.2 Several submissions suggested that through this application the QLDC proposes to intentionally "pump waste" untreated into the environment (Mr Tristin Franklin), "[dump] effluent into our waterways" (Ms Nicola Barnard).

6.3 I agree that deliberate discharge of untreated wastewater to land and water is unacceptable. It is important to note that these discharge events are not deliberate, and that the discharges are unplanned and that they are outside the control of the QLDC. They are anticipated as a result of unplanned and largely impossible to predict system failures. They are relatively infrequent, generally of short duration and are attended to as quickly as possible to minimise adverse effects – i.e. the volume of wastewater reaching streams and lakes is minimised as far as possible.

6.4 I consider that, from a public health perspective, it is responsible and essential to anticipate that events of this nature will occur, and to put in place the systems and an associated response plan that will help minimise human and environmental health risk.

6.5 QLDC is proposing to do that by making upgrades to the wastewater network, and ensuring that the WORP is as effective as it can be, and that it is implemented rapidly and efficiently

6.6 For the reasons given elsewhere in this evidence, I am of the opinion that the proposed capital works program and the WORP will reduce the effects of unplanned discharges, and ensure public health risks are minimised.

Methodology for assessment of risks to human health

6.7 I note in two submissions (Mr Skelton and Ms Byers) that the health risk assessment is considered speculative and inadequate because the assessment was entirely qualitative and not quantitative.

6.8 Similarly, Mr Stephen Skelton (Landscape Architect) objects that the health risk assessment (Hudson 2019) "makes assumptions and is not rooted in facts, data or real-world modelling. This report cannot be given any significant weight and is conjecture."

6.9 As indicated in Section 3 (and in the report), a quantitative assessment is not possible without key data and information. As a consequence, the report focused on the requirement that the response to an unplanned wastewater discharge event should be robust and comprehensive, with an emphasis on minimising exposure of the public to contaminated water, thereby minimising human health risks. This is consistent with what I indicate in Sections 3.7 and 3.8:

(a) The fate of the discharged wastewater may be poorly understood or completely unknown. For example, a discharge that enters a stream will obviously travel in a downstream direction, but the subsequent dilution and resulting pathogen concentration is generally unknown, because flows are generally not measured, making estimation of dilutions impossible;

(b) The fate of wastewater discharged to a lake is even more difficult to predict, because the transport, mixing and dilution is even more complex, and will be unknown unless tracer studies, or a hydrodynamic model are available;

(c) While it may be possible to estimate human health risks using assumed mixing and dilution values, the errors and uncertainties in these estimates will be so large that they will not be useful.

6.10 As a consequence, I maintain that very little data exists, and that modelling will either be impossible, or not useful. I also maintain that having access to a model will not in itself reduce or manage the risks likely to exist following an unplanned discharge (discussed in Sections 3.7 and 3.8). As a result, the human health risk assessment report (Hudson 2019) focused on an emergency response plan, and in Section 5 above, I discuss my review of the response plan where I conclude that it is fit for purpose.

Proposals to treat all wastewater

6.11 Ms Courtney has requested that all wastewater be directed to a wastewater treatment plant prior to disposal.

6.12 As the evidence of Mr Glasner indicates, with the exception of rural properties (where on-site treatment occurs), all other wastewater is routinely directed to a treatment plant for appropriate treatment. This application is for unplanned discharges that occur following blockage, breakage, equipment failure, or other unpredictable circumstances, leading to discharge of untreated wastewater to land or water *en route* to a wastewater treatment plant. As the evidence of Ms Moogan indicates (and summarised in this evidence in Figure 5 and in Figure 6), the incidence of these events is low and the response times are short. The evidence of Mr Hansby and Mr Baker indicates how QLDC intends to reduce the incidence and severity of these events through a capital works programme.

6.13 Ms Courtney is rightly concerned that groundwater quality should not be impacted by these discharges. The short duration of these discharges, generally low discharge rates, and rapid response is likely to reduce the impact to less than minor. In the event that a larger discharge occurs, the WORP will help ensure that appropriate mitigation steps are taken to reduce adverse impacts on surface and groundwater, as well as human health.

Concerns regarding impacts on drinking water

6.14 Mr Skelton also states “It is clear that many of the waterways proposed to accept wastewater form part of the district’s recreation and drinking water resource and the public’s health would be at risk.” Ms Byers, Mr Gavin Dann and Ms Jansen make a similar point to Mr Skelton, namely that drinking water supplies may be vulnerable to contamination: Ms Byers cites a 1984 incident in Queenstown to support her submission.

6.15 It is worth noting that the illness outbreak of 1984 was related to an unplanned discharge that contaminated the water supply. Since that time several actions have been undertaken to reduce the likelihood of similar events:

(a) The pipe used to abstract water from the lake has been extended, and water is now abstracted from greater depth;

(b) The wastewater infrastructure in the district has been improved in response to population growth and to minimise the likelihood of an overflow event;

(c) QLDC has developed a comprehensive emergency response procedure which defines maximum permissible response times and which includes an escalation of response actions – the latter feature ensures that the level of response effort matches the potential for human health or ecological health risk; and

(d) Currently, QLDC has a capital works investment programme that is aimed at further reducing the number and impact of future unplanned discharge events.

6.16 As discussed in Section 5.1, I have reviewed the QLDC WORP, and I consider that the measures proposed are adequate to safeguard water supplies and protect human health. These include responding rapidly to reports of an overflow (with response times performance indicators for the contractor undertaking the response), and following inspection, implementing a series of actions aimed at minimising the volume of wastewater likely to enter surface waters by containing and recovering unplanned discharge material as far as possible, notification and use of signage to minimise contact between the public and potentially contaminated water, and establishing monitoring programmes to define both the spatial extent of contamination, and the level of contamination.

6.17 An important specific response action will include curtailing abstraction of potentially contaminated waters into the drinking water supply, and increasing disinfection of treated water, as well as increasing testing of the microbial quality of raw and treated drinking water.

6.18 The response plan includes a hierarchy of actions, with additional resources assigned to the response as required through an escalation process. I consider the appointment of an Incident Controller a positive feature of the response plan. This individual will be appointed to oversee any unplanned discharge where a public health risk arising from exposure to contaminated water exists. This person will manage the overall response, which will minimise the potential for gaps in the response, which will be an important prerequisite to safeguard public health.

6.19 As the capital works program described by Mr Glasner (Section 5.2) and WORP described by Ms Moogan (Section 5.1) are implemented over time, in my opinion, future effects arising from unplanned discharge of wastewater will continue to be extremely localised, very transient and generally less than minor. When more serious unplanned discharge events occur, the escalating measures included in the response plan will ensure that public and ecological health risks are minimised.

6.20 QLDC will report to ORC after every unplanned discharge event, providing details regarding the response times, estimates of discharge volumes, the fate of the discharged wastewater, and mitigation and remediation details. ORC and Public Health South (**PHS**) will also receive information derived from the monitoring programmes that will be implemented following every unplanned discharge that enters water. This information will be available to the community through normal information requests, and high-level information regarding the efficacy of the response plan will be included in the Council annual report, as well as other reports required in the proposed conditions of consent.

Concerns regarding impacts on recreational users

6.21 Mr Franklin describes recreational water use in Lake Wanaka (and formerly in Lake Hayes) undertaken by members and guests of the Southern Lakes Swimming Club. Their recreational activities will lead to longer exposure times than those experienced by more "typical" recreational users, and involves recreational water users drinking water during their swim. This is likely to maximise the risk potential to these recreational users.

6.22 I accept Mr Franklin's view that open water swimmers should not be subjected to avoidable risk arising from exposure to microbial contaminants. However, I understand that the discharges contemplated in the application for resource consent are not practically avoidable, given that they result from blockages, breakages, and other unplanned system failures. The activities of QLDC are focused on reducing the incidence and severity (including impact on public health) of unplanned discharges of sewage. The CAPEX programme provides evidence of this (described in the evidence of Mr Hansby). Signage will alert swimmers to discharges so that they can relocate to other unaffected swimming locations.

Monitoring

6.23 Mr Franklin suggests that, because of the risks to recreational swimmers, the term of the consent is excessive, and that "*constant transparent monitoring technology"* should be deployed.

6.24 Rather than implementing *"constant transparent monitoring technology"*, I consider it more appropriate to implement a fit-for-purpose monitoring programme that is designed in response to each unplanned discharge event.

6.25 Because of the expense, a programme based on *"constant transparent monitoring technology"* is likely to be limited in terms of numbers of sites and frequency of sampling. It will be unaffordable to monitor every stream reach or area of the lake likely to be impacted by an unplanned discharge event.

6.26 Event-specific monitoring ensures that samples are collected from the reaches of streams and rivers, and areas of lakes, where a health risk is likely to be present, and over the time periods when infection or illness risk is likely. A predefined, rigid monitoring programme cannot provide such adaptability, making it less useful for human health protection.

6.27 The WORP requires implementation of a monitoring programme whenever a discharge enters or is likely to enter water. It requires samples to be collected spatially and over a suitable time period until acceptable microbial water quality is achieved. I consider this an appropriate mechanism to safeguard recreational water users from the effects of unplanned discharge events. It will enable (amongst other things) signage to remain in place until health risks from contact recreation have ceased.

Concerns regarding effects on the trophic state of Lakes Wakatipu and Wanaka

6.28 Paul and Robyn Hellebrekers suggest that unplanned discharges of wastewater to the Queenstown Lakes will alter the trophic state and potentially contaminate Lakes Wakatipu and Wanaka with pathogens, either at local or whole lake scale.

6.29 It is true that altering the trophic state of a lake occurs gradually and it may occur in response to many small incidents (cumulative effects).

6.30 However, it is worth noting the volume of water in either Lake Wanaka or Wakatipu relative to the frequency and volume of unplanned wastewater discharges. The section 42A report of the ORC (section 4.1.5) provides an estimate for one discharge of 43 m^3 over a two-day period. This represents a flow of approximately 0.25 L/s. In contrast the lowest seven-day flow in the Kawarau River is 55,000 L/s and the mean annual low flow is 84,000 L/s.[4] The ORC section 42A report indicates that the average discharge of the entire QLDC sewer network is 147 L/s. This value is nearly six hundred times smaller than the mean annual low flow of the Kawarau River. This comparison is not intended to minimise the undesirability of these unplanned events, but it does demonstrate that their relatively small size, short duration and infrequent occurrence are likely to have an insignificant effect on the lake trophic state and localised potential for human health impacts.

6.31 Natural systems have an ability to tolerate occasional and slight perturbations, including additional nutrients. For example, a flood in a tributary stream or river may lead to one or more head of cattle, or several sheep being drowned and swept into a lake. One moderately sized steer (say 400 kg) represents approximately 16 kg of N and 0.8 kg of P. It is likely that the body of several stock or wild animals enter each lake annually, and have done so every year since settlement. Yet the lakes remain in oligotrophic state. That is because the natural systems are able to process the nutrient load represented by these animal carcasses, causing some of the nutrient to be incorporated into plant biomass (which may be transported from the lake through flushing), or the nitrogen may be mineralised and denitrified (a natural, biologically mediated process that requires carbon, which could potentially be derived from the carcass), and be lost to the atmosphere as nitrogen gas.

6.32 In contrast, untreated wastewater represents a far smaller mass load of nutrient. For example, discharge of 100 m^3 of a moderate strength wastewater containing 35 mg/L nitrogen and 6 mg/L phosphorus represents a mass of 3.5 kg nitrogen, and 0.6 kg of phosphorus respectively.

6.33 Considering the relative mass of nutrient that various contaminant sources may introduce into a lake or river helps put their magnitude into perspective. This information is not provided to justify discharge of wastewater into lakes and rivers – rather, it indicates the relatively small contributions that such materials will make to nutrient enrichment.

Concerns regarding specific contaminants

6.34 Mr Trevor and Ms Annabelle Tinworth identify several contaminants that may be present in untreated wastewater, including radioactive materials, drugs (prescribed and recreational), and gross particulate materials:

(a) I cannot offer an opinion on the mass of radioactive material likely to be excreted from persons receiving radiotherapy, but any residue excreted is likely to be a minor fraction of a clinical dose, and enormously diluted in the wastewater system, and thereafter in the receiving environment.

(b) Similarly, I cannot offer an opinion on the mass of drugs likely to be present in untreated wastewater, but suggest that the concentrations in

[4] https://www.orc.govt.nz/managing-our-environment/water/water-monitoring-and-alerts/kawarau/kawarau-river-at-chards-rd

faeces and urine are likely to be very low and further diluted in the wastewater system, and thereafter in the receiving environment.

(c) Currently wastewater (including wastewater containing wastes derived from patients receiving radiotherapy, and a range of prescribed drugs, or wastewater containing traces of illicit drugs) is discharged to receiving waters after treatment without particular concern for adverse effects. I consider that the very small mass of therapeutic and illicit substances contained in the infrequent discharge of relatively small volumes of untreated wastewater would pose negligible human health risk.

(d) As the Police Wastewater Pilot Programme shows, these substances are not removed by treatment in wastewater treatment plants, and are discharged, without apparent environmental effect, in much larger quantities in many locations throughout New Zealand.

(e) If present and visible, the gross particulates identified above would be offensive to any observer. However, wastewater is often difficult to identify, particularly if highly diluted. Given the low frequency, and relatively short duration of unplanned discharges, the volumes of wastewater discharged during these events will be relatively small. The WORP has several objectives, one being containment and removal of as much of the wastewater as possible. Another is deployment of filters or sieves with the express purpose of preventing gross particulates from entering the receiving environment.

Concerns regarding incursion of communicable diseases

(f) Mr Gilbert van Reenen considers that the potential human health risks to the general population should consent be granted are not adequately addressed in the application, and considers that overseas visitors represent vectors for *"transferring a multitude of pathogenic diseases to the aqueous environment such as newly evolving strains of noravirus highly pathogenic debilitating strains of E coli and much more".*

(i) I acknowledge that international travellers may be vectors of communicable diseases – Sudden Acute Respiratory Syndrome (SARS) is an example. However, international visitors have been coming to Queenstown for decades, yet the illness outbreak in 1984 mentioned by Ms Byers (Section 6.14) appears to be the only such event on record. This was likely attributable to an unplanned discharge of wastewater, rather than incursion of a new strain of a disease.

(ii) Whether the wastewater contains new strains of pathogens or not, the human health risks will be minimised by ensuring that public exposure to disease-causing organisms is reduced as far as possible. I consider that the provisions in the WORP are adequate for this purpose.

6.35 Ms Niki Gladding and Aotearoa Water Action state *"…..it is impossible to adequately assess the potential long and short-term effects of the activity including effects on ecosystems, human health and recreation effects, visual effects, odour effects and economic effects. Given the lack of information the*

Precautionary Principle should be applied. In addition, effects of low probability which will have a high potential impact must be considered including the effects of contaminating water supplies."

(a) I agree that it is impossible to predict the effects of an unplanned discharge – by their nature, unplanned discharges will be unpredictable in terms of size, duration and potential impact;

(b) In these circumstances it is essential to anticipate that events of this nature will occur, and put in place the systems and an associated response plan that will help minimise human and environmental health risk;

(c) I consider that the provisions in the WORP adequate for this purpose.

Concerns regarding effects on irrigation and food crops

6.36 Ettrick Fruit Growers Association are opposed to the consent application because of direct public health effects arising from exposure to contaminated water, as well as indirect health effects arising from consumption of food crops irrigated with potentially contaminated water.

6.37 There may be measurable health risks associated with consuming food containing human wastes.[5] It is worth noting that these risks are often related to use of concentrated, relatively poorly treated effluent. This does not imply application of water containing untreated sewage may not pose health risks.

6.38 Several factors will contribute to a low overall health risk:

(a) As described in the evidence of Ms Moogan and Mr Glasner, historical unplanned discharge events, were infrequent, of short duration and discharged volumes are relatively small;

(b) In the event that these discharges enter water (particularly where the contaminants enter large volumes of water, such as a lakes, or pass through an impoundment, or enter large rivers such as the Kawarau or Clutha Rivers):

(i) massive dilution is likely; and

(ii) pathogenic organisms are rendered increasingly inactive as a result of natural attenuation processes.

6.39 I consider that the risk of harm to human health through discharges, irrigation, and food crops is less than minor.

Overall response to submissions

6.40 Having reviewed all the submissions relevant to my evidence, I understand that all submitters (and probably all residents and visitors) are opposed to deliberate discharge of untreated wastewater to land and water. They are also opposed in principle to unplanned discharge of wastewater to land and water. It is important to clearly understand that these two circumstances are not the same.

5 Eg, Steele and Odumeru 2004; Valipour M. and V.P. 2016.

QLDC is not proposing to discharge untreated sewage at will or in a planned way, whenever the system is under pressure or similar. Rather, the discharge events are the consequence of unforeseen events, many caused by the actions of the community.

6.41 It is either impossible or unaffordable to design and install a wastewater network where unplanned discharges will never occur. An analogy may be made with the State Highway road network:

6.42 Despite the use of best-practice design standards, high-quality materials and road construction techniques, and despite ongoing improvement to the road network and elimination of identified hazards, traffic accidents continue to occur. At times these lead to very severe outcomes. Responsibility for damage, injury and even loss of life is seldom attributed to the agencies who build or operate these roads because many of the factors that lead to these undesirable outcomes are out of the control of these agencies. These include road users choosing to travel at excessive speed, operating vehicles while impaired through use of substances, or drivers refusing to drive in accordance with the conditions – heavy rainfall, ice, or poor visibility.

6.43 Central and local government, health, road and law enforcement agencies have implemented emergency response plans to minimise the effects of road accidents, and implemented education campaigns to reduce the incidence of accidents.

6.44 These actions are similar to those proposed by QLDC to reduce the frequency and impact of unplanned wastewater discharges. For example, WORP has many facets, focused on reducing the potential for adverse effects:

(a) rapid response (to identify the cause of the problem, and remedy the situation to reduce the volume of untreated wastewater discharged from the sewer system);

(b) appointing a specialist incident controller to oversee and coordinate the emergency response when discharge to water has occurred or is likely;

(c) containment and recovery and removal of untreated wastewater so that it may be returned to the treatment system prior to subsequent discharge;

(d) specifically addressing human health concerns by identifying where the untreated sewage enters surface water, and where it is likely to travel, followed by erection of signs warning water-users potentially at-risk of exposure to pathogenic organisms; and

(e) commencing a Faecal Indicator Bacteria monitoring programme to define the extent of affected area, concentration of indicator organisms, and decrease in concentrations of indicator organisms over time.

6.45 The response plan incorporates short, clear lines of communication and involves specialists from other agencies as the response is escalated. This is intended to ensure that the response is comprehensive and thorough. Review of the unplanned discharge event and associated response will allow the plan to be revised to incorporate additional steps as required.

6.46 Although these responses can only occur after an unplanned discharge event has occurred, they represent the most effective way to reduce human health risks.

6.47 The improvements to the sewer network that will arise from the capital expenditure programme described in the evidence of Messrs Hansby and Baker are also analogous to the improvements made to the roading network. Improvements to the sewer network will increase capacity, reduce overflow frequencies and volumes, and will allow unplanned discharges to be detected earlier. Potential discharge points will be relocated away from waterbodies, and on-site storage will be increased if possible to decrease the likelihood of overflows.

7 Section 42A Report

Response times and numbers of discharge events

7.1 In Section 4.1.3 the ORC notes the uncertainty regarding the frequency, location, volume, and strength of wastewater likely to be discharged in unplanned discharges. Having reviewed the data provided by the council for the period 07-Aug-2015-28-Nov-2018, I summarise these data to characterise the discharges as far as the data allows:

(a) Table 1 indicates that 8% of discharge events are known to have entered water;

(b) The number of unplanned discharge events per year has increased (noting that data are available only part of the 2015 and 2018 calendar years), but the number known to have entered water has peaked and decreased over this time;

(c) When expressed in terms of the numbers of connections to the sewer system, the proportion of discharges has increased with time.

(d) The reason for the increasing number and proportion of discharges is unknown, but is likely to reflect the improved response and record-keeping of QLDC and their contractors.

(e) These data are summarised graphically in Figure 3.

Table 1: Number and fate of unplanned wastewater discharges, August 2015-November 2018. Note 2015 and 2018 years are not 12-month periods.

Calendar year	Discharge to water?			Total	No. connections	Proportion of connections
	No	Unknown	Yes			
Date not recorded	1		1	2	-	-
2015	8	11	2	21	21,870	0.10%
2016	25	21	7	53	21,870	0.24%
2017	31	16	4	51	22,006	0.23%
2018	54	23	3	80	22,656	0.35%
Total	**119**	**71**	**17**	**207**	**-**	-
Proportion	57%	34%	8%	-	-	-

	of total

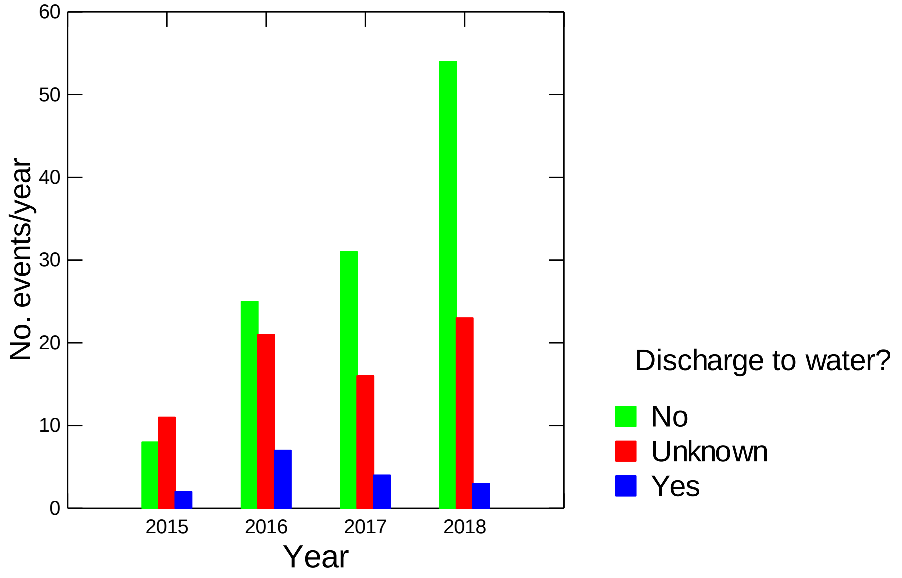

Figure 3: Recorded number of discharges and ultimate fate of discharge, where data are available. This figure excludes two events for which the time of discharge is unknown.

7.2 Figure 4 summarises the unplanned discharge events at monthly time step over the period of record. The variable and unpredictable nature of these events is evident. There is an apparent increase in the incidence of these events over time, but before accepting this conclusion, it is necessary to consider the improved reporting systems that QLDC has implemented over time – the apparent increase in discharge events may just represent more accurate reporting.

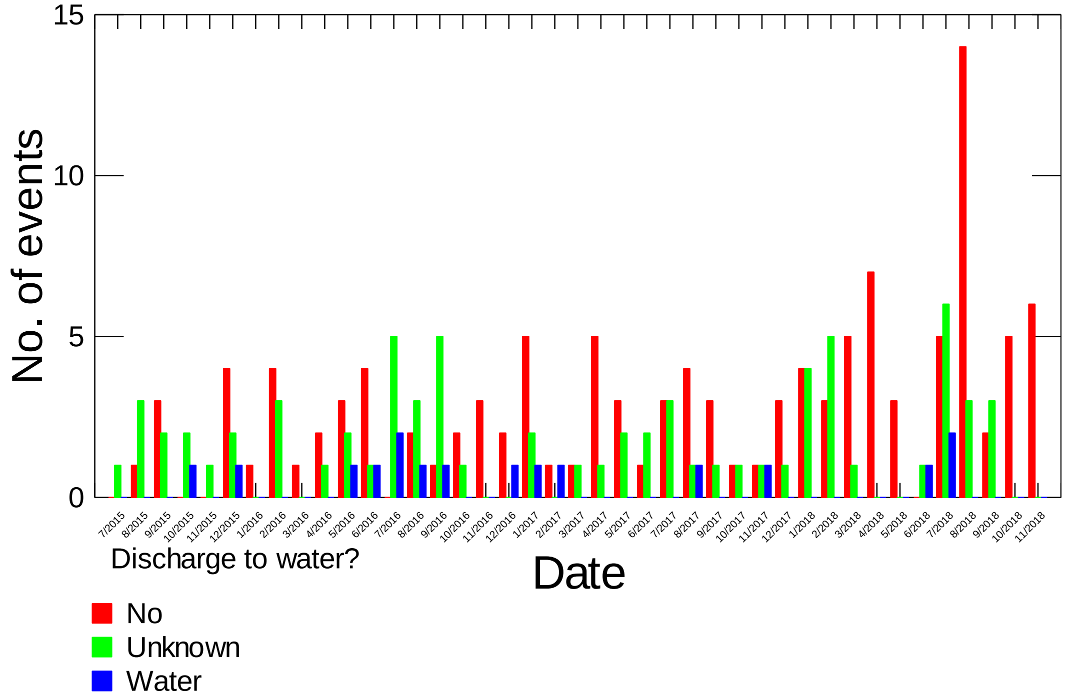

Figure 4: Number of events/month classified by fate of discharge.

7.3 The council records that the resolution of an overflow event as the difference between "Actual callout date and time" and "Service restored date and time".

7.4 Using this understanding of these data, the distribution of resolution times are summarised in Figure 5.

7.5 These data indicate two broad classes of resolution times – those concluded within a four-hour window (the target of the WORP), and a smaller group that take 24 h or more. Reasons for this broad classification are speculative, but could include the requirement for additional resources, unsafe working conditions, or clearance of the blockage, followed by complete repair the next working day.

7.6 The council WORP identifies a target for restoring normal wastewater conveyance of 4 h or less. In 2017/18, approximately 80% of discharges that did not enter water were resolved within 4 h (Figure 5, right), 60% of discharges where the fate is not known were resolved within this time, and 50% of known discharges to water were resolved within 4 h.

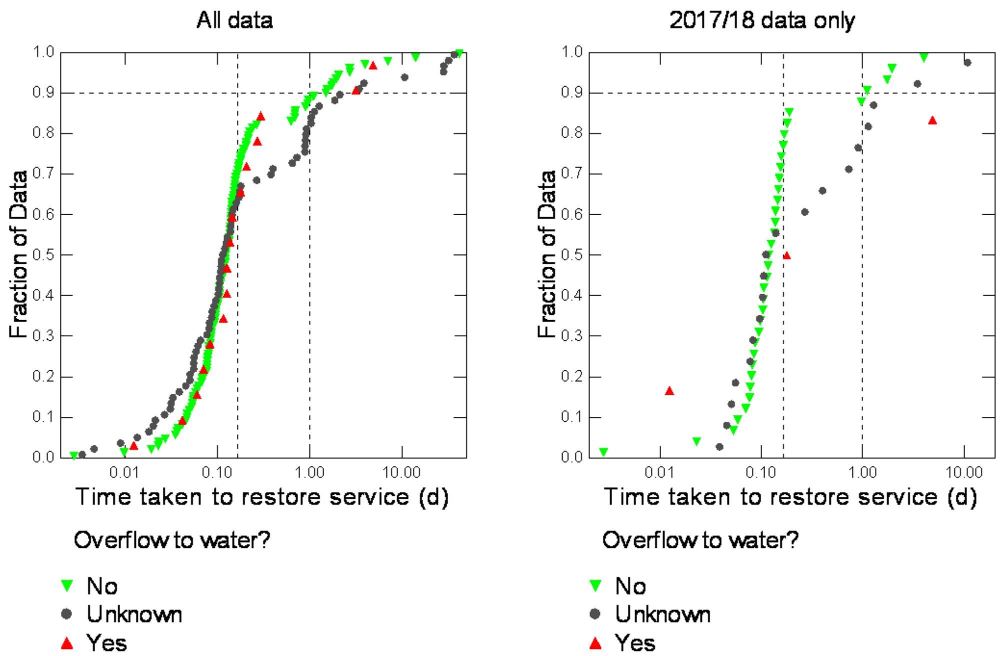

Figure 5: Statistical distribution of time taken to restore normal wastewater services for all data (left) and 2017/18 data only (right). Resolution time expressed in days. The broken vertical lines represent 4 h and 24 h respectively. The horizontal broken line is the 90th percentile.

Frequencies of discharge events

7.7 Dr Greer notes that the period between discharges (all discharges) is approximately six days, and between discharges to water approximately 77 days. He considers these not infrequent.

7.8 If the number of potential sources of overflow (excluding pipes) across the QLDC network is considered,[6] frequency takes on a different perspective. There are

[6] The major components of the QLDC owned and managed wastewater network are summarised in Table 1 of Mr Glasner's evidence.

approximately 7,600 manholes and 72 pump stations ("items") identified in the QLDC Geographic Information System, a geospatial database used to manage infrastructure of this nature. As Dr Greer notes, this infrastructure is distributed over several lake and river catchments

7.9 In view of the terrain, the unpredictable source of materials causing blockages, it is possibly remarkable that just 207 discharges were reported over the 7,600 + 72 = 7,600 x 1,226 = 9,405,872 "item-days" for which data exist.

7.10 When this low incidence of unplanned discharges is considered together with Dr Greer's estimate of a maximum duration of any one discharge of 19 hours or 0.06% of the reporting period (para 4.6), I once more come to the view that the frequency of discharge is low. The idea of "frequency" also needs to have regard for the wide spatial area over which these unplanned discharges have occurred. This conclusion disagrees with that of Dr Greer (section 6.1).

7.11 Figure 6 and Figure 7 (Appendix Three) classify unplanned discharges according to calendar year, show the location of recorded discharge events across the district, their proximity to water supplies and their distribution over space and time. The latter characteristic shows the incidence of unplanned discharge at any specific point to be infrequent.

Inadequacy of the public health risk assessment

7.12 Both ORC (sections 8.1.2.1 and 8.2.1.2) and Dr Greer (section 5) agree with the general approach used for the health risk assessment; Dr Greer makes the point that the approach could be applied "anywhere".

7.13 Both ORC (sections 4.1.3 and 8.1.2.2) and Dr Greer (sections 5.2 and 5.3) agree that a more comprehensive health risk assessment cannot be undertaken with the data available, and come to a view that "effects are more uncertain, more than minor and potentially significant".

7.14 I agree that the effects may be more than minor, and in fact may be severe if an adequate emergency response plan (i.e. QLDC's WORP) is not put into action immediately notification of the discharge is received. Unplanned overflow events may happen at any time, despite careful management and maintenance. That is why I have stressed that protection of public health depends very strongly on having and implementing a robust WORP.

7.15 The adequacy of the response plan will be evaluated after each discharge event, reviewed by external agencies, and if required, the WORP will be revised on an ongoing basis to ensure that it delivers the most important requirements – protection of public health, cultural values and environmental health.

Cross-boundary impacts on water quality

7.16 The evidence of Dr Greer considers that unplanned discharges create a potential for significant adverse effect on aquatic life (section 4.9) and human health (section 6.1).

7.17 One of the criticisms raised by Dr Greer with regard to the ecological and human health risk assessment is absence of "robust information on the volume/flow rate of the overflows", required for a full assessment of effects (section 7.1). I agree completely with this view, but disagree with what it means in terms of managing relatively infrequent events that have a potential to cause environmental or human health damage.

7.18 Both the ORC and Dr Greer agree that it is currently impossible to predict the likely effects of an unplanned discharge because of the unpredictable, largely invisible factors (tree roots, ingress of large items that cause blockages, accretion of fats within the sewers etc.), coupled with data limitations. Their proposed response to such events is prohibition, ignoring completely the circumstances causing the discharge, or what is planned to be done in response.

(a) I suggest that it is more responsible to recognise that no matter how undesirable such discharges may be, unplanned discharges should be anticipated regardless of how well a sewer network is managed, or despite thorough planning. Robust response procedures should be developed, implemented and then evaluated after each event to determine their adequacy.

(b) From a public health perspective, failing to recognise the potential for unplanned discharges would be irresponsible. Granting a consent with stringent conditions is a proactive, responsible approach – it recognises the potential for adverse effects, and then seeks to minimise the risks on a case-by-case basis. The conditions imposed, involvement of other agencies during unplanned discharge events, and post-event reporting and reviews will ensure that the response plans are appropriate, and adequately protect human and environmental health.

8 Conclusions

8.1 I recommend that a similar approach be followed as for the recreational water quality sampling, where a single sample (possibly in replicate) is collected from each site, but if the *E. coli* concentration exceeds a defined threshold, additional samples are collected and analysed on the next (and subsequent) day(s) if required. This approach allows the duration of relatively poor microbiological quality events to be assessed.

8.2 The management/response plan should include immediate reaction (signage, public notification), as well as sampling. The signage and public notification will minimise risk to recreational users, and the sampling will help determine when waters may be considered safe for recreational use. Several agencies are generally involved in these response activities, guided in part by the MfE/MoH recreational water quality guidelines, as well as other emergency response plans.

8.3 Provided adequate steps are taken to reduce the likelihood and size of overflow, and that a robust plan exists to respond adequately to a discharge event of this nature (extremely low probability, moderate risk), the overall health risk to local communities will be very low.

Neale Alan Hudson **18 October 2019**

Appendix One: References

Hudson, N. (2019) Wastewater overflow discharge consent - Queenstown Lakes District Council. NIWA client report prepared for Queenstown Lakes District Council. Report no. 2019063HN, 42 pp.

Hudson, N., McBride, G. (2017a) Quantitative Microbial Risk Assessment for Waimea Inlet, Nelson: Sewer pump station overflows. Prepared for Nelson City Council. October 2017. Report no. 2017348HN, 76 pp.

Hudson, N., McBride, G. (2017b) Wellsford wastewater treatment plant: Assessment of health risk. Prepared for Watercare Services Limited, July 2017. Report no. 2017213HN, 43 pp.

Hudson, N., McBride, G., Jones-Todd, C., Reeve, G. (2019) Quantitative Microbial Risk Assessment for Whanganui WWTP. NIWA client report 2019211HN, prepared for Whanganui District Council, project WNG17201. Report no. 2019211HN, 72 pp.

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Hudson, N., Wadhwa, S. (2017b) Quantitative microbial risk assessment for Waimea Inlet, Nelson. Spatial assessment of risk. Report no. 2017348HN, 79 pp.

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MfE/MoH (2003) Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. . Report no. MfE 474, 124 pp.

Steele, M., Odumeru, J. (2004) Irrigation Water as Source of Foodborne Pathogens on Fruit and Vegetables. *Journal of Food Protection*, 67(12): 2839-2849. 10.4315/0362-028x-67.12.2839.

Valipour M., V.P., S. (2016) *Global Experiences on Wastewater Irrigation: Challenges and Prospects.* . Springer. Water Science and Technology Library: 601. https://doi.org/10.1007/978-3-319-28112-4_18

Data storage and archiving

Most councils store their data as Excel files. The user guide for the Bathewatch software specifies the data file format requirements for loading data into the software. For the MAC component of the SFRG assessment, the data collected from field observations must be stored in a comma-delimited value (*.csv) file format. The data must be stored in this specific file format or it will fail to load properly. It is a simple process to convert files from an Excel format into a *.csv format. The procedure is detailed in the Bathewatch user guide.

It is expected that councils will archive their monitoring data using the council's normal computer back-up system. The council may wish to consider burning the data onto a CD or an otherwise secure file.

Note H(xvi): Reporting to the public

Public health reporting

If exceedances of alert and/or action levels are recorded during weekly monitoring of recreational beaches, the appropriate responses should be undertaken, as described in section D.4 of the guidelines and Note H(xvii) of these notes.

State of the Environment reporting

The two beach water quality indicators can be reported using the data generated by councils. For:

- the percentage of monitored beaches in each beach grade

the indicator provides a measure of the general state of bathing beaches by combining the risk of contamination from the catchment with the microbiological monitoring at the beach. It reports the overall suitability of beaches for bathing. Beaches will be classified into one of five grades (from very good to very poor).

And for:

- the percentage of the season beaches or coastal areas are suitable for bathing or shellfish gathering

the indicator will give an indication of the amount of time in a season the water quality was considered suitable for bathing or shellfish gathering. It provides a measure of the variation of microbiological quality of bathing waters within a bathing season.

Indicator fit with the pressure-state-response model

The Ministry for the Environment has used the pressure-state-response (PSR) model for developing environmental performance indicators – *refer to Note G(iii): State of the Environment Reporting, page G3.*

The indicators on which these guidelines are based - percentage of monitored beaches in each beach grade, and percentage of the season beaches or coastal areas were suitable for contact recreation or shellfish gathering - are state indicators that provide general information on the public health risk presented by recreational waters. Pressure indicators would measure the surrounding land use and discharges to water to assist identification of potential causes of changes in water quality. Response indicators would identify management or policy changes (e.g. infrastructural improvements, land-use management policies, national environmental standards) to manage issues for recreational waters.

Note H(xvii): Management responses to exceedances for marine and freshwater

The planned responses to exceedances of the guidelines should be considered and documented when establishing a regional monitoring protocol, and communicated to all agencies that will have a role to play (e.g. regional councils, territorial local authorities and health agencies). Documentation should clearly state who is responsible for carrying out what actions in response to exceedances. If the response varies from site to site, depending on the overall grade, this should also be clearly stated.

See Section B for details on who monitors and reports.

Single-sample exceedances

The point of having single-sample limits is to identify variations in water quality within the bathing season that pose an immediate risk to human health.

There are two levels of response to single-sample exceedances.

Alert mode

The first is alert (or amber) mode, and is triggered when a single sample is greater than 140 enterococci per 100 mL for marine waters and 260 *E. coli* per 100 mL for freshwaters. In this situation, sampling should be increased to daily to improve the information base and identify whether or not the problem is ongoing. A catchment assessment should be carried out to identify all possible sources of contamination. The monitoring authority should inform the Medical Officer of Health and the other council(s) (either regional or local, depending on who is doing the monitoring).

Action mode

The second level of response to a single-sample exceedance is action (or red) mode. In the case of marine waters this is triggered when two consecutive samples are greater than 280 enterococci per 100 mL, and for freshwaters when a single sample exceeds 550 mL *E. coli* per 100 mL. In this instance the monitoring authority informs the Medical Officer of Health and the other council(s) of the problem. Sampling is increased to daily and a catchment assessment carried out to identify the source of the contamination. The public should be notified of the health risks using appropriate methods identified in the regional monitoring plan. Discussion between the regional council, territorial local authority and Medical Officer of Health should take place to ascertain who is responsible for fixing the problem.

The Ministry for the Environment and Ministry of Health have developed sign templates in consultation with councils and health agencies to use in response to exceedance events and at high-risk sites. (See Appendix 3 for these sign templates.)

High-risk sites

High-risk sites are those sites graded Poor or Very Poor, and will generally have direct discharges, such as sewer outfalls, impacting on them. While the guidelines and notes provide details on assessing these sites and recommend that permanent signs be erected to warn the public of the health risks (see Appendix 3 for sign templates), there is no discussion on remediation work. The agencies responsible for managing the infrastructure or land use affecting water quality, and those responsible for monitoring the sites and public health protection, may wish to discuss and document the remediation work required, and the timeframes, budgets, etc, for achieving this.

Communicating health risks

Communicating health risk is required after exceedance of the action level of the guidelines, as monitoring has identified increased levels of faecal material, which mean the site is unsuitable for recreational use. In order to protect public health, local authorities are required to notify the public of those health risks until the problem has been remedied.

When to issue warnings

The guidelines identify an action level, at which point use of a recreational site is considered unsuitable for contact recreation. For marine waters this is when two consecutive samples taken are greater than 280 enterococci per 100 mL, and for freshwaters when a single sample exceeds 550 *E. coli* per 100 mL. Warnings should be issued as soon as possible after the results from the sample are available. **If contamination is obvious and likely to be ongoing, it is not necessary to wait for results from samples before issuing a health warning.**

Other agencies involved in monitoring and reporting should be notified of exceedances before notifying the public of health risks.

Who to contact

The regional monitoring plan will clearly define lines of communication and responsibilities, such as whose role it is to notify the public. Results should be communicated as soon as possible to the agency responsible for public notifications.

What messages to convey

There are several messages to consider when issuing warnings, other than that there is a health risk. These are:

- there is a health risk
- the council is investigating the cause of the problem (i.e. the council is on to it)
- a list of alternative beaches to visit in the region
- an announcement when the problem has been fixed.

How to deliver the message

There are many ways to communicate information to the public. A number of factors will determine the methods chosen to deliver the warnings, including:

- the urgency of the message
- how well informed the community is
- the demographic make-up of the community.

The public awareness and education section provides more detail on establishing the best methods of delivering messages to the public (see Appendix 1), but the most widely used methods for health warnings are:

- signs
- newspaper articles
- radio
- notices in local shops
- websites
- 0800 numbers.

Signs

The Ministry for the Environment and Ministry of Health have developed sign templates in consultation with regional councils, local authorities and public health agencies. These are provided in Appendix 3.

Fact sheets

Fact sheets have been written to help communicate information about the guidelines and monitoring programmes. These generic fact sheets can be used for media releases, handing out at public at meetings, etc. See Appendix 5 for fact sheets on different topics.

Summary

The most important messages to get across are:

- the health risk
- the council is responding quickly to the event.

It is also important to convey the unpredictable nature of this type of problem and the difficulties in isolating the cause.

Once the problem has been fixed, the public should be notified. This will be apparent from the removal of signs, but should be highlighted through use of the media, community meetings, and contact with user groups, etc.

The public education and awareness programme outline (Appendix 1) provides more information on engaging public support for the monitoring programme.

Management interventions for modified grades

Management interventions will vary in type according to the nature of the predictable event leading to the modification and the target audience. Interventions may range from permanent warning signs on beaches, to public meetings (see Appendix 1: Public Education and Awareness Programme Outline). The ability to demonstrate the effectiveness of interventions in discouraging the public from using the site during periods of high risk is critical. This is what will lead to a modified grade. How this is assessed will vary, but must be verified by the Medical Officer of Health.

See Note H(xii) for details on modifying grades.

Appendix Three: Figure 6 **-** Figure 7

Figure 6: Location and fate of discharges where data were recorded by year, 2015-2018, Lake Wakatipu, Lake Hayes and Arrowtown. Mapped data is from the first section 92 request dated 5 June 2019. There are 202 data points in total plotted on the maps in Figure 6 and 7 (ie 207 less three for which no location was recorded and two for which no year was recorded). Note symbols may over-plot and not be distinguishable.

Figure 7: Location and fate of discharges where data were recorded by year, 2015-2018, Lake Wanaka and Lake Hawea. Mapped data is from the first section 92 request dated 5 June 2019. There are 202 data points in total plotted on the maps in Figures 6 and 7 (ie 207 less three for which no location was recorded and two for which no year was recorded). Note symbols may over-plot and not be distinguishable.