BEFORE THE AUCKLAND COUNCIL

In the matter of	the Resource Management Act 1991 ("the Act")
And	*WATERCARE SERVICES LTD* *First Respondent*
In the matter of	An application for regional resource consents for the Huia Replacement Water Treatment Plant Project Woodlands Park Road, Waima.

Statement of Evidence in Chief of Cate Macinnis-Ng for The Tree Council, Titirangi Residents & Ratepayers Association, Forest & Bird, Waitakere Ranges Protection Society, Titirangi Protection Group and Save Our Kauri Trust

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Dated: 11 April 2021

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1. INTRODUCTION

1.1. My full legal name is Catriona Meredith Olwen Ng and I am known professionally as Dr Cate Macinnis-Ng. I represent The Tree Council, Titirangi Residents & Ratepayers Association, Forest & Bird, Waitakere Ranges Protection Society, Titirangi Protection Group and Save Our Kauri Trust.

1.2. My evidence relates to the risk the proposed Huia Water Treatment Plant replacement will have on site hydrology and associated risk of contaminant transfer to the broader Armstrong and Yorke stream catchments.

1.3. I am generally in agreement with the AEE submitted by Boffa Miskell in terms of ecological effects of the development, however I am concerned that the impact of removal of the plant canopy and resulting potential spread of kauri die back from the development site to the downstream environment is not well addressed.

2. QUALIFICATIONS AND EXPERIENCE

2.1 I am a plant eco-physiologist and eco-hydrologist and am an Associate Professor at the School of Biological Sciences at the University of Auckland. I measure and model carbon and water cycling in forests and am particularly interested in the effects of global change processes (like climate change and land use change) on forests and other vegetation.

2.2 I have a Bachelor of Science in Environmental Biology with First Class Honours (completed in 1998) and I received my PhD in 2003 from the University of Technology Sydney (UTS). I worked at UTS for seven years as a research fellow researching water use of vegetation in several research groups including the National Centre for Groundwater Research and Training. I have published 53 peer-reviewed journal articles and I have written nine technical reports. Several of my journal articles have been on hydrological change caused by vegetation change and I was Associate Editor for the International water resources journal Hydrological Processes 2016-18.

2.3 Since moving to New Zealand in 2010, I have been working on the physiology of kauri. In 2012, I received a Marsden Fund Fast-Start grant from the Royal Society of New Zealand to study the water use patterns of these iconic trees. In 2014, I was awarded the Early Career Research Excellence Award at the University of Auckland and in 2015, I was awarded a Rutherford Discovery Fellowship by the Royal Society of New Zealand. In 2016, I was awarded the New Zealand Association of Plant Biologists Roger Slack Award. I am immediate past President of the New Zealand Ecological Society and Councillor representing the Constituent Organisations for the Royal Society Te Apārangi.

2.4 My current research includes drought impacts on native forests and interactions between kauri dieback infection, drought and other climatic factors.

2.5 In preparing this evidence I have read and in some cases reviewed all literature cited at the end of this document.

2.6 I advise that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014 and have complied with it in preparing this evidence. I confirm that the issues addressed in this evidence are within my area of expertise and I have not omitted material facts known to me that might alter or detract from my evidence.

3. SCOPE OF EVIDENCE

3.1. My statement of evidence covers:

- Root depth of kauri
- Effects of canopy removal on forest hydrology
- Expected increased risk of kauri die back (*Phytophthora agathidicida*) transmission from the cleared site to the downslope and downstream environment.

4. EXECUTIVE SUMMARY

4.1 I believe the kauri dieback pathogen *Phytophthora agathidicida* will be transported from the development site to the downstream environment due to the proposed development at the site.

4.2 Removal of the forest canopy and root structures will increase the overland flow of water and potentially change the flow path of water during rainfall events, especially if they are heavy events.

4.3 Because of the deep rooting depth of kauri, the kauri dieback pathogen *Phytophthora agathidicida* is likely to be present in deeper soil layers below the 50 cm of top soil.

5. EVIDENCE

Depth of kauri roots

5.1 Kauri roots reach well below the approximate 20 cm of topsoil in a forest. My own research has shown two lines of evidence for this. First, we have installed soil moisture probes to 1.2 m depth in kauri forest at the University of Auckland Huapai Scientific Reserve. A large drill bit is used to drill a hole into the ground to the appropriate depth (120 cm). The drill bit has a scoop-type shape at the end that used to bring soil from the hole to the surface. Once the hole is finished, the cylindrical soil moisture sensor is inserted to make a snug fit with the surrounding soil. We installed 12 of these sensors at our site and we consistently found fine roots of kauri in the soil we withdrew from the hole for the full 1.2 m depth. Given the similar forest type at the two sites, we can assume kauri roots extend to a similar depth at the development site.

5.2 Second, we have been recording sap flow (movement of water through trees) at our site since 2011. During that time, there have been two major droughts (summer 2013 and summer 2020). Our sap flow measurements are continuous (recorded every 30 minutes throughout the day and night) and we have matching soil moisture data also recorded at 30 minute time steps. On sunny summer days, rates of sap flow follow a clear pattern of increasing flow during the morning, reaching a peak in the early afternoon and then declining in the late afternoon. During the two drought periods, as the soil in the top 20 cm dried out, this pattern of daily water flow continued for the duration of summer. As the drought progressed, there was insufficient water available in the top 20 cm of soil to maintain the rate of flow, indicating active roots were accessing deeper soil water. Our sensors showed clear declines in soil moisture down to 80 cm and this is indicative of trees withdrawing water from that soil depth.

Rainfall interception

5.3 During a rainfall event, a large canopy of leaves will capture water until the leaf surfaces have been saturated. This process is known as 'wetting up' and it reduces the amount of water reaching the ground because the water stays on the leaves until it evaporates once the rain has cleared. A complex forest canopy similar to that currently at the site would have a leaf area of around 3 m2 of leaves per 1 m2 of ground so this surface area has a significant effect on the water cycle.

5.4 Detailed measurements of rainfall redistribution in kauri forest by Sangster (1986, unpublished MSc thesis, University of Auckland) showed interception loss was 44% of incoming rainfall. This is consistent with other similar forest types around the world and indicates that only 56% of rainfall reaches the forest floor. Removal of trees therefore increases water input onto the land surface and increases water logging and runoff. More runoff can mean more erosion and more frequent and severe floods.

Erosion prevention

5.5 5.5 Tree roots are also important for binding soil. Where there is steep topography, tree cover would be important for stabilisation of the slope. While it is difficult to measure the size of the root system of a group of trees, the root system would be substantial. As a rule of thumb, a tree stores half its biomass above ground and the other half below ground so the root system of the existing forest would be very large.

Annual water use

5.6 The amount of water a tree uses is important to human society because it removes the water from the soil, thereby reducing the incidence of water-logging and floods.

5.7 My colleagues and I at the University of Auckland Huapai Scientific reserve are currently measuring transpiration in kauri trees. We have collected data for almost ten years and have concluded that there is a strong relationship between tree size and the amount of water the tree uses. Based on this relationship (unpublished), a tree of 98 cm DBH (diameter at breast height) will use more than 26000 L of water each year. If a bathtub holds approximately 132 L of water, a kauri tree of the size of the kauri will use almost 200 of these bathtubs per year. While many of the trees that will be removed are smaller than this, their collective water removal is a vital part of the site hydrology.

Conclusion

5.8 Removal of vegetation at the site has a threefold influence on site hydrology. First, the rainfall reaching the forest floor could potentially almost double (depending on the complexity of the current canopy) when the plants are cleared. Second, removal of plants disturbs the root structure of those plants, removing the erosion-buffering capacity of the root system. Finally, removal of vegetation reduces the transpiration of the site, thereby increasing soil waterlogging and water movement after rain, especially when rain events are heavy or prolonged.

5.9 This evidence has shown that the removal of the existing canopy will have a significant impact on the movement of water and soil at the site. Since we know *Phytophthora agathidicida* movement is strongly associated with movement of water and soil, I do not believe the proposed site can be safely cleared without compromising the health of the significant kauri downslope. As the site will become very muddy after rain, I am also concerned about movement of possums, pigs, lizards and invertebrates as potential vectors for the spread of the pathogen.

5.10 Given *Phytophthora agathidicida* is known to associate with living root material, my finding of roots at depths of 1.2 m indicates a likely presence of the pathogen at depths greater than the 1 m that will be removed. Without further investigation, it is impossible to know what depth of soil would be a safe amount to remove at the site but it is clear that the 1 m of removed material is inadequate.

5.11 It is my conclusion that this is an unsuitable site for the proposed works.