Before the Auckland Council
(Hearing Panel)

UNDER the Resource Management Act 1991 (**RMA**)

IN THE MATTER OF an application for regional resource consents for the Huia Replacement Water Treatment Plant Project Woodlands Park Road, Waima.

EVIDENCE OF NARI MICHELLE WILLIAMS
On behalf of Titirangi Protection Group Incorporated, The Tree Council, Titirangi Residents & Ratepayers Association, Waitakere Ranges Protection Society, Royal Forest & Bird Society and Save Our Kauri Trust

Dated: 14 April 2021

Introduction

1. My full name is Nari Michelle Williams
2. My qualifications include
   Bachelor of Agricultural Science (Integrated Pest Management) The University of Adelaide, Australia

   PhD (Biotechnology – Plant Pathology) Murdoch University Centre for Phytophthora Science and Management, Perth Australia.

3. I have 20 years of work and research experience in *Phytophthora* biology and adaptive management. Since 2001 my research has focussed on the biology and management of *Phytophthora* pathogens in forests, natural ecosystems, plantations and horticulture with a predominant focus on soil-borne Phytophthora pathogens impacting trees. From 2002-2012 I worked within the former Centre for Phytophthora Science and Management at Murdoch University where I completed my PhD and went on to work as a post-doctoral researcher and project manager with projects focussed on the adaptive management of Phytophthora pathogens within large scale landscape and mining projects in Western Australia.

   Since moving to New Zealand in 2012 my focus has been on *Phytophthora* pathogens impacting trees of importance to New Zealand's plantation forestry and natural ecosystems including *Phytophthora agathidicida* and kauri forests. I currently hold a joint role of Senior Scientists within the Plant and Food Research, Pathogen Ecology and Control team based in Hawkes bay and recently accepted the role of Senior Lecturer in the School of Biological Science's Joint Graduate Centre for Plant and Food Science/ George Mason Centre for the Natural Environment at University of Auckland.

4. I am the project leader on several projects within the Ngā Rākau Taketake (NRT) within New Zealand's Biological Heritage Science Challenge, https://bioheritage.nz/research/saving-our-iconic-trees. Our work is looking to better understand the biological, physical and chemical factors influencing the survival, persistence and spread of *P. agathidicida* inoculum across the landscape.

Code of Conduct

I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I confirm that the issues addressed in this brief of evidence are within my area of expertise. I have specified where my opinion is based on limited or partial information and identified any assumptions I have made in forming my opinions.

Scope of Evidence

1. I am presenting scientific and technical information on the risks associated with the spread of *Phytophthora agathidicida,* exacerbation of kauri dieback disease expression and impact within the Waima Catchment as evidence on behalf of Titirangi Protection Group Incorporated, The Tree Council, Titirangi Residents & Ratepayers Association, Waitakere Ranges Protection Society, Royal Forest & Bird Society and Save Our Kauri Trust

2. In preparing evidence I have read:
    a. Boffa Miskell Limited 2019. Huia Water Treatment Plant Replacement: Assessment of Ecological Effects. Report prepared by Boffa Miskell Limited for Watercare Services Limited
    b. Shona Myers 2018. Huia Water Treatment Upgrade - Assessment and Review of Ecological Values
    c. Dr Murray Fea, Technical memo, kauri dieback disease, section 42A report
    d. Boffa Miskell Limited 2020. Huia Water Treatment Plant Upgrade: DRAFT Ecological Management Plan. Report prepared by Boffa Miskell Limited for Watercare Services Limited
    e. Boffa Miskell Limited 2020. Huia Water Treatment Plant Replacement; Kauri Dieback Management Plan
    f. BioSense 2020. Kauri dieback disease surveillance of Watercare's proposed replacement water treatment plant site at Waima Catchment
    g. Supplementary evidence Dr Sarah Flynn, April 2021

3. My evidence will address the following:
    a. The biology, impact and risk of kauri dieback in the context of the proposed Huia Water Treatment Plant project and the Waitakere Ranges Kauri Ecosystem.
    b. The depth of potential infestation and risk of movement of infested soil using the proposed approach.
    c. Decontamination of infested water prior to discharge

4. Evidence
    a. The biology, impact and risk of kauri dieback in the context of the proposed Huia Water Treatment Plant project and the Waitakere Ranges Kauri Ecosystem.

    Phytophthora agathidicida is a soilborne, water driven plant pathogen for which *Agathis australis* (kauri) has been shown to be a primary susceptible host. There is growing evidence that a large proportion of the kauri population is highly susceptible to infection with the majority of trees showing symptoms of infection rapidly succumbing to the disease. This appears to be the case Waima Catchment with 56% of kauri within the footprint of the proposed replacement water treatment plant showing signs of ill thrift or kauri dieback symptoms and a strong association between the detection of *P. agathidicida* and symptomatic trees (ref Appendix 9; BioSense Report, 2020).

    As with other soil-borne Phytophthora species, *Phytophthora agathidicida* is sustained within the roots and cambium of susceptible host plants and in fine degraded root fragments within the soil profile. Upon infection, *P. agathidicida* produces an abundance of stable spores called oospores within the roots of the host plant, killing the fine roots in the process (Bellgard et al. 2016). The oospores and mycelium within the decaying roots contribute significantly to the pathogen's survival during periods of environmentally unfavourable conditions. In preliminary studies cut short last year by COVID, I found the fine organic fraction was a key inoculum source within the soil and likely contributing to the pathogen's survival and spread within the soil (Williams and Arnet 2020). Phytophthora belong to the golden brown algae and are favoured by the availability of water. When there is available free water *P. agathidicida* will produce motile zoospores.

Implications of the persistent inoculum of Phytophthora agathidicida *for hygiene*

Given the diversity of propagules with which *Phytophthora agathidicida* can survive, I am concerned by the risk associated with the potential lack of diligence and over-confidence in wash down procedures and over-reliance on Sterigene for decontamination.

It cannot be emphasised enough how important it is to fully remove all soil from vehicles, equipment and footwear before applying disinfectants as these will only be effective on direct contact with the spore. It will not reliably kill all propagules encapsulated within soil colloids or organic matter such as fine root material.

Conditions favouring the development of disease

Beyond the survival and spread of infectious propagules, the availability of a susceptible host and water play key roles in the potential intensification and spread of the pathogen within and beyond an area of established infestation. Areas down-stream of an infested area are vulnerable to being inundated by the pathogen depending on changes in water flow.

Upon exposure to an infectious pathogen, the development of kauri dieback disease is impacted by the interactions between the host, environment and pathogen. Trees experiencing periods of drought are predisposed to succumbing to infection by Phytophthora pathogens (Corcobado et al. 2014; González et al. 2020). This is of relevance in the Waima Catchment as hydrological changes in the lower catchment may result in trees already exposed to the pathogen being more vulnerable to either increased levels of infection due to increased water interception or increased disease expression due to lower water interception with changes in the flow of water through the catchment.

b. The depth of Phytophthora infestation within the soil profile

Overall I am very concerned by the underestimation of risk for further spread of the pathogen due to movement of material within and off site, especially the assertion based on the Bellgard (2013) study in which it was reported that no *P. agathidicida* was isolated from below 20 cm. While the majority of soil sampling for soilborne *Phytophthora agathidicida* has been focussed in the top 20 cm targeting high densities of fine roots, the study being cited did not include a comprehensive excavation of the host's root system. Focussed investigation to understand the inoculum dynamics of the pathogen at depth was beyond the scope of their study and interpretation of the results as providing evidence for lower pathogen loadings at depth should be considered with caution.

Phytophthora pathogens have been found to penetrate the soil profile to depth in relation to the presence of fine and coarse roots of host plants, the water table and presence of Phytophthora spores or inoculum laden organic material through the soil profile (Hill et al. 1994; Crone et al. 2013; Crone et al. 2014). Several studies have shown that inoculum lower in the soil profile can be more stable and maintain viability longer than that found at the surface suggesting this presents a significant risk for pathogen spread along with the more ephemeral inoculum within the topsoil (Meadows and Jeffers 2011; Dunstan et al. 2020). This is of direct relevance to the proposed project as both fine and vertical peg roots are noted to penetrate up to 5 m into the soil.

In a forest system in Australia, two thirds of vertical ("peg") roots penetrating the cap rock were found to be infected with *Phytophthora* with the majority of vertical roots found to be lesioned or dead with active lesions extending upwards (Shea et al. 1982). While similar excavations to depth have not been carried out within infested kauri stands, the physiology of the tree and pattern of infection mean that it is highly likely infections and hence *P. agathidicida* inoculum extend through the soil profile to depths of at least 5 m.

c. Decontamination of infested water prior to discharge

It is of concern that there is no intent to decontaminate water leaving the site given there are numerous approaches that could be taken to do this. Chlorination, UV, heat and sand filtration are all feasible for large volumes of water where integrated appropriately (Williams and Arnet 2020). For such treatment to be effective in reducing the risk of Phytophthora transmission, they must consider the volume, turbidity, sediment and organic content of the water/water slurry to ensure efficacy and prevent discharging infested material into the lower catchment.

It is unclear to me whether the proposed use of kanuka bundles is for stabilisation, filtration or microbial/*Phytophthora* suppression. While research into plant exudate and concentrated plant extracts including those from kanuka have been shown to inhibit *Phytophthora* on direct contact, this is not applicable for the suppression of *Phytophthora* in the current plan as the diffusion of inhibitory compounds, concentrations and exposure of inoculum are all at orders of magnitude lower than can be expected to be effective within the operations proposed.

5. Conclusions
    a. The proposed activity on the heavily infested Watercare site at the head of the Waima Catchment presents a significant risk for the spread of the pathogen across the site and to the catchment below. While *P. agathidicida* may be already present in the broader catchment, extensive excavations and changed patterns of water movement present a key risk for increasing surface inoculum flow and discharge or disruption of current water flows to the lower catchment. Either scenario is likely to put trees already exposed to the pathogen under greater inoculum load or environmental stress leading the exacerbation of disease expression.
    b. The proposed staging of vegetation and soil removal based on a premise of the pathogen's distribution being limited vertically within the soil profile is flawed. While the inoculum density will be lower at depth and less evenly distributed, it is likely to be associated with coarse roots and present a relatively stable source of inoculum. Given the vegetation cover, the level of infestation and likelihood of host root material to depth, it is not possible to delineate risk based on soil depth within the proposed site for the replacement treatment plant.
    c. There are methods available for decontaminating water that is infested with *Phytophthora* pathogens which have not been considered in the current proposal. To be effective in eliminating the risk of spreading *Phytophthora agathidicida,* water treatment must consider the operational practicalities of efficacy of treatment given the scale of operation, organic and mineral son contaminants contained within soil-water slurries.
    d. Kanuka bundles are not an effective means of treating water contaminated with *P. agathidicida* within an operation of this size.

6. References

Bellgard SE, Padamsee M, Probst CM, Lebel T, Williams SE 2016. Visualizing the early infection of *Agathis australis* by *Phytophthora agathidicida*, using microscopy and fluorescent *in situ* hybridization. Forest Pathology. 46(6): 622-631.

Blellgard S, Weir BS, Pennycook SR, Paderes EP, Winks C, Beever RE, Than DJ, Hill L, Williams SE 2013. Specialist Phytophthora Research: Biology, Pathology, Ecology and Detection of PTA - Final Report Kauri Dieback Joint Agency Response.

Corcobado T, Cubera E, Juárez E, Moreno G, Solla A 2014. Drought events determine performance of *Quercus ilex* seedlings and increase their susceptibility to *Phytophthora cinnamomi*. Agricultural and Forest Meteorology. 192-193: 1-8.

Dunstan WA, Howard K, Grigg A, Shaw C, Burgess TI, Hardy GESJ 2020. Towards Eradication of *Phytophthora cinnamomi* Using a Fallow Approach in a Mediterranean Climate. Forests. 11(10).

González M, Romero M-Á, García L-V, Gómez-Aparicio L, Serrano M-S 2020. Unravelling the role of drought as predisposing factor for *Quercus suber* decline caused by *Phytophthora cinnamomi*. European Journal of Plant Pathology. 156(4): 1015-1021.

Hill T, Tippett J, Shearer B 1994. Invasion of Bassendean Dune Banksia Woodland by *Phytophthora cinnamomi*. Australian Journal of Botany. 42(6): 725-738.

Meadows I, Jeffers S 2011. Distribution and recovery of *Phytophthora cinnamomi* in soils of mixed hardwood-pine forests of the south-eastern USA. New Zealand Journal of Forestry Science. 41S (2011)
Shea SR, Shearer B, Tippett J 1982. Recovery of *Phytophthora cinnamomi* From Vertical Roots of Jarrah (*Eucalyptus marginata* Sm.). Australasian Plant Pathology. 11(3).
Williams N, Arnet M 2020. Phytophthora agathidicida inoculum deactivation: Determining the source of persistent Phytophthora agathidicida inoculum within soils Plant & Food Research report prepared for: Ministry for Primary Industries. .