

## Before the Commissioners appointed by Canterbury Regional Council

**IN THE MATTER OF** The Resource Management Act 1991

**AND**

**IN THE MATTER OF** Application CRC012011.1 by Christchurch City Council to change/cancel conditions of the discharge permit CRC012011 to discharge treated wastewater from the Christchurch Wastewater Treatment Plant into the Avon Heathcote Estuary/Ihutai

### Submission from the Avon Heathcote Estuary Ihutai Trust



1. My name is Christine (Chrissie) Williams, and I am a member of the Trust Board of the Avon Heathcote Estuary Ihutai Trust.
2. Also presenting today on behalf of the Trust is Professor Emeritus Wally Clark and Mr Alex Drysdale, Chairman of the Trust.
3. The Trust board have discussed our submission and have delegated us to submit on their behalf.
4. I will introduce the Trust, and will provide background to this application. Professor Clark will address the effects of ammonia on the Estuary ecology, and Mr Drysdale will focus on the treatment plant and oxidation pond processes.

### The Avon Heathcote Estuary Ihutai Trust

5. The Avon Heathcote Estuary Ihutai Trust (AHEIT, The Trust) is an incorporated society registered in 2003.
6. It was formed as a result of community requests over many years for the formation of an organisation that included committed representation from statutory bodies, tāngata whenua and other agencies.
7. The vision of the Trust is

Communities working together for  
Clean Water  
Open Space  
Safe Recreation  
and  
Healthy Ecosystems  
that we can all enjoy and respect

*Toi tū te taonga ā iwi  
Toi tū te taonga ā Tāne  
Toi tū te taonga ā Tangaroa  
Toi tū te iwi*

8. The AHEIT Trust Deed contains six objects. These objects shape and direct the activities of the Trust. They are:
- i. To pursue for the Avon-Heathcote Estuary Ihutai (“the Estuary”) the preservation of its natural and historic resources to maintain their intrinsic values, and to seek the protection of these resources, including restoration and enhancement, for their appreciation and recreational enjoyment by present and future generations.
  - ii. **To achieve healthy working ecosystems for the Estuary and its catchments through “Integrated Environmental Management”, meaning a systematic effort to understand, through interactive interpretation and analysis, the linkages between ecosystems, resources and people.**
  - iii. To involve individuals, community groups and statutory agencies in learning and practicing the principles of integrated environmental management so that all parties responsible for the management of the Estuary and its resources apply these principles.
  - iv. To strengthen relationships between mana whenua, communities, interest groups and statutory agencies for the better management of the Estuary and its resources.
  - v. To acquire, publish and use information and knowledge of the Estuary through research and monitoring, public education, contributing to planning, and any other actions that are necessary for the integrated environmental management of the Estuary, its resources and its catchments.
  - vi. To increase public recognition, understanding and appreciation of the qualities and values of the Estuary.
9. AHEIT prepared a draft Ihutai Management Plan (IMP) during 2003/2004 and following feedback and submissions from the community a final plan has been published. The plan includes Goals, Targets and Actions. Those relevant to our submission are:

***Goal 2: Healthy ecosystems are sustained in the Estuary and its surroundings***  
*Target 1: Water quality in the Estuary and its rivers supports healthy aquatic ecosystems.*  
*Target 2: The Estuary again supports healthy mahinga kai.*  
*Target 3: The incidence of macro-algae as a nuisance in the Estuary is continuously reduced.*  
*Target 4: The Estuary provides a healthy and safe ecosystem for birds.*  
*Target 5: Estuarine fish populations are monitored and restored.*  
*Target 6: Healthy estuarine invertebrate populations are restored and enhanced.*  
*Target 7: Waste and contaminants entering the Estuary are continuously reduced.*  
*Target 8: Protect, enhance and increase the natural areas of the Estuary and its catchments.*

## **Introduction**

10. Because the Christchurch City Council (the Council) cannot meet the current conditions it has chosen to seek a variation to legalise the current non-compliances.
11. The Council insists that it cannot comply with the existing conditions of CRC012011, even though these conditions were set by a lengthy hearing process and Environment Court appeal.
12. We oppose any change to conditions 16 (a), 16(b) and 17(a).
13. We ask that the variations to or cancellation of conditions 16(a), 16(b) and 17(a) are not granted and that the Council is required to make changes to the treatment system to reduce the ammonia levels being discharged into the Estuary. We acknowledge in achieving this, consequent changes in other conditions may be required.
14. The Trust submits that the Council has had more than ten years warning about the increasing ammonia levels, but has taken very little action to do anything about it. Too much weight has been put on consultants' predictions, and not enough effort put into understanding the specific characteristics and dynamics of the Avon Heathcote Estuary/Ihutai and the Christchurch Wastewater Treatment Plant (CWTP) and ponds. As a result the current AEE provides insufficient information for assessing this application.
15. We highlight a number of areas in which advice has been given in the past that further investigation is required. Very little research or investigation has been undertaken and too much weight has been given to theoretical predictions.
16. We refer to information presented in various Council documents in recent years. In doing this it may seem we dwell on the past. But what our research has shown is that a number of decisions have been made based on inadequate information and wrong assumptions, which we believe has led to the predicament the Council is now in.
17. Our analysis of the information presented in the AEE for this application suggests similar flaws. Evidence in the Section 42A report has also identified gaps and inaccuracies in the AEE.
18. We also detect a lack of rigour in the consultant/Council relationship. The Council has put total reliance on the consultants' work without enough critical analysis of their advice. Objectivity has been lost because of the close consultant-consultant and consultant-Council relationships typical of a small city, minimal competitive tendering and lengthy engagement periods of a single consultant.
19. The discharge will remain into the Estuary for another 40 months. We do not see this as 'short-term' or 'temporary' and are concerned about the detrimental effects of increased ammonia levels on the estuary ecosystem.

20. The full description of the characteristics of the CWTP influent and effluent, and the pond effluent have not been included in the AEE. Only the discharges the applicant consider relevant to the application are described. This has made it difficult to consider and comment on the whole system, especially with the BOD<sub>5</sub> figures not presented. The fact that only limited information has been presented is an indicator of the narrow focus being taken by the Council and its consultants, rather than considering the complex interactive systems critical to this application and to any solutions.

## **Documentation**

21. We accept that re-presenting all the evidence from the original application and hearings for CRC012011 is not necessary. But aspects of it are important to understanding why the Council offered the original condition that is now condition 16(b). We quote from some of this documentation in our submission.
22. Also of importance is the Beca Steven 1996 report on the capacity of the CWTP and options for upgrading 1996-2026. We quote from this as the treatment plant upgrading and oxidation pond modifications have resulted from the advice in this report.
23. The documents I refer to in my submission are:

Knox GA and Kilner AR, October 1973. The Ecology of the Avon Heathcote Estuary. Department of Zoology, University of Canterbury Estuarine Research Unit.

Capacity of Christchurch Wastewater Treatment Plant and Options for Upgrading 1996-2026. Main Report. Beca Steven. August 1996

Christchurch City Wastewater Discharge: Issues and Options. Prepared for Christchurch City Council 12 November 1998

Assessment of Environmental Effects for Christchurch Wastewater Discharge. 29 March 2001

Christchurch Wastewater Consent Applicants Submissions and Evidence September 2001. Evidence of G D James, M Bourke and CJM Tipler

In Defence of the Avon Heathcote Estuary. Collected and revised submission presented by the CEA to 2001 hearing. Christchurch Estuary Association 2002

Christchurch City Council ocean outfall pipeline applications for Resource Consent. May 2005. Section 42A Officer Reports

Letter to Environment Canterbury from Christchurch Estuary Association, 8 August 2005 – Attachment 1, below

Information presented by Dr Rupert Craggs, NIWA, at Estuary and ammonia issues meeting, 1 September 2005 at ECan. Attachment 2 - below

24. We have provided copies of the last two of these documents as attachments. If the Commissioners do not have access to the others I have my personal copies of these available for reference.

### **Consultation and Discharge Audit Group**

25. We are represented on the Discharge Audit Group (DAG) set up to monitor the resource consent CRC012011 to continue to discharge to the Estuary.
26. We attend these meetings regularly, and our attendance has always been without prejudice. Meetings have been lead by the Council despite our requests for an independent facilitator, and minutes from the meetings have been written by Council staff. Many of the meetings have comprised information dissemination from the Council to DAG.
27. The issue of the non-compliance with the consent conditions for the discharge has been discussed at every DAG meeting. We have been advised of the Council's intention to apply for the variation under consideration at this hearing.
28. We do not consider the DAG meetings as adequate consultation on this issue. Wider consultation would have raised this issue within the community and may have initiated more submissions.
29. We are concerned about the low number of submissions on this important variation consent. Over 2000 people and groups were involved with the resource consent process in 2001, and would have been aware and probably accepting of the conditions imposed. Many others then made submissions on the ocean outfall consent in 2005. We believe the low interest in this consent is because the community are fatigued with their participation over the last 10 years, and may not have realised the significance of the changes sought. They will not have realised how the Council and their consultants got things so wrong in their 2001 evidence.

### **Elevated ammonia levels well-known for many years**

30. The Council has been aware of the impacts of the high levels of ammonia and nutrients in the discharge for many years, and that the effluent quality needed to be improved.
31. The 1973 Knox and Kilner report recommendation 6: *“Water quality criteria should be established for the receiving waters of the Avon-Heathcote Estuary in order to reduce the nutrient inputs to levels that will control the eutrophication in the Estuary.”*

32. Beca Steven 1996 (page 42): *“Near the Pleasant Point Yacht Club, oxidised nitrogen and ammonia nitrogen concentrations have doubled between 1970/72 and 1989/91. ... Very high nutrient levels (especially for nitrogen and phosphorous) were also recorded at Sandy Point monitoring station in the 1989/91 period (mean concentration of 4.01 g/m<sup>3</sup> of ammonia nitrogen and total phosphorous of 0.976 g/m<sup>3</sup>).”*
33. Beca Steven 1996 (page 46): *“The impacts of ammonia toxicity on the aquatic life of the Estuary are not documented. However, because average oxidation pond effluent concentrations of ammonia nitrogen are high, it is reasonable to assume that the potential exists for toxicity problems to occur near the discharge, particularly during the warmer months.”*
34. Beca Steven 1996 (page 58): *“Excessive concentration of ammonia nitrogen, as well as trace elements ... can have lethal and sub lethal toxic effects on aquatic life forms under certain conditions.”*
35. Issues and Options 1998: *“Since there is very limited dilution available within the receiving waters of the estuary, a relatively high effluent quality will be required prior to discharge. Improved nutrient removal will be required, particularly of ammoniacal nitrogen which is toxic to aquatic life and present at quite high concentrations (20-35g/m<sup>3</sup>) in the existing pond effluent.”*
36. Issues and Options 1998 (page 3-4): *“The issue of “clean water” has been of major concern to all members of the working party and all others who have been involved in the consultation programme. All parties desire that the water quality is improved within the estuary, and that water quality in any potential receiving environment does not suffer deterioration. ....Some individuals and groups are particularly concerned about water quality in terms of human users of the environment. ... For others, water quality concerns are more closely related to the health of the estuary ecosystem. In this situation, species presence, species diversity and abundance, are some measures which could be used to determine water quality.”*
37. At the 2001 hearings the Christchurch Estuary Association emphasised the toxic effects of ammonia on the ecosystem. The compilation of their submissions *‘In Defence of the Avon Heathcote Estuary’* was produced to ensure the concerns they raised at the hearings were widely known.
38. The Expert Review in 2002 (page 10) had concerns about ammonia effects: *“Data on concentrations in the discharge and dilution in the estuary indicates that organisms may be exposed to toxic concentrations of ammoniacal nitrogen at times. The available data indicates that acute criteria for the protection of marine organisms from the adverse effects of ammoniacal nitrogen are exceeded regularly in the estuary.”*

39. In the AEE for this application the Council acknowledge that concerns were raised in 2001 regarding ammonia levels and its effect on the estuary ecosystem. AEE 2005, page 2-10: *“During the resource consent process concerns were raised about the potential effects of ammonia in the discharge.”*
40. There has been over the years a misguided justification that the high loads of nutrients (90% of which comes from the CWTP) is beneficial for the Estuary, as it increases the productivity in the Estuary, and hence increases species numbers.
41. It is disappointing that subsequent to the publication of the Issues and Options document in 1998 the Council’s focus right through to the 2005 ocean outfall hearing has been on the indicator organisms for human health, and on the growth of nuisance algae, especially sea lettuce. The concerns about other effects of nutrients and ammonia on the estuary ecosystem have been effectively disregarded.
42. The reduction in ammonia should have been a critical requirement of the CWTP upgrade and modification of the ponds.
43. The concerns presented above were expressed when the discharge ammonia levels were lower than now. With increasing ammonia concentrations in the discharge since the pond upgrade the effects on the Estuary are more than minor. Rather than regulating to allow for these higher levels a precautionary principle must apply, existing conditions be retained, and the applicant be obliged to make changes to reduce the ammonia in the discharge.

### **CWTP Discharge and Estuary Ammonia Concentrations**

44. In our written submission we expressed concern about the graphs on pages 4-18 and 4-19 in the Jeerer in relation to the correlation of the estuary and discharge ammonia concentrations. These graphs should be disregarded.
45. The dispersal of the discharge from the oxidation ponds is complex complicated by wind, current and tidal effects. It is not unexpected that there is not a strong statistical relationship between the CWTP ammonia discharge volumes and concentrations in the Estuary.
46. More importantly we dispute the conclusion that *“reductions in the wastewater discharge concentration are unlikely to have a consistent effect of reducing ammonia concentrations in the estuary receiving environment.”*
47. The reviewers and investigating officer take a similar view. (paragraph 52, S42A report)

### **Effects of ammonia on aquatic life**

48. The Council claims that there are no significant adverse effects associated with the continuing high concentrations of ammonia in the discharge. (Page 2-10 2005 AEE, Section 5 2005 AEE).

49. Professor Clark will discuss the sensitivity of organisms to ammonia, and will provide commentary on the ANZECC guidelines and USEPA criteria.
50. Concern on the ammonia toxicity has been to the forefront of previous discussions:
51. From Beca Steven 1996 Appendix D Notes of workshop: *“David Lewis – Ammonia leaving plant at 15-25 g/m<sup>3</sup> is high and could cause toxicity to fish.”*
52. From Gavin James evidence, 2001 hearing: *“Whereas ammonia is known to be harmful to fish in elevated concentrations, it is only the non-ionised form which is toxic, with chronic effects appearing at levels > 0.025g/m<sup>3</sup> (Alabaster & Lloyd 1982). The proportion of non-ionised (to total) ammonia varies with temperature and pH. Median concentrations of total ammonia in the current CWTP effluent are about 26g/m<sup>3</sup>, with some reduction in levels expected in the proposed upgrade. Given minimum dilutions of between 4 to 9 times within the estuary, toxic effects are possible. However it is unknown how much ionisation occurs in the ponds or estuary, and it is difficult to make predictions about the concentrations of the non-ionised form that the fish may be exposed to.”*
53. The Commissioners from the 2001 hearing, when they issued their final decision, noted *“The estuarine environment is in their view highly sensitive to ammoniacal nitrogen, and a number of submitters expressed concern in this regard.”*
54. The Expert Review in 2002 of the state of the ecology of the Estuary also identified the risks from the ammonia concentrations. (page 9) *“This indicates that under the current discharge scenario, the acute total ammonia criteria will be exceeded on a regular basis over a significant area downstream of the discharge. This situation has the potential to cause adverse effects of estuarine organisms entrained into the plume.”*
- 55. They went on to say that *“even with the proposed reductions in total ammonia in the discharge (26g/m<sup>3</sup> to 15-20 g/m<sup>3</sup>) the threshold concentration fields downstream of the discharge are considered to be significant.”***
56. So these experts had concerns, even with the total ammonia concentrations at the predicted but unachieved levels of 15-20g/m<sup>3</sup>. This differs significantly from the views expressed by the applicant in the AEE.
57. This expert panel thought that with discharge continuing for 5-8 years (from 2002) no additional measures would be required for estuarine ecology apart from the work already being undertaken, including the current upgrade of the wastewater discharge committed by the Council. (Expert Review page 3)

58. The AEE (page 7-2) suggests that the expert panel felt there was no pressing need to remove the discharge from the Estuary in a very short time frame. The expert panel were expecting total ammonia discharge levels of 15-20 g/m<sup>3</sup> to be achieved, leading us to conclude they might not be able to give such an assurance now that the levels of ammonia have increased instead of falling.

### **Mixing Zone**

59. There was no mixing zone defined in the decision for CRC012011. It was clear to the Commissioners that the applicant was relying on using the whole of the Estuary as its mixing zone. But the Commissioners did not consider the whole of the Estuary, or even some large but indeterminate part of it, can be considered to be a reasonable mixing zone. (Decision Paragraphs 11.20 and 11.179)

60. In the appeal the Council explained they did not claim that the whole of the estuary is a reasonable mixing zone on every discharge but said that in the nature of things the mixing takes place in different parts of the Estuary depending on wind, weather and other conditions. They argued that the actual mixing zone could be quite small and could be in different parts of the Estuary from day to day.

61. In this application a mixing zone of 500m is suggested, but this is not described accurately or justified. Considering the approach taken in the 2001 hearing and subsequent appeal we are surprised the Council is now attempting to define a mixing zone based on area – are we correct in assuming a semi-circle of radius 500m, centred on the outfall structure?.

62. Dr Bolton-Ritchie accepts a mixing zone 500m from the discharge point. Whereas Dr Robertson suggests a defensible estuary mixing zone is set in the order of 50-75m. Neither of them describes the shape of this mixing zone.

63. We submit that if a mixing zone is to be set it is as a minimal area and clearly defined geographically. If the Commissioners decide to change discharge conditions they would need to set precise monitoring requirements at the boundary of the mixing zone that would ensure the protection of aquatic life outside the defined mixing zone.

64. To minimise the area of the Estuary affected by the discharge the timing of the discharge should be set to ensure as much of the plume is discharged on the first tidal cycle as possible. We question why any discharge occurs before high tide. Professor Clark will discuss this.

### **Suggested studies over many years**

65. Over the years a number of studies have been suggested to the Council to give better information on which to base planning and design.

66. Beca Steven 1996 (page 4) *“The key upgrading measure and implementation sequence for Stage one are summarised ... as follows: .... Undertake studies into effects on the Estuary”*
67. Beca Steven 1996 (page 13): *“High Priority Items .... Undertake Estuary studies of ammonia toxicity, bacterial numbers, algae/clarity and discharge/flushing issues.”*
68. Beca Steven 1996 (page 58): *“Because the pond ammonia nitrogen concentrations are significant, further investigations will be required to establish their impact on aquatic life, as part of future consent applications for effluent discharge.”*
69. Beca Steven 1996 (page 64): *“Analysis of the potential toxic impacts of existing and proposed effluent ammonia nitrogen concentrations, as well as other trace constituents, on aquatic life.”*
70. From Gavin James evidence, 2001 hearing, paragraph 32: *“Recent experimental studies have shown that both the duration and frequency of exposure has an important influence on the toxicity of ammonia to fish (Milne et al 2000). The issue of ammonia toxicity has been commented on by several submitters, and likely impacts on fish species in the Estuary should be investigated more fully.*
71. Despite this, and other advice, there have been few studies undertaken in the last ten years. The Beca Steven report put gave higher priority to further studies before upgrading the plant and ponds, but this was not done. In the last year the first of six fish survey was commissioned, but only after significant advocacy from our Trust.
72. We agree with the reviewers comments in paragraph 57 of the S42A report that suggests a number of studies should be completed before the discharge is removed from the Estuary, and again after removal over a number of years. We have been asking the Council for this many months, so that *“the large scale biological experiment”* the AEE (Section 4.4.4) refers to is well documented.

### **Purpose of the Treatment Plant and Oxidation Ponds**

73. The AEE for this variation application states that *“the objective of the ponds is to reduce pathogens ...in the wastewater ...”* (S 2.3.2) and *“The design of the system and the various improvements have never been intended to remove nutrients such as nitrogen and ammonia.”* (S 2.8)
74. We dispute these statements and again refer to a number of documents. In the past the community has expected nutrient removal and to a certain extent this has been achieved. It is a recent and mistaken phenomenon to solely focus on reduction of indicator organisms and BOD.
75. BecaSteven 1996 – Appendix C. Peer Review by Woodward Clyde, S4: *“The question of nutrient removal has been discussed in general terms in the report. If the proposed estuary studies show that nutrient removal will be required to meet*

*environmental standards this may have a significant impact on some of the currently proposed upgrading measures for the plant. It will therefore be desirable to ensure that the results of the estuary studies are known before final commitments to specific upgrading measures are made.”*

76. The Christchurch Wastewater Treatment Plant (CWTP) has been upgraded to a Trickling Filter/Solids Contact (TF/SC) process. It was asserted by the Council that this would reduce the nitrogen in the wastewater. 2001 AEE *“The upgraded treatment plant and reconfigured ponds will also reduce the amount of nitrogen in the wastewater in the short-term. The long-term sustainability of the nitrogen removal process once the load on the treatment plant increases will be determined through ongoing research during the term of the consent applied for.”*
77. At the hearing in 2001 Mike Bourke admitted that *“Currently the present plant reduces total nitrogen by an average of 20%, but **increases** ammonium nitrogen by approximately 18%”*. At that stage the ponds were functioning biologically and there was nitrification occurring in the ponds. From the upgraded plant Mike Bourke expected a 40% ammonium nitrogen reduction at flows of up to 160,000 m<sup>3</sup>/day, with a decline to a 25% reduction at flows of 200,000 m<sup>3</sup>/day. He considered these reductions relevant in considering potential impacts on fish in the Estuary.
78. So at the 2001 hearing the Council was aware of the impacts of the high ammonia levels to life in the Estuary, and were intending to reduce them.
79. The pond modifications have generally met the predicted levels for faecal coliforms, but not only have the ammonia levels not reduced with the pond modifications; they have actually increased:

**Means of selected properties for Pond 6 discharge for 1995-97 and 2004-05**

	<b>Mean TN ppm</b>	<b>Mean NH4 ppm</b>	<b>NH4/TN %</b>	<b>NO2+ NO3 range</b>	<b>Mean SS g/m3</b>	<b>Mean Org N ppm</b>	<b>Mean pH</b>
<b>Year 1995-97</b>	38.6	25.8	66.7	0.1-4.9	50	12	7.9
<b>Year 2004-05</b>	33.9	28.9	85.3	0.05-0.6	27.3	4.8	8.3

(From CEA letter to ECan, 8 August 2005)

80. While the total nitrogen, organic nitrogen and suspended solids have all reduced, a greater proportion of total nitrogen appears as ammonia. *“Nitrification is barely evident, even over the warmer months of last summer. The evidence seems plain that the present ponds are hardly functioning as biological communities of phytoplankton and zooplankton.”* (CEA letter to ECan, 8 August 2005)

## **Reliance on consultants' predictions in 2001**

81. The reasons given in the AEE S1-6 for this application arose *“from overly optimistic commitments by the City Council in 2003, in relation to the expected reductions in nitrogen and ammonia concentrations in the CWTP wastewater discharge. The treatment plant upgrades that were carried out in 2003-2004 were overall very successful, except that the expected reduction in ammonia and nitrogen concentrations did not occur.”*
82. The modifications to the oxidation ponds were predicted by the consultants and reported in the 2001 AEE to reduce the total nitrogen and ammoniacal nitrogen discharge concentrations to annual medians of 30 and 20g/m<sup>3</sup> respectively. The conditions eventually granted for nitrogen and total ammonia concentrations are those that were offered by the Council at the consent hearing based on these predictions.
83. In fact the BecaSteven report predicted even lower levels were achievable. In the BecaSteven 1996 (page 55) figures are given in Table 4.8 citing possible CWTP improved concentration of total ammonia (as N) as 10 g/m<sup>3</sup>. The note to this figure (note h to Table 4.8) states: *“With nitrification being achieved in summer in the TF/SC process and/or between Pond 3 and Pond 5 and between Pond 4 and Pond 6 using cascade filters.”*
84. BecaSteven 1996 (page 58): *“It is noted in Section 6.5.4\* of this report, that the pond ammonia nitrogen effluent levels could be substantially improved to achieve an average of 10 g/m<sup>3</sup>. This concentration is based on improvements to the oxidation ponds to achieve a greater degree of nitrification/denitrification.”*  
(\*Note: There is in fact no Section 6.5.4 in the report)
85. It is surprising that that the consultants and Council accepted any reduced levels for ammoniacal nitrogen as in BecaSteven 1996 (page 114): *“Nitrification is the biochemical conversion of ammonia to nitrate accomplished by a group of bacteria called nitrifiers. If retention time in a pond system is about 50 days, it is possible to reduce ammonia concentrations but ammonia concentrations do not start to drop until after 25 days retention time. ... The CWTP retention is about 20 days and there is no effective drop in ammonia concentrations through the ponds”.* The modified ponds have a retention time of 21 days so using the above retention time criteria any reduction in ammonia should not have been expected. This was known to the Council at the time of the 2001 hearing. To later claim it was from *overly optimistic commitments by the City Council in 2003* stretches credibility.
86. To us there is conflicting, uncertain and vague predictions in the Beca Steven report. But it is these predictions that the consultants in 2001 took to the hearings for CRC012011.
87. Interestingly the Beca Steven report was peer reviewed by Woodward Clyde (now URS). (BecaSteven 1996 appendix C). They comment that no attempt was made to check detail in the report as there is insufficient supporting information to allow a

comprehensive check. Soon after this peer review Woodward Clyde/URS was engaged to prepare the Issues and Options report. To us there appears to have been a lack of rigour in the consultant/council relationship, and some complacency in critiquing the advice given.

88. In BecaSteven 1996 section 7.4 (pages 112-114) the proposed changes to the ponds are described and in Appendix K are shown as a concept layout. These included non-porous baffles to prevent short circuiting and increase residence time; porous rock filters/baffles; nitrifying rock trickling filters with sprinkler distribution or gravity cascade; and possible planted wetlands habitats in sheltered areas.
89. Other pond upgrade options were discussed and evaluated in the Issues and Options report 1998, pages 6-20 to 6-31. Two options were considered as feasible, although the reasons for these two being preferred are not given in the report. These options were 'slightly modified ponds' and 'significantly modified ponds and wetlands'.
90. The 'slightly modified pond' option predicted final effluent quality with mean ammoniacal N of 22.7 g/m<sup>3</sup> in winter and 11.7 g/m<sup>3</sup> in summer. Mean TN was calculated as 6.0 g/m<sup>3</sup> (winter) and 5.0 g/m<sup>3</sup> (summer). This disparity was because the equations for maturation pond ammoniacal-N removal (Pano and Middlebrooks, 1982) and total nitrogen (TN) removal (Reed, 1985) do not have comparable N removal rates. Hence the result of predicted ammoniacal-N concentrations being higher than the predicted TN concentrations. To be conservative it was assumed that the TN concentration be equal to the ammoniacal-N concentration
91. The 'slightly modified pond' option described increased the number of pond cells in series from 3 to 11. *"The BOD loading on the pond system will be much reduced compared to that existing at present. The abundant nutrient entering the ponds will ensure algae will flourish."* (Issues and Options 1998)
92. The Issues and Options Report 1998 included the summary (page 6-31): *"The slightly modified pond option, which has conventional stabilisation ponds receiving contact stabilisation effluent provides reasonable low levels of TN and TP. Removals of up to 50% total nitrogen could be achieved, but this is a very difficult parameter to predict. **High ammoniacal-N concentrations in these discharges could be a problem.**"* (our emphasis)
93. A further report is referred to in the S92 response from URS (10 April) which was prepared by CH2M Beca Ltd. (*Design Report for CWTP Ponds, September 2002*). We do not have access to that report but the reported nitrogen and ammonia reduction through the ponds is the similar, if not better, to that predicted earlier.
94. Described in the 2001 AEE the 'slightly modified pond' option was modified to have seven cells in series, and this was taken through to construction in 2004. While the total hydraulic residence time (HRT) increased for the ponds in series, the HRT in each individual cell has been reduced. The very features included in the pond design

in Beca Steven 1996 that were specifically for removing ammonia – the porous baffles and the gravity cascades - were omitted from the pond modification. It is no wonder the modified ponds have not performed as hoped.

95. The predicted reductions in ammoniacal nitrogen were based on uncertain and inconsistent theoretical predictions. We find it hard to believe that \$1million pond upgrades, and promises made in a lengthy resource consent process, were reliant on such imprecise and contradictory science.

### **Biological Oxygen Demand**

96. The CWTP upgrade has reduced the BOD load to such a level that the carbon input to the ponds is not high enough to sustain algae growth. Professor Clark will expand on this.
97. This is despite advice in the Beca Steven report regarding optimum BOD levels in the ponds. BecaSteven 1996 (page 84) *“Ideally, to maintain the ponds in their **optimum** working condition, the organic loading should be maintained at about 84 kg/ha.d, or 8 t/d BOD, with higher loadings of up to about 120 kg/ha.d (10-12 t/d) being permitted as a maximum. Therefore any additional BOD must be removed by the processes upstream of the oxidation ponds.”*
98. This value of 84 kg/ha.d Beca Steven converts to 8 t/d. For this conversion they must have assumed an area of about 100ha. This was then the effective area for each set of ponds when the six ponds were operated as two parallel flows. So for the two sets of ponds the optimum load coming from the CWTP would need to be 16t/d. With the six ponds now in series (with an area of over 200ha) the optimum load for the ponds would still be 16t/d.
99. At 160,000 m<sup>3</sup>/day flow the pond influent optimum BOD<sub>5</sub> concentration would be 100g/m<sup>3</sup>, much higher than 30g/m<sup>3</sup> reported in the AWS report.
100. The understanding regarding optimal BOD load on the ponds was repeated later in the report. (Page 116). *“If Ponds 1 and 2 receive a load of a bout 80kg BOD/ha/day, then the final effluent quality will be slightly improved even with the present configuration. In order to make the significant improvements to the final effluent quality by creating more cells in series as outlined in Section 7.4, it is necessary to ensure that the loading on Ponds 1 and 2 is **held** at 80kg/ha/day. **This is a pivotal factor.**”*(Our emphasis)
101. The consent condition requires a median value of 5.4 t/d in pond 6. Assuming 40% BOD<sub>5</sub> reduction through ponds (from BecaSteven 1996), that implies a pond influent BOD<sub>5</sub> of 9t/d, just over half of the optimum.
102. However the actual discharges from the ponds have BOD<sub>5</sub> much lower than the 5.4t/d = 5400 kg/d, and during 2005 ranged from 381 kg/d – 3363 kg/d (These equate

to 3g/m<sup>3</sup> and 19g/m<sup>3</sup> - using actual daily flows) (From reports to Discharge Audit Group).

103. It appears that the Council have been aiming to **minimise** BOD in the pond influent, rather than aiming to achieve the **optimum** level of BOD. It seems to us that the Council has forgotten they are dealing with a complex biological system, reliant on photosynthesis.

104. This is reinforced in the AEE for this application (page3-2): *“At present the concentration of algal solids in the ponds is low, and while this is a good thing in terms of colour and clarity for the discharge, it means there is little uptake of ammonia into the algae. The primary limiting factor for the growth of algae in the ponds is organic carbon. This is because the CWTP is very efficient at reducing carbon (BOD reduction) as this is the prime contaminant removed by the treatment. Therefore to increase algal production, an external carbon source would be required.”*

105. In the Woodward Clyde peer review of the Beca Steven report they acknowledge that BOD may get too low in the CWTP: (BecaSteven 1996 Appendix C page 4): *“The increased capacity of the treatment plant upstream of the oxidation ponds should provide the operational flexibility necessary to ensure the ponds perform as reliably as possible. Provision should be made in the upgrading of the treatment plant to ensure that the load to the oxidation pond can be increased, if necessary, for example, in the event that the trickling filter effluent has a lower BOD<sub>5</sub> than required for the optimum loading on the ponds.”*

106. Our submission is that BOD and carbon levels should be increased in the ponds to improve algal growth. We would accept a resultant increase in colour, decrease in clarity, increase of algae and increased BOD in the discharge.

107. Dr Gillespie in paragraph 11 of his report to the S42A report advises that the process in the ponds is complex and over-simplified discussion is potentially misleading. He suggests *“that additional expert advice be requested to discuss the feasibility of upgrading the wetlands system and/or other N-removal options.”* We agree.

### **Treatment Plant and Oxidation Ponds**

108. Alex Drysdale will describe further why the current plant and ponds are not achieving ammonia reduction and will outline possible actions that the Council could take to reduce the ammonia levels, to be able to comply with the existing consents.

109. We do not agree with the statement that it is not practicable to reduce ammonia nitrogen in the CWTP and ponds at this stage. In fact we argue it is crucial that they do.

110. The current Trickling Filter/Solids Contact (TF/SC) process was one of the options described in Beca Steven 1996 (page 119-121). *“Most studies in New Zealand and elsewhere have shown that, for sites without space constraints, the TF/SC process has the lowest capital and operating cost. Operating energy cost is the lowest of all processes, capable of achieving an effluent quality down to 15:15 (BOD:SS). At the CWTP, an average effluent quality about 20:20 would be targeted but it is only necessary to achieve an average BOD concentration of about 40g/m<sup>3</sup> to keep the load on Ponds 1 and 2 below 10 tonne/day.”*
111. Methods for removal of nutrients were identified. Beca Steven 1996, Page 119: *“It has been found in USA plants, that SC or Activated Sludge (AS) processes following a TF achieve reliable nitrification at lesser retention times than in standard AS process. ... If this is a future requirement, one way of smoothing the ammonia loading on the biological processes would be to only recycle sludge lagoon supernatant and dewatering streams at night, when incoming ammonia loads are lower.”*
112. Beca Steven 1996, Page 121: *“An AS plant could be coupled in parallel with the existing TF to achieve N and P removal if required in the future. Nitrogen can be removed by biological nitrification and denitrification. Nitrification occurs in the TF and aerobic zones of the AS plant and denitrification occurs in the anoxic zone.”*
113. In 2001 (AEE 2001 page 2-9) it was identified that nitrification could occur with certainty over the following 15 years by increasing the air supply to the SC aeration tanks.
114. Rupert Craggs at a meeting in September 2005 gave the reasons for the ponds not removing ammoniacal N as the short hydraulic retention time, the low organic loading and invertebrate grazing on algae. He described the ponds as a eutrophic lake. He also gave suggestions for improving algal growth in the ponds – increasing the retention time in one pond and adding carbon to the pond water. The notes from this meeting are included below as Attachment 2.
115. Alex Drysdale will discuss both Craggs’ suggestions, and those in the AWS report.
116. There are possibilities for modifying the CWTP and pond processes, but these have not all been identified. By retaining the existing conditions 16(a), 16(b) and 17(a) the Council will be required to take urgent action to investigate and invest in improved ammonia and nitrogen reduction.
117. Not only will this benefit the health of the Estuary ecosystem for the next 40 months, but it will limit increasing degradation until the discharge is removed from the Estuary, and will give a better chance for the Estuary to recover following the ocean pipeline construction.

118. We concur with Dr Gillespie’s comments reported in paragraph 128 of the S42A report that any gains made in reducing total nitrogen in the discharge will have positive benefits on the ocean and seabed when the discharge transfers directly to the ocean. Any efforts made now will not be wasted.

**Comments on Conditions**

119. We next make comment on the conditions as offered by the applicant at the 2001 hearing, the Commissioners interim and final conditions, and the existing conditions applied after the appeal process.

120. Conditions offered by the applicant in 2001 (Hearing evidence of Cliff Tipler)

*“Based on weekly samples, taken over each 26 week period commencing 1 May and 1 November of each year, not more than 16 values in each period exceed the following value:*

<i>Constituent</i>	<i>Unit</i>	<i>Standard before second anniversary of commencement date</i>	<i>Standard after second anniversary of commencement date</i>
<i>BOD5 (filtered)</i>	<i>g/m<sup>3</sup></i>	<i>10</i>	<i>10</i>
<i>TSS</i>	<i>g/m<sup>3</sup></i>	<i>45</i>	<i>30</i>
<i>Total Nitrogen</i>	<i>g/m<sup>3</sup></i>	<i>40</i>	<i>30</i>
<i>Ammoniacal Nitrogen</i>	<i>g/m<sup>3</sup></i>	<i>30</i>	<i>20</i>
<i>Dissolved Reactive Phosphorous</i>	<i>g/m<sup>3</sup></i>	<i>8</i>	<i>8</i>

No mass loads were offered.

121. In the interim decision issued by the Commissioners on 30 April 2002 the conditions were:

***“Contaminant Limits***

*10 (a) Based on the twice weekly sampling required under Condition 8(b) of this consent, and taken over each 13 week period commencing on 1 February, 1 May, 1 August and 1 November of each year during the term of this consent, no more than 16 values in each 13 week period shall exceed the following standards for each of the named contaminants:*

<i>Contaminant</i>	<i>Unit</i>	<i>Standard before second anniversary of commencement date</i>	<i>Standard after second anniversary of commencement date</i>
<i>BOD5 (filtered)</i>	<i>g/m<sup>3</sup></i>	<i>10</i>	<i>10</i>
<i>TSS</i>	<i>g/m<sup>3</sup></i>	<i>45</i>	<i>30</i>
<i>Total Nitrogen</i>	<i>g/m<sup>3</sup></i>	<i>40</i>	<i>30</i>
<i>Dissolved Reactive Phosphorous</i>	<i>g/m<sup>3</sup></i>	<i>8</i>	<i>8</i>

The condition for ammoniacal nitrogen set standards based on the 90%ile figures.  
 “10 (b) Based on the **twice** weekly sampling required under Condition 8(b) of this consent, and taken over each 13 week period commencing on 1 February, 1 May, 1 August and 1 November of each year during the term of this consent, no more than **five** values in each 13 week period shall exceed the following standards for ammoniacal nitrogen.

Contaminant	Unit	Standard before second anniversary of commencement date	Standard after second anniversary of commencement date
Ammoniacal Nitrogen	g/m <sup>3</sup>	30	12

**“Mass Loads**

11 (a) Based on the daily volumes of wastewater discharged as calculated from records required pursuant to Condition 6 of this consent and the wastewater monitoring required under Condition 8 of this consent the following mean and maximum masses of each named contaminant shall not exceed in any 13 week period:

Contaminant	Standard before second anniversary of commencement date. Tonnes per 13 week period		Standard after second anniversary of commencement date. Tonnes per 13 week period	
	Mean	Maximum	Mean	Maximum
BOD <sub>5</sub>	425	550	438	525
BOD <sub>5</sub> (filtered)	135	175	146	175
TSS	575	747	438	525
Total Nitrogen	395	513	365	438
Ammoniacal Nitrogen	267	350	220	264
Dissolved Reactive Phosphorous	65	85	102	123
Total Phosphorous	77	100	118	141

122. In the final decision released by the Commissioners on 20 June 2002 Condition 10(a) above remained unchanged.

Condition 10(b) was relaxed to use median values instead of 90%iles values, and for the second anniversary introduced a ‘higher value’ of 20g/m<sup>3</sup> based on the 90%ile.

“10 (b) Based on the **twice** weekly sampling required under Condition 8(b) of this consent, and taken over each 13 week period commencing on 1 February, 1 May, 1 August and 1 November of each year during the term of this consent, no more than **16** values in each 13 week period shall exceed the following applicable standard values, and after the second anniversary of commencement of this consent, no more than 5 values in each 13 week period shall exceed the higher value for ammoniacal nitrogen.

<i>Contaminant</i>	<i>Unit</i>	<i>Before second anniversary of commencement date</i>	<i>After second anniversary of commencement date</i>	
		<i>Standard Value</i>	<i>Standard Value</i>	<i>Higher value</i>
<i>Ammoniacal Nitrogen</i>	<i>g/m<sup>3</sup></i>	<i>30</i>	<i>15</i>	<i>20</i>

In setting this amended condition the report said “The Commissioners consider it is both appropriate and necessary to put in place an ammonia standard. Having considered the applicant’s submissions, and re-read the evidence, they accept that the standard proposed after the second anniversary date of consent – 12g/m3 – may be inappropriately tight. They also accept that they should not put in place a condition which is unachievable. ... They acknowledge that these standards are tight, but in their view ammoniacal nitrogen is an important contaminant, which poses a significant environmental risk. On the information provided by the applicant, the standards should be achievable over the term of the consent given the discharge flows predicted.”

Condition 11 (a) for mass loads also changed:

“11 (a) Based on the daily volumes of wastewater discharged as calculated from records required pursuant to Condition 6 of this consent and the wastewater monitoring required under Condition 8 of this consent no more than 16 values in 26 samples taken shall exceed the following standard value and not more than 5 values in 26 samples shall exceed the higher value in any three month period.

<i>Contaminant</i>	<i>Standard before second anniversary. kg/day</i>		<i>Standard after second anniversary kg/day</i>	
	<i>Standard value</i>	<i>Higher value</i>	<i>Standard value</i>	<i>Higher value</i>
<i>BOD<sub>5</sub></i>	<i>4200</i>	<i>Not specified</i>	<i>4800</i>	<i>Not specified</i>
<i>BOD<sub>5</sub> (filtered)</i>	<i>1400</i>	<i>1800</i>	<i>1600</i>	<i>1900</i>
<i>TSS</i>	<i>6300</i>	<i>Not specified</i>	<i>4800</i>	<i>Not specified</i>
<i>Total Nitrogen</i>	<i>5600</i>	<i>7300</i>	<i>4800</i>	<i>5800</i>
<i>Ammoniacal Nitrogen</i>	<i>2800</i>	<i>3500</i>	<i>2400</i>	<i>2900</i>
<i>Dissolved Reactive Phosphorous</i>	<i>1120</i>	<i>1450</i>	<i>1300</i>	<i>1600</i>

123. After the appeal the conditions were renumbered.

Condition 10(a) became Condition 16(a) and was effectively unchanged.

Condition 10(b) became Condition 16(b). Median values were applied, and for the second anniversary a maximum value was introduced rather than a value based on the 90%ile.

The Environment Court applied the levels offered by the applicant in the original hearing.

“16 (b) Based on the twice weekly sampling required under Condition 15(a) of this consent, and taken over each 13 week period commencing on 1 February, 1 May, 1 August and 1 November of each year during the term of this consent, no more than 16 values in each 13 week period shall exceed the following applicable standard values, and after the second anniversary of commencement of this consent, **no value** in each 13 week period shall exceed the **maximum** value for ammoniacal nitrogen.

Contaminant	Unit	Before second anniversary of commencement date	After second anniversary of commencement date	
		Standard Value	Standard Value	Maximum value
Ammoniacal Nitrogen	g/m <sup>3</sup>	30	20	35

11(a) became 17(a) and the higher values were removed:

“17 (a) Based on the daily volumes of wastewater discharged as calculated from records required pursuant to Condition 14 of this consent and the wastewater monitoring required under Condition 15 of this consent **taken on the same day as the discharge volume measurement**, no more than 16 values from **26 consecutive samples** shall exceed the following standard.

Contaminant	Standard Kg/day
BOD <sub>5</sub>	5400
BOD <sub>5</sub> (filtered)	1800
TSS	8100
Total Nitrogen	5600
Ammoniacal Nitrogen	3600
Dissolved Reactive Phosphorous	1260

124. Summarising these, conditions for ammoniacal nitrogen were based on the following (all in g/m<sup>3</sup>):

	Before second anniversary of commencement date			After second anniversary of commencement date		
	Median	90%ile	Max	Median	90%ile	Max.
<b>Offered by applicant Sept 2001</b>	30			20		
<b>Commissioners Interim Decision 30 April 2002</b>		30			12	
<b>Commissioners' Final Decision 20 June 2002</b>	30			15	20	
<b>Environment Court Decision</b>	30			20		35
<b>Applied for in this variation</b>	30			40		45

125. What this shows is that the concentration of ammoniacal nitrogen in the discharge was a critical and difficult part of the Commissioner's decision in 2002. They responded to the applicant's submissions after setting very stringent conditions in their interim decision.

126. Prior to issuing their final decision they received confirmation from the applicant regarding the predicted discharge concentrations, and balanced these with consideration of the effects on the receiving environment.

127. The decision on this consent must be based on the environmental effects on the Estuary ecosystem.

### **Section 107(2) of the RMA 1996**

128. CRC012011 was granted under S107 (2) of the RMA 1991. That is, a discharge permit was granted to do something that would otherwise contravene section 15 or section 15A of the Act. In the decision the Commissioners stated that exceptional circumstances justified the granting of the permit and they considered that the discharge is of a temporary nature.

129. The decision was considered to be consistent with the purpose of the RMA but only because the Commissioners were imposing conditions designed to minimise the risks to health and safety and to the environment. They noted that loadings of key contaminants, and in particular nitrogen, ammonia, phosphorous and some heavy metals, were not likely to increase over five years, and might even decrease in the shorter term.

130. The decision on this variation must also be under S107 (2) of the RMA, and must be consistent with the purpose of this Act.

131. We submit that the purpose of the Act will not be met if the ammonia levels are allowed to increase as it will not sustain the potential of the natural and physical resources of the Avon Heathcote Estuary and it will not safeguard the life-supporting capacity of the **water** and the Estuary ecosystems. Continuing a discharge with elevated ammonia concentrations will not avoid adverse effects on the **environment**.

132. It is possible to remedy or mitigate the adverse effects of the activity on the **environment** by making changes to the CWTP and ponds urgently.

133. S107(3) of the RMA: *"In addition to any other conditions imposed under this Act, a discharge permit may include conditions requiring the holder of the permit to undertake such works in such stages throughout the term of the permit as will ensure that upon the expiry of the permit the holder can meet the requirements of subsection (1) and of any relevant regional rules."*

134. Professor Clark will now present his evidence. We will summarise what decisions the Trust wishes the consent authority to make after Alex Drysdale's evidence.

Attachment 1

Letter to Environment Canterbury from Christchurch Estuary Association, 8 August 2005

Attachment 2

Information presented by Dr Rupert Craggs, NIWA, at Estuary and ammonia issues meeting, 1 September 2005 at ECan.