BEFORE THE HEARINGS PANEL SOUTHLAND REGIONAL COUNCIL

IN THE MATTER	of the Resource Management Act 1991
AND	of an Application for Resource Consent to Discharge from Stormwater Network
BY	**INVERCARGILL CITY COUNCIL** **APP-201668843**
	Applicant

BRIEF OF EVIDENCE OF SUSAN BENNETT

Dated 25 July 2017

Filed by
Invercargill City Council
Civic Administration Building
101 Esk Street
Private Bag 90104
Invercargill 9840
Ph: (03) 211 1777
Solicitor Acting: M D Morris
e: Michael.Morris@icc.govt.nz

I, Susan Bennett state:

INTRODUCTION

1. My full name is Susan Bennett. I hold a BA (Hons) in Natural Sciences from Cambridge University, UK, where I specialised in Chemistry and Molecular Biology.

2. I am employed as Principal Environmental Scientist with Stantec New Zealand Limited (previously known and MWH New Zealand Limited), based in Dunedin. Prior to joining the Dunedin office at the start of 1997, I worked for MWH in Hong Kong for five years.

QUALIFICATIONS AND EXPERIENCE

3. I have over 25 years' experience in environmental consulting, primarily involved with wastewater, stormwater, solid waste and biosolids management. My specialist area is the environmental effects of discharges.

4. Since joining Stantec, in late 1991, I have worked on a range of environmental management projects in Hong Kong, Australia and New Zealand. Relevant projects in the Southland region include:

    4.1 Obtaining consents for Gore, Southland, and Invercargill councils' stormwater discharges to freshwater and review of monitoring information to determine ongoing monitoring requirements for Gore stormwater;

    4.2 Obtaining consents for Te Anau, Riversdale, and Nightcaps wastewater discharges, development of initial phases of wastewater strategy and biosolids strategy for the Southland District, application for changes to the Mataura wastewater discharge consent;

5. I acted as either technical lead for the projects for these projects, or as technical specialist providing input and review of the environmental effects, particularly water quality.

6. Whilst not strictly required for first instance RMA hearings, I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

7. Since September 2015, I have been the technical lead for this project to assist the Invercargill City Council (ICC) in preparing the application for resource consents for the discharges from the Invercargill stormwater network to freshwater. I have attended the consultation meetings and the inspection of each of the outfalls monitored under the existing consent and their catchments, which was undertaken as part of the review of potential treatment options that was attached as Appendix

A of the application, as well as a number of visits to the streams undertaken over the past two years.

SCOPE OF EVIDENCE

8. My evidence will provide:

   8.1 a summary of the discharges, their receiving environments, and the environment effects of the discharges.

   8.2 an assessment of the effects against the relevant Regional Water Plan Standards and the requirements of s107(1)(c) to (g) of the RMA.

   8.3 The rationale behind the draft conditions and how they will work together to reduce the adverse effects of the discharges over the term of the consent.

9. Where my opinion differs from that of Mr West, I will discuss this in the relevant part of my evidence.

NATURE OF THE DISCHARGES

10. Mr West and Mr Loan have provided descriptions of the discharges from the stormwater network which are generally consistent with that provided in Section 2 of the application and I generally agree with them.

11. However, I would clarify that the presence of a discharge from the network during dry weather conditions does not automatically mean that this discharge must be sewage. During the monitoring under the existing consent, the ICC was able to collect samples of discharges in both dry and wet weather.

12. Figure 2-4 (page 10) of the application presents a summary of the *Escherichia coli* (*E.coli*) concentrations in the discharges. The data from the ICC were sorted into three groups: 1) ‘dry’, which includes the data collected in dry conditions; 2) ‘wet’, which were collected in wet conditions; and 3) ‘sewage’, which includes all the data from those discharges suspected of containing sewage, this group includes data collected in both wet and dry conditions. The dry weather discharges have lower *E coli* concentrations than the “sewage” group and significantly lower than actual raw sewage, which typically have *E.coli* concentrations several orders of magnitude higher. Therefore, there are discharges from some of the outfalls in the network in “dry” weather and it is not sewage, but the other sources as given in Section 2.1 (page 4) of the application. There were some samples in the “dry” group with elevated *E.coli* concentrations, as shown by the top 25% of the data set in Figure 2-4; this could be a result of sewage being intermittently but not consistently present at the discharges in this group, or due to natural variability in bacterial concentrations from other sources.

13. I note that the rates of discharge during dry weather conditions have not been quantified but I would expect them to be insignificant compared to wet weather, and may not be present for all of the discharge points from the network.

14. As described in Section 2.4 of the application, the monitoring indicates that the quality of the non-sewage impacted discharges is consistent with, and if anything slightly lower concentrations than, the national data set. The relatively low concentrations measured in the ICC stormwater discharges may be due to the timing of sample collection or the nature of rainfall patterns in Invercargill, which receives regular rainfall with relatively short intervals between rainfall events in which contaminants within the catchment can accumulate, as indicated in Figure 3-6 of the application.

NATURE OF RECEIVING ENVIRONMENT

15. Mr West and Dr Stewart have provided detailed descriptions of the receiving environments. The descriptions provided are consistent with Section 3 of the application, and I agree with them. This included the immediate receiving environment being the five surface water bodies which directly receive discharges from the stormwater network, and the Waihopai Arm of the New River Estuary and the main body of the Estuary itself. I will collectively refer to these water bodies as "the streams" in my evidence. I note that these streams are 'rivers' according to the RMA definition.

16. In my opinion, the five streams which are the immediate receiving environments are of relatively low sensitivity to the impact of the stormwater discharges for the following reasons.

17. In the case of Waikiwi Stream and Waihopai River, the catchment of the streams are large in comparison with that of the stormwater network, with substantial flows. Their catchments have been subject to significant modification to rural activities, which has impacted on water quality in these water bodies.

18. Otepuni Stream, Kingswell Creek and Clifton Channel are all highly modified, with a large proportion of their catchment being urban development. The upper catchment of the streams above the stormwater network has reduced their water quality prior to the discharges from the network.

19. I would consider the New River Estuary and, in particular, the Waihopai Arm of the Estuary to be more sensitive than the streams. The estuary is experiencing environmental effects, which Mr West and Dr Stewart identified as resulting from eutrophication and sedimentation. The stormwater discharges (excluding the sewage) will contribute a small load for the relevant parameters for these effects in comparison to the loads from the rest of the catchment of the estuary, which I will discuss later in my evidence. With respect to the determinands to which the stormwater would be a main contributor, being metal and organic compounds, there is some increase in concentrations which is restricted to the Waihopai Arm

with minimal increase in concentration in the wider estuary. Therefore, I conclude that the wider estuary, whilst being more sensitive, due to lesser degree of modification and wider range of values than the streams, is relatively insensitive to the nature of the contamination in the discharges from the stormwater network.

EFFECTS ON THE RECEIVING ENVIRONMENT

20. The application contains a summary of the available information on the effects of the discharges on the receiving environment. Mr West has summarised those effects in Section 3.2 of his report. I generally agree with his summary but would make the following comments. These are presented in the same order as in Mr West's report.

Effects of Existing Activity

21. In Section 2.3 on page 12 of his report, Mr West states that the effects of the existing discharges do not form part of the existing environment. He appears to indicate that this means that the assessment of the effects of the discharges need to be made in the context of the upstream water quality only, without recognition of the impact from the previous prolonged period of discharge from the stormwater network.

22. I understand that whilst the discharges to be consented cannot be included in the existing environment, the impact of the historic discharge of stormwater forms part of the existing environment to which the network will discharge under the consent. The quality of the discharge from the network will improve as a result of the measures proposed in the consent during its term. Therefore, the existing water quality measured in the streams can be used to predict the expected upper envelope of effects from the discharges as the actions proposed in the consent will improve the quality of the discharges.

Beneficial Effects

23. In his report, Mr West summarises the beneficial effects that result from the stormwater network as those associated with the economic benefits of the network by enabling land use, and that the contamination of the stormwater will have a negative economic effect on the Region (page 24). He notes that those are not quantified in the application but should be acknowledged. He does not mention the significant other beneficial effects relating to public health and water quality.

24. The application briefly summarises the beneficial effects of the network in Section 4.1 on page 42.

25. The discharges for which consent is being sought are the direct result of the provision of the stormwater network, which is the current form of the original drainage network that enabled the development of Invercargill as a city. As its basic function, the stormwater network provides the drainage function that enabled the development of the ground on which Invercargill is founded.

26. Whilst purely theoretical, it may be useful to consider the possible degree of effects that would result if the stormwater network is not present but the city still is. Whilst this is theoretical, it provides an illustration of the benefits of the stormwater network, particularly in terms of water quality.

27. The stormwater network removes the shallow groundwater and rainfall from ponding, flooding and stagnating within the urban area. The public health effects of uncontrolled surface water relate to both disease and safety. These effects are well documented in the improvement in public health in the older cities around the globe with the provision of drainage services.

28. Prolonged flooding of unsealed areas, of which there is a large amount in Invercargill, will result in destabilisation of the soil and its erosion into the streams. This would lead to significant discharges of sediment into the streams and hence the estuary that would be significantly greater than that discharged from the current network. This would result in decreased clarity in the streams, and increase the sediment load to the Estuary. These sediment discharges could also cause oxygen depletion and nutrient enrichment. The surface water would also carry contaminants from activities undertaken in the urban area at a significantly higher load than from the current network.

29. Also, the increased flooding and standing water would place greater strain on the sewer network, as inflow and infiltration of surface water and groundwater would be significantly higher than occurs in the current network. The surface flooding that would result if there is no stormwater network, would both result in and transfer a greater amount of rubbish which would enter both the sewer and stormwater networks. Both the increased flow rates and rubbish would lead to a substantially higher rate of surcharging and blockages which would result in a much higher incidence of sewer overflows.

30. These issues reflect the public health and water quality benefits that result from the provision of the stormwater network with its discharges.

Zone of Reasonable Mixing

31. The scale of environmental effects are assessed through the application of water quality and sediment standards, which allow for ‘reasonable mixing’ prior to assessment of compliance with the standards. ‘Reasonable mixing’ does not necessarily mean full mixing (it can be any distance from the point of discharge through to the point where the discharge is fully mixed) and it is determined on a case-by-case basis but, importantly, it is a zone within which non-compliance with receiving standards are anticipated and allowable. The extent of the zone of reasonable mixing and hence the degree of dilution available is critical to determining if compliance with the required outcome can be achieved, and hence the degree of adverse effect which may occur. The existing consent allowed for a zone of reasonable mixing of 50 m.

32. Mr West make no specific recommendations on the appropriate zone of reasonable mixing.

33. In Section 4.2 of his report, Mr West presents calculations of the extents of a zone of reasonable mixing that would result from the definition in the proposed Southland Water and Land Plan being applied. I note that there are submissions on this policy and the Council has yet to make decisions regarding the appropriateness of this policy so very little weighting should be given to it. The size of the zone of reasonable mixing would be different in each of the streams given the different characteristics of the streams, and for Waikiwi Stream, Waihopai River and Otepuni stream would result in zone of reasonable mixing of greater length than that in the existing consent being from 35m to 80m, given the variation in the channel width.

34. Typically the definition of a zone of reasonable mixing is relevant where there is a point source discharge with a defined plume. However, its practical application to a global consent for all the discharges from the Invercargill stormwater network is problematic. Given the number of point source discharges from the Invercargill stormwater network and the relatively close proximity between each of them, many of the discharges will be located within the zone of reasonable mixing of the upstream discharge(s). Also, given the number of discharge locations, implementing a monitoring programme that samples the effects at the edge of each individual zone of reasonable mixing is impractical.

35. The proposed monitoring programmes is based on the use of a number of monitoring sites along each of the streams with a known number of discharges between the monitoring sites, such that cumulative impacts detected through the monitoring can be attributed to those discharges. There are more proposed monitoring sites than in the monitoring undertaken in the existing consent which will provide substantially better data to detect effects, particularly the presence of sewage within the discharges. Therefore, for effects determined through monitoring, rather than observation, the zone of reasonable mixing will effectively be applied to groups of less than 10 point source discharges, with a maximum distance between sites of 500 m as shown in the maps attached to the proposed conditions.

36. The individual zone of reasonable mixing will apply to the assessment of visible effects which will be monitored through the annual visual inspections and the observations recorded during the dry and wet weather monitoring events throughout the year.

37. Having different zones of reasonable mixing in each water body will render the administration of the consent, in particular interpreting the results of the monitoring, difficult and unwarrantedly complicated. I recommend that a single zone of reasonable mixing of 50 m for visual effects from each individual discharge along the length of the stream be adopted for all streams.

38. With respect to a zone of reasonable mixing to apply across the stream, (ie 2/3 the width), the discharges would not extend across the stream width most of the time given the relative flows in the stream and from each discharge. During high tide, I have observed that the flow in the lower reaches of the streams slows and the discharges may spread across the channel, rather than progressing downstream. This is a temporary effect that would not result in an increase in adverse effects in the water body but could result in non-compliance if a width based zone of reasonable mixing for observable effects is applied. To avoid non-compliance without actual adverse effects, I recommend that an 'across width' zone of reasonable mixing is not applied.

39. Mr West states that there will be little mixing of sediment beyond the turbulent area around each outfall, and indicates a very small zone of reasonable mixing of 1 to 2 m may be appropriate. In my view, the definition of a zone of reasonable mixing for sediment for the Invercargill stormwater network is problematic. Whilst the discharges will contain sediment that will settle out of the water column onto the streambed, this sediment will be re-suspended and moved progressively downstream. Therefore, the concentrations in any single location will reflect the cumulative effects of upstream discharges including those from the catchment upstream of the stormwater network.

40. The tidal conditions in the lower reaches of the streams may result in metals/compounds precipitating out of the water column, and hence elevated concentrations in the sediments in these lower reaches. This sediment will then be moved out into the Estuary over time. Therefore, linking sediment quality to individual outfalls is not appropriate in my view and specific compliance with the sediment guidelines should be for reporting and trending purposes rather than strict compliance at the edge of a defined zone of reasonable mixing.

Visual and Amenity Effects

41. Mr West states that the application identifies that stormwater discharges can result in conspicuous discolouration and rubbish accumulation can have more than minor local effects. Mr Loan indicated the maintenance programme for the outfalls and the annual inspections of all of the outfalls will identify any issues.

42. There are two separate issues involved with this aspect, being colour and clarity, which I will deal with separately.

43. The colour of the stormwater discharges will not be different to the colour of the stream. Different coloured material should not be present in the discharges under normal circumstances, unless as a result of spillage which is excluded from the permitted discharges under the consent as identified in Condition 2 of the proposed conditions.

44. Therefore, the discharges should not result in a conspicuous colour change in the streams.

45. Generally, the water clarity will reduce and suspended sediment concentration of streams will increase as the flow increases in response to the rainfall event (including rural streams and those within forested areas). For the streams with smaller catchments, namely Otepuni Stream, Kingswell Creek and Clifton Channel, the stream will respond in a similar fashion to the rainfall related discharges from the network. This will mean that there will not be a conspicuous difference between the discharges and the general stream condition. The urban environment generally has faster run-off surfaces than rural, which means that rainfall will become surface run-off faster in urban environments than in rural ones. Given this difference in run-off surfaces, there may be a minor delay between the discharges commencing and the streams responding. However, given a zone of reasonable mixing of 50 m, any change in clarity would not be conspicuous after mixing.

46. For Waihopai River and Waikiwi Stream, the catchments are significantly larger and hence these streams will not respond in a similar fashion to the network discharges. However, there is considerably more dilution available for the discharges in these streams and hence while these two larger streams will not respond to rainfall events over the urban area in the same way that the smaller streams will, the increased degree of available dilution from their higher base flows will reduce visual impact

47. Over the last two years, I have visited Invercargill typically once every four to six weeks, and, on each visit, I have walked along sections of the streams, typically the Otepuni Stream and Waihopai River, under a variety of conditions. During these visits, I have not noticed any conspicuous discharges from the stormwater outfalls beyond a short distance from the outfall. Therefore, I expect that there will not be a conspicuous change in clarity or colour beyond the 50 m zone of reasonable mixing.

Effects on Aquatic Habitat

48. I agree with Mr West's summary that there is no clear evidence of adverse effects on the benthic communities in the aquatic habitat from the stormwater discharges, which I note are consistent with the views of Dr Stewart in his evidence. The primary impacts on habitat result from the modifications to the streams from the urbanisation of the area.

Effects on Public Health

49. As noted in Mr Loan's evidence, the stormwater network has a significant role in maintaining the health of the Invercargill community and provides significant public health benefits.

50. The primary adverse effects on public health from the current discharges are associated with the discharge of sewage from the network. There are also public

health risks associated with the discharge of normal stormwater, but these are much less than those associated with raw sewage.

51. The primary risk to public health results from the public not being aware of the discharge being present and hence being exposed to the pathogens present in the sewage.

52. As described by Mr Loan, there are a number of sources of sewage into the network. If sewage is present as a result of a spill from or blockage of the sewer system that has resulted in a discharge to the stormwater system, this would typically be detected either by the operational monitoring of the sewer network, maintenance works, or a complaint. Condition 19 of the proposed conditions attached to Mr Dunning's evidence addresses the risk of the public exposure to sewage by requiring notification of relevant parties as soon as practicable, such that the public can be advised of the presence of sewage in the receiving environment.

53. The presence of sewage as a result of illegal connections or cross-contamination will be determined through the surveillance and indicator programmes described in proposed Conditions 4 to 8. Within the first two years of the consent these programmes will identify the outfalls with probable sewage connections. At this point, signs can be established for these outfalls to inform the public of the risk of sewage being present. These signs would be removed as the source of the sewage is identified and removed.

54. The continued implementation of the surveillance programme through the life of the consent will ensure that new sources of sewage are identified and addressed. These measures will reduce the risk to public health from sewage within the discharges.

55. I note that normal stormwater without sewage contains human pathogens, although at much lower concentrations than in raw sewage. As indicated in Figure 2-4 of the application, the *E.coli* concentrations in the discharges without sewage are elevated over those in the recreational guidelines[1], and would require considerable dilution to meet them, in both wet and dry conditions. Hence, undertaking contact recreational activities, such as swimming, after significant rainfall events is not generally advisable. This increased risk following rainfall is noted in the recreation guidelines. Mr West identifies that full contact recreation is not generally undertaken in the affected streams, and hence, this risk is considered to be minor.

Nutrient Effects

56. I will discuss the nutrient load from the discharges in more detail later in my evidence when I discuss cumulative effects. Mr West states that the total

[1] Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, June 2002, updated in June 2003: Ministry for the Environment

phosphorus concentrations in the Otepuni Stream increases as it passes through the city, indicating an impact of the stormwater discharges.

57. Figure 3-15 of the application presents the available data on dissolved reactive phosphorus (DRP) concentrations in the streams. This is the bioavailable form of phosphorus which is the critical form of phosphorus for nutrient effects. This includes the data from the three Environment Southland State of the Environment (SOE) sites as well as the data collected by the ICC as part of the existing consent. There are considerably more data at the SOE site, which is reflected in the much wider spread of results. However, for the bulk of the data set where 50% of the data exists between the 25%ile and the 75%ile, there is no increasing trend in DRP concentrations along the Otepuni Stream. This indicates the relatively small impact of the discharges on DRP.

Effects from Persistent and bio-accumulative contaminants

58. The primary effect from persistent and bio-accumulative contaminants is toxicity. Mr West's summary of toxicity effects in the water column refers only to an increase in concentration but does not reference them against relevant guidelines. There are no numerical standards for these parameters in the Regional Water Plan. The ANZECC 2000 Guidelines[2] contain trigger values for protection against toxicity to aquatic organisms, these are provided for a range of protection levels. The 95% trigger value is typically applied to slightly to moderately impacted eco-systems. The 80% trigger value is typically used in more impacted systems. The streams to which the discharge occur are impacted both by the physical changes to their morphology, the presence of a significant urban area and the upstream reduced water quality.

59. Whilst not a persistent or bio-accumulative substance, I note that ammoniacal nitrogen concentrations in the water column were much less than the 95% toxicity guideline, and hence do not represent a risk of toxicity effects.

60. As summarised in Table 3-2 (page 35) of the application, a number of the metal parameters in the water column were higher than the 95% trigger value in more than half if not all of the samples, dependent on location. For all metals other than zinc and copper, they were less than the 80% trigger value at all locations. Zinc and copper were elevated over the 80% trigger value for about 25% of samples in most locations, except the lower Otepuni Creek and Clifton Creeks which had a greater number of elevated samples being up to half of the samples.

61. This indicates that there is a risk of toxicity effects from metals in the water column. However, the water samples collected over the last 5 years were analysed for 'total' concentrations and hence are a conservative indication of potential toxicity effects. In order to exert a toxicity effect, the compound must be available to the organism. Metals attached to particulates are not readily bioavailable and hence a significant

[2] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000 ANZECC

portion of the concentrations found in the water column will not be able to be toxic. Therefore, whilst the monitoring shows that the discharges are contributing to an increase in the metal concentrations in the water column, this will result in minor toxicity impacts in the water column. The monitoring of metals under wet weather conditions in Condition 9 of the proposed conditions includes analysis for both dissolved and total forms to better indicate the potential for toxicity effects.

62. Some of the measured concentrations of metals and polycyclic aromatic hydrocarbons (PAHs) in sediment collected from the streams exceeded the ANZECC Interim Sediment Quality Guidelines (ISQG) 'Low' guidelines at the downstream locations in the Otepuni Creek, Waihopai River and Clifton Creek. Concentrations above ISQG-Low suggest that adverse effects on aquatic organisms *may* occur. This area is where the freshwater meets the tidal zone and hence precipitation of metals from the water column to the sediment in the area would be expected. Elevated concentrations are not observed in the wider estuary, so the effect is constrained to a localised area around the mouths of the streams. I note that no sites exceeded the ISQG-High guidelines (above which adverse effects are *likely* to occur), indicating a moderate level of contamination in a localised area. There was minimal temporal trend in sediment concentration apparent over the five years of the monitoring.

63. The observed localised increase in sediment concentrations, in itself, is not an adverse effect. The effect that could result is a toxicity effect on the eco-systems in the area. As discussed in Dr Stewart's evidence, there is no further degradation over the last three decades to communities in the area where the elevated sediment concentrations are occurring. Therefore, whilst the increases in concentrations of metals and organic compounds indicate a risk of adverse effects, actual effects have not are not being detected, and hence the adverse effects of the increase in sediment concentration is considered minor.

64. Whilst metals and organics are an expected component of stormwater, the sewage in the current discharges will also contain these parameters. The load of metals and organics from the stormwater discharges will be reduced through the inspections of industrial and commercial premises (proposed Condition 3), the removal the sewage from the discharge (proposed Conditions 4 to 8) and the implementation of reduction measures identified for the critical sources of metals within the catchment (proposed Condition 11 and 12).

65. I note that metals can be sourced from rural activities which are present upstream of the network in all of the streams. This may be contributing to the elevated sediment concentrations at the mouths of the streams. Whilst I understand that metals and organics are not the primary focus of the 'limit setting' process currently being undertaken by Environment Southland, actions to reduce sediment loads to the streams would be expected to also reduce particulate associated metals and organics from the wider catchment which would also reduce the concentrations of these in sediments at the stream mouths over time.

66. Mr West indicates that the future use of chemicals in the urban area could be addressed through a stormwater bylaw and education. The ICC do not currently have a stormwater bylaw, but one could be established if the other control methods identified in Mr Loan's evidence are insufficient. I note that the need for and implementation of these measures would be the subject of discussions at the Working Party required by proposed Condition 13 which will facilitate a collaborative approach to the implementation of measures to reduce contamination, including education.

Health risks from fish consumption

67. The application and Mr West summarise the findings of the Landcare report into metals and organic compounds which showed low concentrations in fish flesh, which were less than the relevant guidelines. This indicates minimal risks to public health as a result of fish consumption.

Cumulative effects – Catchment loads

68. Mr Leahy has discussed the nutrient and bacterial load from the Invercargill stormwater network that was estimated as an input to the limit setting process. The purpose of that report was to determine the stormwater load relative to that of the treated wastewater. The stormwater load is estimated to represent 3-5% of the nutrient load from the treated wastewater. Hence efforts to reduce overall loads should focus on the treated wastewater rather than the stormwater. This is particularly the case given that there are more feasible options to reduce wastewater nutrient loads than for stormwater, as discussed by Mr Leahy.

69. Mr West presents an analysis of the per hectare load of nutrients and states that on this basis the stormwater is comparable to per hectare load from sheep/beef/deer pasture systems in Southland.

70. Whilst this may be true on a per hectare basis, the referenced Environment Southland report identifies in Table 2 that there are 858,466 hectares of land in sheep/beef/deer high and low production in Southland, which represents 70% of the land and 50% of the nutrient load from production land. The report does not split the areas into the individual freshwater management units. The Invercargill stormwater catchment is 2,330 hectares which is less than 0.3% of that land. Therefore, on a total load basis, the load from the Invercargill stormwater is minimal.

71. The relevance of this relative size of the nutrient load is important in determining the level of effort that should be made to improve the accuracy of estimating the load. Mr West states that the desk-top estimates need to be confirmed with monitoring. I do not agree that the effort involved with this confirmation is appropriate.

72. I recognise that monitoring to confirm concentrations from an individual outfall for a single event is readily undertaken, and has been undertaken as described by Mr

Cocker. The determination of load requires the measurement of flow. Given the nature of the ICC stormwater network, accurate flow monitoring is problematic. Issues include generally partial flow in the stormwater pipes, a lack of space to create a flume and a number of outfalls are below the water level of the streams and hence do not flow freely. In order to confirm the estimate of annual catchment loads, monitoring of a sufficient number of outfalls with representative catchments of the various land uses contributing to the network would be required over a number of different storms. Dependent upon the range of parameters, the cost of analysis for the number of samples required will be significant, as well as the sampling effort involved. Auckland Council, with its significant stormwater network and resources, developed a Contaminant Load Model which is proposed for use in proposed Condition 11 to identify the significant sources of copper and zinc so that implementation of appropriate mitigation measures can be identified and implemented. This model focuses on sediment, copper, zinc and total petroleum hydrocarbons (TPH). It does not address nutrients.

73. As discussed by Mr Loan, there are considerable constraints on the available budgets for management of stormwater. I consider that the nutrient load from the stormwater discharges as determined by the desk-top exercise is relatively small in comparison to that from the treated wastewater and that from production land. Therefore, in my opinion, the money that would otherwise be used to confirm the loads from the stormwater network would be better spent on actions to actually reduce the loads in the discharges and monitoring of their effects in the sediment and water column as outlined in the proposed conditions.

Cumulative effects – New River Estuary

74. Dr Stewart has summarised the environmental condition of the New River Estuary. The primary impacts in the main body of the estuary relate to eutrophication and sedimentation. As previously discussed, the stormwater discharges represent a minimal contribution to these effects.

75. There is a localised increase in metals and organics in sediments of the Waihopai arm of the estuary around the mouths of the streams, some of which exceed the ISQG-Low but not the ISQG-High. This represents a localised moderate impact on sediment quality.

76. Dr Stewart states that there is no significant effects attributable to the current stormwater discharges on the ecosystems of the Waihopai Arm and the wider Estuary. With the proposed improvements in the quality of the discharges through the removal of the sewage and the reduction in concentrations of metals and organics, any adverse effects will reduce over time.

Stock Drinking Water

77. Mr West does not specifically address the impact of the discharges on the suitability of the receiving water for stock drinking purposes, probably because the

receiving water is not used for this purpose, except for the central area of the Clifton Channel, the Waikiwi Stream and the Waihopai River upstream of Queens Drive. Therefore, actual effects on the suitability of the receiving waters for stock drinking is only relevant in these areas.

78. I note that the Regional Water Plan standard relating to faecal coliforms, being a maximum of 1,000 cfu/100 mL, applies at all points along the streams, as given in my discussion on compliance with Regional Water Plan standards below. Whilst this standard is based on protection of stock drinking water, it is actually more stringent that the relevant national guideline.

79. The most relevant national guideline for stock drinking water is the ANZECC 2000 Guidelines[3] which states that "drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median)." Thermotolerant coliforms is another term for faecal coliforms (FC).

80. Concentrations of bacterial organisms are highly variable. For a data set of water quality taken from the same location over time, the difference between the median concentration and the maximum recorded concentration can often be several orders of magnitude. Therefore, for a data set with a median faecal coliforms concentration of 100 MPN/100 mL, the maximum recorded concentration may be more than 100,000 MPN/100 mL, as shown in Figure 3-8 (page 30) of the application. Therefore, imposing a standard of 1,000 cfu/100 mL as a maximum (as the Regional Water Plan does) is considerably more stringent than the relevant national guideline for stock drinking water.

81. I will use the ANZECC guideline in my assessment of the potential effects on stock drinking water. In the three areas where the water may be taken from the streams for stock drinking, the median of the *E.coli* concentrations (all in MPN/100mL), which can be used as a surrogate for probable faecal coliforms concentrations, from the data sets presented in the application are:

81.1 Clifton:

- Upstream: 1,000,
- mid catchment: 124, and
- lower catchment: 159

81.2 Waihopai:

- Upstream: 480,
- ES SOE 400 m upstream of Queens Drive: 350, and

[3] Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000 ANZECC

- 50 m downstream of Queens Drive: 580

81.3 Waikiwi:

- ES SOE 1.2 km upstream of SW discharge: 500;
- 50 m upstream of discharge: 637,
- 50 m downstream of discharge: 628

82. For Clifton Channel, the upstream water quality exceeds the ANZECC stock drinking guideline with the water quality improving by an order of downstream through the catchment but still does not comply with the guideline.

83. For Waihopai River, there is minimal change in *E.coli* concentration in the relevant reach of the stream upstream of Queens Drive and all median concentrations are greater than the ANZECC stock guidelines.

84. For Waikiwi Stream, the stock drinking guideline is exceeded. However, there is no difference in the median of the upstream and downstream concentrations showing minimal impact of the discharge.

85. I note that the ICC data set is skewed towards dry weather conditions when bacterial concentrations would be expected to be lower than wet weather. However, the ES data sets are much larger and include both dry and wet conditions.

86. Therefore in all three locations, if the upstream water quality improved sufficiently, it is considered likely that the relevant reaches of the streams could comply with the ANZECC stock drinking guideline, and hence the discharges from stormwater network do not render the water unsuitable for stock drinking water.

Summary

87. In summary, my assessment of the adverse effects of the discharge are that the discharges from the stormwater network have a minor effect on water quality and aquatic eco-systems, when considered without the effects of the sewage which is present.

88. I note that the assessment in the application as summarised by Mr West on Page 18 concluded that effects on the water quality are minor to moderate. The moderate assessment was on the basis of the non-compliance with the Regional Water Plan standard for faecal coliforms in wet weather particularly in the smaller streams. I have further considered the effects on the discharges on the two adverse effects that can result from elevated bacterial concentrations, namely public health and stock drinking. I consider that, if the effects of the sewage are excluded from the assessment, while the wet weather discharges to the smaller streams may result in the exceedence of the Regional Water Plan standard, the associated adverse

effects on stock drinking water and public health are minor. Also, these adverse effects are balanced by the beneficial public health effects resulting from the provision of a stormwater network.

89. The assessment in the application indicated that visual and amenity effects of the discharges are moderate. I cannot comment on amenity effects. However, earlier I concluded that there would not be conspicuous changes in clarity or colour of the streams as a result of the discharges. Therefore, I would consider the visual effects of the discharge to be minor.

90. I consider that the adverse effects of the sewage in the discharges is more than minor. As described by Mr Cocker, the ICC have been working to remove the cross connections of sewage from the stormwater network over the past 5 years. The proposed conditions contain a robust method for identifying and removing the illegal sewage connections from the discharges. Mr Loan has described the renewal process which will reduce the frequency and volume of sewer overflows to the stormwater network over time.

ASSESSMENT AGAINST REGIONAL WATER PLAN STANDARDS

91. Section 4.2.6 of the application on Page 44 contains an assessment of the impact of the stormwater discharges on the Regional Water Plan standards as given in Appendix G of the Regional Water Plan. This assessment was based on the monitoring that has been conducted.

92. There are a number of standards that are not complied with in the streams. However, most of these are not considered to be a result of the stormwater discharges, but are a result either of upstream water quality or the highly modified nature of the streams as they pass through Invercargill. This is the case for change in temperature, dissolved oxygen, clarity, algae, and macroinvertebrate communities. Whilst the nutrients in the stormwater could be contributory to the algae growth in the streams (and thereby also contribute to lower dissolved oxygen diurnal minima concentrations), as previously discussed, it is not considered to be the significant in comparison to the upstream sources.

93. The only standard which is not complied with that the stormwater discharges would influence is the standard for faecal coliforms, which is a maximum of 1,000 MPN/100 mL. Both the ICC and ES SOE monitoring indicate that the standard is not complied with for a significant number of events at all monitored locations, both upstream of the stormwater network and throughout the catchment.

94. The sewage component of the discharges will significantly contribute to the faecal coliforms concentration in the water column. The removal of this source over time will reduce this impact but it will not remove it altogether.

95. As noted above, urban stormwater that has no sewage overflows or cross connections contains bacteria from various sources. For the streams, where the stormwater system is a significant part of the overall catchment, ie Otepuni Stream,

Kingswell Creek and Clifton Channel, it is likely that in wet weather events, the discharges will contribute to exceedences of the standard. For the larger water bodies, the effect of the wet weather stormwater discharges would be less due to the greater dilution available, and the discharge of normal stormwater is not expected to result in non-compliances with the faecal coliforms standard beyond the proposed 50 m zone of reasonable mixing.

96. In dry weather, the stormwater discharges are expected to be of relatively low flow and hence it is expected that they would not impact on compliance with the standard.

97. Therefore, the discharges for which this consent is sought are anticipated to contribute to the observed non-compliance with the Regional Water Plan faecal coliforms standard, generally during wet weather in the water bodies with smaller catchments. The extent of this contribution outside of the proposed 50 m zone of reasonable mixing is dependent upon the concentrations in the discharge, the volume of the discharge and the flow in the stream, all of which are highly variable.

98. The monitoring of the streams proposed in Conditions 5 and 9 will provide a good data set to determine the impact of the discharges on compliance with the faecal coliforms standard. Monitoring required by proposed Condition 9 is during wet weather and includes both *E.coli* and faecal coliforms. The monitoring required by proposed Condition 5 is for *E.coli* (which is a sub-set of faecal coliforms) only during dry weather. Given the scale of the monitoring proposed by Condition 5 in terms of number of sites (35 sites) and frequency (every 2 months), analysis for both *E.coli* and faecal coliforms for this monitoring is not considered necessary. *E.coli* was used as the indicator for the monitoring undertaken under the existing consent on which the trigger values in Condition 4 were based, and hence is used in preference to faecal coliforms to detect sewage contamination for this programme.

99. The other Regional Water Plan standards, including temperature, pH, bacterial or fungal slime, ammonia, and consumption of fish, will be complied with given the monitoring data available.

ASSESSMENT AGAINST REGIONAL WATER PLAN POLICIES AND OBJECTIVES

100. The objectives and policies on which I will provide comment are Objectives 3 and 4 and Policies 4 of the Regional Water Plan. Whilst I am not a planner, these objectives and policies include reference to environmental effects on which I will comment.

101. Objective 3 requires that water quality be maintained or enhanced to protect a number of values. Given that the streams are not identified as Popular Bathing Sites in Appendix K of the Regional Water Plan, nor in Appendix G of the Proposed Southland Water and Land Plan. None of the bathing sites for which information is provided in Environment Southland Information system would be potentially

impacted by the stormwater discharges to the streams. Therefore, whilst some contact recreational activity is undertaken in the streams, the streams are not designated as popular bathing sites and I consider that the value does not require protection under Objective 3 in these streams.

102. Objective 3 identifies the protection of trout where present otherwise native fish. The discussion earlier in my evidence shows that that the effects on fish from toxicity will be minor. The localised increase in metal and organic concentrations in sediment may pose a risk but these increases are localised to the mouths of the streams. Also, as stated by Dr Stewart, there is no evidence of further degradation the aquatic eco-systems in the area over the past 30 years. The actions given in the proposed conditions to remove the sewage in the stormwater and to reduce metals and organics loads in the stormwater will enhance the quality of the water with respect to trout and native fish values.

103. Similarly as discussed above, these actions are also expected to result in the streams in the relevant reaches complying with the stock drinking water guidelines.

104. I am not qualified to discuss impact on Ngai Tahu cultural values. However, I note that the Landcare Research report identified minimal risk from the consumption of fish due to metals and organic compounds that would be present in the discharges. The actions in the proposed conditions will reduce the loads of these parameters.

105. I am not qualified to comment on the impact of the discharges on the natural character of the streams. However, I can comment that while the discharges may result in decreases in the clarity of the streams, this is either anticipated to be resolved within the zone of reasonable mixing or will be reflected in the general response of the streams to rainfall events and hence will not affect the characteristics of the stream itself. The streams are highly modified but that is not a result of the discharges.

106. Objective 4 requires a 10 percent improvement in microbiological parameters, nitrate, phosphorus and clarity over the 10 years from 2010. Whilst difficult to accurately quantify, the removal of the sewage from the discharges will considerably reduce the loads of each of these parameters. Given the granting and implementation of the consent from this hearing, I would anticipate that the actions required should identify the outfalls affected by sewage discharges by mid to late 2019. As discussed by Mr Loan and Mr Cocker, and required by Condition 8, the ICC are committed to then finding the source of the sewage in the catchment of the outfall and removing it.

107. Policy 4 requires the management of discharges to meet the Regional Water Plan “Water Quality Standards” in Appendix G to avoid levels of contaminants that could harm the health of humans, domestic animals including stock, and/or aquatic life.

108. My earlier discussion of these impacts are relevant. The impact of the discharges on public health relate the sewage component of the discharges and hence the

actions to remove the sewage will reduce this impact and the residual impact of the "normal" stormwater discharge is considered to be minor, and the level of potential harm can be managed to a low level.

109. The impact on stock drinking water quality is discussed in my paragraphs 77 to 86, and is considered to be currently minor in the reaches of the streams used for stock drinking. In the lower reaches of the streams, the presence of sewage may pose a risk from the use of the streams by domestic animals, including dogs. The removal of the sewage will reduce this impact. It is noted that the incidence of poisonous algal mats, which can affect dogs, is related to the nutrients in and temperature of the water. As discussed earlier, the stormwater discharges do not significantly impact on either of these aspects of the water quality in the streams. Therefore, the level of harm from the stormwater on domestic animals including stock is equivalent to that inherent in the relevant guidelines.

110. The previous discussion on aquatic life indicated the potential for an impact of the discharge on aquatic life. However, this is considered to be minor in the water column itself from toxic effects, and increases in sediment concentrations are limited to a localised area at the mouth of the streams in the sediment. As stated by Dr Stewart, there is no evidence of further degradation of the aquatic eco-systems in the area over the past 30 years. Therefore, the discharge from the network (excluding sewage) is not resulting in harm to aquatic organisms. The removal of the sewage will reduce the impacts and the measures to reduce the contamination in the stormwater will also reduce the effect over the term of the consent.

ASSESSMENT AGAINST SECTION 107 RMA EFFECTS

111. Section 107 of the RMA specifies a number of effects as follows:

> (c) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:
>
> (d) any conspicuous change in the colour or visual clarity:
>
> (e) any emission of objectionable odour:
>
> (f) the rendering of fresh water unsuitable for consumption by farm animals:
>
> (g) any significant adverse effects on aquatic life.

112. Each of these effects are not to occur after reasonable mixing and have been discussed earlier in my evidence, except for odour. I would not expect that the normal stormwater discharges would result in objectionable odour. Any objectionable odour would be as a result of spills or accidental discharges which are specifically excluded, though managed, by the proposed conditions.

113. I consider that the discharges from the stormwater network, excluding the sewage component, will not result in any of these effects after reasonable mixing in the relevant reaches of the stream in which these effects could occur.

DEVELOPMENT AND OPERATION OF PROPOSED CONDITIONS

114. The proposed conditions for the consent were drafted based on the effects identified in the assessment performed in the application. They were discussed with the submitters and further developed to address their concerns, as identified both in their submissions and in the subsequent consultation meetings and the pre-hearing meeting(s). As such, I will not discuss the individual submissions in detail.

115. Stormwater management involves a complex interaction between the various sources of contamination that can enter the system. I note that the ICC itself is not entirely responsible for the sources of the contamination that can be found in the stormwater but accept the contamination which is sourced from the individual property owners. The only contaminant source that is directly controlled by the ICC is the sewer network and overflows from that into the stormwater network.

116. As such, the ICC has to work in a “once removed” capacity to reduce contamination, and this is reflected in the conditions. Mr Loan has discussed the various methods that the ICC can use to require that sources improve the quality of their discharges. The proposed conditions largely relate to identifying the sources of the contamination and then implementing methods to reduce it.

117. The proposed conditions specify monitoring programmes, trigger values, standards and reporting guidelines, required actions by the ICC and reporting requirements, both regular and in response to specific events. The specific effects which they have been designed to reduce have been identified previously in my evidence.

118. I note that Mr West proposes a number of conditions which could be incorporated into a consent. Most of these aspects are included in the proposed conditions. The only element that is not included is a Management Plan and monitoring of the overflow discharges.

119. The proposed conditions require that the Annual Report must include the plan for actions in the forthcoming year as well as reporting retrospectively. This allows more scope for adaptive management of the network in response to issues throughout the consent, rather than preparing a Management Plan at the start of the consent. It is also more efficient than requiring two separate documents (ie the Management Plan and the Annual Report) to be prepared separately.

120. Methods for control and monitoring of the overflows is not included in the proposed conditions as these discharges are not included in this application.

121. Given the complexity of the proposed conditions and their interaction, I have developed a series of flow charts which illustrate how the conditions will work

together. These flow charts are attached to my evidence as Attachment 1. I hope the flow charts assist the hearings panel in understanding the function and intent of the proposed conditions.

122. In general, the following approach has been employed in the conditions.

123. The ICC will undertake a long term renewal process of its sewerage and stormwater assets. This is coupled with a surveillance and monitoring programme to identify and enable illegal sewage discharges to be identified and removed.

124. The sediment and wet weather monitoring will provide an indication of the continuing impacts of the discharges within the receiving environment, Appendix 3 and 4 of the proposed conditions provide trigger values which will provide targets to be aimed for through the consent. These provide the tension to ensure that the ICC keeps making improvements until water and sediment quality is within the boundaries of the trigger values provided. I note that some of the targets are definitely stretch targets and may not be achieved during the consent term, largely due to sources other than the stormwater network, such as bacterial, nutrient and sediment loads from upstream rural activity. The wet weather monitoring programme was not included in the initial draft conditions discussed with submitters but has been added following the pre-hearing meeting to address concerns raised at that meeting.

125. Primary contaminants from the monitoring under the existing consent are the four metals which are identified in proposed Conditions 11 and 12, namely copper, zinc, nickel and lead. Reduction of these metals is through mapping or identification of the sources and then implementing appropriate reduction measures. Any other parameters requiring action will be identified through the Working Party in proposed Condition 13 and through the water column and sediment monitoring and any other monitoring or investigations undertaken by other parties.

126. The implementation of the industrial inspections will minimise the risk of spillage of contaminants from those sites, and should also reduce habitual contamination due to improving yard practices.

127. These reduction measures need to be identified in the Annual Report each year and progress on implementing them documented each year. They will include implementing within catchment treatment for specific high sources, (eg the high traffic or braking areas, or concentrated industrial areas), requiring painting of roofs if they are copper or zinc (but probably not zincalume, as identified by NZSteel), education of public about what not to pour down their drains, and car washing on grass. On a national basis, the ICC and its collaborators in the Working Party could campaign to get copper-less brakes as has been done in California.

128. I note that as identified by Mr Leahy, there is not much the ICC can do reduce faecal coliforms concentration in normal stormwater, this may remain as an issue during the consent even with the removal of the sewage from the discharges.

CONCLUSION

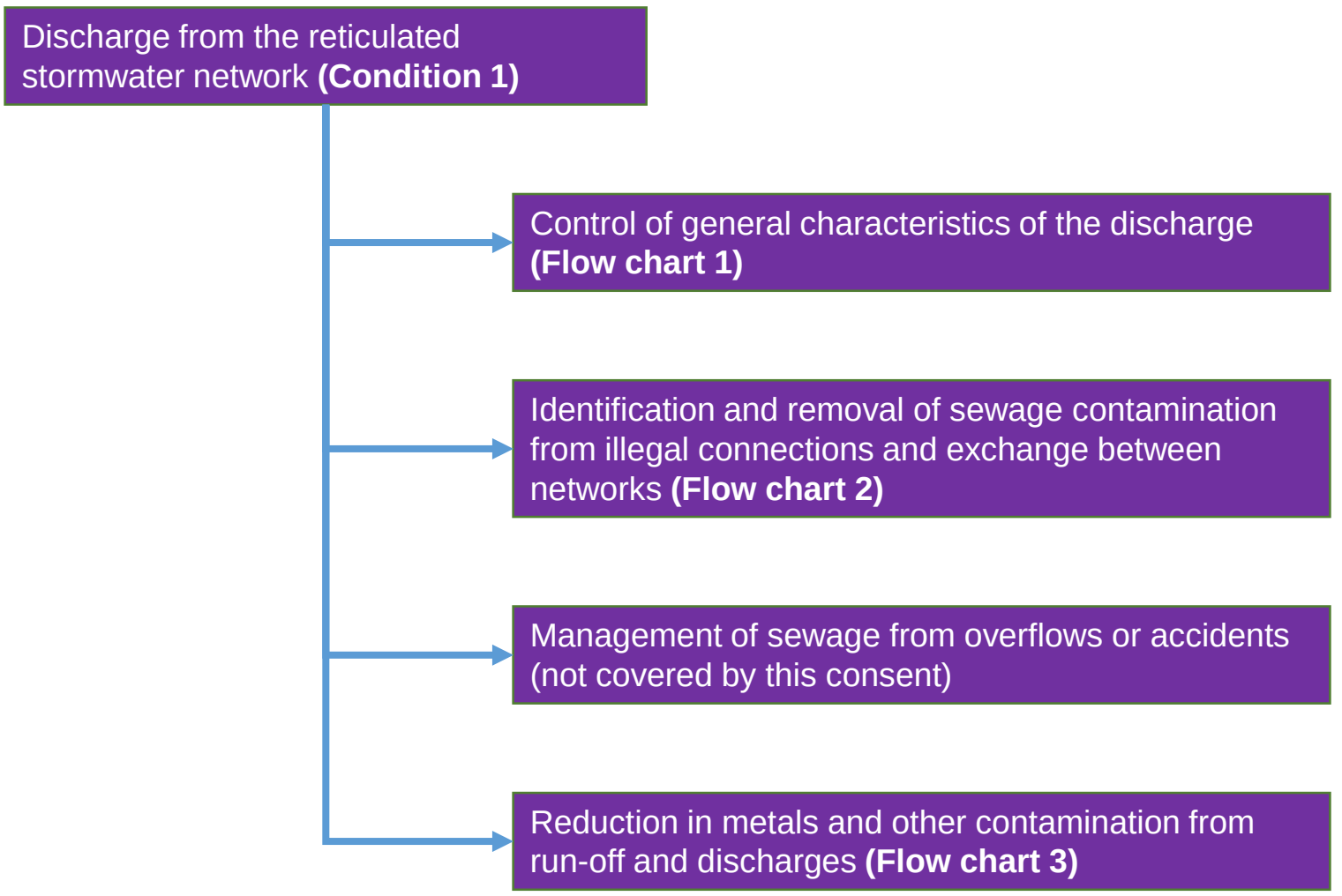
129. I conclude that the stormwater network is essential infrastructure and that there is no environmental effects reason why the consent for the discharges from the network should not be granted.

Dated: 25 July 2017

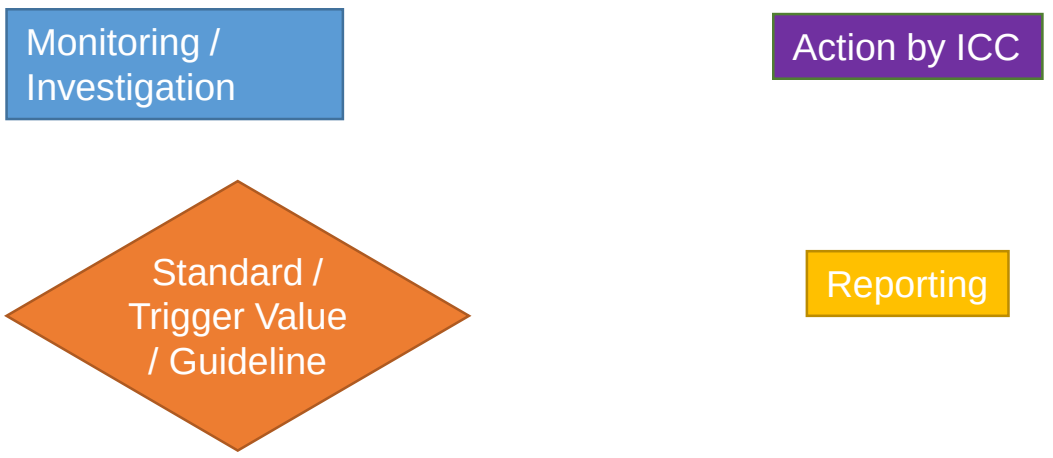
……..
Sue Bennett
Principal Environmental Scientist

Attachment 1: Flow charts of the Interactions in the proposed conditions

Flow charts of the Proposed Conditions of consent



Legend for flow charts:



Control of general characteristics of the discharge **(Flow chart 1)**

Annual Visual inspection of all outfalls **(Condition 18b)**

Are any of effects given in **Conditions 14, 15, 16** occurring ? **(Condition 18a)**

No

Maintain log of results of inspection to be available to ES on request **(Condition 18b)**

Yes

Implement mitigation measure **(Condition 18)**

Report on mitigation measures in Annual Report **(Condition 21d)**

In event of spill of contaminant into SW system:
- Prevent discharge of contaminant by closing off sumps, as far as practicable
- Clean up contamination

(Condition 19)

As soon as possible, notify identified parties of spill **(Condition 19a)**

Within 48 hours of incident, provide report to ES on details of incident and remediation / prevention measures undertaken **(Condition 19b)**

Use of dye to trace source of contaminants **(Condition 1)**

Before dye release, notify ES **(new Condition 20)**

Prior to dye release, erect sign at relevant outfall **(new Condition 20c)**

Consider applications for sub-division consents that will link to the ICC stormwater network **(Statutory function)**

Is proposed stormwater infrastructure in accordance with best practice and low impact design measures ? **(Condition 17)**

No

Consider whether to grant consent with requirement that applicant improve the proposal **(Statutory function)**

Yes

Grant consent and then incorporate into ICC assets as appropriate **(Statutory function)**

Design and build new stormwater infrastructure in accordance with best practice and low impact design measures **(Statutory function and Condition 17)**

Will proposed new stormwater infrastructure connect to an existing outfall with no change to outfall required ? **(Condition 17)**

No

New infrastructure included in scope of current consent – no change to consent required. **(Condition 1)**

Yes

Obtain change to consent to include new or changed outfall. **(Condition 1)**

Identification and removal of sewage contamination from illegal connections and exchange between networks **(Flow chart 2)**

Surveillance Programme in streams every 2 months in dry weather throughout term of consent **(Condition 5)**

Are trigger values (TV) in **Condition 4** exceeded more than once in last 6 events **(Condition 6)**

No

Include results in Annual Report to ES and Working Party **(Condition 5 & 21)**

Yes

Report results in to ES within 4 weeks **(Condition 5)** and in Annual Report **(Condition 21)**

Always

Include results in Annual Report to ES and Working Party **(Condition 7 & 21)**

Indicator Programme in relevant discharges monthly in dry weather for 6 months **(Condition 7)**

Are trigger values (TV) in **Condition 4** exceeded more than once in 6 events **(Condition 8)**

No

Yes

Establish signage to inform public of presence of sewage (Condition 8a)

Always

Report to ES on progress with investigations and implementation every 6 months **(Condition 8)**

Investigation of catchment of relevant discharge **(Condition 8)**

Is source of sewage identified **(Condition 8)**

Yes

Implement identified mitigation measures **(Condition 8)**

No

Reduction in metals and other contamination from run-off and discharges **(Flow chart 3)**

Wet weather Monitoring Programme in streams **(Condition 9)**

Are guidelines in **Appendix 3** achieved in streams? **(Condition 9c)**

Yes

Always

Report in Annual Report to ES and Working Party **(Condition 9e & 21c)**

No

Identify key concerns in conjunction with Working Party **(Condition 13)**

Identify works in forthcoming year to address concerns in Annual Report to ES and Working Party **(Condition 21c and f)**

Undertake works identified in Annual Report **(Condition 21e)**

Report on works undertaken in Annual Report to ES and Working Party **(Condition 21e)**

Sediment Monitoring programme in streams **(Condition 10)**

Are guidelines in **Appendix 4** achieved in sediment? **(Condition 10c)**

Always

Report in Annual Report to ES and Working Party **(Condition 10c & 21c)**

Yes

Map sources of copper and zinc to identify the most significant sources **(Condition 11a)**

Report outcome of mapping exercise to ES **(Condition 11a)**

Each year, identify actions to reduce loads **(Condition 11b)**

Undertake works each year as identified in Annual Report **(Condition 16)**

Report on works undertaken in Annual Report to ES and Working Party **(Condition 11b & 21)**

Identify premises that may contribute nickel or lead **(Condition 12)**

Report on identification and mapping of nickel and lead sources to ES **(Condition 12a)**

Create and update list of premises for inspection **(Condition 3a)**

No

Inspection of each premise on list every 5 years. Any sites identified in Condition 12 (Ni or Pb) to be inspected in first 3 years of consent **(Condition 3b and c)**

Are Improvements required for "at-risk" sites **(Condition 3d)**

Always

Enforce implementation of required improvements through available regulatory methods **(Condition 3)**

Report in Annual Report to ES and Working Party **(Condition 3e & 21)**

Yes

Inspect at-risk sites every 12 months till resolved **(Condition 3f)**