My name is Clinton Rissmann. I have undergraduate and postgraduate qualifications in environmental toxicology, biogeochemistry and earth sciences, a masters in earth sciences and aqueous geochemistry, and PhD in earth sciences and fluid (gases and liquids) chemistry. I have held roles as a regional council scientist, principal scientist, and as a senior scientist at an NZ Crown Research Institute. I am currently an Adjunct Senior Fellow to the Waterways Centre for Freshwater Management that spans the engineering, earth, and environment schools at the University of Canterbury. I am the founder and director of Land and Water Science Ltd.

My company provides monitoring, measurement, and technical services to Scope Resources Limited ("SRL") with a focus on Land Fill Gas (LFG) dynamics at the Victoria Flats Landfill ("Landfill"). My company has monitored landfill gas emissions and odour dynamics at Victoria Flats Landfill since 2014. I have personally made over 3,000 measurements of landfill gas and odour, causing trace gases at Victoria Flats. My role has included identifying the source and drivers of odour, causing gases across the site. I have undertaken landfill gas measurement and odour detection surveys at landfills nationally.

While CO_2 and CH_4 are the dominant gas species at landfills, neither have any odour. Odour arises from trace gas species that typically compromise <1% of the bulk gas. Of the odour causing trace gases, hydrogen sulfide and organo-sulfur compounds constitute the top ten most potent odourants at landfill sites. This reflects the heightened sensitivity of the human nose to sulfurous gases with as little as 0.5 parts per billion or 0.5-parts hydrogen sulphide in 1 billion parts of air (0.5: 1,000,000,000) detectable by humans (also Appendix 1). Ammonia, a common odourant at poultry farms and composting facilities, is not considered as strong an odorant as hydrogen sulfide and organo-sulfur compounds. Importantly, the majority of odour causing sulfurous gases are associated with sulfur-rich young waste. As the waste ages, the sulfur concentration declines in response to the formation and release sulfurous gases under anaerobic conditions in the waste pile.

Capping of a landfill, gas extraction and destruction systems can play an important role in odour reduction. However, no landfill is hermetically sealed, with large areas of active landfilling and young (0 – 3 years old), sulfur-rich waste exposed over the life-cycle of an operating landfill. For capped landfills with established gas extraction and destruction systems, areas of 'active' landfilling are commonly the source of the majority of odour. For example, odour complaints at both the Green Island (Dunedin City), and ABLime (Southland) landfills, both which have established gas extraction and destruction systems, are associated with the areas of active landfilling of young, sulfur-rich waste. I am happy to elaborate on my experience of odour generation at both of these sites.

Climatically, the Victoria Flats landfill is especially sensitive to odour accumulation due to the extreme frosts and associated temperature inversions that typify Central Otago. Temperature inversion traps a layer of still cold air at ground level, resulting in a ground frost and still conditions under which odorous gas can accumulate. These are the same conditions that cause frost damage to grape and stone fruit across the region and is also when the vast majority of historical odour complaints have been made (the complaint register is provided along with this statement of evidence).

From repeat surveys made during the summer, winter, spring, and autumn months, it is evident that the majority of odour causing gases are emitted from the external batters and open face of the landfill. [The reports documenting these findings are submitted to Otago Regional Council as part of consent monitoring requirements]. As the area surrounding the landfill is flat, see attached topographic map, landfill gas which is slightly heavier than air, flows out from the batter faces across the flat-lying land that surrounds the landfill. During a temperature inversion, the gas accumulates under the still conditions until such time that ground temperatures rise sufficiently to generate airflow. Airflow, wind, then entrains, dilutes, and ultimately disperses the pooled gases. If the prevailing wind is from the northwest, then the pooled gases will move to the southeast towards the Kawarau River.

In my experience, it is common practice for landfills to be surrounded by a buffer area to distance the source of odorous trace gases from members of the public[1]. Given that Victoria Flats Landfill site is especially sensitive to odour accumulation, the buffer area becomes an important mitigating factor in terms of odour[2]. Submission 3349 seeks to re-zone land that will be occupied by buildings and facility staff and visitors. Even when the landfill is in full compliance with its conditions, it is highly likely members of the public occupying this land will be exposed to odorous trace gases, particularly during the winter months. On the basis of my experience and that reported in international peer-review literature, it is likely that this will result in a significant increase in the number of odour complaints.

[1] & [2] See also the review paper of Ko et al. 2015.