

Dunedin City Council – RM20.280 Hearing for proposed operation of a landfill at Smooth Hill May 2022

Applicant expert witnesses' comments made at the Hearing in response to issues raised in submitters evidence

Fire landfill design: Mr Anthony Dixon

Submitter issue	Evidence	Reference	Mr Anthony Dixon response
Provision of fire tetrahedron model	Andrew Rumsby	71	<ul style="list-style-type: none">Noted. This was considered in preparation of the evidence however was not been referenced in my expert statement.
Controls proposed by the applicant are not preventative	Andrew Rumsby	75	<ul style="list-style-type: none">Fire mitigation measures are primarily focussed on minimising their frequency and extent. Where practical and reasonable, prevention measures have been proposed such as waste screening, compaction and cover.
Control measures for lithium batteries are not proposed	Andrew Rumsby	75	<ul style="list-style-type: none">I have proposed a practical approach to the current limitations in waste collection and sorting if lithium batteries are received at the site and have proposed mitigation measures. Eg a controlled active tipping area under constant observation, with trained staff able to extinguish any surface fire caused by a battery. I note local programs and other site screening measures would be in place to assist in reducing the likelihood of fires occurring as a result of landfilled batteries.
Sub-surface landfill fires and risk of damage to HDPE geomembrane liners	Andrew Rumsby	80-81	<ul style="list-style-type: none">The position is to prevent subsurface landfill fires through cover, gas monitoring, application of cover materials and compaction of waste materials to minimise oxygen ingress.
Site presents a higher risk for fires migrating off site	Blair Judd	61	<ul style="list-style-type: none">See responses provided by Mr Paul de Mar.

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Fire Risk Management: Mr Paul de Mar

Submitter issue	Evidence	Reference	Mr Paul de Mar response
Ember transfer risk outside the landfill boundary	Blair Judd	59	<ul style="list-style-type: none"> • Mr Judd correctly identifies that it only takes one ember landing in dry pine forest fuels on a high fire risk day to start a fire in surrounding pine plantations. • However, the aggregate effect of bushfire risk reduction measures identified for the proposed landfill is to minimize the potential for airborne ember transport from the landfill to occur such that a fire could be ignited in surrounding pine forests. A key requirement for ember spotting from a landfill fire into adjacent plantation is a vigorous landfill fire with strong convection, sufficiently strong enough to loft large glowing embers to a height that prevailing wind can blow from their origin in the uncovered active working area of the landfill, over covered areas of the landfill, over the 10 metre wide internal fire break, over the internal green screen planting and over Big Stone Road. The fire risk reduction measures identified for the proposed landfill mitigate against the occurrence of a vigorous landfill fire with convection strong enough to enable spotting beyond the landfill boundaries. During landfill operations active uncovered landfill working areas are limited in extent, with non-active areas covered so that a fire cannot develop into a large fire (spread is only able to occur in the uncovered section). Early detection and response at source measures deprive landfill fires of the ability to develop sufficient convective strength to generate off-site ember spotting. Firebreaks around the landfill area plus the additional width of Big Stone Road itself provide a prudent degree of separation between active landfill areas, vegetated areas on site and surrounding pine plantations. Additionally, procedural inclusions can be provided in the proposed Fire Prevention and Response Plan which further limit the extent of uncovered areas on high risk days and pause waste unloading operations during the peak fire danger periods on the highest risk days. This is also reflected in the draft conditions of approval. • The aggregate effect of the proposed fire risk reduction measures is to minimize the potential for fires with sufficient convective energy capable of generating ember spotting beyond landfill site boundaries. • I note there is no recorded incidence of fire spread by ember attack from landfill fires recorded at Green Island landfill.

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Landfill gas: Mr Matt Welsh

Submitter issue	Evidence	Reference	Mr Matt Welsh response
Oxygen concentration limit	Andrew Rumsby	76-79	<ul style="list-style-type: none">The evidence notes that the landfill gas system will be designed, installed, operated and maintained to minimise potential oxygen ingress into the landfilled waste whilst adequately controlling landfill gas generated. Example measures identified included; minimisation of oxygen ingress during design and installation phases, regular oxygen and carbon monoxide monitoring of the gas, regular inspection and maintenance of above ground pipework and regular 'balancing' of the gas collection and treatment system.Mr. Rumsby suggested that a condition be added that outlines a 5% v/v limit for oxygen be set for operational gas wells. I consider the most suitable party to set oxygen concentration limits (or other trigger levels) for operating a gas collection system to be the operator who will be undertaking the detailed design and operation of the system. I have seen 5% v/v oxygen limits set in a similar manner to that suggested by Mr. Rumsby at other sites. I therefore suggest that a condition be added to the consent requiring the operator to develop and implement a landfill gas operation and maintenance plan for the gas collection system. That plan would outline the required operation and maintenance activities for the system including trigger levels for gases like oxygen and associated response activities to those trigger levels. It was agreed with the court that I would work with others to develop a draft condition to this effect.

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Landfill Design: Mr Richard Coombe

Submitter issue	Submitter	Reference	Mr Richard Coombe response
Adoption of the EPA Victoria Best Practice Environmental Management – Siting, design, operation and rehabilitation of landfills (BPEM, 2015)	David Ife	9	<ul style="list-style-type: none"> This guideline is not adopted in NZ and the Victoria wastes disposed and landforms and receptors are quite different to NZ. Mr Ife proposes the BPEM guidelines for liners be adopted as international best practice. This guideline is less adopted in NZ than WasteMINZ guidelines. The Victoria BPEM states the audience to be "the broader community, to provide information on the standards required for landfills in Victoria." – not for NZ also. The Smooth Hill landfill design is based on the WasteMINZ (2018) <i>Guidelines for disposal to land</i> as current best practice in NZ.
WasteMINZ Technical Guidelines for Disposal to Land in Draft	David Ife	12	<ul style="list-style-type: none"> I have talked to one of the notable co-authors of the WasteMINZ guidelines who advised the status of the guideline "<i>It is not a draft as far as WasteMINZ is concerned but it has not yet been put on the MfE Website</i>"
Site selection process is 30 years old	David Ife	56	<ul style="list-style-type: none"> I confirm that the selection criteria assessed in the 1992 Beca evaluation are the same criteria in the WasteMINZ (2018) <i>Guidelines for disposal to land</i>. I confirm that seismic suitability was included in the 1992 assessment
Loess in its natural state is not suitable for a landfill liner	David Ife	23	<ul style="list-style-type: none"> This is agreed. – the landfill base grade is proposed to be generally 5m below existing site levels to remove the loess in its entirety and allow replacement with engineered fill where necessary. The evidence by Ms S Webb states that the loess would need to be modified to address dispersiveness and improve permeability. The options for either a type 1 or type 2 liner type (the latter has a geosynthetic clay liner (GCL) in lieu of meeting 10⁻⁹ m/s compacted clay liner (CCL)) is to provide a contingency if the permeability of 10⁻⁹ m/s for the CCL cannot be met. It is preferred however to use the type 1 liner system where the lower permeability clay liner is applied. Irrespective of the achievement of 10⁻⁹ m/s for the CCL, the GCL will be incorporated in the base liner for the lower ("flat") base of the landfill as a risk management measure where the "flat" base of the landfill liner may be subjected to depth of leachate exceeding 300mm from time to time. I am confident to specify the type 1 liner with the addition of the GCL to the flat base of the landfill, however still prefer to allow for a type 1 or type 2 liner for the inclined side liners. A draft consent condition will be submitted for consideration by the commissioners.
HDPE Geomembrane Liners (life expectancy)	Andrew Rumsby	46 – 64	<ul style="list-style-type: none"> The risk management procedure should leachate seep from a perforated HDPE liner, provides for leachate detection and collection in the groundwater drainage system under the landfill liner, and to pump the contaminated groundwater to the leachate system for disposal off site. To put context to the feasibility of collection and disposal of contaminated groundwater as leachate; the leachate flow expected at closure is 46,000m³/A and the groundwater flow is 69m³/A. i.e. a further 0.2% added to the leachate volumes and has little effect to the daily leachate volumes. Leachate composition changes over time to become significantly less concentrated as the organics in the waste are digested. The UK Dept of Environment suggested that in 60 years, the leachate is practically inert (Copied from <i>A Guide for the Management of Closing and Closed Landfills in New Zealand</i>). Once the leachate is inert, there is less reliance on the competence of the landfill liner system for retaining leachate

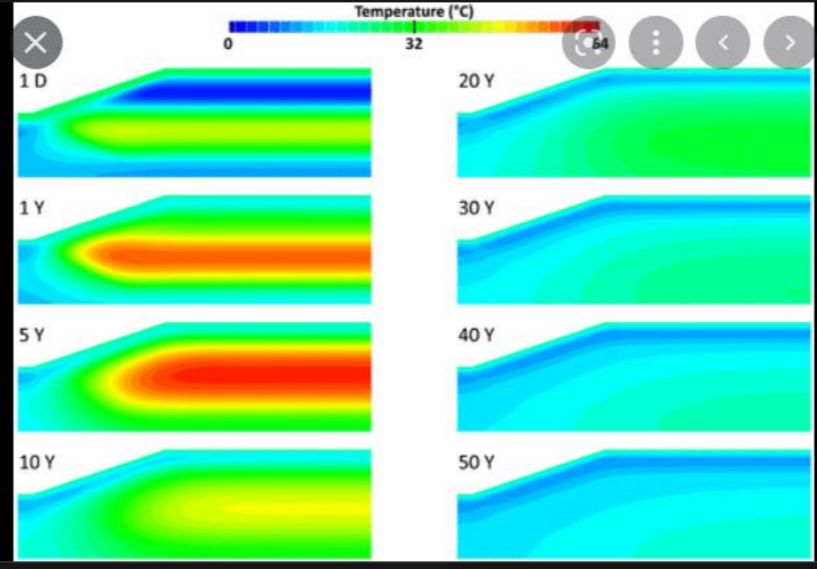
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Submitter issue	Submitter	Reference	Mr Richard Coombe response
			<div data-bbox="1210 384 1991 884" data-label="Figure"> <p>The graph plots 'Leachate composition: Percentage of maximum concentration' on the y-axis (0 to 100) against 'Time' on the x-axis. The x-axis is divided into five stages: Stage I (Days), Stage II (1-6 months), Stage III (3 months - 2 years), Stage IV (30-50 years), and Stage V (60+ years). Stage I is labeled 'Aerobic', Stage II and III are 'Anaerobic', and Stage V is 'Aerobic'. Several curves are shown: 'Mobile Permeable Soluble' (dashed line) peaks early in Stage I; 'COD' (solid line) peaks in Stage II; 'Ammonia' (solid line) peaks in Stage III; 'pH' (dashed line) starts high and drops through Stage II and III; 'Biodegradable cellulose fraction' (dotted line) peaks in Stage III; and 'Volatile fatty acids' (dotted line) peaks in Stage III. A shaded area under the COD curve indicates the period of maximum concentration.</p> </div> <p data-bbox="1210 894 1941 940">Figure 3.1: Changes in composition of leachate Source: Modified Figure C.4 from UK Department of the Environment, Waste Management Paper No. 26B, 1996.</p> <ul data-bbox="1210 1003 2635 1713" style="list-style-type: none"> • Any losses through the HDPE is also restricted through the GCL and the 600mm clay liner laid beneath the HDPE and will not degrade as HDPE will. • I covered HDPE liner life in my main evidence. I agree with Mr Rumsby that the HDPE liner will deteriorate before the theoretical HDPE life of 400 years. • P.70 of my evidence stated the HDPE would last to 400 years under ideal conditions. I stand by this but point out I also discussed that there are number of factors that reduce the life of the liner. These factors are the same as those discussed by Mr Rumsby • The aging of the HDPE is as Mr Rumsby says; related in part to landfill temperature. This in turn is related to the biological and methanogenic phase of waste degradation that in itself is affected by temperature. Economic landfill gas extraction is expected to be viable for around 10 years after the fresh waste is applied to the landfill implying that the waste is less reactive and produces less heat after 10 years. • Temperature is developed in landfills in part by the biological breakdown of putrescible waste and the removal of this waste from the waste stream will reduce the heat developed in the landfill waste mass. • The removal of a significant portion of the putrescibles (in the forms of kitchen scraps) from the waste stream will reduce the biological action and temperature that would otherwise be generated by the breakdown of that kitchen waste. • The higher temperatures developed in landfills are more in the centre of the waste than the sides that contact the HDPE liner • This is supported by the modelling by Kunar Kopp et al (2021) where the following figure shows the location and period of heat generation in a landfill

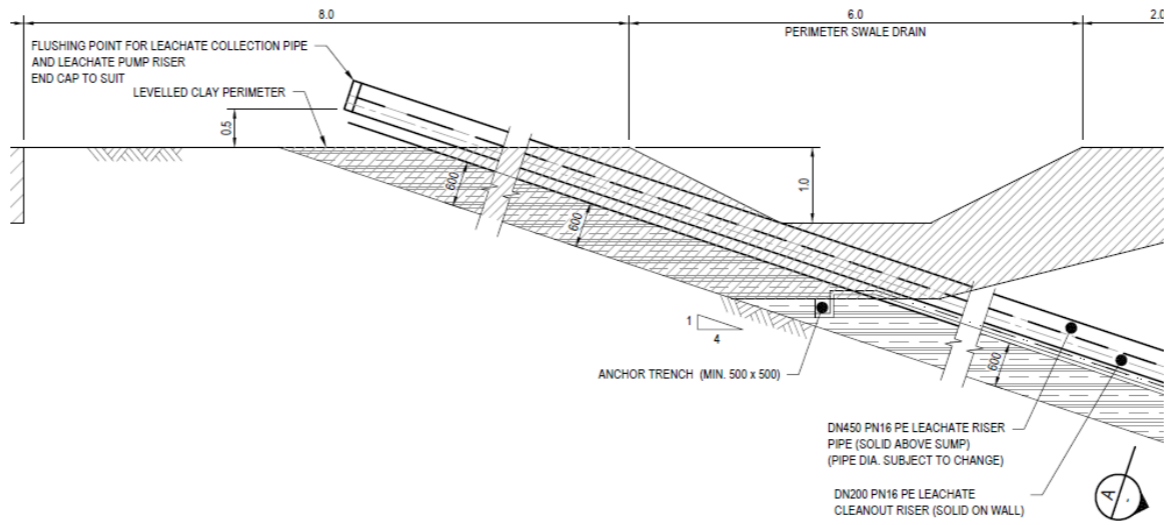
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			 <p>Kumar, Kopp e.t al. (2021) <i>Influence of Waste Temperatures on Long-Term Landfill Performance: Coupled Numerical Modeling</i> (Journal of Environmental Engineering: Volume 147 Issue 3 - March 2021)</p> <ul style="list-style-type: none"> From the above – note that the heat is accumulates closer to the centre of the landfill and not adjacent to the liner (and therefore extreme temperatures are not expected to be adjacent to the HDPE liner), and that the bulk of the heat dissipates after 10 years. Also from the above; the stabilisation of the landfill temperatures for a given deposition of waste will occur after a 10 year period. Well within a pessimistic life expectancy of an HDPE liner As stated in Jafari, Stark et el (2014) <i>Service Life of HDPE Geomembranes Subjected to Elevated Temperatures</i> and referred to in Mr Rumsby's evidence – normal operating temperatures of MSW landfills not subjected to fires in the waste: is 35 to 40 degrees Celsius: <ol style="list-style-type: none"> The presented case history shows temperatures at a MSW facility increased from normal operating conditions (35–45°C) to elevated temperatures (70–85°C) due to APW reactions and smoldering combustion of MSW. Thermistors installed in leachate collection pipes were used to develop a time-temperature history plot to assess the service life of the geomembrane. For GM3b, Case 1 and 2 temperatures are in the range of normal MSW landfills; the geomembrane is expected to have a service life of several centuries. When peak temperatures reach 60–80°C, the geomembrane service life can be reduced to decades for the conditions examined and thus raises concerns regarding the integrity of the geomembrane at high temperatures. <ul style="list-style-type: none"> The Ontario Regulation 232/98 referred to in P.62 of Mr Rumsby's evidence states the assumed life of the landfill liner is 150 years (allowing for the design and construction practices proposed in the Smooth Hill concept design) and utilising a 1.5mm thick HDPE membrane liner

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Leachate collection systems have limited life	Andrew Rumsby	65	<ul style="list-style-type: none"> I agree that there is a limited service life – however this can be extended with appropriate design and regular water jetting (Ref Ontario Regulation 232/98)
Older landfills have blocked leachate systems and rising leachate levels	Andrew Rumsby	66	<ul style="list-style-type: none"> Reference to these landfills that were closed 10 to 20 years ago and constructed according to far less stringent standards than proposed to Smooth Hill is misleading. The reason the standards have been improved is to address the shortcomings of the landfills referenced.
“Life expectancy” of leachate systems	Andrew Rumsby	67	<ul style="list-style-type: none"> Reference to clogging by coal ash is irrelevant to Smooth Hill that will not receive such material. The leachate collection media is overlain with geotextile to prevent fines entering the media and blocking it or the drainage pipes The Ontario Regulation 232/98 referred to in P.62 of Mr Rumsby’s evidence states the assumed serviceable life of a well maintained leachate collection system is 100 years where regular jetting of the leachate lines occurs. This will be the case in the Smooth Hill landfill. For the system proposed at Smooth Hill, the leachate pipes are over-sized and duplicated to provide for the adjacent pipe to convey flows should one pipe block . Further the drainage media itself will convey the 0.7 l/s average leachate flow over the longer period towards the end of the life of the leachate collection system (one pipe system on each side of the landfill containing separated pipe systems) should the pipe systems fail in 100 years. The drainage media is protected from siltation by the filter geotextile placed above the drainage media and below the waste.
Ability to water jet leachate pipework	Andrew Rumsby	68	<ul style="list-style-type: none"> Provision for water jetting of the leachate pipes is provided in the design (refer Drawing 12506381-01-C402). Additionally, the leachate pumps will be installed in heavy walled HDPE inclined risers. Separate pump risers from the leachate collection pipes allows for easy jetting of the risers and removal of leachate from the leachate sump with leachate conveyed through the drainage media (should the leachate pipes block in the future). The following is an extract from Drawing C402 and shows that the leachate collection pipes extend to the surface to facilitate jetting of the pipework. 

Surface water/storm water: Mr Allen Ingles

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Submitter issue	Evidence	Reference	Mr Allen Ingles Response
Mr lfe refers to the WasteMinz criteria and notes that landfill site is in a valley and at risk of high stormwater flows breaching diversion drains, flowing into active cells and merging with leachate.	lfe	Table 2 Assessment of site against WasteMINZ criteria	The site occupies the head of the valley. There is little or no upstream catchment which avoids the risk of significant runoff draining into the landfill. Landfill staging has also been designed to minimise the potential for runoff ingress into the landfill.
In his evidence, regarding the site setting, Mr lfe refers to a series of wetlands connected by defined watercourses and describes these as perennial, although noting they dry up during dry periods such as that over the 20/21 summer.	lfe	Para 48	Site inspections have shown that during the drier seasons there has generally been little or no flow. This is consistent with information provided by Mr York which also indicates that flow ceases during drier periods most years. We therefore consider that the watercourse is "intermittent" rather than perennial.
Mr York's evidence has included information on flow and quality records he has been collecting at McLaren Gully Road on a weekly basis, approximately, since 2013. The flow information provided is based on stage levels adjacent to a small V notch weir at a location upstream of McLaren Gully Road.	York	Paras 15 - 18	<p>While this information provides a general indication of when flow is occurring and an indication of the general magnitude, I do not consider that a more detailed quantification assessment of flows is possible from the stage levels recorded. This is based on site observations including an inspection during October 2020 which showed that flows over the weir are controlled by downstream conditions rather than the weir structure. The flow is also out of bank for higher flows.</p> <p>While it would be theoretically possible to assess flows from the stage records by developing a stage discharge curve for the site, development of a robust stage / discharge relationship at this location would not be practically achievable due to a combination of the downstream culvert structure, flowpath profile and vegetation cover that has varied over time.</p>
Mr York notes in his evidence flow velocities of up to 8 m/s were recorded crossing McLaren Gully Road and concludes that if a leachate breach was to occur it would reach Brighton Beach in 40 mins.	York	Para 23	<p>No information was provided on how these velocities have been assessed. I consider that these assessments are unrealistically high and that if they were to have occurred they would have caused a scour failure of the road in a relatively short period. The indicated flow time of 40 mins from site to the lower reaches of Ōtokia Creek at Brighton (a flow distance of approximately 13 km) equates to an average velocity in the order of 5 m/s. Even during an extreme flood event, this is considered unrealistic given the nature and capacity of the main channel and the nature of the out of bank flow path. Extreme event times of flow would be expected to be around 4 hours with flow times from site to Brighton significantly longer during normal and low flow regimes.</p>
Ōtokia Creek and Marsh Habitat Trust raise concerns about the attenuation basin capacity particularly with respect to increased flows due to climate change	Ōtokia Creek and Marsh Habitat Trust	Para 47	It should be noted that design to date has included allowances for climate change out to 2100. Detailed design will also include the same climate change allowance.

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Dunedin City Council: Mr Chris Henderson

Submitter issue	Evidence	Reference	Mr Chris Henderson response
<p>Mr Keogh's evidence is to advise the Commissioners on potential alternative locations for waste (particularly putrescible wastes) and puts forward a case for the use of the Nash and Ross commercial landfill and composting operation in Kaikorai Valley (for which he provides environmental and planning advice).</p>	<p>Ciaran Keogh (on behalf of DIAL)</p> <p>Sarah Ramsey</p>		<ul style="list-style-type: none">• Dunedin City Council has explored multiple options for waste disposal during feasibility studies conducted as part of the business case process for Smooth Hill. These investigations included options both within and outside of the Dunedin district, and have determined that alternative options to Smooth Hill pose significant challenges and risks, which include the export of waste out of district being unacceptable to mana whenua.• Some submitters appear to have assumed that it will be possible to remove all putrescible waste from the general waste stream prior to disposal. Although DCC has already committed to separating putrescible waste to the greatest extent possible, achieving complete separation would require a screening process that is impossible to implement; therefore, disposal of residual general waste must be to a class one facility.• In addition, some submissions have also raised the concept of an increase to the landfill footprint of the existing Green Island landfill. Once again, this option has been investigated and discounted during the business case process due to the significant and costly engineering challenges that would need to be overcome for a significant expansion of the site, as well as the Te Rūnanga o Ōtākou desire for the Green Island landfill to be closed as soon as practicable.

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Hydrogeology: Mr Anthony Kirk

Submitter issue	Submitter	Reference	Anthony Kirk response
The applicant has not provided a detailed and specific list of Waste acceptance criteria within its AEE or Draft Landfill Management Plan (LMP). Requirement to reflect Persistent Organic Pollutants as a requirement of the Stockholm Convention newly prohibited items and EPA requirements	Andrew Rumsby	8	<ul style="list-style-type: none"> A key area of discussion provided by Mr Rumsby is the outdated nature of MfE landfill guidance for setting landfill waste acceptance criteria and the need to reflect the evolving requirements outlined by the EPA for persistent organic pollutants (POPs) under the HSNO Act. I disagree with the extent to which the EPA notices referenced by Mr Rumsby require landfill waste acceptance criteria for all POPs, but I do agree that reference the HSNO Act and associated standards and notices is appropriate in developing the landfill waste acceptance criteria. I have made this recommendation to Mr Dale for inclusion in the conditions of consent. I recognised the current interest in understanding PFOS discharges from landfills in particular as a mobile POP. In the absence of appropriate ecological guideline values, I adopted the position that information should be gathered for consideration at the time when standards and criteria are adopted in New Zealand. This is already reflected in monitoring requirements of the conditions of consent. The reference to the HSNO act as a required consideration of the LMP, rather than specifying waste acceptance criteria within the consent, will allow waste acceptance criteria to be reviewed as needed, such as when new guidance and standards are released by either MfE or the EPA. The LMP and the waste acceptance criteria are to be finalised following review by the landfill technical review group and certification by regional council, so that any additional constraints required by the HSNO act and associated publications will be correctly adopted. This amendment and consideration of recently identified POPs in landfill leachate does not change the conclusions I have drawn from my assessment. Importantly, I expect any future restrictions on hazardous substance disposal and improvements in waste management practices would result in improvements in leachate quality, over historical leachate quality. It is unclear when or how MfE will provide updated guidance for landfills to reflect the growing body of knowledge around recently identified POPs and the release of new standards by the EPA. Importantly, the MfE and the EPA have, to date, taken a considered view on implementing requirements under the Stockholm convention. This includes cost benefit analysis for how to manage POPs and not all international requirements are reproduced in New Zealand. An example of this is in the consideration of brominated flame retardants, another POP relatively recently identified in e-Waste. The National POP Implementation Plan of 2018 states. <i>Testing showed that only very low levels of BDEs (a brominated flame retardant) were present in the leachate of three landfills tested. Landfilling in secure landfills is therefore considered as a potential option to dispose of BDE-containing polymers and plastics in an environmentally sound way. However, this will be subject to further research and investigation.</i>
The recommendations of the PFAS National Environmental Management Plan (Version 2.0 - 2020) states that landfills should not be sited within 1000 m of a surface water body where groundwater is a key contributor to surface water flow.	Andrew Rumsby, David Ife	AR - 34	<ul style="list-style-type: none"> Mr Rumsby references The NEMP in discussion of landfill siting and potential impacts to surface water quality. He also references other international guidance. These documents present a generic position and recommendations that do not accommodate site specific characteristics. New Zealand has its own guidance, but regardless, all such guidance recommends site specific assessment to better understand the actual risks. This is industry best practice. Based on findings from the site-specific assessment I have led, I do not consider that groundwater discharge makes a meaningful contribution to the aquatic environment during those intermittent periods when surface water is flowing. Instead, groundwater provides a very small water flow to sub-surface wetland sediments. Surface flow in the wetlands is generated by run-off and interflow to the wetland.
An estimated PFOS concentration in groundwater which exceeds the ANZG 99% ecosystem species protection value (0.00023 µg/L) to protect wildlife from this contaminant. Based on the three-fold exceedance he is suggesting this presents an unacceptable risk to the environment	David Ife		<ul style="list-style-type: none"> The 99% ecosystem species protection value for PFOS (0.00023 µg/L) referenced by Mr Ife and Mr Rumsby is a draft value and not a finalised default guideline value that is otherwise used for assessment of ecotoxic effects in New Zealand. As such, I caution considering the comparison and I do not consider it to be an appropriate criterion for regulatory use. Mr Ife used the same calculation as I did to conservatively estimate the concentration of contaminants in groundwater flowing towards the wetland. Due to the limited effect of leachate discharges of groundwater quality and even improvement of water quality, I did not see the need to progress the analysis further to an estimate of surface water quality i.e. how these limited changes and improvements to groundwater could subsequently influence the aquatic environment. I left the assessment as a highly conservative prediction of water quality effects.

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			<ul style="list-style-type: none"> • The concentration of PFOS calculated by Mr Ife likewise does not predict the concentration in the surface water environment for which the draft criteria for PFOS should more appropriately be applied. • Groundwater levels at the wetlands only fluctuate by a small degree due to the limited groundwater recharge. Upwelling of groundwater to surface water has not been identified as a key process. During periods of rain and run-off, when surface water flow in the wetland occurs, run-off and interflow floods the wetland sediments. Very high amounts of dilution of groundwater within the sediment would occur, prior to the mixed water reaching the surface water aquatic ecosystem. • Additionally, for ecotoxicity considerations such as proposed in the use of this draft criteria, the EPA Hazardous Substances Notice 2017 referenced by Mr Rumsby, outlines that effects to receiving environment water quality should be considered in the context of reasonable mixing. • Groundwater inflow rates are only in the order of 6 m³/day, whereas run-off volumes and flow in the wetland are typically orders of magnitude larger when surface water flow occurs. Where these hydrological conditions are considered, the predicted concentration of PFOS in the aquatic environment would be at least an order of magnitude lower than predicted by Mr Ife and significantly lower than the draft PFOS criteria applied. <p>It is my opinion that the potential for adverse effects to human health and the environment associated with landfill PFOS discharges are less than minor. Taking into consideration the draft water quality criteria I reach this opinion due to:</p> <ul style="list-style-type: none"> • The limited discharge from the landfill. • The significant dilution groundwater discharge would realise before ecosystem contact and subsequent reasonable mixing in surface water. • The only intermittent presence of flow to support a notable aquatic ecosystem. • The small scale of the swamp wetland environment. • The limited access for food gathering. • But most importantly, the ability to mitigate such discharges if needed by interception of impacted groundwater.
<p>Baseline groundwater monitoring requires more than 12 data points and at least 4 data points for each season to develop trend based trigger levels.</p>	<p>Andrew Rumsby</p>	<p>82-88</p>	<ul style="list-style-type: none"> • Guidance documents commonly present different views regarding monitoring and statistical analysis, reflective of the common practices at the time of development, sector expectations and intent for which they were developed. As an example of differing recommendations between guidance, the UNEP 2018 guidance for specially engineered landfills, which Mr Rumsby has referenced, outlines that prior to waste placement, groundwater levels and quality should be measured monthly for at least ten (10) months, or quarterly for at least eight (8) quarters to establish baseline conditions for the site. This is less than I have currently proposed. • My view is that a trend analysis, such as a seasonal Mann-Kendall test will be appropriate for the trend-based trigger levels. • The quarterly monitoring frequency I have proposed takes into consideration the very low permeability and limited groundwater recharge and response measured in groundwater wells. In this environmental setting more frequent monitoring is unlikely to provide a notably more meaningful understanding of water quality variability. • Mr Rumsby suggests four (4) measurements for each season are required for seasonal Mann-Kendall test, but provides no reference. This is not my understanding, which is supported by the USEPA guidance for statistical analyses of groundwater data (EPA 530/R-09-007) that outlines a requirement for at least 10-12 samples, including 3 measurements for each season for the seasonal Mann-Kendall test. • Likewise, United States Geological Survey (USGS, 2020) guidance on statistical methods in water resources and the original author of the seasonal method (Hirsch, 1982) makes no requirement for 4 measurements for each season for this analysis.

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			<ul style="list-style-type: none"> Trend analysis is different from traditional statistical analysis of a data set, in that it is refined over time. This allows for representation of improvements in water quality during years between which landfill development commences and also progressive refinement over the years before leachate could feasible be detected in groundwater monitoring wells. I have used such statistical methods extensively in the management of water quality and water resources and it is my opinion that the proposed background monitoring and use of trend analysis is appropriate for the conditions and the purpose of providing trigger levels for degradation of conditions.
Groundwater levels in the deep and shallow bores at BH01 are similar, suggesting a degree of hydraulic connectivity between the deep and shallow aquifer systems at the creek level.	David Ife	29	<ul style="list-style-type: none"> I have considered a range of observations and site investigation findings outside of the water levels depicted in the cross section referenced by Mr Ife, to reach my conclusions regarding groundwater in the deep aquifer. Other key pieces of information include: <ul style="list-style-type: none"> The absence of any meaningful response of deeper groundwater levels to rainfall events or the occurrence of flow in the wetlands. The very limited baseflow that occurs within the creek far downstream of the site. The downward gradients typically being evident in the catchment. The very low permeability of the deep groundwater system. The general lack of upward hydraulic gradients (from deep to shallow) to the wetlands, which would be required for deeper groundwater to contribute to shallow groundwater and the wetland. My assessment also considers that any leachate leaked from the landfill reports directly to the wetland area, without attenuation during groundwater flow or loss to the deeper groundwater system.
That the aquifer at the site is a drinking water aquifer and development of a landfill over a drinking water aquifer is not desirable and human health exposure via drinking water should be considered.	David Ife	34, 35, 43	<ul style="list-style-type: none"> Water quality is not the only consideration of determining whether an aquifer is a viable potable water aquifer and human health exposure via drinking water should be considered. The permeability of the aquifer and potential for it to yield water at rates viable for water supply is also a fundamental consideration. This is recognised in MfE contaminated land management guidance (guideline 5) in the consideration of appropriate contaminant exposure and also in the framework for the assessment of groundwater contamination provided in the MfE Guidelines for Petroleum Hydrocarbon Contaminated Sites. Because of the very low permeability of the aquifer at Smooth Hill, the potential yields from the aquifer are minimal and would not provide a viable water supply. Monitoring has demonstrated that the bores take many days to recover following abstraction of small volumes of water for collecting water samples, these being insufficient for water supply. The aquifer is not utilised for this purpose and ORC do not consider this area as a groundwater resource for allocation purposes. In the absence of potential to provide a viable water supply I do not consider that human health exposure via drinking water is a viable exposure route for discharges from the site.
Potential for leachate leakage to be higher than predicted and PFAS impacted groundwater could be captured by the groundwater interception trench and subsequently discharged to the wetlands	David Ife	93	<ul style="list-style-type: none"> The predicted landfill leachate rate assumes a high number of liner defects and pinholes, equivalent to a poor quality installation, to provide a conservative estimate for leakage during the operational period of the landfill, when contaminant concentrations are greatest. The volumes of groundwater reporting to the interception trench will only be high during the very early stages of landfill construction as groundwater is drawn down to the desired level and the liner is progressively placed across the landfill footprint, which stops groundwater recharge into the area. I expect the volume of groundwater being captured, by the time any leachate may migrate to the trench, to be small and less than 1 m³/day. Regardless, groundwater captured by the trench will be continuously monitored for the influence of landfill leachate, including for parameters reflective of other mobile contaminants in leachate. These are more readily detectable than PFAS and will provide a reliable means of identifying whether contaminant concentrations in groundwater are increasing. Actions are proposed in the event that leachate influence is detected in groundwater to mitigate adverse effects to the environment.

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Geotechnical/geology: Ms Samantha Webb

Submitter issue	Submitter	Reference	Samantha Webb response
Suitability of loess for use as a landfill liner due to its dispersive nature and permeability in the range 5×10^{-10} to 3×10^{-8} m/s Lime addition 2.5% prevents dispersivity	David Ife	23, 50,	Laboratory testing to date has successfully identified that the dispersivity of loess can be managed by stabilisation with the addition of lime. Further testing on lime for the effects on plasticity due to the additional of lime will be part of the detailed design. Additional permeability testing will be carried out on the compacted stabilised loess.
Permeability of untreated loess and its dispersivity	David Ife	62	Loess will be re-tested during detailed design as per item G1 above.
Unsuitability of loess as a liner material due to dispersivity and plasticity	David Ife	72	The testing completed to date does not provide all the answers, but the indication is that loess can be made to be non-dispersive with lime stabilisation. Further testing is required on the use of loess as a lining material. This testing will focus on different stabilisation materials (lime and/or bentonite) and testing stabilised materials for changes in plasticity and permeability.

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Bird strike hazard: Mr. Phil Shaw

Submitter issue	Submitter	Evidence Reference	Mr Phil Shaw response
General birdstrike risk considerations	Richard Roberts, Daniel Debono, Sean Roberts, Matt Bonis, Phil Page		<ul style="list-style-type: none"> The range of issues raised in the various submissions are best addressed by responding to certain parts of Mr Page's evidence.
Birds as a penetration of the Obstacle Limitation Surface	Phil Page	6,7,8	<ul style="list-style-type: none"> The suggestion that birds in the airspace over SHL could present a penetration of the Obstacle Limitation Surface (OLS), is unfounded and unprecedented in my experience. Obstacles as intended in the NZCAA Advisory Circular AC139-6 Section 4 are fixed structures, not moving animate objects such as birds: "...where the erection of buildings, masts and so on, are prohibited." To extrapolate the proposition that birds are an "obstacle" it would be necessary to consider any bird that flies over the runway of any major aerodrome (including DIA) as in breach of the OLS. This is clearly non-sensical and unmanageable in the context of OLS.
Agreement on zero increased aviation hazard	Phil Page	11	<ul style="list-style-type: none"> There is agreement that zero additional risk is the only acceptable outcome. In my opinion this will be achieved through the measures proposed in the draft conditions and through the implementation of the Bird Management Plan. This includes the management of BBG during the closure of Green Island landfill and the management of the regional BBG population which would very likely reduce the overall bird strike risk that would otherwise be present.
Question on whether or not I was aware of the inclusion of "odorous waste" when preparing my evidence.	Phil Page	12	<ul style="list-style-type: none"> I was aware of this inclusion. The volumes of 'highly odorous wastes' especially those that could have potential to attract birds such as animal remains, fish wastes, wool scour/tannery/fellmongery, are likely to be in relatively low volumes. Based on recent waste volumes for Green Island Landfill provided to me by Mr Henderson, these waste types tend to be around 1% of total waste volume and less than 1 truck load per day. It is acknowledged that these waste volumes may differ at SHL with the new 4 bin system for waste sorting and potential for "contaminated waste" to be treated as special waste. This may increase the amount of such wastes, but I understand from Mr Henderson that they will still be relatively low by percentage. These wastes will be pre-booked, prioritised and buried immediately in a pit such that bird access to the potential food source is prevented.
Rejects that zero putrescible waste cannot be guaranteed as suggested in paragraph 77 of my evidence.	Phil Page	13	<ul style="list-style-type: none"> My evidence refers to the inclusion of very small amounts of food waste that could enter the waste stream despite all efforts from DCC and/or its contractors due to non-compliance by the public. This is inevitable, but likely to be extremely small amounts compared to the overall waste volume and expected to be of no interest to birds as has been indicated at other landfills such as the Kate Valley Landfill. I agree that highly odorous wastes could be redirected to an alternative facility, but for reasons previously outlined, do not believe they will be an attraction to birds. If I am proved wrong, the monitoring of birds and the requirements for escalation of initiatives will prevail and this may require the reassessment of accepting certain types of waste. It will be in the interest of the applicant and its operators to determine what is driving the bird attraction and alter practices accordingly.
Assertion that putrescible and highly odorous wastes will "inevitably attract birdlife to Smooth Hill".	Phil Page	15	<ul style="list-style-type: none"> I reject outright that these wastes as proposed to be dealt with will inevitably attract birds. Such wastes do not attract hazardous birds at Kate Valley Landfill which demonstrates that denying bird access to such wastes can be achieved.

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Submitters comments in evidence	Submitter	Evidence Reference	Mr Phil Shaw response
Concern around birds in the airspace above SHL rather than on the ground. Also, that there will be a time lag between hazard and response and that that response may include lethal methods for BBG that are objected to by the Ngai Tahu.	Phil Page	17	<ul style="list-style-type: none"> It is true that if birds visit the site that this could be a potential hazard. The consequence of which could be great, but the probability is remote. The "Site Risk" as outlined in paragraph 37 of my evidence is only one of three types of risk that may arise where of airport bird attractions are created. In my view the submitter has unduly emphasised the Site Risk above the Flight Path and Spill Over risk components and this indicates a misunderstanding of the dynamic airspace collision risk that arises from birds being attracted to certain sites. Irrespective of this apparent misunderstanding, the measures to ensure the bird risk to aviation from the SHL is not increased, are robust. The Bird Management Plan requires the operator to have appropriately trained and equipped personnel on site ready to respond immediately to bird presence. In the unlikely event that immediate actions are unable to bring numbers under thresholds, the operator will need to identify the source of the bird attraction and remedy this through whatever means is appropriate. If a type of waste is found to be attractive to birds, this may require immediate cover, or temporary or permanent diversion of that waste to an alternative site. Culling BBGs is a reasonable action if required in the scope of the escalating response to bird presence. In my experience it is very unlikely to be required at the site as dispersal activities alone will be likely to suffice, if even these actions are required. Provided the waste stream is largely devoid of putrescible waste and that special wastes are treated as described, then the attraction to birds is likely to be very low.
ICAO advice is that municipal solid waste landfill sites be located no closer to 13km from and airport property	Phil Page	37	<ul style="list-style-type: none"> ICAO guidance does not say that. It says that such land use should be subjected to an assessment and where appropriate, measures introduced to manage the risk. To be clear, the ICAO guidance primarily focuses on putrescible waste landfills such as that at Green Island, not the type of landfill proposed for SH where most of the organic matter will be removed from the waste stream.
Question raised as to what is considered acceptable risk	Phil Page	40, 44	<ul style="list-style-type: none"> We agree that acceptable risk is no additional risk caused by the development of the landfill. The measures proposed are designed to meet that objective. Given that DIAL accepts the current birdstrike risk at DIA is high, they probably should examine their own practices, or it could be concluded that a high risk is acceptable to them.
Concern around potential for a catastrophic incident because of BBG flying above the SHL	Phil Page	43	<ul style="list-style-type: none"> In assessing the risk of such an event, one must consider the consequence (which in the described incident is very high) and also the probability (or likelihood). Given all that is suggested for the conditions of consent, the probability is remote which results in an acceptable risk outcome.

Aquatic ecology: Dr Tanya Blakely

Submitter issue	Submitter	Evidence reference	Dr Tanya Blakely response
Ecological value of and species found with Ōtokia Creek	Kelvin Lloyd; Andrew Hutcheon	Para 17-21 & 45; 2 & 9,	<ul style="list-style-type: none"> Submitters Dr Lloyd and Mr Hutcheon (on behalf of Ōtokia Creek and Marsh Habitat Trust) have provided additional information to my evidence regarding the ecological values, and particularly fish diversity, within Ōtokia Creek. I note that while I have already discussed the ecological values and fish diversity with Ōtokia Creek in my evidence (paragraph 73), it is worth additional discussion.

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			<ul style="list-style-type: none"> • Dr Lloyd discusses fish and macroinvertebrate records from Ōtokia Creek, which have been obtained by members of the Ōtokia Creek and Marsh Habitat Trust from 2011 to 2017, and include indigenous freshwater fish species giant kokopu, inanga, common bully, giant bully and shortfin eel, and the introduced brown trout. Kōura (freshwater crayfish) and kākahi (freshwater mussel) have also been found in the Ōtokia Creek catchment. Dr Lloyd also discusses that Ōtokia Creek and Marsh Habitat Trust recently collected a water sample from the lower Ōtokia Creek and from which environmental DNA (eDNA) was analysed. This novel technique gained additional understanding of the freshwater fauna present in the Ōtokia Creek catchment, confirming the presence of indigenous fish species giant kōkopu, banded kōkopu, common bully, redfin bully, and shortfin and longfin eels in the catchment. • This eDNA sample was collected from a location in the lower catchment, close to the coast. What this means is that the water sample will potentially have collected eDNA from extensive habitat upstream of the sampling location, which includes approximately 70 km of upstream waterway. The results of the eDNA sampling are of no surprise to me and in line with my expectations given the proximity to the coast. • Mr Hutcheon notes that he lived at 197 McIntosh Road from 2008 to 2022. He notes that colleagues from the Department of Conservation surveyed the freshwater fish community of Ōtokia Creek within this property, where they found a giant kōkopu and longfin eels, along with various small fish species. • I note that, based on viewing on Google Maps, 197 McIntosh Road is situated within the lower reaches of Ōtokia Creek, and that again records of these types of species are not surprising to me given the proximity to the coast. • I confirm that the ecological surveys that I have undertaken within the unnamed tributary of Ōtokia Creek, immediately downstream of the designation, are appropriate and sufficient for identifying the fish values present, and that only shortfin and longfin eels are present.
Use of EIANZ EclA framework	Kelvin Lloyd	Para 39 – 42	<ul style="list-style-type: none"> • Dr Lloyd is critical of the use of the Environment Institute of Australia and New Zealand ecological impact assessment guidelines (EIANZ EclA) for assessing potential effects of the proposed landfill. In his evidence, Dr Lloyd states that the EIANZ EclA framework is not helpful to the application, noting that the framework relies on subjective assessment of ecological values and the effects of this flow through to the outcomes of the framework. • The EIANZ EclA framework was developed for NZ in 2015 and has since been revised in 2018. It has also been peer reviewed and tested in various legal settings. It is a widely accepted and used framework, and is an approach used by ORC reviewers, T+T. • It is a framework that provides a nationally consistent approach for assessing ecological impacts. It is a framework to make an otherwise subjective process more objective, repeatable, and consistent. • The EIANZ EclA approach involves four steps and requires technical experts to assess ecological findings using criteria that have been developed and peer-reviewed by scientists and Resource Management practitioners. The EIANZ EclA approach has been summarised in my evidence and includes assessing ecological value, determining magnitude of effect, determining level of effect, and then using this level of effect to guide the extent and nature of the ecological effects management response required. • Assigning ecological value using the EIANZ EclA framework is an objective process, where criteria or assessment matters are considered, using detailed rational. The magnitude of effect is then considered taking into account the level of confidence in understanding the expected effect; the spatial scale of the effect; the duration and timescale of the effect; the relative permanence of the effect; and the timing of the effect in respect of key ecological factors. All of these matters are carefully considered, and the framework allows a more objective, transparent, robust and repeatable process for what could otherwise be subjective.

Terrestrial ecology: Dr Jaz Morris

Submitter issue	Submitter	Reference	Dr Jaz Morris response
In relation to downstream effects on the swamp wetland, Dr Lloyd notes the potential for an increase in dryland species including weeds in the 'swamp wetland' if " <i>persistent adverse hydrological changes occur.</i> "	Kelvin Lloyd	Para 27	<ul style="list-style-type: none"> • I acknowledge the submitter's point, which is a logical and complementary point to my EclA assessment and evidence (at para 52) that changes in runoff volumes to the swamp wetland may at worst slightly diminish the available habitat for obligate wetland plant species. • However, the potential for this effect depends on the degree of hydrological change, as already discussed at length in my evidence (at para 38-60) and in the evidence of Mr Ingles. For dryland weeds, even if this specific adverse effect

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			might otherwise occur, it would be avoided directly via weed management as part of draft Vegetation Restoration Management Plan measures.
In relation to downstream effects on the 'valley floor marsh wetland', and the degree to which it is resilient to any water supply changes, Dr Lloyd queries my conclusion that the 'downstream pond' would be important for buffering hydrological change. He asserts that the downstream pond " <i>appears to be a sink for water rather than a source</i> " for the wetland.	Kelvin Lloyd	Para 28	<ul style="list-style-type: none"> Background to this comment from the submitter is partly addressed in my evidence (particularly at para 60) and in the evidence of Mr Ingles, and I noted in my oral submission my intention in responding to this point is not to stray outside my expertise into areas of surface water hydrology matters. However, in terms of my ecological understanding of how ponded areas of water behave within wetlands of this sort, they act as both a sink and a source. My understanding of the importance of the downstream pond to wetland hydrology has been formed with regard to my observations during three visits to the downstream pond, two of which were in dry conditions (April 2021 and February 2022). At all these times the pond could be discernibly heard to be delivering slight downstream flows. I consider that delivery of such flows is the likely mechanism by which the pond buffers downstream wetland hydrology.
Submitters including Dr Lloyd and (for example) the evidence of the Ōtokia Creek and Marsh Habitat Trust indicate general objectives for the enhancement of ecological values in the Ōtokia Creek area.	Kelvin Lloyd, Ōtokia Creek and Marsh Habitat Trust	Attachment 1 of Dr Lloyd's evidence; and statements throughout the evidence of the Trust and separate submissions of Trust representatives	<ul style="list-style-type: none"> I submit that measures outlined in the draft Vegetation Restoration Management Plan* are consistent with the objectives of ecological enhancement for the Ōtokia Creek catchment. Although some measures are in my view required based on adverse effects arising from the proposal, I consider that the overall restoration measures (which include fencing and weed control in forest and wetland areas in the landfill designation) go over and above what is required on an effects basis (ref. paras 67 and 80 of my evidence). They can therefore be partly considered a benefit of the proposal. <p>*Version dated May 2021, which was submitted with the revised application as an attachment to the draft Landfill Management Plan in response to ORC's s92 request.</p>

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Avifauna: Ms Karin Sievwright

Submitter issue	Submitter(s)	Ms Karin Sievwright response
Concern about contamination risk on the coastal environment at Brighton Beach and Ōtokia Creek marsh habitat and ecological values, including on coastal avifauna	Various including Andrew Hutcheon, Blair Judd, Kelvin Lloyd, Matthew York, Otokia Creek and Marsh Habitat Trust, Te Runanga O Otakau Edward Ellison	<ul style="list-style-type: none">• Based on Mr Ingles hydrology evidence, my understanding is that any effect on water quality in the wetlands directly downstream from the landfill will be less than minor and that given that any effect on water decreases as you progress downstream, any effect in the lower reaches of Ōtokia Creek and Brighton would be undetectable. Using this information, I conclude that there will not be any contamination risk to avifauna using habitat at Brighton Beach and Ōtokia Creek marsh habitat.

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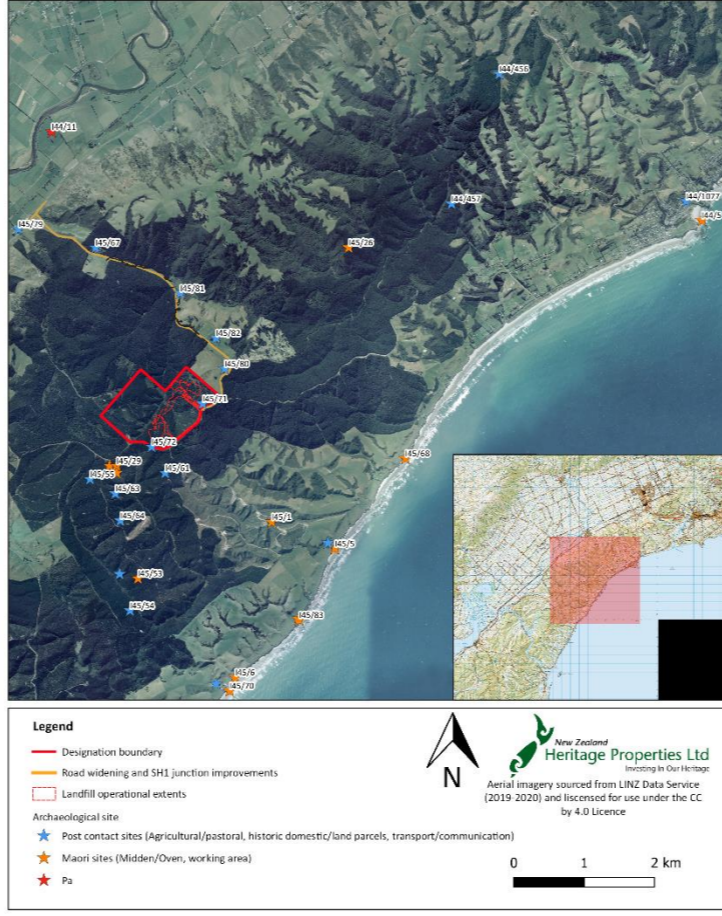
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Herpetology: Ms Samantha King

Submitter Issue	Submitter	Ms Samantha King response
Concerned regarding predator control, the lack of a detailed predator control plan and the requirement to have landscape wide predator control.	Andrew Hutcheson	<ul style="list-style-type: none">• I think the peer review panel should ensure that landscape scale predator control is sufficiently covered in the predator control plan when written.• Predator control within the lizard release area will be reviewed upon finalising the Lizard Management Plan.• The submitter also raises the need for extensive predator control – is his experience this was for a large bodied (slow to reproduce) skink which is much more vulnerable to predation effects than southern grass skink. Southern grass skink is generally resilient to predators in degraded environments such as those at smooth hill.• Any translocated southern grass skink would be protected from predators through two means – protective habitat enhancement and predator control. Large bodied lizards (those not found at Smooth Hill) do not respond to protective habitat enhancement due to their size and the ability of the habitat to exclude predators, therefore a high level of predator control is required for those species.• Predator control described in the draft Lizard Management Plan is provided to enhance the receiving habitat and reduce the effects of salvage such as competition and displacement in order to increase post translocation survival.

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Archaeology: Ms Megan Lawrence

Submitter issue	Submitter	Ms Megan Lawrence response
<p>No consideration to the cultural and archaeological significance of the Ōtokia landscape</p>	<p>Anne Mauger</p>	<ul style="list-style-type: none"> • Through desktop research and a site survey, my assessment considered the potential for physical archaeological remains (relating to both mana whenua and Pākehā activity) to be present within the project area. • I assessed effects to archaeological sites for which there is evidence for physical remains to be present. • No archaeological sites relating to mana whenua occupation have been recorded within the project area. • There is potential that unrecorded archaeological remains associated with mana whenua activity may be encountered during works. This is to be managed through the archaeological authority process. • I have provided the new map (Fig 2) below as an alternative archaeological site map to that provided by Anne Mauger. • Figure 2 distinguishes between sites relating to mana whenua occupation and those recording post contact farm, transport, and domestic sites. It also shows the sites in relation to the project area to provide perspective on potential effects of the proposed works on these sites.  <p>Figure 2: Archaeological sites (tabled at the Hearing 17 May 2022)</p>