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 BRIAN GEORGE STEWART

Dated 24th day of July 2017

Filed by
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I, Brian George Stewart state:

QUALIFICATIONS AND EXPERIENCE

1. My name is Brian George Stewart. I reside in Dunedin. I am a trained marine biologist and hold a BSc in Zoology from the University of Canterbury, a Post-Graduate Diploma in Marine Science from the University of Otago and a PhD in Marine Science, also from the University of Otago.

2. I am employed as a Senior Environmental Scientist with Ryder Consulting Limited, an environmental consulting business based in Dunedin. Prior to this I have held lecturing positions at the University of Otago and the University of Canterbury.

3. During the past 25 years, I have worked on a wide variety of marine and freshwater projects involving macroinvertebrates, fish and algae, sedimentation rates in marine environments, environmental monitoring, and general water and sediment quality throughout the North and South Islands.

4. I have been contracted by private companies, regional councils and government departments to provide detailed ecological assessments of inter-tidal and sub-tidal habitats within Southland and Otago. I have also undertaken estuary habitat mapping for Otago Regional Council (ORC), investigated the effects of sewage and stormwater disposal into the marine environment for Dunedin City Council (DCC) and have been contracted to supply numerous resource and ecological surveys for fishing interests in Southland and Otago.

5. I was, for the four years from 1996 to 1999, the manager of the biological monitoring programme for Meridian Energy in Doubtful and Milford Sounds. The aim of this programme was to determine effects on the fiord ecosystems of any sediments released as a result of the Manapouri Second Tailrace Project by undertaking extensive annual dive surveys at multiple control and impact sites in the fiords.

6. In 2011 I was retained by the Environmental Protection Agency (EPA) as an expert advisor on marine ecological matters pertaining to the Waterview Connection motorway project in Auckland, including the effects of motorway runoff on estuarine communities.

7. I have prepared numerous reports on monitoring effects of stormwater discharges on the receiving environment for DCC and have been closely involved in the preparation of the Assessment of Environmental Effects (AEE) for a number of coastal discharges and other projects.

8. In preparing this evidence I have reviewed the AEE prepared for this application and other reports relevant to my area of expertise.

9. I have also read the evidence of Susan Bennett and the Section 42A report prepared by Environment Southland.

10. 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.

SCOPE OF EVIDENCE

11. I have been asked by Stantec, on behalf of the Invercargill City Council (ICC), to present evidence in relation to receiving water quality associated with the stormwater discharges in the watercourses draining four catchments, namely Kingswell, Otepuni, Waihopai, and Waikiwi.

12. I have also been asked to comment on the appropriateness of using macroinvertebrate community health indices (MCI and SQMCI[1]) to determine ecological community health in estuarine environments.

13. Lastly, I have been asked to comment on how I believe contaminants carried in stormwater may affect the wider New River Estuary.

14. I verify that the evidence contained herein is within my area of expertise. However, references have been provided where I have relied on information from other sources.

[1] MCI = Macroinvertebrate Community Index, SQMCI = Semi-quantitative Macroinvertebrate Community Index

THE PRESENT ENVIRONMENT

15. The ICC stormwater system is a reticulated and channelled network that receives runoff from roofs, roads and other impervious surfaces, and permeable land, including reserves, lawns, gardens and rural areas.

16. In April 2016 a colleague and I undertook a benthic macroinvertebrate survey of four sub-catchments of the Invercargill City network, namely Kingswell, Otepuni, Waihopai, and Waikiwi (Figure 1).

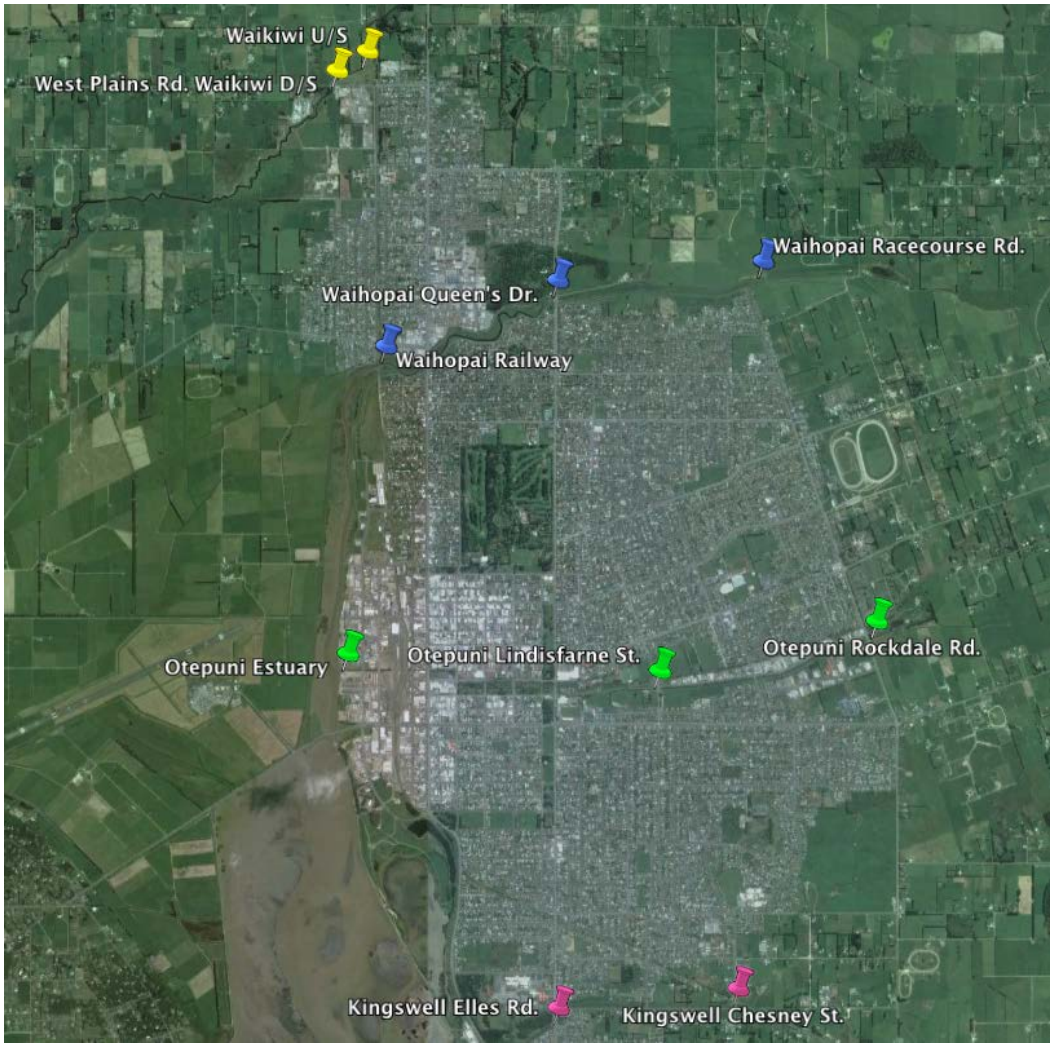

Figure 1. *Locations for sampling points for data presented in Table 1.*

17. The survey also included a subjective assessment of stream conditions at each site. Although flow at the time of sampling was

slightly higher than ideal, I do not consider that this unduly affected the results obtained.

18. Kingswell Creek is characterised by managed grasses covering stream banks, with adjacent land use being residential, roads, parks, and urban and semi-rural dwellings. Stream flow is generally moderate due to the gentle gradient of this lowland creek, and aquatic plants are common within the stream channel. Gravel is the main substrate type, with cobbles and boulders being less common.

19. Further downstream riparian vegetation is once again managed grasses, and similar urban land uses surrounded the creek. Stream flow (volume) is very slightly higher than upstream. Mud and fine sediment are the dominant substrate type and aquatic plants cover most of the stream bed.

20. Along upstream sections of the Otepuni Stream bank-side vegetation consists of long and short grasses and exotic trees. Adjacent land-use is predominantly rural pasture and cemetery grounds/gardens. Small cobbles, gravels, and some fine sediment characterise the substrate, with aquatic plants densely populating the stream channel.

21. In the “middle” reaches of the stream long grasses, bushes and exotic trees are the main riparian vegetation, with impervious roading prevalent beyond the true left bank. Bed substrate, aquatic plant life, and stream velocity are similar to that of that encountered upstream.

22. Nearer the confluence with the Waihopai River the stream becomes distinctly tidal in nature. Substrate comprises deep, fine grey sediment with rip-rap at the highest extremes. Beyond the rip-rap banks are characterised by unkempt exotic grasses and impervious areas. Stream macroflora are notably sparse with just a few small clumps of *Gracilaria chilensis* and occasional patches of diatom film on the surface of the mud.

23. The stretch of the Waihopai River directly affected by Invercargill City stormwater runoff is some 4 km long, starting at Racecourse Road. Riparian vegetation consists primarily of ungrazed pasture grasses, while adjacent land-use is predominantly urban and rural pasture. Gravels and some small cobbles characterise the substrate and aquatic plant growth is very abundant.

24. Further downstream long grasses dominate the riparian zone immediately adjacent to the stream. A band of mature native plantings is present on the true right, while residential housing blocks and roading are common beyond the riparian zone on both sides of the stream. Substrate is similar to that observed upstream, but aquatic plant growth is less abundant.

25. Nearer the mouth the river becomes tidal and the habitat is considered estuarine. A mix of industrial and urban land surrounds the river and stream banks are covered by largely wetland shrub and rush species. Substrate comprises moderately deep, fine grey sediment, with scattered beds of exposed cobbles and gravel. Macroflora are notably scarce, but there exists a diatom film on the surface of sediments.

26. The Waikiwi Stream meanders through rural pasture before reaching the city. Riparian vegetation comprises pasture grasses, with some exotic trees further removed from the stream edge. Upstream substrate is fine silty sediment with an abundance of aquatic vegetation, especially charophytes.

27. Further downstream the riparian vegetation remains generally pasture grasses and mature exotic trees. However, surrounding land includes both rural and industrial sites. Substrate comprises predominantly mud. Aquatic plants densely populate the streambed.

STREAM WATER QUALITY DETERMINED BY MACROINVERTEBRATE METRICS

28. The April 2016 benthic survey of Kingswell Creek, Otepuni Stream, Waihopai River, and Waikiwi Stream in the vicinity of the ICC stormwater catchment revealed that molluscs (snails), oligochaetes (worms), and crustaceans (amphipods and ostracods) were numerically the most abundant taxa.

29. In comparison, ephemeroptera, plecoptera and trichoptera (EPT) taxa, particularly stoneflies and mayflies, were absent or rare. The high abundance of low-scoring ‘pollution tolerant’ taxa (i.e., small crustaceans, snails and worms), and low abundance of ‘pollution sensitive’ taxa (i.e., EPT taxa), meant that MCI and SQMCI scores were recorded were low for all sampled sites.

30. All average MCI and SQMCI scores fell within the 'poor' water quality class, with the exception of the average MCI score for the upstream Waihopai River sampling site, which fell within the 'fair' water quality class. Also, the average SQMCI score for the downstream Kingswell Creek sampling site just fell within the 'fair' water quality class (Table 1).

Table 1. *Results for macroinvertebrate metrics at sites surveyed in April 2016.*

	Replicate	Number of taxa	Number of EPT taxa	% EPT taxa	MCI score	SQMCI score
Kingswell U/S @ Chesney Street	**1**	5	0	0.0	52	3.4
	2	5	0	0.0	52	2.5
	3	7	0	0.0	60	2.5
Kingswell D/S @ Elles Road	**1**	11	1	9.1	67	3.8
	2	9	0	0.0	73	3.9
	3	9	1	11.1	76	4.2
Otepuni U/S @ Rockdale Road	**1**	12	3	25.0	73	3.5
	2	12	2	16.7	75	4.0
	3	12	2	16.7	73	4.1
Otepuni D/S @ Lindisfarne Street	**1**	12	1	8.3	72	3.6
	2	12	1	8.3	72	3.5
	3	10	0	0.0	66	4.0
Waihopai U/S @ Racecourse Road	**1**	20	6	30.0	83	3.4
	2	15	5	33.3	81	3.7
	3	17	8	47.1	87	4.7
Waihopai D/S @ Queen's Drive	**1**	10	3	30.0	64	3.2
	2	15	3	20.0	63	4.0
	3	12	3	25.0	75	3.8
Waikiwi U/S @ West Plains Road	**1**	13	4	30.8	75	4.0
	2	14	4	28.6	73	3.2
	3	14	3	21.4	79	3.8
Waikiwi D/S	**1**	15	4	26.7	71	3.7
	2	13	2	15.4	68	3.9
	3	15	3	20.0	71	3.8

Key	Quality Class A	Quality Class B
	Clean water	Excellent
	Doubtful quality	Good
	Probable moderate pollution	Fair
	Propbable severe pollution	Poor

31. Overall, the MCI and SQMCI scores at all sampling sites indicate poor habitat quality and the possibility of pollution throughout the Invercargill City Stormwater Catchment.

32. However, statistical analyses revealed some differences in the macroinvertebrate matrices when upstream and downstream samples were compared.

33. For the Kingswell stormwater catchment the change in macroinvertebrate community structure with distance downstream indicates improved, rather than degraded, habitat quality. Thus there is no evidence to suggest that the discharge of stormwater is adversely affecting macroinvertebrate communities in Kingswell Creek.

34. For the remaining three sub-catchments, while there are some differences between sampling sites indicating poorer habitat quality at sites downstream of the stormwater outfalls, these require a little further explanation.

35. For the Otepuni sub-catchment, the differences are confined to just the number of caddisflies. For MCI and SQMCI the differences among sites are not significant. A significant difference in EPT taxa would not be considered conclusive evidence that the stormwater discharge is adversely affecting benthic communities in the Otepuni Stream.

36. For the Waikiwi sub-catchment, while there is a significant difference between MCI scores (upstream site being higher than the downstream site) there is no significant difference for SQMCI scores. SQMCI scores relate to relative abundance, so, once again, there is no clear evidence that stormwater discharges are adversely affecting benthic communities.

37. At the Waihopai sites, there were significant differences in MCI scores and EPT taxa, with the upstream site appearing of slightly better quality. However, the presence of a marine polychaete worm at the downstream site would suggest that salinity may be a factor. Consequently, without further investigation into the salinity and water quality at this site, it is difficult to come to any conclusions about benthic community health with respect to discharge of stormwater.

38. Two of the sites sampled (i.e. the extreme downstream sites at Waihopai and Otepuni) are considered estuarine. Stark (1993, 1998) and Stark and Maxted (2007) have not determined MCI and SQMCI scores for estuarine habitats, so they are not directly comparable to sites further upstream.

39. However, data for these sites can be compared with data for similar sites in southern New Zealand, and with data collected during State of the Environment (SOE) monitoring carried out in the New River

Estuary since 2001 (e.g. Robertson and Stevens 2006, 2010, 2011, 2013).

40. Organisms encountered were much as expected for modified estuarine environments in southern New Zealand and reflect those seen in cores from the New River Estuary SOE monitoring carried out since 2001.

41. While the data collected during this survey cannot be compared directly with upstream data collected for the April 2016 survey they may be used as a baseline against which future surveys can be compared to establish any trends in the health of the intertidal macroinvertebrate communities at the study locations.

SUITABLIITY OF MACROINVERTEBRATE METRICS FOR SOFT BOTTOM AND ESTUARINE SITES

42. For the majority of the sites assessed in the April 2016 survey the MCI and SQMCI metrics are suitable and appropriate. However, MCI and SQMCI were originally intended for the assessment of hard bottom (i.e., stony) streams and rivers (Stark 1985, 1993, 1998).

43. Maxted *et al.* (2003) found that the MCI and SQMCI were sensitive to organic enrichment in soft bottom streams, i.e. urban and rural sites with poor habitat and water quality had significantly lower index scores than reference sites. However, in soft bottom streams, the MCI and SQMCI showed a restricted range in index scores between reference sites and severely degraded sites compared with hard bottom streams in similar condition.

44. Consequently a set of metrics were developed explicitly for soft bottom streams (Stark and Maxted 2007). Such metrics aim to more realistically assess benthic community health in streams where substrate is comprised of mainly soft sediments.

45. However, using soft bottom metrics at the sites where they are applicable in the April 2016 survey, we find that there is no improvement in water classification. Indeed, for one replicate at the Kingswell downstream site and one at the Waikiwi upstream site the water quality class has changed from fair to poor (Table 2).

46. While such metrics may be useful for streams where soft sediment is prevalent, there are no equivalent metrics for estuarine systems. Suren *et al.* (2010) have developed a South Island wetland community index score, but, although many of the wetlands sampled for the development of these metrics were coastal, they were not estuarine.

Table 2. *Results for macroinvertebrate hard bottom vs soft bottom metrics at sites surveyed in April 2016.*

	Replicate	MCI score	MCI-sb score	SQMCI score	SQMCI-sb score
Kingswell U/S @ Chesney Street	**1**	52	48.4	3.4	2.4
	2	52	55.6	2.5	2.9
	3	60	55.7	2.5	2.9
Kingswell D/S @ Elles Road	**1**	67	54.5	3.8	2.4
	2	73	54.4	3.9	2.6
	3	76	51.1	4.2	3.2
Waikiwi U/S	**1**	75	64.5	4.0	3.4
	2	73	63.0	3.2	2.8
	3	79	64.4	3.8	2.6
Waikiwi D/S	**1**	71	62.0	3.7	2.7
	2	68	52.5	3.9	2.3
	3	71	63.9	3.8	2.7

Key	Quality Class A	Quality Class B
	Clean water	Excellent
	Doubtful quality	Good
	Probable moderate pollution	Fair
	Propbable severe pollution	Poor

47. Consequently, assessment of macroinvertebrate community health for infauna relies on the presence or absence of species known to be pollution tolerant or intolerant, and on comparison with other communities in similar habitats where data are available for levels of nutrient enrichment and/or other contaminant concentration.

48. For the April 2016 study results should be compared with results for other estuarine sites in the New River Estuary (e.g. Robertson and Stevens 2006, 2010, 2011, 2013) and not compared with upstream results.

HEALTH OF THE NEW RIVER ESTUARY

49. Monitoring, commissioned by Environment Southland, of various aspects of the environmental health of the New River Estuary has been carried out for at least three decades (e.g. McBride 1987, Robertson 1992, 1996, ICC 1999). Such monitoring has included

water chemistry, sediment heavy metals, waterborne pathogens, and benthic ecology.

50. Results have shown that, in general terms, contaminants tend to settle out in the upper estuary flats, with a pattern of gradual accumulation over time being apparent as early as the mid-nineties (Robertson 1996). Turbidity is high, exacerbated by silt laden runoff from rural land, and levels of nutrients (phosphorus and nitrogen) are also high (Robertson 1996).

51. However, species diversity and abundance are much as one would expect for sizeable, shallow estuaries draining largely rural catchments (Robertson 1996).

52. More recent monitoring has come to similar conclusions. Robertson and Stevens (2007) found that fine mud continued to dominate the Waihopai Arm and that sedimentation rates from 1967 – 2007 were higher than in the period 1906-1967. Sediments were generally very soft, anaerobic and sulphide rich, indicating the breakdown of organic material. However, healthy *Zostera* (seagrass) beds were a feature of the northern Waihopai Arm.

53. Increases in the cover of grassland, herbfields and estuarine shrubs, were evident in the six year period since 2001, while rushland and reedland showed declines (Robertson and Stevens 2007).

54. Based on their findings Robertson and Stevens (2007) identified excessive sedimentation, nuisance macroalgae growth, exacerbated by high nutrient loads, and loss of saltmarsh habitat and margin development to be key issues.

55. Broad scale mapping of the estuary, carried out in 2012, echoed these findings, with sedimentation showing further increases, eutrophication trending upwards, and seagrass extent showing decline (Stevens and Robertson 2012).

56. Stormwater discharges from Invercargill City have been monitored for quite some time (e.g. Ryder 1992, evidence of Sue Bennett). By and large, contaminant concentrations observed in stormwater runoff appear to fall within the concentrations seen for other urban centres in New Zealand (e.g. Stewart and Ryder 2004, ARC 2007).

57. Many of the contaminants found in the sediments of the Waihopai Arm are commonly found in stormwater runoff and, as such, are likely to be sourced from the Invercargill urban area.

58. Ryder (1993) found that the concentration of some contaminants (e.g. copper, lead, zinc, petroleum hydrocarbons) in sediments at the mouths of watercourses conveying urban stormwater to the Waihopai Arm to be higher than in some other urban centres. Further, Ryder concluded that the absence of surface dwelling animals at these sites was indicative of pollution and that sustainable management was not being achieved. He was of the opinion that all the chemicals found in high concentrations in the estuarine sediments are indicators of urban stormwater pollution as opposed to pollution from rural runoff.

59. Monitoring of heavy metal concentrations in Southland estuaries in 1995 concluded that, while overall concentrations were in the low to medium range compared with contaminated harbours and estuaries in New Zealand and overseas, the Waihopai Arm of the New River Estuary had concentrations of lead, nickel, cadmium and zinc at levels that were potentially of concern (Robertson 1995). It was concluded that urban runoff was the major source of these metals.

60. Fine scale mapping in 2009 – 2010 identified that, along with an increase in muddiness, metal concentrations have generally increased for nickel and zinc, but decreased for cadmium, and lead (Robertson and Stevens 2010). However, it must be noted that levels of all metals remain well below the ANZECC ISQG low trigger guidelines. General organic enrichment was noted to be slight to moderate.

61. The most recent fine-scale mapping, carried out in 2012 – 2013 confirms that metal concentrations continue to be below the ANZECC ISQG low trigger guidelines. However, it is also noted that sedimentation and organic enrichment are such that animal life has difficulty establishing in the sediments (Robertson and Stevens 2013). Seagrass cover continues to diminish and is of concern.

62. Thus, although some areas of the New River Estuary reflect conditions encountered in other southern New Zealand estuaries (e.g. Stewart 2007, 208a,b, 2009a,b) the Waihopai Arm is subject to heavy sedimentation and exhibits relatively low community health compared with less impacted parts of the estuary.

63. While there may well have been adverse effects on the ecology of the receiving environment as a result of contaminants introduced with stormwater in the past, this is very difficult to determine absolutely, given the lack of historical baseline data (i.e. prior to 1970s).

64. Indeed, numerous other sources of contaminants need to be considered when determining whether adverse effects have arisen historically, and what the cause of those effects may be.

65. More recent studies (see Appendix B, Application document) show that levels of some contaminants in sediment in watercourses continue to occasionally exceed ANZECC ISQG low trigger guidelines, especially in the lower reaches of the Otepuni Stream and Waihopai River.

66. However, Robertson and Stevens (2013) found that the concentration of metals in the wider New River Estuary, including the Waihopai Arm generally do not exceed ANZECC ISQG low trigger guidelines. The conclusion is that contaminated sediment settles relatively near to the mouths of the respective streams and, as a result, metal and hydrocarbon contamination is comparatively localised.

67. Ingress of fine sediment and nutrients, however, appears to be more widespread. The input of such contaminants is much more likely to be as the result of runoff from rural areas and, while some of this load will be carried by stormwater, there are also likely to be a multitude of small watercourses and non-point sources that contribute runoff from rural land around the shores of the estuary.

68. For stormwater in Dunedin a case was made for the establishment of zones around stormwater outfalls, with a non-complying area of 50m radius from major stormwater outfalls being considered appropriate (Stewart and Ryder 2004).

69. While not pristine, the New River Estuary and the communities associated with the intertidal areas adjacent to major stormwater inputs do not appear to be undergoing any significant further degradation as a result of stormwater discharge over the past three decades.

70. Ms Bennett, in her evidence, states that she would not expect the stormwater discharges (excluding the sewage) to significantly contribute to these effects. I would agree with this statement.

71. It is suggested that continued monitoring of stormwater quality, estuary water quality, sediment quality and intertidal community health is a worthwhile exercise with respect to determining the fate and/or effects of stormwater within the receiving environment.

72. However, as stated earlier in my evidence, it is not appropriate to use MCI and SQMCI in the determination of community health in estuarine environments. Rather, investigations such as those used in estuary SOE monitoring might be considered more useful.

73. Proposed mitigation measures include regular cleaning of sumps (mud tanks), investigation into discharges of sewage and appropriate remedial action once sources are identified. For metal contamination it is proposed that continued monitoring to track trends be carried out, with targeted monitoring of areas identified as contributing significant loads.

74. Based on the results of the targeted monitoring, the most appropriate treatment or management method for reducing the load from the area shall be identified. This may include installing a treatment device, implementation of a management regime to reduce the risk of loads entering the system or methods to reduce the production of the contaminant, such as painting of roofs.

SUBMISSIONS

75. I have read the submissions of those opposed to the current application and wish to comment on those that relate directly to my area of expertise.

76. The submission by New Zealand Steel voices concern with respect to any requirements pertaining to levels of zinc in runoff. From an ecological perspective the trend towards roofing materials that lower the amount of zinc in stormwater runoff is to be encouraged.

77. New Zealand Fish and Game and DairyNZ oppose the application on the grounds that water quality is degraded. They rightly point out that

water quality based on macroinvertebrate indices is “poor”. However, quality at upstream sites is equally poor. High sedimentation and nutrient inputs, characteristic of rural runoff are factors that must be considered and it is unlikely that instream water quality is attributable solely to stormwater runoff. I would support their call to revisit the locations of macroinvertebrate sampling sites to better represent the variety of receiving water environments.

78. Lastly, Te Ao Marama Inc. oppose the application on the grounds that the Oreti Estuary is under extreme pressure from contaminants entering its waterways, including from stormwater. While I do not disagree with the overall assumption, SOE monitoring would suggest that although degradation of the estuary habitats continues, largely as a result of increased sedimentation and loss of seagrass and perimeter habitat, continued discharge of stormwater is resulting in very localised contamination and is likely having a less than minor effect on the wider estuary.

SECTION 42A REPORT

79. I have read the Section 42A report compiled by Environment Southland staff and make the following observations/comments.

80. I agree with the statement under the heading *Effects on Aquatic Habitat* in Section 3.2 of the report that states that “there is no clear evidence that the stormwater is adversely affecting benthic communities in the receiving waters”.

81. Under the heading *Nutrients Effects* (Section 3.2) it is said that “elevated concentrations [of nutrients] can lead to excess weed and algal growth in waterways.” However, despite monitoring showing phosphorus levels increased in the Otepuni Stream as it passed through the city, there was no evidence during the 2016 survey that nutrients were contributing to excess weed or algal growth.

82. Lastly, under Section 4. Conditions, it is recommended that monitoring during low flow/dry weather be carried out. I think it is worthwhile mentioning that dry weather monitoring has been a condition of Dunedin City Council’s storm water monitoring since their last consent came into force.

83. While it has been useful in identifying outfalls where there is gross contamination, they are contemplating requesting a change to conditions such that it may be discontinued as it as it is no longer revealing further new information.

84. Consequently I believe that if such a conditions imposed it should not be expected to be for the duration of the consent.

CONCLUSION

85. That the stormwater carries contaminants that **may** harm the environment is without doubt. The level of these contaminants, in Invercargill stormwater, however, is within the range experienced for other New Zealand urban centres (e.g. Auckland, Hamilton and Christchurch) and certainly well below figures for many overseas examples (ARC 2007).

86. Despite extensive sampling within the intertidal zone of the New River Estuary there is no compelling evidence that stormwater derived contaminants are causing widespread or significant harm to flora and fauna in any more than very localised areas near the mouths of watercourses into which stormwater is discharged.

87. I believe the proposed mitigation measures are appropriate and, if implemented, will ensure the quality of stormwater discharged from Invercargill City will gradually improve over time.

88. However, the continued input of sediment and nutrients, largely from rural runoff, and contamination by sewage, continues to be of concern.

DATED this 24th day of July 2017

Brian Stewart

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