IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of Resource Consents and Notices of Requirement for the Central Interceptor main project works under the Auckland Council District Plan (Auckland City Isthmus and Manukau Sections), the Auckland Council Regional Plans: Air, Land and Water; Sediment Control; and Coastal, and the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health

STATEMENT OF EVIDENCE IN REPLY OF
PETER ROAN ON BEHALF OF WATERCARE SERVICES LIMITED

MARINE ECOLOGY

1. INTRODUCTION

Qualifications and experience

1.1 My full name is Peter Anthony Roan. My qualifications and experience are set out in my primary statement of evidence, dated 12 July 2013.

1.2 I confirm that I have reviewed, and agree to comply with, the Code of Conduct for Expert Witnesses set out in the Environment Court's Practice Note (2011).

Scope of this supplementary evidence

1.3 The purpose of this reply evidence is to respond to matters raised by submitters[1] on the potential effects of discharge from the Emergency Pressure Relief ("**EPR**") structure. My reply evidence addresses:

(a) the Manukau Harbour ecological, water quality data and harbour modelling work that I have utilised in undertaking my assessments;

(b) harbour residence times for freshwater inflows, and the relevance of this with regard to EPR discharge dilution and dispersion;

(c) additional comment on the rate and volume of a potential EPR discharge; and

(d) additional comment on the potential effects of an EPR discharge on the ecology of the Manukau Harbour receiving environment.

2. AVAILABLE INFORMATION ON MANUKAU HARBOUR

2.1 In my primary evidence I identified that my assessments were based on harbour modelling studies undertaken by Watercare for the Mangere Wastewater Treatment Plant ("**WWTP**") resource consent process and on the ecological, water quality, sediment quality and shellfish quality monitoring completed since the oxidation ponds were removed. Specifically, that work includes the followings studies:

(a) **Harbour modelling studies**: Three hydrodynamic modelling assessments were completed by NIWA, dated April 1995, December 1995, and June 1996. Each of those assessments utilise hydrodynamic and transport – diffusion models developed by NIWA for the Manukau Harbour. The assessments considered effluent dilution and dispersion for the discharge locations that were being assessed as part of the Mangere WWTP resource consent process, including discharge from the tidal storage basin (the existing discharge), a potential sub-tidal discharge in the Purakau Channel, and a potential

1 Including Mr Skeates, Mr Kitching, and Ms Vaughan on behalf of Mr Lawrie of the Miranda Naturalists' Trust.

discharge location on the southern shoreline of Puketutu Island. The assessments predicted effluent dispersion and dilution for a buoyant freshwater effluent plume under a range of tidal (spring and neap tides) and wind (calm vs south west wind) conditions, for discharges occurring in both the day and the night, and included simulations for both contaminants that decay (ie contaminant concentrations that are reduced by physical and chemical / biochemical processes, in addition to dilution processes) and contaminants that do not decay (ie concentrations that are reduced by dilution alone).

As I noted in my primary evidence, the NIWA assessments did not consider a shoreline discharge at the location of the EPR structure. However, those assessments did consider dispersion over several tidal cycles, and identified how effluent disperses into and out of the ex-oxidation pond area (the area into which the EPR structure would discharge) over incoming and outgoing tides. Accordingly, the NIWA assessments provide a reliable basis for inferring dispersion of any discharge from the EPR structure from the shoreline out to the point where mixing occurs in the Purakau Channel and in the Manukau Harbour environment beyond. My description of discharge dilution and dispersion is presented in paragraphs 3.10 to 3.15 of my primary evidence.

(b) **Harbour receiving environment monitoring studies**: A series of annual harbour receiving environment studies have been completed by Watercare starting five years prior to commissioning of the tidal storage basin discharge and removal of the oxidation ponds. These studies have been undertaken by Bioresearches Group Limited and are presented in annual reports prepared for Watercare over the period 1996 to 2012. The studies comprise:

(i) The Harbour Environment Monitoring Programme ("**HEMP**") - The HEMP assesses water quality conditions at a number of sites in the north eastern Manukau Harbour.

(ii) The Pond Recovery Monitoring Programme ("**PRMP**") - Since 2002 when the oxidation ponds were decommissioned, the PRMP has assessed sediment quality, benthic macroinvertebrate communities, shellfish quality, macroalgal communities and birds at a number of sites located both within the ex-oxidation pond area and in the adjacent Manukau Harbour. The PRMP is designed to assess recovery of the ex-oxidation pond intertidal habitats.

My summary of sediment quality conditions and the macroinvertebrate communities in the intertidal area from the point of discharge to the point where the discharge would mix with tidal waters (refer paragraphs 4.5 to 4.7 of my primary evidence) is based on the data presented in these studies.

(c) **Bypass discharge shellfish quality monitoring**: In addition to the PRMP and HEMP monitoring, Watercare also undertakes monitoring of the existing approved bypass discharges and monitors virus and microbiological indicator levels in shellfish at Nga Kuia e Toru Reef and at a site on the northern shore of Puketutu Island. This monitoring includes the collection of shellfish samples at Nga Kuia e Toru Reef within 48 hours of a bypass discharge occurring. Annual reporting on that monitoring is undertaken for Watercare by the Microbiological Review Group and the Disinfection Review Group (technical advisory groups established under the Mangere WWTP resource consents). Watercare has provided me with the reports produced by these technical advisory groups, which I have utilised to consider the possible public health risks associated with gathering shellfish after a discharge from the EPR structure.

2.2 Mr Skeates and other submitters have suggested that my assessments have not been based on scientific information. To the contrary, I note that the receiving environment database that I describe above is extensive and has been developed over many years; it is scientifically robust and it has been produced by independent expert advisors for Watercare. From my experience, it represents the most extensive and longest running harbour receiving environment monitoring programme in New Zealand.

3. HARBOUR RESIDENCE TIMES FOR FRESHWATER

3.1 Mr Skeates' evidence refers to research on the residence time for freshwater in the north eastern Manukau Harbour. The original research reference for that work is a 1992 publication by Vant & Williams.[2] In the August 2012 Assessment of Effects on the Environment ("**AEE**"),[3] reference is also made to residence time, with the original research publication for that reference being a 1977 study by Heath et al.[4]

3.2 Residence time is a term used to describe the average time that it takes for a buoyant particle to be flushed from an estuary. As a concept it is often expressed as the time required for the freshwater inflows to replace the total volume of freshwater that is present in the estuary at high tide.

3.3 The Vant & Williams study referred to by Mr Skeates utilises a number of techniques to estimate residence time for the Manukau Harbour. Utilising a relatively coarse scale model, the study estimates that in the north eastern Manukau Harbour, a free floating particle introduced to the head of the Mangere Inlet would take an average of 12.6 days to travel to somewhere near the middle of the harbour. This is the residence time figure that Mr Skeates refers to in his evidence. Other methods utilised by Vant & Williams predict the residence time for the same particle traveling through the same part of the harbour to range from 4.5 days to 9.5 days. The Heath et al study referenced in the AEE estimates an average residence time for the harbour to be 22 days, which is more conservative.

3.4 Regardless, in the context of a discharge from the EPR structure, the residence time for a particle introduced to the harbour at this location is of only limited relevance, as it does not consider the various processes which will ultimately determine the fate[5] and transport of any contaminants associated with the discharge. It does not account for

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2 Vant, W.N., Williams, B.L, 1992: Residence times of the Manukau Harbour, New Zealand. NZ Journal of Freshwater & Marine Research, 26: p. 393 – 404.

3 Watercare Services Ltd, August 2012: Central Interceptor Main Project Works, Assessment of Environmental Effects, p. 90.

4 Heath, R.A., Greig, M.J., Shakespeare, B.S., 1977: Circulation and hydrology of the Manukau Harbour. NZ Journal of Freshwater & Marine Research, 11 p. 589 - 607.

5 Contaminant fate refers to the processes determining how contaminants move or are transformed physically, chemically, and biologically in the environment.

dilution processes nor tidal and wind-induced mixing, and does not account for the physical, chemical, and biological processes that act to degrade or transform contaminants, regardless of dilution processes (eg sun light, chemical / biochemical decay). Residence time simply tells us about the travel time of a particle due to volume exchange processes.

3.5 Modern 3D hydrodynamic models, like those used in the NIWA studies referred to above, are a powerful and commonly used tool for assessing contaminant fate and transport in complex estuarine and marine environments. These models utilise site specific data on bathymetry, tidal range and tidal currents, meteorology (wind in particular), and physical water quality parameters (salinity, density and temperature) to predict the fate and transport of a solute[6] in three dimensions and they do this at a fine spatial grid scale. They make it possible to simulate and predict fate and transport in the marine environment for a buoyant discharge (i.e. freshwater) containing a variety of contaminants.

3.6 The NIWA hydrodynamic models that I described above draw on detailed site specific data for the Manukau Harbour and assess the fate and transport of the buoyant (freshwater) wastewater discharge in the harbour environment. As I note, a wide range of model runs have been completed to simulate this for different tidal, wind, day and time of year conditions, and for different rates of discharge, including discharge under storm inflow conditions and for contaminants with different rates of degradation. The models are at a fine spatial scale, overlaying a 200 metre square grid across the Manukau Harbour, and with an even finer 50 metre square grid used in the north eastern portion of the harbour where effluent mixing occurs. By comparison, the coarse model utilised in the Vant & Williams study on residence time (referred to by Mr Skeates) divided the entire harbour into a total of only 10 cells.

3.7 In this regard, I am very comfortable that the NIWA modelling work that I have relied upon is highly robust and utilises modelling techniques that are considerably more sophisticated than the work by Vant & Williams, and, equally, that it provides a suitable basis for considering dilution and dispersion of any discharge from the EPR structure.

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6 A substance that is dissolved in another substance (a solvent), forming a solution.

3.8 The statement made by Mr Skeates that the discharge could be floating around in the harbour for some days (paragraph 15.3) is factually correct in terms of the concept of residence time. However, it ignores the various processes that will be in action over this timeframe, where the discharge and associated contaminants will be subject to dilution and tidal mixing and to physico-chemical degradation processes. As I indicate in paragraph 3.14 of my primary evidence, the NIWA modelling shows that once in the Purakau Channel, rapid mixing and dilution will occur.

4. RATE AND VOLUME OF DISCHARGE

4.1 Mr Skeates refers to a potential EPR discharge rate of some 72 million litres per hour (or 72,000 m^3 per hour). This figure would be correct if the discharge from the EPR structure was at a continuous rate of 20 m^3/s over an hour. However, this would not be the case. As Mr Cantrell has described, the figure of 20 m^3/s is the peak rate of discharge expected in a 10 year storm event discharge scenario. As Mr Cantrell described in his primary evidence,[7] flows can be diverted from the tunnel by a system of control gates. Modelling shows that in the 10 year storm event discharge scenario (which Mr Cantrell confirmed to be the worst case scenario), a discharge at the EPR would peak quickly to somewhere in the order of 20 m^3/s, but would then also quickly subside reflecting the effects of the gate closures and flow diversion. Mr Cantrell has indicated that the volume of discharge predicted from the EPR structure in a 10 year storm event is in the order of 511,000 m^3. The likelihood of the discharge occurring in a 10 year storm is in the order of 1 event in 250 years. The 1 event in 50 years referred to throughout Watercare's evidence is based on a discharge in a 1 year storm.[8] The predicted peak rate of discharge in this 1 year storm is 3 m^3/s (significantly less than the 20 m^3/s peak rate in the 10 year storm) and the expected volume is 90,000 m^3 in total.

4.2 The analysis of potential public health and water quality and ecological effects that I have presented in my primary evidence focuses on discharge from the EPR structure in the 10 year storm (ie 1 event every 250 years). I have focussed on that scenario for two reasons: it represents the worst case discharge scenario; and the peak rate of

7 Refer paragraph 8.4 of the primary evidence of Mr Cantrell.
8 Refer Watercare Section 92 response dated 27 May 2013, pp. 2 - 4.

discharge (20 m^3/s) is similar to the discharge rate assessed in the NIWA modelling studies (25 m^3/s). However, unlike discharge from the EPR structure, which quickly subsides from the 20 m^3/s peak rate, the NIWA modelling considers a continuous discharge rate of 25 m^3/s. As such, the NIWA studies are a more conservative scenario than the worst-case discharge from the EPR structure.

4.3 Applying the findings from the NIWA modelling to the worst case scenario discharge from the EPR structure (and without any allowance for the difference between the NIWA modelled rate of discharge (25 m^3/s) and the modelled EPR rate of discharge (maximum 20 m^3/s and reducing)) indicates that the discharge would be diluted to very low levels (100 times) within one tidal cycle of the discharge ceasing. At these levels contaminant concentrations would be below receiving environment water quality guidelines. For example, using wastewater overflow quality data from the existing Lyon Avenue overflow, a dilution factor of only 5 times would be required to reduce ammonia levels to below water quality guideline levels (USEPA water quality limit is 3.6 mg/L).

4.4 In this regard, the 10 year storm EPR discharge scenario that I have focused on (1 in 250 years) represents a conservative basis for considering dilution and dispersion and associated effects. Any discharge from the EPR structure in the 1 year storm scenario, where the discharge rate is significantly lower than the discharge rate modelled by NIWA (i.e. 3 m^3/s compared to 25 m^3/s), would result in considerably higher levels of dilution and hence a much lower level of effect.

5. ADDITIONAL COMMENT ON POTENTIAL EPR DISCHARGE EFFECTS

Effects on Migratory Waders

5.1 Evidence has been presented by Ms Vaughan, on behalf of Mr Lawrie of the Miranda Naturalists' Trust, and by Mr Kitching raising concerns about the potential for discharge from the EPR structure to adversely affect the habitats utilised by migratory waders.

5.2 I have outlined the potential ecological effects of an EPR discharge in paragraphs 4.5 to 4.10 of my primary evidence. The concerns raised by Mr Lawrie and Mr Kitching relate principally to the effects of the freshwater EPR discharge on benthic macroinvertebrates, including shellfish, as these organisms are the principal food source for migratory waders. Mr Kitching notes, in his paragraph 2.13, that shellfish cannot survive continuous immersion in freshwater.

5.3 In this regard I note that intertidal shellfish (and all other intertidal macroinvertebrates) are exposed to a constantly changing salinity regime due to tidal influences and the influences of rainfall and stormwater runoff from surrounding land areas. Within this normal range of salinity exposure are periods where rainfall falls directly onto the exposed (dry) intertidal flats.

5.4 While continuous exposure to freshwater will result in shellfish mortality, in the context of the macroinvertebrate communities inhabiting the ex-oxidation pond area, I cannot see a scenario where any discharge from the EPR structure could result in extended immersion of these mudflats in freshwater. I describe the discharge dispersion scenarios in paragraphs 3.10 to 3.13 of my primary evidence. In paragraph 3.13 of my primary evidence I note that, when the tide is out, the discharge would drain across the intertidal mudflat until it mixes with tidal waters, in the same way that the outgoing tide does. In this regard, it is most unlikely that extensive ponding of the discharge could occur on the mudflats, or that intertidal macroinvertebrate communities could be exposed to extended periods of emersion in freshwater (or to salinity conditions outside the norm).

5.5 As I note in paragraph 4.5 of my primary evidence, I would expect a zone of reduced water quality between the point of discharge and the Purakau Channel, which would persist until the discharge ceases and tidal mixing occurs. In terms of the macroinvertebrate communities within the zone, Watercare's PRMP indicates that these communities are relatively low in diversity and numerically dominated by species more tolerant to environmental stress (predominantly by the polychaete worms *Scolecolepides* and *Heteromastus filiformis,* and by amiphods). From work completed by the former Auckland Regional Council on a benthic health model for classifying intertidal sites within the region according to categories of relative ecosystem health,[9] these communities would be described as being associated with increased contamination levels. I would not expect these macroinvertebrate communities to be significantly altered by short duration exposure to the reduced water

9 TR2010/034, June 2010: Assessment of the Benthic Health Model.

quality conditions in this zone in the event of any discharge from the EPR.

5.6 In this regard, I cannot agree with Mr Lawrie and Mr Kitching that the discharge could adversely affect macroinvertebrate communities to an extent that would have a consequential effect on migratory waders.

5.7 While the restored intertidal habitats in the area of the former oxidation ponds have recovered significantly since the Mangere WWTP upgrading, and the PRMP database indicates that the area is now well utilised for feeding by migratory waders, it does not currently support the same diversity of macroinvertebrate communities as other parts of the Manukau Harbour.[10]

Effects on fisheries

5.8 Mr Kitching has raised concerns regarding potential effects of a discharge from the EPR structure on fish or on the macroinvertebrates on which they feed. Based on my consideration of the likely discharge quality and the available dilution and dispersion conditions, it is most unlikely that the discharge could result in conditions that are acutely toxic to fish. While I note in paragraph 4.5 of my primary evidence that there could be some avoidance of the zone of reduced water quality by fish, any effect would be short term and temporary only. Similarly, and as I describe above, I do not expect the macroinvertebrate communities on which fish feed to be significantly altered by short duration exposure to the reduced water quality conditions. Overall, I consider that any discharge from the EPR structure is most unlikely to have adverse effects on fish.

Effects of floating discharge

5.9 A number of submissions have suggested that, because any discharge from the EPR is of freshwater, it will float on the seawater and that this, in turn, presents an additional environmental risk. In this regard, the NIWA modelling of the existing discharge from the tidal storage basin treats that effluent plume as buoyant and identifies that stratification occurs in the water column. This is to be expected and the modelling shows that the stratification breaks down with tidal dispersion, as mixing

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10 TR2009/112 September 2009: Environmental Condition and values of the Manukau harbour: Auckland Regional Council Technical Report.

through the water column occurs. I would expect the same scenario for discharge from the EPR structure, with the time taken for mixing through the water column being determined by the rate of discharge and the tidal and wave conditions at the time. I have taken this into consideration in my assessments.

5.10 Mr Skeates raises concern about the potential for faeces to float in the harbour for some distance from the EPR structure. I have attended many wastewater overflow events with Watercare's contractors as part of my work in developing the Overflow Response Manual.[11] It is my experience that faecal solids are generally not evident in wet weather overflow discharges and I would not expect faecal solids to be evident in any discharge from the EPR structure. My experience is that wastewater debris conveyed to receiving environments in wet weather overflow events is generally that material which does not either dissolve or break up in the turbulent flow conditions.

5.11 I have also attended a number of overflow clean up responses with Watercare and its contractors. Receiving environment clean-up, particularly in coastal environments, generally involves recovering wastewater debris where it has been stranded on beaches. I note that the proposed Watercare Consent Conditions envisage preparation of an EPR Discharge Management Plan.[12] I expect that plan would address provisions for clean-up and recovery of wastewater debris, in the event that it is stranded on mudflats or beaches.

5.12 I note also that Mr Cantrell has addressed provisions for screening at the EPR structure in Section 5 of his supplementary evidence.

6. CONCLUSION

6.1 Overall, I confirm the conclusions presented in my primary evidence.

6.2 My assessments are based on a robust and extensive database of modelling and monitoring studies and I have adopted a conservative worst case scenario for assessing a potential discharge from the EPR structure.

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11 Refer paragraphs 1.6 and 1.7 of the primary evidence of Peter Roan.
12 Refer to Watercare's proposed Consent Condition 10.4.

6.3 While discharge from the EPR structure is possible in unlikely scenarios, any potential ecological effects will be of short duration and limited to an area of reduced water quality between the point of discharge and the Purakau Channel. Given the nature of the macroinvertebrate communities that inhabit this area I would not expect any short duration exposure to reduced water quality conditions to significantly alter community structure. Similarly, I do not consider that any discharge from the EPR structure would result in adverse effects on migratory waders or fish. Overall, I am satisfied that any ecological effects will be low.

Peter Roan

13 August 2013