IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application lodged by Tasman District Council.

STATEMENT OF EVIDENCE OF PAUL DUNCAN CHAMPION ON BEHALF OF ENGINEERING SERVICES DEPARTMENT, TASMAN DISTRICT COUNCIL

Date 13th November 2015

A. INTRODUCTION

1) My name is Paul Duncan Champion. I am a Principal Scientist and programme Leader at the National Institute of Water and Atmospheric Research Limited (NIWA) based in Hamilton.

2) NIWA is a crown-owned research and consultancy company, with a global reputation as experts in water and atmospheric research.

3) I hold the following qualifications relevant to this consent application:

   - A Bachelor of Science with honours in Biological Sciences, obtained at the University of Leicester, UK.

   - A Master of Science in Biological Sciences, obtained at the University of Waikato with my thesis title: "The ecology and management of kahikatea in the Waikato".

4) I am a full member of the New Zealand Botanical Society, New Zealand Freshwater Science Society, New Zealand Plant Protection Society, New Zealand Biosecurity Institute and Waikato Botanical Society.

5) I have been a member of the aquatic plant management research team at NIWA (formerly part of the Ministry of Agriculture and Forestry) since 1988, and have over 30 years' experience in the field of plant ecology.

6) I was an Advisory Officer (Aquatic Plants), MAF Quality Management from 1988 to 1994. This role involved national coordination of Class A Noxious Plants eradication programmes and control and other technical advice for regional authorities managing aquatic weeds.

7) I joined NIWA in 1994 as a plant ecologist and have held the position of Principal Scientist since 2004 and was appointed Programme Leader – Freshwater Biosecurity in July 2015. I work in a team of ten staff carrying out freshwater biosecurity research. Our programme of work includes refining pest control techniques (e.g. selective

pesticides effective at low concentrations, smarter application technologies) to maximise efficacy and minimise environmental load.

8) I have carried out research specialising in biosecurity and wetland ecology and management, with around 50 published papers, books or book chapters, also authoring or co-authoring more than 130 NIWA client reports.

9) At NIWA I have provided advice on the management of aquatic and wetland pest plants to various government departments and regional authorities. I have also worked in conjunction with the Department of Conservation, Regional and District Councils in assessing the conservation needs for nationally endangered plants and vegetation types, and also the selective control of weed species with minimal damage to native species. For example:

- Champion, P.D.; Reeves, P. (2009). Factors causing ephemeral wetlands to be vulnerable to weed invasion. Research & Development Series 310. Department of Conservation, Wellington.

10) I have been involved in various trials researching control options for aquatic and wetland plants and also assessing the impacts of control activities on non-target species and the surrounding environment. This information has been integrated into species-specific programs for the management of problem weeds, used in regionally and nationally coordinated weed control programs. Examples include:

- Champion, P.D.; Clayton, J.S. (2003). The evaluation and management of aquatic weeds in New Zealand. In Child, L.E.; Brock, J.H.; Brundu, G.; Prach, K.; Pysek, P.; Wade, P.M.; Williamson, M. Plant Invasions-Ecological Threats and Management Solutions. Backhuys, Leiden, The Netherlands.

- Champion, P.D.; Hofstra, D.E. (2006). Management options assessments for eight pests of national concern (*Ceratophyllum demersum, Egeria densa, Eichhornia crassipes, Hydrilla verticillata, Lagarosiphon major, Phragmites australis, Salvinia molesta, Zizania latifolia*). NIWA Consultancy Reports to MAF Biosecurity New Zealand. HAM2006-159-166.

11) These trials have included the assessment of ecotoxic and environmental effects of herbicides used to control aquatic plants. Examples include:

- Champion, P.D.; James, T.K.; Carney, E. (2008). Safety of triclopyr triethylamine to native wetland species. New Zealand Plant Protection 61: 378–383.

- Champion, P.D.; Nipper, M.; MacKay, G.C.; Wilcock, R.J.; Williams, E.K.; Martin, M.L. (1997). Monitoring the effect of the herbicide metsulfuron methyl in Kaipara District. NIWA Client Report KDC70201, Hamilton.

12) I have provided evidence on behalf of Hamilton City Council supporting the management of yellow flag iris and construction of a walkway around Hamilton Lake. Subsequent pest plant control and restoration around the lake are a good illustration of the benefits accrued by controlling such weeds, with little environmental impact on non-target species.

13) I have reviewed the Waikato Regional Council alligator weed eradication programme and provided management advice on this programme:

- Champion, P.D. (2008). Review of alligator weed (*Alternanthera philoxeroides*) management in the Waikato Region. NIWA Client Report HAM2008-001, Hamilton.

14) More recently, I have acted for members of the Agrichemical Reassessment Group (is comprised of the Ministry for Primary Industries, Department of Conservation, Land Information New Zealand, 12 Regional Councils (including Unitary Authorities) and Mighty River Power) providing technical advice in a modified reassessment application under Section 63A of the Hazardous Substances and Organisms Act (HSNO 1996) for alterations to existing controls on agrichemicals containing the active ingredients haloxyfop-R-methyl, imazapyr isopropylamine, metsulfuron-methyl and triclopyr triethylamine.

15) As part of this process I collated information on ecotoxicity and environmental effects on those agrichemicals and also glyphosate isopropylamine:

- Champion, P.D. (2012). Review of ecotoxicology and environmental fate of four herbicides used to control aquatic weeds (with supplementary information: Comparison of herbicides with glyphosate). NIWA Client Report HAM2012-049, Hamilton.

16) Following the successful outcome from this hearing, I represented Waikato Regional Council, Department of Conservation and Ministry for Primary Industries and Fish and Game Council in the gaining of a region-wide resource consent for the control of aquatic pest plants in Waikato Region.

17) I have coordinated the monitoring of six sites where those herbicides have been applied – monitoring effects on benthic invertebrates, aquatic vegetation and residues of herbicides in water and sediment:

- Champion, P.D.; Wells, R.D.S.; Wright-Stow, A. (2014). Monitoring the effects of agrichemicals used for aquatic pest plant control. NIWA Client Report HAM2014-050, Hamilton.

18) I am therefore familiar with the management approaches for pest plants within a New Zealand context, as well as the methodology and techniques proposed in this consent application.

19) I have been contracted by Tasman District Council to provide expert technical advice for the resource consent application for the use of herbicides for the control of woody weeds on river fairways and berms.

20) I consider that I am familiar with all aspects of the consent application, its statutory context and the effects of the activities proposed.

21) My evidence has been peer reviewed by other NIWA senior staff including Dr David Roper (Environmental Chemist and Regional Manager) and Dr John Clayton (Principal Scientist – Aquatic Plant Management); discussions on ecotoxicology and environmental fate were held with Dr Chris Hickey (Principal Scientist - Ecotoxicology and Environmental Chemistry); and the statements made in my evidence are endorsed by NIWA, as are the NIWA reports referred to in my evidence.

B. CODE OF CONDUCT FOR EXPERT WITNESSES

22) I confirm that I have read the ‘Code of Conduct' for expert witnesses contained in the Environment Court Practice Note 2014. To the extent I am giving expert evidence, my evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my sphere of

expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

c. FACTS RELIED UPON TO INFORM OPINIONS

23) Information on the ecotoxicology, risks to aquatic and wetland flora and fauna and environmental fate of substances containing glyphosate isopropylamine, metsulfuron-methyl, triclopyr butoxyethyl ester and organosilicone adjuvant was sourced from Specimen Labels and Material Safety Data Sheets for each product, websites collating environmental information, published scientific literature and unpublished New Zealand studies.

24) In preparing my evidence, I have also:

- Read the application to Tasman District Council "River Fairway & Bank Weed Control programme: Resource Consent Application For Herbicide Spraying" authored by Mr Murray Tonks of Environmental Management Services Limited, including the appended reports from Tiakina te Taio and Manawhenua Ki Mohua Cultural Impact Assessments, spray plan template and contingency accountability plan, material safety data sheets, water sampling results from 2012 and references used;

- Sought further information from Mr. Tonks and also Mr. Giles Griffith, Rivers & Coastal Engineer at Tasman District Council;

- Where appropriate, sought advice from other agencies (as identified in my evidence)

- Read all submissions relating to this consent application;

- Read the evidence of Mr Tonks and Mr Griffith;

- Reviewed the officer's report, and the specific recommendations concerning the consent application.

D. SCOPE OF EVIDENCE

25) This statement of evidence will focus on the following matters pertinent to an assessment of the consent application including:

- The purpose of the consent to use herbicides to manage predominantly woody pest plants on the river fairways and bank weeds in various waterbodies in Tasman District.
- The appropriateness of the methods for which the consent is applied, including mitigation measures.
- The effectiveness of alternative methods for controlling pest plants and the effectiveness of using alternative herbicides to control the plants targeted.
- Assessment of the effects arising from the use of the four agrichemicals detailed in the consent application.
- Response to reports from Tiakina te Taio and Manawhenua Ki Mohua Māori Values/Cultural Impact Assessments (Section 10 of the consent application)
- Comments on the report by the Cawthron Institute 'Review of Tasman District Council's pesticide use report' (Champeau & Tremblay 2014), will be included in my response to submissions.
- Matters relating to the other appendices.
- The conclusions and recommended conditions in the consent application.

E. DESCRIPTION OF APPLICATION

26) My understanding of the primary rationale for the consent is to protect the health, safety and social and economic well-being of communities through the prevention of flood damage and damage to river protection works and bridges resulting from woody weeds affecting the passage of flood waters.

27) Additionally, management of woody weeds in the river fairways will assist in maintaining habitat for indigenous birds utilising these areas. One species reliant on these gravel fairways is the nationally critically endangered black-billed gull, a species currently declining at a rate of greater than 70% each decade, or over three generations, due to recruitment failure (Robertson et al. 2013).

28) Consents are sought for the use of three herbicides, glyphosate isopropylamine, metsulfuron-methyl and triclopyr butoxyethyl ester and also organosilicone adjuvants to assist with absorption of herbicide into target weeds. These agrichemicals are proven to be effective in managing the weed species mentioned on page 5 of the consent application.

29) Herbicides would be applied either aerially or using ground based application.

30) Aerial application would be carried out by helicopter with spray boom using Controlled Droplet Application to ensure accurate delivery of herbicide to target sites. The conditions outlined in section 3.1 of the consent application are appropriate and the proposed 5 m buffer strip between aerial applications and flowing or surface water would ensure that no significant amount of herbicide will be discharged directly into water. This was also the opinion of Mr Hamish Campbell, Advisor-Compliance Coordination, New Zealand Environmental Protection Authority (NZEPA), with whom I discussed this matter by phone on 9th June 2015.

31) Ground based application would use predominantly a gun and hose application, or boom spray where vegetation density and height permitted. The conditions outlined in section 3.2 of the consent application are appropriate for this purpose and would ensure that no significant amount of herbicide will be discharged directly into water.

32) Timing of herbicide application between November to April, or more restricted in the case of boom application, is to manage the pest plants during active growth, when they are most receptive to those herbicides.

33) Alternative methods of control are discussed in the consent application including the 'no control' option, manual/mechanical weed clearance and use of 'organic herbicides'.

34) Tasman District did use a form of mechanical control in the 1990's, known as root-raking (information received from Mr Griffith). However, additional to the uprooting of weeds, this action disturbed the gravel beds providing a seed bed for weed re-establishment, reduced hydrological efficiency and resulted in excess sediment entering the river channels. This method of control is no longer used by Tasman District Council.

35) Organic herbicides are not translocated, only affecting the plant parts they come into contact with. Of the organic products registered for use as herbicides, none would be effective in the control of weeds in the consent application. This assessment is based on a discussion with Dr Trevor James, Weed Scientist at AgResearch Ltd.

36) None of the alternative methods listed in the consent application would provide adequate control of the target weed species.

37) Alternative methods of control such as classical biological control were not considered in the consent application. Several biocontrol agents have been introduced into New Zealand for the plants listed in the consent application. These include six agents for the control of broom, five agents for the control of gorse, three agents for the control of old man's beard (Landcare Research 2015) and an agent introduced to control buddleia by Scion. Currently none of these biocontrol agents have reduced these weeds to levels of infestation where other control methods are not required. Therefore, the agrichemicals listed in the consent application are the most appropriate tools to manage those weeds.

38) The information on assessment of effects of glyphosate isopropylamine, metsulfuron-methyl and triclopyr butoxyethyl ester and also organosilicone adjuvants provided in the consent application is adequate.

39) Following the reassessment hearing, NZEPA (December 2012) approved the use of metsulfuron-methyl for application onto or into surface water, with a series of controls governing this use pattern. They also refer to NZEPA approval for the use of glyphosate isopropylamine for aquatic use, without such controls.

40) These NZEPA approvals are for the discharge of those herbicides onto or into water. In the current consent application, no direct discharge of those herbicides in surface waters is anticipated, provided the mitigation measures detailed in the consent application are adhered to.

41) The herbicidal control methods detailed in the consent application are also used by other agencies, such as Land Information New Zealand (LINZ) for the purpose of controlling woody weeds in similar situations to the application (discussion with Mr Marcus Girvan, Project Manager – LINZ Biosecurity, Boffa Miskell). Glyphosate-based herbicides have been used for this purpose in Tasman District since the 1980's (information received from Mr Griffith).

42) In some regions, glyphosate isopropylamine use in or over water is a permitted activity, with no resource consent required (discussion with Ms Sheryl Roa, Principal Project Leader, Resource Use Group, Waikato Regional Council).

43) I am comfortable with the response to points raised in the reports from Tiakina te Taio and Manawhenua Ki Mohua Māori Values/Cultural Impact Assessments relating to environmental impacts. I will refer to some of these issues in section F of my evidence.

44) I am not qualified to comment on issues regarding the impacts relating to the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, valued flora and fauna, and other tāonga.

45) Appendix B of the consent application details a worst case scenario, with the discharge of 1.68 Litres of herbicide mix into a river channel, with consequent herbicide concentrations falling below reported acute toxic levels. In my opinion, this scenario is most unlikely to eventuate.

46) The consent application does not refer to environmental limits set by NZEPA.

47) NZEPA have set maximum concentrations of active ingredients of these herbicides in the environment that must not be exceeded (NZEPA 2015). These include:

- Tolerable Exposure Limits (TELs) set to control hazardous substances entering the environment in quantities sufficient to present a risk to people (0.04 mg/L for metsulfuron and 0.1 mg/L for glyphosate and triclopyr butoxyethyl ester) – information downloaded from the NZEPA website.

- Environmental Exposure Limits (EELs) set to control hazardous substances entering the environment in quantities sufficient to present a risk to the environment (0.0084 µg/L for metsulfuron and 0.37 mg/L for glyphosate). No EEL has been set for triclopyr butoxyethyl ester as this herbicide is not registered for use where application into or onto water may occur.

- The much lower EEL values reflect the toxicity of herbicides to plants. However toxicity to animals is invariably much lower as herbicides target enzyme pathways unique to plants.

48) Appendix C of the consent application contains material safety data sheets (MSDS) for the agrichemicals listed in the consent application. The sheets for metsulfuron-methyl are for the incorrect concentration of the active ingredient (20% rather than 60%) and the Grazon sheet refers to a product registered under that name in Canada, but with different active ingredients to the product referred to in the application. The information relating to the organosilicone wetting agent Pulse was the agrichemical label not MSDS. Correct MSDS are now presented in the evidence of Mr Tonks.

49) I endorse the conclusions and recommended conditions (Section 12) of this consent application.

F. MATTERS RAISED IN SUBMISSIONS

50) I will respond to the following matters raised in submissions:

- The concern over poisons or toxins being introduced into the environment.
- Acute versus chronic toxicity and relevance to this application.
- Potential effects on human health (including additional substances added to the active ingredient in herbicide formulations).
- Herbicide resistance in weeds.
- Breakdown products of herbicides and persistence of herbicides in the environment.
- Potential effects on threatened and at-risk native species.
- The validity of the spray accuracy trial undertaken on the Aorere River.

G. TOXINS IN THE ENVIRONMENT

51) All the agrichemicals listed in the consent application are listed as ecotoxic – being toxic (glyphosate and organosilicone adjuvants) or very toxic (metsulfuron-methyl and triclopyr butoxyethyl ester) in the aquatic environment with long lasting effects.

52) This statement refers to the toxicity of the concentrated herbicide formulation in the container as supplied by the manufacturer.

53) Toxicity is, however, dose dependant. In the words of Paracelsus (1493-1541), often regarded as the father of toxicology, “Everything is poison, there is poison in everything. Only the dose makes the thing not a poison" (sourced from Toxipedia.org).

54) Herbicides are diluted with water from the concentrated form to a spray mixture that is toxic to the target weed but with limited impact on non-target organisms. Any contamination of natural water will be rapidly diluted to below the TEL or EEL set for that chemical.

H. ACUTE VERSUS CHRONIC TOXICITY

55) Toxicologists determine the acute and chronic toxicity of a substance. Acute toxicity being the toxic effect of one exposure to an organism, whereas chronic toxicity refers to long-term exposure to a, usually much lower, concentration that causes toxic effects.

56) Acute toxicity is often expressed as the concentration of the substance that causes mortality (Lethal Dose) in half of the test organisms expressed as the weight of the substance causing that effect per kilogram body weight of the organism (LD_{50}). As the calculation of toxic concentration uses a per kg body weight, then the lighter a person is, the more susceptible they are to toxicity.

57) Examples of toxicity of substances measured as LD_{50} are presented (in mg/kg) from most toxic to least toxic (Cornell University 2009):

- Botulin 0.00001
- Cyanide and Vitamin D 10
- Nicotine 50
- Caffeine 150
- Aspirin 1000
- Table salt 3000

58) This can be compared with the acute toxicity of the agrichemicals in this consent application:

- Triclopyr butoxyethyl ester and organosilicone penetrant >2000
- Glyphosate isopropylamine and metsulfuron-methyl >5000

59) As an example, a dose of greater than 5 g/kg of metsulfuron (the highest concentration tested) would be required to cause the mortality of 50% of test rats. A typical concentration that this herbicide is applied to the environment (the spray mix

applied to plants) is 20 mg/L. Assuming a rat has a weight of 250 to 500 g, then it would need to drink more than 62.5 L for this to occur.

60) The concentration of herbicide likely to be encountered in the aquatic environment as a result of the proposed herbicide application is much lower than this. For example, in my recent report to NZEPA (refer to point 17 of my evidence) we measured a further dilution of the herbicide of 2.0×10^{-5} and 7.5×10^{-6} (a minimum of a $1/200{,}000^{th}$ dilution) from applied herbicide rate as the maximum contamination of water where the herbicide was applied over water, and 6.4×10^{-7}, 3.7×10^{-7} and 4.7×10^{-6} (a minimum of $1/4{,}700{,}000^{th}$ dilution) where herbicide was applied to vegetation immediately next to a water body.

61) Alternatively, a lethal concentration (LC_{50}) is calculated for many aquatic organisms, referring to the exposure of an aquatic organism to a concentration of herbicide over a period of usually 48 or 96 hours. For example, the LC_{50} has been determined for triclopyr butoxyethyl ester at between 0.65 and 2.7 parts per million (mg/L) for rainbow trout over a 96 hour period (Section 6.3.4 of the consent application). In this case a dilution of 1/55,000 would be needed to reduce the concentrated spray mix below this level, but well below the maximum recorded dilution rate measured in the field.

62) Minimum flows in the rivers affected by this consent application would be in the order of two cubic metres per second (information received from Mr Griffith). Thus, there would be a two-thousand-fold dilution of each litre of water containing any agrichemical at the point of application every second within in the receiving environment. If there were to be minor agrichemical contamination it would only be an extremely brief exposure to a very low concentration in the rivers adjacent to herbicide treatment.

63) Chronic toxicity measures are typically calculated based on a daily intake of a substance for the life of that individual. These form the basis for the TEL values derived by NZEPA (refer to point 47 of my evidence), equating to an allowable daily intake of each substance by a human over a 70 year life span without appreciable health risk.

64) As these herbicides would only be applied at each site at a maximum frequency of once each year, information relating to chronic toxicity has much less relevance than

acute toxicity to the situation for which this consent is sought. However, chronic toxicity measures form the basis for much of the information provided by submissions against the granting of consent in the application.

I. POTENTIAL EFFECTS ON HUMAN HEALTH

65) The agrichemical of greatest concern, as raised in the submissions, is glyphosate isopropylamine. Much of the opposition to its use appears to be its link with genetically engineered (GE) crops where tolerance to glyphosate allows this relatively non-selective herbicide to be used to control weeds without damage to the crop. Because of this, the use pattern for the herbicide is far different in countries permitting GE crops. Currently, New Zealand does not grow such crops.

66) It is my understanding that much higher volumes and repeated applications of herbicide are used in these situations, compared with the proposed use in the current consent application. Evidence of contaminated ground water, contamination of food etc relate to the use patterns associated with GE cropping.

67) The New Zealand Food Safety Authority (November 2004), now part of MPI, undertook tests on New Zealand grown potatoes and imported wheat from Australia and Canada for residues of glyphosate and its principal metabolite aminomethylphosphoric acid (AMPA). No herbicide residues were detected in New Zealand or Australian produce, but there was residue in five of six Canadian samples. According to the report “None of the residue levels presented any food production concerns, and all levels were vastly below health or food safety limits. Maximum Residue Limits (MRLs) are a measure of good agricultural practice and are not a measure of safety. MRLs are generally set well below levels that can be consumed over a lifetime without harm, called Acceptable Daily Intakes (ADIs)”.

68) Some of the submissions e.g. that of Gina Wilson, highlight a series of recent papers outlining human health concerns relating to glyphosate poisoning. The evidence of Mr Tonks has highlighted issues with the science and interpretation of results from many of these papers.

69) All of the agrichemicals to which this consent application refers have been approved for use to manage weeds in terrestrial situations. In the recent NZEPA (December

2012) decision on the use of several herbicides over and in water, the following statement is made (Section 5.3): “the risks to human health and the environment associated with the remaining lifecycle stages of the substances were addressed during the original approval of the substances for terrestrial weed control”.

70) As part of their assessment process NZEPA are privy to the full formulation of an agrichemical additional to the active ingredient. This information is commercially sensitive, but the risks relating to all components of a formulation is taken into account in the decision making process.

71) NZEPA have set limits (TEL) for the protection of humans from exposure to ingestion of those substances.

72) The risk of exposure to toxic concentrations of these substances is greatest to personnel involved in their manufacture, then those involved in the mixing and application of herbicides to target weeds, then exposure to herbicide sprays at the place and time of application and finally to persons in downstream areas where contamination of water may have occurred.

- Safety in the manufacture of agrichemicals is covered under HSNO and Responsible Care® New Zealand (formerly NZ Chemical Industry Council (NZCIC)).
- Section 3 of the consent application covers the requirement that all applicators of the agrichemicals are appropriately qualified Registered Chemical Applicators.
- Public notification of intended spray operations (Section 12, pages 34 to 36 of the consent application) should mitigate exposure to direct herbicide sprays.
- Downstream concentrations of agrichemicals would be below TELs set by NZEPA.

73) Thus the exposure of humans to health risks related to the use of herbicides detailed in the consent application is much less than possible exposure to other uses of glyphosate, available for the general public to purchase and use without regulation. Similarly, the other agrichemicals metsulfuron and triclopyr are commonly used terrestrially for the control of brushweeds and other woody weeds and risk of exposure to humans would be greater than their use relating to this consent application.

74) This year (March 2015), the International Agency for Research on Cancer (IARC; Lyon, France) assessed the carcinogenicity of several agrichemicals and assigned glyphosate to the rating "Probable carcinogen 2A". Group 1 are known human carcinogens. "Group 2A is used when there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals. *Limited evidence* means that a positive association has been observed between exposure to the agent and cancer but that other explanations for the observations (called chance, bias, or confounding) could not be ruled out. This category is also used when there is limited evidence of carcinogenicity in humans and strong data on how the agent causes cancer".

75) Examples of Group 1 carcinogens include alcoholic beverages, diesel exhaust fumes, tobacco smoke, asbestos and benzene. Examples of Class 2B substances include creosotes, acrylamide, malaria and shiftwork involving disruption to circadian rhythms (American Cancer Society 2015).

76) The USEPA have been undertaking a review of glyphosate toxicity over the last six years, but have delayed the release of the report while the information used by IARC is being reviewed (Reuters May 2015).

77) I discussed the USEPA review with aquatic weed researcher Dr Michael Netherland, US Army Engineer Research and Development Center, and University of Florida Center for Aquatic and Invasive Plants, Gainesville, Florida during his recent visit to New Zealand (April 2015). He doubted that many significant changes would eventuate regarding the use of glyphosate to control weeds in non-cropping situations where contamination may occur.

78) Any change in the use of glyphosate in New Zealand would require reassessment by the NZEPA under HSNO. Should this occur, any resource consents issued under the Resource Management Act would need to be changed to reflect additional controls set by NZEPA.

79) Toxicity data does not account for Multiple Chemical Sensitivity or allergic reactions that individuals may suffer as a result of exposure to agrichemicals or any other allergen for that matter.

80) I re-emphasise point 73 of my evidence, as herbicides like glyphosate are readily available for use by the general public, the risk of exposure to the agrichemicals is likely to be greater from uses outside of those proposed in this consent application.

J. HERBICIDE RESISTANCE

81) Herbicide resistance results when an individual organism develops the ability to tolerate the toxic effects of a herbicide, usually through natural gene mutation. Under continued frequent use of the herbicide those individuals will be selected for as they persist while intolerant plants are killed by the herbicide and thus their genes will be passed down through generations of the organism.

82) Harrington (2014) states that "herbicide resistance is much less common than fungicide or insecticide resistance. Most weed species complete their life cycle only once each year, whereas fungi and insects often complete many life cycles within one year. This means resistance genes build up much more quickly within fungal or insect populations than with weeds. In addition, following applications of insecticides and fungicides, most susceptible individuals within a sprayed area are killed, leaving only resistant individuals to multiply. In contrast, because herbicide applications do not kill dormant weed seeds, weeds that lack resistance genes are not easily removed from the population and this helps to delay the onset of resistance".

83) Glyphosate resistance is not a common occurrence, with the first reported New Zealand cases of resistance found in ryegrasses in Marlborough and Nelson vineyards (Harrington et al. 2014).

84) In the case of woody weeds, generation times are much longer than a year and species such as gorse and broom have very long lived seed, so the selection for herbicide resistance to develop is much less likely than for annual or short-lived perennial herbaceous plants. Additionally, herbicide treatment is only planned for a maximum of one application per year, so there is not a huge selection pressure for herbicide resistance.

85) In situations similar to the one applied for in this consent application, Harrington et al. (2014) recommend adding metsulfuron to glyphosate from time to time, for example every three or four applications to avert the build-up of resistant weeds. Metsulfuron

mixed with glyphosate is part of the strategy for woody weed control detailed in the consent application.

K. HERBICIDE PERSISTANCE AND BREAKDOWN

86) As referred to in point 69 of my evidence, NZEPA state "the risks to human health and the environment associated with the remaining lifecycle stages of the substances were addressed during the original approval of the substances for terrestrial weed control". Therefore NZEPA have examined the toxicity of breakdown products as well as the active ingredient of these herbicides.

87) As discussed in points 60 to 62, the main mechanism of reducing the concentration of these agrichemicals in the environment to below toxic rates is by dilution in receiving waters.

88) Additional to dilution, these products do breakdown in the environment. The consent application details the breakdown of herbicides in water, listing the time taken for half the substance to break down. Mechanisms for herbicide breakdown include microbial activity (e.g. glyphosate, metsulfuron and triclopyr butoxyethyl ester), hydrolysis (e.g metsulfuron and triclopyr acid) or photolysis (e.g. metsulfuron and triclopyr butoxyethyl ester and acid). Glyphosate is rapidly adsorbed to mineral clays and organic matter, which would prevent the majority of any herbicide reaching the soil from leaching into groundwater or adjacent surface water bodies.

89) Ultimate breakdown products of the three herbicides are:

- Glyphosate – ammonia, formaldehyde, phosphate, carbon dioxide, carbohydrates, amino acids and other acids (University of California 1998)
- Triclopyr – carbon dioxide, organic acids and water (University of California 1997)
- Metsulfuron – carbon dioxide and saccharin (Environment Canada 1987)

90) Several submitters noted references to the persistence of triclopyr in dead tissues of plants susceptible to this herbicide. This herbicide does appear to persist in dead plant tissue but is rapidly degraded by microorganisms once plant material reaches the soil (University of California 1997).

91) Triclopyr, like metsulfuron and glyphosate, is rapidly cleared by animals through ingestion and the potential for these herbicides to bioaccumulate in the food chain is thus regarded as little to none (Environment Canada 1987, University of California 1997 & 1998).

L. POTENTIAL EFFECTS ON NATIVE AQUATIC ANIMALS

92) There are few studies on the toxicity of the agrichemicals to indigenous aquatic fauna.

93) Hickey (2000) compared the toxicity of four substances, cadmium, zinc, phenol and sodium dodecyl sulphate (SDS) in the laboratory to common test organisms and 25 native invertebrate and 12 fish species. These substances are representative of inorganic and organic toxicants. He found that eels were less sensitive to all toxicants compared with rainbow trout, whereas inanga were less sensitive to phenol but more sensitive to SDS (see table listing EC_{50} mg/L).

Species	Cd	Zn	Phenol	SDS
rainbow trout	0.003	0.29	4.6	37.6
longfin eel	3.57	8.92	24	47
shortfin eel	8.72	11.1	21.5	44.1
inanga	not tested	not tested	9.02	24

94) It is therefore likely that elvers and inanga have similar tolerances to the four substances as rainbow trout, and therefore unlikely that the proposed use of these substances would have a more than minor impact on these species.

95) My own research found no metsulfuron-methyl toxicity to longfin or shortfin elvers (*Anguilla dieffenbachii* and *A. australis*) at rates well above herbicidal concentrations used. Caged eels, inanga (*Galaxias maculatus*), freshwater shrimp (*Paratya curvirostris*) held upstream and downstream of treated areas on the Waikato River showed no mortality during and after the treatment and there was no difference in

the number or diversity of other fish or invertebrate species captured in the treated areas (Champion and Chisnall 1994, Champion et al. 1997).

96) The submission of Felicity Fitz-William notes the presence of eleven nationally at-risk declining freshwater fish within Tasman District based on the assessment of Allibone et al. 2010).

97) A more recent assessment has been undertaken (Goodman et al. 2013), with two of those eleven species now classified as nationally endangered – vulnerable. These species are lamprey and shortjaw kokopu. The remaining nine species remain nationally at-risk declining.

98) According to McDowall (1990), the habitat requirements of only three species of the eleven species; bluegill bully, torrentfish and juvenile longfin elvers are likely to be resident in rivers adjacent to areas of herbicide application in this consent application. Most of the other species are largely restricted to native forested streams, slower flowing waters or wetlands.

99) Regardless of habitat requirements, fish living in water bodies adjacent to the application areas are most unlikely to be exposed to toxic concentrations of the agrichemicals.

100) Inanga spawning habitat was also raised as a potential impact of herbicide application detailed in this consent application. This species spawns in herbaceous terrestrial vegetation growing on the floodplain of flowing waters influenced by tidal activity, with spawning occurring during high tides (McDowell 1990). This spawning habitat is not present on the fairway and bank areas targeted in this consent application.

M. THE AORERE TRIAL

101) A few submissions question the validity of the Aorere spray trial conducted in December 2011. Details of the trial were present in the submissions and also forwarded to me by Mr Griffith. However, I note that this trial is not referred to in the consent application.

102) These submissions rightly point out that the vegetation was less than 5 m away from the active river channel. Contamination of some cards three metres away from the

sprayed area was reported, but no cards were placed 5 m away – the distance from active channels specified in the consent application. Cards even further away from the application site would have been a useful addition to the trial.

103) The trial usefully recorded some contamination of cards, but no attempt was made to determine what volume of herbicide spray was associated with these measures. This could have permitted a calculation of off-target herbicide contamination.

104) Also wind speeds were sufficient to raise the concern of the pilot and were mentioned in the report as a factor that may have led to contamination of some spray cards. It would have been better to delay the trial to a day where lower wind speeds were experienced.

N. MATTERS RAISED IN THE OFFICER'S REPORT

105) The Officer's S42A report provides a clear outline of the respective roles of key legislation relating to the use of agrichemicals.

106) Specifically, point 7.48 of the Officer's report states:

- HSNO Act - addresses risks to the environment, people, and communities by conducting thorough risk, cost and benefit assessment on specific hazardous substances so that the overall benefits are balanced against potential risks. Through this assessment controls are applied to the hazardous substance to prevent or manage adverse effects of it.

- RMA - identifies and manages potential adverse effects on the environment associated with the discharge of the substances (contaminants) through the use of plan provisions and resource consent conditions. These controls can be applied at any geographic level.

107) It appears that many of the concerns raised by submitters, and much of the information provided in the Cawthron reports (Champeau and Tremblay 2013; 2014), confuse these two functions. They relate to the assessment of inherent risks posed by the agrichemicals rather than the way the herbicides are to be used, as outlined in the application for consent.

108) Assessments of the broader inherent risks are a responsibility of the NZEPA, under the HSNO Act (through which determinations have already been made on each of the herbicides), whereas what is relevant to the RMA, and this hearing, are matters relating to the safe use of these agrichemicals in specific operational settings. This should not be an opportunity to re-litigate decisions already made by under the HSNO Act by the NZEPA.

109) The importance of drawing this distinction is also identified in the Officer's Report (point 9.54).

110) I support the overall recommendation in the Officer's report recommending that the application be granted.

111) However, I disagree with two of the revised proposed conditions.

112) Condition 1D states:

- The Consent Holder shall commission a review by an appropriately qualified expert for Glyphosate, Metsulfuron and Triclopyr along with organo-silicone penetrants every 5 years to assess the current information and any changes to their registration.

113) I agree with the intent of this condition, but in my opinion such a review needs to carried out in view of all available information. As stated in point 70 of my evidence, the NZEPA are privy to the full formulation of an agrichemical additional to the active ingredient. This information is commercially sensitive, but the risks relating to all components of a formulation is taken into account in the decision making process. Therefore only the NZEPA should undertake such a review of information.

114) Condition 10A states:

- Only Glyphosate along with organo-silicone penetrants shall be aerial spraying

115) As stated in point 39 of my evidence NZEPA (December 2012) have approved the use of metsulfuron-methyl for application onto or in to surface water, with a series of controls governing this use pattern.

116) This herbicide is highly effective at controlling a range of woody weeds including the species included in this application and its use would reduce the potential need for

follow-up herbicide application if control using glyphosate did not give the desired control.

117) I therefore consider that aerial application of metsulfuron-methyl should be permitted.

O. CONCLUSIONS

118) I endorse the consent application to use the four agrichemicals glyphosate isopropylamine, metsulfuron-methyl, triclopyr butoxyethyl ester and organosilicone adjuvants to control woody and other target weeds in order to protect the Tasman District from the impacts caused by those weeds including flood protection, infrastructure damage and maintenance of habitats for indigenous birds.

119) I regard those agrichemicals, the application methods, timing and mitigation measures as outlined in the consent application to be the most effective and appropriate control methods, with limited impacts on human health and environmental values.

120) I noted that similar control has occurred in Tasman District since the 1980's and elsewhere in New Zealand with no reports of unwanted harm, to my knowledge.

121) Human health concerns relating to the use of these herbicides have been evaluated by the New Zealand Environmental Protection Agency, with limits set for contamination levels in water for consumption and protection of the environment. These limits are most unlikely to be exceeded provided the mitigation measures proposed are adhered to.

122) Thank you for the opportunity to present this evidence on behalf of the applicant group. If you have any matters that require clarification, I am happy to answer your questions.

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