23 July 2020

AB Lime Limited
c/- Jacobs New Zealand Limited
Wynn Williams Building- Level 2
47 Hereford Street
Christchurch Central 8013
Attention: Ryan McCone
Ryan.McCone@jacobs.com

Also to: AB Lime Limited
Attention : Fiona Smith
FSmith@Ablime.co.nz

Tēnā koe Ryan

S92(1) Request for Further Information – AB Lime Limited – APP 20202200, APP 205862-01-V2

Thank you for applying for resource consent for various new resource consents, and a variation to an existing discharge permit, for the AB Lime site.

As you are aware, the application has been formally received.

However, I will require further information from you before your application can progress, following the technical peer review process of which you have previously been advised.

This letter outlines the information I am requesting, the reasons for the request, your options and how they affect you. **Please read the points below carefully or have someone explain them to you.**

I will need the information requested below to decide whether there are any affected parties and whether the application needs to be publicly notified.

The information I am requesting is structured in three key areas, reflecting the respective areas of technical peer review:

1. **Air Quality and Odour**
   Set out below is a list of questions received from Beca Limited. Beca Limited's letter is attached for context.

   1.1 Section 6 of the NZAir Technical Memo and Section 10.5 of the AQMP refer to the current monitoring of hydrogen sulphide (H_2S) on the boundary of the landfill and in the vicinity of the leachate tank. In order to gauge the extent of the current concentrations of H_2S at these locations, please provide:
   a. a summary of the results of the boundary and leachate tank H_2S monitoring;
   b. An explanation of the basis for the 20 ppb boundary trigger limit and the 1 ppm trigger limit for the leachate tank monitor; and
   c. An indication of the frequency that these trigger limits have been exceeded.

1.2 Section 6.1.2 of the NZAir Technical Memo notes that the area of the tip face and exposed waste area will be limited to 1,000 m^2. In order to assess the potential impact on odour and dust emissions of limiting the area of the tip face to 1000m^2 please provide:

a. An estimate of the current area of the tip face.

1.3 Section 6.5 of the NZAir Technical Memo describes the methods that will be used to mitigate the generation of dust at the landfill. Some of the mitigation methods rely on the use of water as a dust suppressant. Please provide:

a. Information on the source of water that will be used to suppress dust; and
b. Evidence that there will be sufficient water available to control dust on the areas of the landfill that will be the major sources, including, haul roads, tip face, unvegetated and unconsolidated surfaces and stockpiles.

1.4 Sections 6.5.2 and 6.7.3 of the NZAir Technical Memo describe the mitigation and monitoring measures that will be used to minimise dust emissions. Section 6.1.2 notes that the onsite weather station will have automated alarms which will alert site staff of conditions which could blow emissions from the site towards the nearest neighbouring receptors but does not provide any details as to what those alerts will

a. Please provide the following:
b. The temperature, wind speed and direction alert levels for warning staff of adverse weather conditions for odour discharges.

1.5 Section 7 of the NZAir Technical Memo describes the atmospheric dispersion modelling methodology used to estimate the ambient concentrations of contaminants that will arise from the combustion of coal and landfill gas (LFG) in the lime kilns and the combustion of LFG in the landfill flare. The modelling is based on a set of emission values, the derivation of which, is only briefly described. Please provide the following information:

a. The calculations used for deriving the emissions of particulate matter (PM_{10}), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and carbon monoxide (CO) discharged from the lime kilns when burning only coal and when burning coal and LFG;
b. The calculations used for deriving the emissions of PM_{10}, SO_2, NO_x and CO from the burning of LFG in the flare;
c. An explanation of why the emission factors in Chapter 1.7 of the AP42 Compilation of Emission Factors for burning lignite in external combustion sources were used to estimate the emissions from coal burning in the lime kilns instead of the emission factors included in Chapter 11.7 of AP 42 which provides specific factors for lime manufacturing.
d. The emission rates of PM_{10}, NO_x and CO from the lime kilns based on the emission factors included in Chapter 11.7 of AP 42.
e. A copy of the calculations used to calculate the efflux velocities used in the revised modelling scenarios included in the NZAir Addendum, as measured values are not included in the Verum Group emission test reports appended to the document.

1.6 Section 7 of the NZAir Technical Memo describes the different scenarios that were modelled to assess the effects of the combustion discharges from the LFG flare and lime kilns. For scenarios 1 and 2, the report includes information on the quantities of LFG and coal that will be burnt in each of the combustion sources. However, for scenario 3 the report states that "*even less coal*" will be burnt but does not provide

the quantity of coal to be burnt that was used as a basis for the modelling scenario. Neither does the description of the scenario identify the proportion of LFG that will be burnt in the landfill flare. There also appears to be some typographical errors associated with the units used for describing the quantities of LFG to be burnt as some quantities are referred to as kg/hr and others as m^3/hr. Please provide the following:

a. The quantity of coal to be burnt that was used as the basis for scenario 3;
b. The quantity of LFG that will be burnt in the landfill flare in scenario 3;
c. Clarify the units that apply to the production rate of LFG.

1.7 Table 1 of the AQMP notes that the "*fence line odour neutralising sprays are to be operational at all times during working hours*". Please provide;

a. a description of the odour neutralising spray system including:
    i. The chemical composition of the spray, and
    ii. A general description of the design and operation of the spray system.

1.8 Section 5 of the AQMP describes the hazardous waste streams that are consented to be received by AB Lime and the specific controls that are used to manage these wastes. The AQMP includes the potential discharges to air from aluminium dross but does not include any information on how this material is managed to minimise toxic fumes and dust. In order to assess the potential effects of disposing of aluminium dross in the landfill please supply:

a. information on how waste containing aluminium dross is and will be managed.

1.9 Please provide copies of the relevant CALMET and CALPUFF inputs files used for the revised dispersion modelling assessment described in the NZAir Addendum.

1.10 Please provide further details of the MM5 meteorological model predictions used as inputs to the CALMET model including whether the MM5 inputs were developed by NZAir or provided by a third party.

1.11 Please provide further details as to how the modelled LFG flare discharge parameters (detailed in Table 1 of the NZAir Addendum) were derived.

1.12 A number of concerns are raised by the emission testing undertaken at the site and used to inform the NZAir Addendum assessment. The summary results presented in Appendix A of the addendum indicate that emission testing occurred when the lime feed rate to the kiln was between 1.76 – 3.31 t/hour. However, the current resource consent permits up to 120 t/hr of lime to be processed by the two kilns (or approximately 60t/hr per kiln). The testing appears to have occurred when the kiln was operating at only 3 -5.5% of the consented capacity. There is some uncertainty as to how well the testing represents emissions during normal and peak operating conditions. Please provide the following additional information:

a. An indication of how representative the testing of the lime kilns is to typical and peak operating conditions;
b. An assessment of how the SO_2 emission rate and stack discharge parameters (i.e. stack discharge temperature and velocity) will vary from the emission test results when the kilns are operating at peak capacity.

1.13 The emission test results also show that the percentage oxygen in the discharged kiln flue gas to be 20.7%. The observed oxygen content is close to the oxygen content of ambient air (approximately 21.0%). The testing suggests that the combustion gas

produced by the burning of LFG at the point of discharge was highly diluted by the inflow air to the kiln. This is also highlighted by the lower discharge temperature. To better understand kiln operating conditions during the LFG fired testing, please provide the following information:

a. The maximum proposed LFG usage rate when the kiln is operating at peak capacity;
b. Whether the operating conditions observed during the emission testing programme are representative of normal operating conditions when the kiln is fired with LFG;
c. What the discharge conditions will be when the kilns are operating at peak capacity and fired with LFG.

1.14 The modelled kiln discharge parameters used in the NZAir Addendum dispersion modelling assessment appear to be based on the discharge parameters observed when the kiln was coal fired only, and the coal feed rate was approximately 1.14 t/hr (or 40% of the current consent limit of 2.8 t/hr). Please provide the following information:

a. How the kiln's discharge parameters will vary from those modelled if the kilns were operating at peak capacity;
b. The effect any changes to the kiln's discharge parameters will have on the predicted ground level concentrations, and the conclusions reached in the addendum.

1.15 It is noted that maximum SO2 emission rates were recorded when the kiln was LFG fired, but that the modelled discharge parameters are based on the coal fired test results. Given the low buoyancy of the emission plume, (i.e. discharge temperature of 29°C compared to the modelled 75°C), and therefore possibly poorer dispersion of the discharged emission plume, and the higher SO2 emission rate when the kiln was LFG fired, please provide the following information:

a. Why the modelled discharges parameters were based on coal fired emission test results and not the more conservative LFG fired emission test results;
b. The effect on predicted contaminant concentrations and conclusions of the assessment if the LFG fired emission parameters for the kilns operating at peak capacity were used in the modelling.

2. **Landfill Engineering, Leachate Collection and Management and Landfill Gas Management**

Set out below is a list of questions received from Riley Consultants Limited. Riley Consultants Limited's letter is attached for context.

Landfill capacity and lifespan

2.1 Please provide qualitative and quantitative information to confirm the derived tonnages per annum including consideration of population growth and per capita waste generation.

2.2 As waste generated per annum is a function of population, population growth and per capita generation, please provide information on whether the effects of economic growth (upturn/downturn), the waste disposal levy and waste minimisation initiatives which directly impact per capita generation and hence resulting tonnages per annum have been considered.

2.3 Please confirm what sensitivity analyses have been undertaken to confirm the robustness of the derived tonnages as well as the assumptions used in their derivation.

2.4 Please advise how the expiry of the current consents in June 2038 and any new consents which are potentially acquired under the proposed removal of the tonnage limits on waste quantities for a maximum period of 35-years (hence potentially expiring circa 2055/56 if granted in 2020) have been considered in the analysis.

2.5 Please provide validation of the derived 240,000t/yr using available data from all local authorities within the catchment identified in the LCLTM as the lower South Island.

2.6 Please provide comment whether the above is an accurate assessment of the data provided.

Site Traffic

2.7 Please both qualitative and quantitative information to confirm the understanding stated including existing documented policies and procedures and independent verification of adherence to such policies and procedures.

2.8 Please provide information on existing practices (recommended traffic detours) under the removal of the tonnage limits on waste quantities and specific measures to manage any associated issues as a result of more waste from a larger waste catchment, multiple sources and non-local transporters.

2.9 Please provide a copy of the email referred to in the footnote.

2.10 Please provide qualitative and quantitative information to reconcile the time frames stated in Table 15 for waste truck types (In: 30 to 40 seconds and Out: 3 to 4 minutes) with the activities required to be completed as per Section 7.2 of the Draft LOMP.

2.11 Please provide qualitative and quantitative information on the proportions of each vehicle type (waste, lime, fertiliser, blend) for the current operations and how this impacts the assessed/evaluated capacity.

2.12 Please provide qualitative and quantitative information on the proportions of each vehicle type for the proposed operations under the removal of the tonnage limits on waste quantities and specific measures to manage any associated issues.

2.13 Please provide qualitative and quantitative information to support or clarify the statement or amend the statement as the removal of the tonnage limits on waste quantities may lead to an acceleration of quarrying to create the necessary airspace in a timely manner and consequently need to be transported off site increasing the demand on the weighbridge from blend, fertiliser and blend truck type vehicle movements.

2.14 Please provide qualitative and quantitative information on the following under the removal of the tonnage limits on waste quantities assuming that the landfill is operating to its full capacity (e.g. two weighbridges, fully available consented operating hours) and assist with further clarification around constraints:

- Stockpiling – potential stockpiles (area/volume) for quarried materials, processed materials, landfill capping (intermediate and final cover materials).
- Waste Storage – if waste cannot be transported to the off-load area/working face for immediate disposal and management of the effects of waste storage (vermin, odour, etc.).
- Potential for on-site queueing – limits on queueing, impact on other on-site activities, on-site roads carriageway width.
- Potential for bin exchange area.
- Working face operation – failure of compactor/bulldozer.
- Time taken from when a waste truck enters the weighbridge to when it leaves the weighbridge including queueing, speed restrictions, travel to the point of unloading, unloading at the off-load area adjacent to the working face area, travel from the point of unloading to the weighbridge, queuing (if any before the weighbridge) when the landfill is operating fully to the limit of consented operational hours.

Landfill Operations

2.15 Please confirm that the LOMP will include a process for assessing new contaminants and for developing acceptance criteria and please provide a draft of the proposed process.

2.16 Please provide information on how materials and wastes containing persistent organic pollutants (POPs), including perfluorinated compounds (PFAS, PFOS and PFOA) are currently received, handled, disposed of and monitored at the landfill, in order to enable an assessment of how these compounds are being managed to ensure protection of human health and the environment.

2.17 Please provide information on how the landfill complies with the Hazardous Substances (Storage and Disposal of Persistent Organic Pollutants) Notice 2004.

2.18 Please comment on and confirm the potential risks to human health from possible exposure to leachate and landfill gas contaminants.

2.19 Please provide an assessment of likelihood of Persistent Bio accumulative and Toxic (PBT) EmCoC within the leachate that could have a potential impact on human health receptors.

2.20 Please also confirm how these compounds will be managed at the landfill in terms of waste acceptance criteria and site management practices.

2.21 Please provide comment on whether a weight (or volume) limit on waste acceptance may need to be imposed through the operational management plan should limestone extraction continue at the current rate, or a rate which does not accommodate all waste that may be generated within the proposed waste catchment area, assuming no on-site stockpiling of either quarried material or waste.

2.22 If quarried material or waste is to be stockpiled to allow additional waste acceptance, please provide information on how that is to be operationally managed.

2.23 Please provide comment whether there is an action item within the LOMP and/or a variation on the proposed relevant conditions of consent that will encourage greater compliance by the landfill operator with the requirements following any increase in waste acceptance limits.

2.24 Please provide comment including qualitative and quantitative information on whether waste slopes steeper than recommended are acceptable.

2.25 Please provide comment whether removal of the waste acceptance limit, allowing a greater rate of waste placement, is expected to reduce the working face to be compliant with the LOMP.

2.26 Will the recommended maximum working face in the LOMP be subject to revision?

2.27 Is 1,000m^2 workable for the proposed rate of filling?

2.28 Please provide information on the recommended maximum expected period for temporary capping and the reasons why this is considered appropriate for the proposed cap.

2.29 Please provide information on the target permeability for the temporary cap and commentary on whether this will be achieved?

2.30 Please provide clarification as to what is the maximum recommended angle for the final landfill surface and confirmation that the relevant documents and drawings have been updated to reflect the recommendations.

2.31 Please provide information on an alternative proposal should the trial sample not achieve the target maximum permeability.

2.32 Please provide information on what is proposed should the field trials not achieve the expected performance targets.

2.33 Please provide information about the original consented capping design including the availability and quantification of suitable soil available on site to form the cap?

2.34 Please provide information including any calculations on the permeability of the GCL at strains less than the ultimate value to assess whether longitudinal shear stress and/or strain in the GCL affect permeability at values less than ultimate.

2.35 Please provide information on the methodology of extending and joining the GCL liner from cell to cell.

Landfill Gas

2.36 Please provide further information on what risks that lithium batteries contained in waste pose to the landfill, on-site and off-site receptors and what control measures the applicant believes are appropriate to mitigate those risks.

2.37 Please provide all landfill gas monitoring reports and copies of all AB Lime Gas Flare monitoring reports, as well as identifying what actions have been undertaken to correct any issues identified in these reports.

2.38 Please provide an indication of the frequency and accumulative time that the ABL Gas Flare operated at temperature below 750°C. What was the reason for the low flare temperature and what corrective action has been undertaken to prevent this from re-occurring?

2.39 Please provide an assessment of the potential for dioxin and furan formation as well as other hazardous substances during low temperature operations of the gas flare and what were to potential risks to off-site receptors.

2.40 Please confirm that the distance of nearest receptors outlined in AEE Table 5 (Location of nearest receptors) from the nearest boundary of the landfill once all the filling has been completed.

2.41 Please provide an assessment of the maximum probable distance that landfill gas could migrate from the landfill under worst case conditions.

2.42 Is it possible that landfill gas could migrate to any of the residential houses surrounding the landfill?

2.43 Does the geology surrounding the landfill (karst limestone) provide an opportunity for preferential pathway to exist and what investigations have been undertaken to identify any potential preferential gas pathway?

2.44 Please provide all landfill gas and surface walkover monitoring data for the existing landfill.

2.45 Please provide further information for the landfill gas migration monitoring probes, including:

a) Depth of each monitoring probe.
b) Maximum and minimum depth of groundwater in each monitoring probe.
c) Screen interval of the probes.
d) Borehole logs for the probes.
e) Rationale for monitoring well spacing and whether the spacing meets or exceeds international best practice (i.e. Construction Industry Research and Information Association CIRIA C665).

2.46 Please provide further information on how the expected changes to landfill gas generation will impact on-site and off-site receptors?

2.47 Please provide further information on how climate change may affect landfill gas generation rates given the LGTM (which discusses the predicted lifespan and capacity of the AB Lime Landfill) indicates that the landfill lifespan with the revised waste acceptance condition could run to 2065.

2.48 Please provide justification for parameters used in the landfill gas model, including:

a) L_O - ultimate gas generation potential.
b) K- gas rate constant.
c) Total organic carbon.

2.49 Please confirm if the backup flare has been installed in June 2020 as indicated by the report.

2.50 Please provide an assessment on predicted landfill gas versus measured extracted gas at the flare time series from installation of the gas extraction system until present day.

2.51 Please provide information on what testing has been undertaken to identify the radius of influence for the gas wells and extraction efficiency of landfill gas extraction system.

2.52 Please provide further information on what investigations have been undertaken to identify the reasons for low landfill gas flow rate at the principal flare.

2.53 Please provide an explanation of why the ratio of carbon dioxide is elevated within the extracted landfill gas, and whether there is a possibility this could pose a risk to off-site receptors.

Landfill Gas System Design and Construction

2.54 Please provide further information regarding durability of design/material selection with regards to the landfill gas extraction system.

2.55 Please provide information on the construction quality assurance programme associated with the landfill gas extraction system.

2.56 Please provide information on how the design of the landfill gas collection system allows for differential settlement with respects to condensate management.

2.57 Please provide details on how the design of the landfill gas extraction system will ensure proper sealing around the wellhead given the LGTM indicates that poor sealing around wellhead gas extraction may be occurring.

2.58 Please provide detail calculations of pipe sizing (taking into account pressure drop) to verify proposed design and sizing of plant.

Landfill Leachate

2.59 Please provide qualitative and quantitative information of how climate change has been considered with respect to landfill leachate management (generation/production, treatment, and disposal).

2.60 Please provide comment on how the current practice complies with existing consent conditions for monitoring, reporting, and measuring leachate levels.

2.61 Please confirm the unit of measure for leachate quantities.

2.62 Please provide qualitative and quantitative information to explain the quantity of leachate in 2018.

2.63 Please provide further information on the further investigations including any other potential contributing factors.

2.64 Please provide information from any site records, monitoring reports and/or annual report for site stormwater management during 2017/2018 including breaches (if

any) or malfunction of the stormwater system (e.g. diversion bund overtopping/breached).

2.65 Please provide the full annual result of leachate production for 2019.

2.66 Please provide further evidence to support the conclusion that leachate production volumes at the landfill are decreasing.

2.67 Please provide a drawing/plan of the landfill base grades for the entire landfill footprint including proposed leachate collection pipe network. Also, please quantify the base area and sidewall area of the entire landfill.

Site Stormwater

2.68 Please provide qualitative and quantitative information on consideration of the effects of climate change on site stormwater management (system design, treatment, and disposal).

2.69 Please provide information including calculations to confirm what Annual Exceedance Probability (AEP) event the existing pond has been designed to accommodate?

2.70 Please provide information including rationale or reasons for departure from the recommended criteria?

2.71 Please provide information including calculations which supports this statement and demonstrates the stormwater system has been specifically designed to accommodate these additional loads and is consistent with the relevant New Zealand recognised technical guideline (e.g. Auckland Council GD05 or equivalent)?

2.72 Please provide information including identification of likely scenarios and quantification of stockpiling within the site under these scenarios, any likely constraints, and systems to manage the stormwater effects of this as a review of recent aerial images shows no obvious existing stockpile areas.

Groundwater Quality

2.73 As relevant environmental quality criteria show some impact from landfill leachate on groundwater down-gradient, please confirm whether the statement in Section 8.7 of AEE stating no adverse effects is correct.

Monitoring

2.74 Please provide the following consent compliance documents for leachate quality and water quality monitoring to date:

- All six-monthly water quality monitoring reports (excepting July 2016, January 2017, and July 2017, which have already been made available by ES).
- All six-monthly leachate dissolved oxygen, quality, and recirculation reports (excepting June 2014 and December 2014 which have already been made available by ES).
- All independent peer review reports and minutes.

Landfill Rehabilitation and Aftercare

2.75 Please provide information on how the effect of climate change has been considered in the rehabilitation and aftercare of the landfill.

2.76 Please provide information on whether the implied surcharge loading of these mounds could induce differential settlement in the underlying landfill and possibly cause distress to the cap in the vicinity of the margins of the mound.

2.77 Please provide information on whether monitoring of the cap surface and its condition is part of the aftercare plan and confirm if any triggers are assigned or to be assigned and what these triggers are.

Environmental Management

2.78 Please provide comment whether the Draft EMP would benefit from stating a purpose of the EMP is to operate the landfill consistent with industry accepted best practice guidelines.

Others

2.79 Please provide information including rational on whether there is a maximum angle upon which the liner can be safely placed.

2.80 Please provide confirmation including revised drawings to clarify which of the liner options is proposed for the side slope.

2.81 Please provide information on the expected normal force and the effect this may have on the proposed GCL and whether permeabilities in this range can be achieved in such a situation.

2.82 Please provide a copy of the referred Landfill Capping Design Concept Design Memo to enable a review of the proposed capping.

2.83 Please provide information regarding the solubility of this material near surface, where it will likely be exposed to alternate wetting and drying cycles.

2.84 Please provide information as to the robustness of the proposed alternative capping system to periods of little to no maintenance that may exceed recommended intervals. In such a situation, please confirm whether the capping layer will meet the recommended minimum requirements outlined in Table 5-8 of the WasteMINZ Guidelines 2018.

2.85 Please provide information on the ability of the GCL in the capping layer to avoid or have acceptable cation exchange when the confining stress is less than that recommended for the liner.

2.86 Please provide a drawing(s) illustrating the relationship between the leachate recirculation plumbing and proposed GCL liner and comment whether the risk of this occurrence being repeated is reduced, increased or similar.

2.87 Please provide information on whether temporary and intermediate capping are also expected to increase in rate. If so, please provide confirmation of the availability of suitable material on site to form these caps.

2.88 Please provide quantitative and qualitative evidence to support the statement that 1(V):4(H) will provide an adequate Factor of Safety for the waste and final capped layer. This should include the assessed and target Factors of Safety.

2.89 Please also provide commentary on the potential effect of the GCL on stability, with respect to the thin cover possibly leading to breaking of the fabric bond and possible ooze through the fabric which could create a plane of weakness.

2.90 Please provide information to support the variation from the WasteMINZ recommendation.

3. **Geotechnical and Seismic Engineering**

Set out below is a list of questions received from GHD Limited. GHD Limited's letter is attached for context.

3.1 Please provide a groundwater recharge model post closure of the landfill and a discussion of how the groundwater flows through the limestone e.g. defect and bedding controlled, in order to establish the behaviour of groundwater in the limestone once the landfill is complete and to support an understanding of the need for side wall underdrainage.

3.2 In view of the outcomes of query 1) above, please provide details of how groundwater underdrainage on the side walls will be addressed if it is shown that recharge will impact the side walls in order to ensure that there will be adverse impact on the liner.

3.3 Please provide an up to date ground water draw down zone of influence assessment and an assessment of effects related to this zone of influence in order to ensure that the drawdown zone of influence has no adverse effect outside of the property boundary.

3.4 Please provide a methodology on how the groundwater draw down zone of influence will be monitored over time, in order to ensure that the potential for adverse effects is being addressed.

3.5 Please provide the technical specification for area 15 in order for this reviewer to review the details of karst remediation specifics.

3.6 Please amend drawings 1017 and 1018 to consistently show the requirements of underdrainage for the side wall. In the event that a review of the recharge model and the likely groundwater impact of the side wall liner, please amend the drawings to consistently show any revised design.

3.7 Please provide quantitative slope stability documentation, either from the original consent application or newly developed ground models for all required load cases and the changed ground water regime now and post closure in order to allow satisfactory review of landfill stability.

3.8 Please provide an identification methodology, risk assessment and mitigation for buried tomos under the floor of the landfill in order to understand the quantum of this potential risk on the landfill.

3.9 Please provide a reason as to why engineering geological mapping is not a written requirement on the limestone side walls in order to understand if there is the potential for defect related ground water seepage.

You must, by **13 August 2020** (15 working days from today):

- agree to provide the information, or
- refuse to provide the information.

It is recognised that a significant amount of additional information is being requested, so an indication of agreement to provide and an indicative timeframe would be greatly appreciated for workflow planning purposes.

Please consider what to do carefully. Your decision is important because:

- if you provide the information we will proceed with processing your application;
- if you agree to provide it we will continue processing your application when we receive the information. We may set a deadline for providing the information and may grant or decline the application after that date with or without the new information;
- we can decline the application if we have insufficient information to grant it;
- if you refuse to provide the information we must publicly notify the application. Public notification means the public may make submissions on the application and there may be a hearing to determine it. Additional payments are required for notified applications.

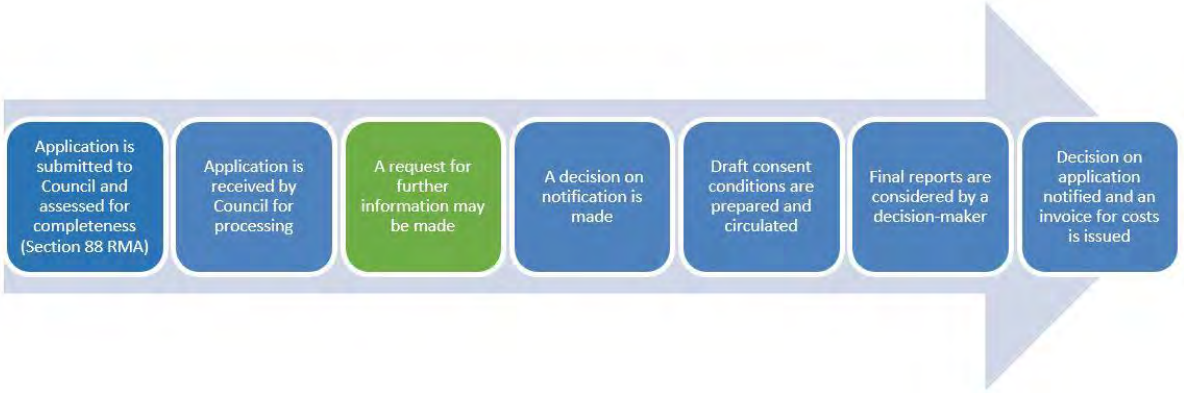
Our work on your application will cease until you respond to this request. The time taken between this email and our receipt of the information will not be included in our total processing time for the application.

Please contact me if you have any questions. I can be contacted by phone at Environment Southland Monday-Friday 8.30 am–5.00 pm on 0800 768 845 or at this email address any time. Otherwise, if you need more information:

- go to es.govt.nz/environment/consents or
- go to mfe.govt.nz/rma/rma-processes-and-how-get-involved/resource-consent-processes

Nāku noa

Bruce Halligan
Principal Consents Officer



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Environment Southland
Private Bag 90116
Invercargill 9840
New Zealand

22 July 2020

Attention: Bruce Halligan

Dear Bruce

AB Lime Landfill Air Quality Assessment Review Request for Further Information

Environment Southland (ES) has commissioned Beca Limited (Beca) to review the technical aspects of the application made by AB Lime Limited for discharges to air associated with a planned expansion of the AB Lime Landfill. The documents to be reviewed are:

- NZAir "*AB Lime Limited Landfill Resource Consent Application Landfill Air Quality Technical Memo*" 29 May 2020 (NZAir Technical Memo).
- NZAir "*AB Lime Limited, AB Lime Landfill Air Quality Management Plan*" 29 May 2020 (AQMP).
- NZAir "*AB Lime Landfill Air Discharge Consent Application (APP 20202200, APP 205862-01-V2)- Addendum to Air Dispersion Modelling Assessment*", 14 July 2020, (NZAir Addendum)

In undertaking our initial review, Beca has also referred to the following documents included in the resource consent application:

- Jacobs "*AB Lime Limited Landfill Resource Consent Application*" 29 May 2020 (Consent Application)
- Jacobs "*AB Lime Limited Landfill Resource Consent Application Landfill Gas Technical Memo*" 29 May 2020 (LFG Technical Memo)
- Jacobs "*AB Lime Limited Landfill Gas Management Plan*", 29 May 2020 (LGMP).

In order to complete this review, we require the following additional information.

1. Section 6 of the NZAir Technical Memo and Section 10.5 of the AQMP refer to the current monitoring of hydrogen sulphide (H_2S) on the boundary of the landfill and in the vicinity of the leachate tank. In order to gauge the extent of the current concentrations of H_2S at these locations, please provide:
    a. a summary of the results of the boundary and leachate tank H_2S monitoring;
    b. An explanation of the basis for the 20 ppb boundary trigger limit and the 1 ppm trigger limit for the leachate tank monitor; and
    c. An indication of the frequency that these trigger limits have been exceeded.
2. Section 6.1.2 of the NZAir Technical Memo notes that the area of the tip face and exposed waste area will be limited to 1,000 m^2. In order to assess the potential impact on odour and dust emissions of limiting the area of the tip face to 1000m^2 please provide:
    a. An estimate of the current area of the tip face.

3. Section 6.5 of the NZAir Technical Memo describes the methods that will be used to mitigate the generation of dust at the landfill. Some of the mitigation methods rely on the use of water as a dust suppressant. Please provide:

    a. Information on the source of water that will be used to suppress dust; and

    b. Evidence that there will be sufficient water available to control dust on the areas of the landfill that will be the major sources, including, haul roads, tip face, unvegetated and unconsolidated surfaces and stockpiles.

4. Sections 6.5.2 and 6.7.3 of the NZAir Technical Memo describe the mitigation and monitoring measures that will be used to minimise dust emissions. Section 6.1.2 notes that the onsite weather station will have automated alarms which will alert site staff of conditions which could blow emissions from the site towards the nearest neighbouring receptors but does not provide any details as to what those alerts will be. Please provide the following:

    a. The temperature, wind speed and direction alert levels for warning staff of adverse weather conditions for odour discharges.

5. Section 7 of the NZAir Technical Memo describes the atmospheric dispersion modelling methodology used to estimate the ambient concentrations of contaminants that will arise from the combustion of coal and landfill gas (LFG) in the lime kilns and the combustion of LFG in the landfill flare. The modelling is based on a set of emission values, the derivation of which, is only briefly described. Please provide the following information:

    a. The calculations used for deriving the emissions of particulate matter (PM_{10}), sulphur dioxide (SO_2), nitrogen oxides (NO_x) and carbon monoxide (CO) discharged from the lime kilns when burning only coal and when burning coal and LFG;

    b. The calculations used for deriving the emissions of PM_{10}, SO_2, NO_x and CO from the burning of LFG in the flare;

    c. An explanation of why the emission factors in Chapter 1.7 of the AP42 Compilation of Emission Factors for burning lignite in external combustion sources were used to estimate the emissions from coal burning in the lime kilns instead of the emission factors included in Chapter 11.7 of AP 42 which provides specific factors for lime manufacturing.

    d. The emission rates of PM_{10}, NO_x and CO from the lime kilns based on the emission factors included in Chapter 11.7 of AP 42.

    e. A copy of the calculations used to calculate the efflux velocities used in the revised modelling scenarios included in the NZAir Addendum, as measured values are not included in the Verum Group emission test reports appended to the document.

6. Section 7 of the NZAir Technical Memo describes the different scenarios that were modelled to assess the effects of the combustion discharges from the LFG flare and lime kilns. For scenarios 1 and 2, the report includes information on the quantities of LFG and coal that will be burnt in each of the combustion sources. However, for scenario 3 the report states that "*even less coal*" will be burnt but does not provide the quantity of coal to be burnt that was used as a basis for the modelling

scenario. Neither does the description of the scenario identify the proportion of LFG that will be burnt in the landfill flare. There also appears to be some typographical errors associated with the units used for describing the quantities of LFG to be burnt as some quantities are referred to as kg/hr and others as m^3/hr. Please provide the following:

a. The quantity of coal to be burnt that was used as the basis for scenario 3;

b. The quantity of LFG that will be burnt in the landfill flare in scenario 3;

c. Clarify the units that apply to the production rate of LFG.

7. Table 1 of the AQMP notes that the "*fence line odour neutralising sprays are to be operational at all times during working hours*". Please provide;

    a. a description of the odour neutralising spray system including:

        i. The chemical composition of the spray, and

        ii. A general description of the design and operation of the spray system.

8. Section 5 of the AQMP describes the hazardous waste streams that are consented to be received by AB Lime and the specific controls that are used to manage these wastes. The AQMP includes the potential discharges to air from aluminium dross but does not include any information on how this material is managed to minimise toxic fumes and dust. In order to assess the potential effects of disposing of aluminium dross in the landfill please supply:

    a. information on how waste containing aluminium dross is and will be managed.

9. Please provide copies of the relevant CALMET and CALPUFF inputs files used for the revised dispersion modelling assessment described in the NZAir Addendum.

10. Please provide further details of the MM5 meteorological model predictions used as inputs to the CALMET model including whether the MM5 inputs were developed by NZAir or provided by a third party.

11. Please provide further details as to how the modelled LFG flare discharge parameters (detailed in Table 1 of the NZAir Addendum) were derived.

12. A number of concerns are raised by the emission testing undertaken at the site and used to inform the NZAir Addendum assessment. The summary results presented in Appendix A of the addendum indicate that emission testing occurred when the lime feed rate to the kiln was between 1.76 – 3.31 t/hour. However, the current resource consent permits up to 120 t/hr of lime to be processed by the two kilns (or approximately 60t/hr per kiln). The testing appears to have occurred when the kiln was operating at only 3 -5.5% of the consented capacity. There is some uncertainty as to how well the testing represents emissions during normal and peak operating conditions. Please provide the following additional information:

    a. An indication of how representative the testing of the lime kilns is to typical and peak operating conditions;

b. An assessment of how the SO_2 emission rate and stack discharge parameters (i.e. stack discharge temperature and velocity) will vary from the emission test results when the kilns are operating at peak capacity.

13. The emission test results also show that the percentage oxygen in the discharged kiln flue gas to be 20.7%. The observed oxygen content is close to the oxygen content of ambient air (approximately 21.0%). The testing suggests that the combustion gas produced by the burning of LFG at the point of discharge was highly diluted by the inflow air to the kiln. This is also highlighted by the lower discharge temperature. To better understand kiln operating conditions during the LFG fired testing, please provide the following information:

    a. The maximum proposed LFG usage rate when the kiln is operating at peak capacity;

    b. Whether the operating conditions observed during the emission testing programme are representative of normal operating conditions when the kiln is fired with LFG;

    c. What the discharge conditions will be when the kilns are operating at peak capacity and fired with LFG.

14. The modelled kiln discharge parameters used in the NZAir Addendum dispersion modelling assessment appear to be based on the discharge parameters observed when the kiln was coal fired only, and the coal feed rate was approximately 1.14 t/hr (or 40% of the current consent limit of 2.8 t/hr). Please provide the following information:

    a. How the kiln's discharge parameters will vary from those modelled if the kilns were operating at peak capacity;

    b. The effect any changes to the kiln's discharge parameters will have on the predicted ground level concentrations, and the conclusions reached in the addendum.

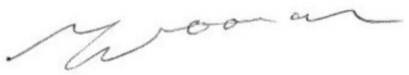
15. It is noted that maximum SO2 emission rates were recorded when the kiln was LFG fired, but that the modelled discharge parameters are based on the coal fired test results. Given the low buoyancy of the emission plume, (i.e. discharge temperature of 29°C compared to the modelled 75°C), and therefore possibly poorer dispersion of the discharged emission plume, and the higher SO2 emission rate when the kiln was LFG fired, please provide the following information:

    a. Why the modelled discharges parameters were based on coal fired emission test results and not the more conservative LFG fired emission test results;

    b. The effect on predicted contaminant concentrations and conclusions of the assessment if the LFG fired emission parameters for the kilns operating at peak capacity were used in the modelling.

If you have any questions please contact the undersigned.

Yours sincerely



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Environment Southland
Southland Regional Council
bruce.halligan@es.govt.nz

20 July 2020

Our Ref: 200239-A

Attention: Mr Bruce Halligan

Dear Mr Halligan

TECHNICAL PEER REVIEW OF RESOURCE CONSENT APPLICATION APP-20202200, APP-205862-01-V2 BY AB LIME LIMITED

1.0 Introduction

Riley Consultants Ltd (RILEY) has undertaken a Technical Peer Review of the Landfill Engineering aspects of the above-named resource consent application for Environment Southland (ES) as our client in accordance with the Services Schedule of Consultancy Contract No. A565139 for Professional Services. Following a request for clarification and correspondence between ES and the two other reviewers (Beca and GHD Ltd), the RILEY technical peer review scope was updated to include additional elements thus ensuring that all elements of the application were covered by the reviewers. In addition, as part of the RILEY team, EHS Support NZ Ltd undertook the technical peer review of the Landfill Gas aspects of the resource consent application.

Hence the RILEY technical review focuses on the following landfill design, operation, monitoring, and closure elements of the resource consent application document:

- Environmental Management.
- Contaminated Land.
- Landfill Capacity and Lifespan.
- Site Traffic.
- Landfill Operations.
- Landfill Gas.
- Landfill Leachate.
- Site Stormwater.
- Groundwater Quality.
- Monitoring.
- Landfill Rehabilitation and Aftercare.
- Others including landfill liner and capping.

The review focused on the sections of the Assessment of Environmental Effects (AEE) relevant to the above as well as the corresponding Technical Memoranda and draft Management Plans.

2.0 Technical Peer Review – Commentary and Request for Further Information

The technical review presented below provides commentary, questions, and reasons for requesting further information for each of the elements of the application reviewed in accordance with s92(3)(a) of the Resource Management Act 1991 (RMA).

The technical review has also considered current best practice for municipal solid waste landfills and whether the relevant elements of the proposal meet the requirements of the New Zealand 2018 WasteMINZ Technical Guidelines for Disposal to Land ('WasteMINZ Guidelines 2018').

Other issues to provide commentary on include – recommendations as to whether the document is: technically robust and comprehensive as per our brief from ES; Jacobs disclaimer, other issues/flags.

These initial comments relate to whether the content of the resource consent application supporting documentation is technically robust and comprehensive from a landfill engineering perspective:

- Several assumptions have been made by the applicant/applicant's consultant regarding the anticipated environmental effects of expanding the landfill and removing all incoming waste limits.
- For a 'Class A' landfill (for all intents and purposes a Class 1 Landfill as per the 2018 WasteMINZ Technical Guidelines for Disposal to Land) these assumptions are considered too broad in nature and further explanation/justification is required in order to more effectively support the conclusions reached.
- Furthermore, the information currently provided is unlikely to be sufficiently robust in terms of its quality to support the application for "the removal of the current 100,000 tonne limit".
- Additionally, and of equal or greater concern is the disclaimer by the applicant's consultant (refer the "Important Note about this Report") prefacing the application and most of the technical memoranda which does not inspire confidence overall in the robustness of the application or in the conclusions that have been reached by the authors. The second paragraph of the disclaimer is of particular concern. The logical extension of this is that if the consultant has reservations then the regulators must have even greater reservations.

  RILEY understands that ES is resolving this issue with the applicant's consultant.

2.1 Landfill Capacity and Lifespan

The documents referred to include the AEE Section 4.1 and Appendix O Landfill Capacity Lifespan Technical Memo (LCLTM).

Commentary and Questions

The LCLTM provides estimates of expected tonnes of waste per annum for the scenarios identified and evaluated.

Q1. Please provide qualitative and quantitative information to confirm the derived tonnages per annum including consideration of population growth and per capita waste generation.

Q2. As waste generated per annum is a function of population, population growth and per capita generation, please provide information on whether the effects of economic growth (upturn/downturn), the waste disposal levy and waste minimisation initiatives which directly impact per capita generation and hence resulting tonnages per annum have been considered.

Q3. Please confirm what sensitivity analyses have been undertaken to confirm the robustness of the derived tonnages as well as the assumptions used in their derivation.

Q4. Please advise how the expiry of the current consents in June 2038 and any new consents which are potentially acquired under the proposed removal of the tonnage limits on waste quantities for a maximum period of 35-years (hence potentially expiring circa 2055/56 if granted in 2020) have been considered in the analysis.

Section 2.2.2 of the LCLTM notes that over the 10-years between 2009 to 2019, total accepted waste at Class 1 landfills across New Zealand increased in the order to 45% from 2.5 million tonnes to 3.6 million tonnes. When considering the total waste in the lower South Island in relation to this data and assuming a constant 8% population value over this time period, waste in the lower South Island has increased from 200,000t/yr to 240,000t/yr.

Q5. Please provide validation of the derived 240,000t/yr using available data from all local authorities within the catchment identified in the LCLTM as the lower South Island.

Calculations attached to the LCLTM indicate that for every $1m^3$ of limestone quarried generates some $2.72m^3$ of air space for landfilling. On this basis, with continued sales of quarried products at approximately 100,000t/yr this provides for an enlarged airspace for landfilling of approximately $319,000m^3$/yr (pre-settlement). Given the LCLTM's assessed density of $0.94t/m^3$ for placed landfill this provides 300,000t/yr of waste placement made available.

Q6. Please provide comment whether the above is an accurate assessment of the data provided.

2.2 Site Traffic

The documents referred to include the Drawings, the AEE Sections 3.4, 4.8, and 8.10, Appendix M Site Traffic Technical Memo (STTM), and Appendix V Draft Site Traffic Management Plan (Draft STMP).

Commentary and Questions

Section 2.2.3 of the STTM notes that it is understood that most AB Lime Ltd traffic does not presently use the State Highway 6 (SH6)/State Highway 96 (SH96) intersection. It is also understood that AB Lime Ltd recommends that AB Lime Ltd related traffic detours around Winton. Many of the drivers are local and are familiar with the local routes and traffic patterns, and if delays are expected will utilise alternative routes. Given this, it has not been considered necessary to include the SH6/SH96 intersection in the traffic impact assessment for the AB Lime Ltd waste increase analysis.

Q7. Please both qualitative and quantitative information to confirm the understanding stated including existing documented policies and procedures and independent verification of adherence to such policies and procedures.

Q8. Please provide information on existing practices (recommended traffic detours) under the removal of the tonnage limits on waste quantities and specific measures to manage any associated issues as a result of more waste from a larger waste catchment, multiple sources and non-local transporters.

Section 3.4 Table 15 of the STTM summarises data received from AB Lime Ltd regarding processing times for the different trucks associated with the various on-site activities as per the email referred to in Footnote 3.

Q9. Please provide a copy of the email referred to in the footnote.

Section 3.4 Table 15 of the STTM summarises data received from AB Lime Ltd regarding processing times for the different trucks associated with the various on-site activities as per the email referred to in Footnote 3. Section 7.2 of the Draft Landfill Operations Management Plan (LOMP) list all the activities for incoming waste at the weighbridge and notes that all loads of waste will be weighed and inspected prior to entering the site and on leaving the site.

Q10. Please provide qualitative and quantitative information to reconcile the time frames stated in Table 15 for waste truck types (In: 30 to 40 seconds and Out: 3 to 4 minutes) with the activities required to be completed as per Section 7.2 of the Draft LOMP.

Section 3.4 Table 15 of the STTM notes the Heavy Commercial Vehicle (HCV) types (waste, lime, fertiliser, blend) using the weighbridge and the assessed return trip times. Section 4 of the Draft STMP notes information documented and generated on a computer system at the weighbridge.

Q11. Please provide qualitative and quantitative information on the proportions of each vehicle type (waste, lime, fertiliser, blend) for the current operations and how this impacts the assessed/evaluated capacity.

Q12. Please provide qualitative and quantitative information on the proportions of each vehicle type for the proposed operations under the removal of the tonnage limits on waste quantities and specific measures to manage any associated issues.

Section 3.4 of the STTM note that as the increase proposed is specifically for waste trucks, the number of HCVs/hr would be between 12 to 17 HCVs.

Q13. Please provide qualitative and quantitative information to support or clarify the statement or amend the statement as the removal of the tonnage limits on waste quantities may lead to an acceleration of quarrying to create the necessary airspace in a timely manner and consequently need to be transported off site increasing the demand on the weighbridge from blend, fertiliser and blend truck type vehicle movements.

Section 4 of the STTM notes the effects resulting from removal of the tonnage limits on waste quantities on traffic management. The effects occur both on-site and off-site and the traffic management on-site is intrinsically connected to operations of on-site activities and consideration of all factors that may impose limits or constraints both individually and collectively.

Q14. Please provide qualitative and quantitative information on the following under the removal of the tonnage limits on waste quantities assuming that the landfill is operating to its full capacity (e.g. two weighbridges, fully available consented operating hours) and assist with further clarification around constraints:

- *Stockpiling – potential stockpiles (area/volume) for quarried materials, processed materials, landfill capping (intermediate and final cover materials).*
- *Waste Storage – if waste cannot be transported to the off-load area/working face for immediate disposal and management of the effects of waste storage (vermin, odour, etc.).*
- *Potential for on-site queueing – limits on queueing, impact on other on-site activities, on-site roads carriageway width.*
- *Potential for bin exchange area.*
- *Working face operation – failure of compactor/bulldozer.*
- *Time taken from when a waste truck enters the weighbridge to when it leaves the weighbridge including queueing, speed restrictions, travel to the point of unloading, unloading at the off-load area adjacent to the working face area, travel from the point of unloading to the weighbridge, queuing (if any before the weighbridge) when the landfill is operating fully to the limit of consented operational hours.*

2.3 Landfill Operations

The documents referred to include the Drawings, the AEE Section 4.3, Appendix G Landfill Operational Management Technical Memo (LOMTM), and Appendix Q Draft Landfill Operations Management Plan (Draft LOMP).

Commentary and Questions

Section 2.1 of the Landfill Operational Management Technical Memo (LOMTM) notes that the current waste acceptance criteria follow those identified in the New Zealand good practice landfill guidelines, such as the WasteMINZ Guidelines 2018.

Section 2.3 of the LOMTM outlines the expected changes to the waste acceptance criteria resulting from a removal of a tonnage limit for waste acceptance and states that the LOMP will be critical in ensuring that best practices are continually adhered to for the waste acceptance criteria.

Attachment 5 of the Draft LOMP provides some high-level contractor assessment measures for how asbestos, medical waste, methamphetamine-contaminated wastes and contaminated soils are to be transported and received.

Q15. Please confirm that the LOMP will include a process for assessing new contaminants and for developing acceptance criteria and please provide a draft of the proposed process.

Q16. Please provide information on how materials and wastes containing persistent organic pollutants (POPs), including perfluorinated compounds (PFAS, PFOS and PFOA) are currently received, handled, disposed of and monitored at the landfill, in order to enable an assessment of how these compounds are being managed to ensure protection of human health and the environment.

Q17. Please provide information on how the landfill complies with the Hazardous Substances (Storage and Disposal of Persistent Organic Pollutants) Notice 2004.

The main mechanisms by which contaminants can be released from the landfill are via leachate and landfill gas.

Q18. Please comment on and confirm the potential risks to human health from possible exposure to leachate and landfill gas contaminants.

Emerging contaminants of concern, such as pharmaceutical compounds, personal care products, anti-microbial agents, and persistent bio accumulative toxic substances (and candidate compounds) are listed in the Stockholm Convention (including short chain chlorinated paraffins and poly chlorinated naphthalene and hexachlorobutadiene). Furthermore, substances of very high concern have been identified by the European Union (i.e. highly environmental mobile substances such as nonyl phenol, alkylphenols and alkylphenol ethoxylates (APEOs) and listed PBT/vPvB substances) as well as 1,4-Dioxane.

Q19. Please provide an assessment of likelihood of Persistent Bio accumulative and Toxic (PBT) EmCoC within the leachate that could have a potential impact on human health receptors.

Q20. Please also confirm how these compounds will be managed at the landfill in terms of waste acceptance criteria and site management practices.

Section 2.4 of the LOMTM outlines that a removal of the tonnage limit will have no fundamental effect on waste acceptance criteria to the landfill. As outlined in the Landfill Capacity Lifespan Technical Memo the quarrying of limestone will generate a certain amount of additional air space each year, inferred to be equivalent to some 300,000t/yr at current limestone extraction rates.

Q21. Please provide comment on whether a weight (or volume) limit on waste acceptance may need to be imposed through the operational management plan should limestone extraction continue at the current rate, or a rate which does not accommodate all waste that may be generated within the proposed waste catchment area, assuming no on-site stockpiling of either quarried material or waste.

Q22. If quarried material or waste is to be stockpiled to allow additional waste acceptance, please provide information on how that is to be operationally managed.

Section 3.4 of the LOMTM notes that the removal of an upper limit on waste acceptance on waste slopes can be appropriately managed by site operations adhering to the procedures outlined in the LOMP. The LOMP provides a maximum waste slope of 1(V):3(H), consistent with industry guidelines. However, independent peer review often notes repeated non-compliance with this requirement by having steeper slopes.

Q23. Please provide comment whether there is an action item within the LOMP and/or a variation on the proposed relevant conditions of consent that will encourage greater compliance by the landfill operator with the requirements following any increase in waste acceptance limits.

Q24. Please provide comment including qualitative and quantitative information on whether waste slopes steeper than recommended are acceptable.

Section 4.1 of the LOMTM notes the current working face is 3,625m^2. The Draft LOMP recommends a maximum working face of 1,000m^2. It is commented within the LOMTM that procedures for waste placement and compaction are not expected to change and the LOMP will be critical regarding the working face.

Q25. Please provide comment whether removal of the waste acceptance limit, allowing a greater rate of waste placement, is expected to reduce the working face to be compliant with the LOMP.

Q26. Will the recommended maximum working face in the LOMP be subject to revision?

Q27. Is 1,000m^2 workable for the proposed rate of filling?

Section 10.3 of the Draft LOMP states the Temporary capping comprising 600mm thickness of low permeability soil may be present for months and years. No maximum limit in time is suggested.

Q28. Please provide information on the recommended maximum expected period for temporary capping and the reasons why this is considered appropriate for the proposed cap.

Q29. Please provide information on the target permeability for the temporary cap and commentary on whether this will be achieved?

Section 10.4.1 of the Draft LOMP states the maximum gradient for the landfill final surface is 1(V):3(H). This contrasts to Section 6.1.2 of the Landfill Geotechnical Engineering Technical Memo (LGETM) which recommends a maximum gradient of 1(V):4(H). In addition, drawing 1017 also shows a capping angle of 1(V):4(H).

Q30. Please provide clarification as to what is the maximum recommended angle for the final landfill surface and confirmation that the relevant documents and drawings have been updated to reflect the recommendations.

Section 10.4.2.3 of the Draft LOMP outlines measures to join the Geosynthetic Clay Liner (GCL) to an original capping layer, which includes a block of bentonite and knap rock mixture. This will comprise 65% knap rock and 35% bentonite to be mechanically blended and target a maximum permeability of 1 x 10^{-7}m/s. A trial is proposed to confirm it meets these requirements.

Q31. Please provide information on an alternative proposal should the trial sample not achieve the target maximum permeability.

Section 10.4.4 of the Draft LOMP discusses a proposed field trial of the alternative final cap, following which a Specification and Quality Control Standard will be issued for approval to an Independent Peer Reviewer and ES. This would appear not to follow best practice as per the WasteMINZ Guidelines 2018 as the performance of the alternative cap has not been proven prior to the consent application.

Q32. Please provide information on what is proposed should the field trials not achieve the expected performance targets.

Q33. Please provide information about the original consented capping design including the availability and quantification of suitable soil available on site to form the cap?

Section 10.4.5.2 of the Draft LOMP discusses the potential performance of the GCL across a future landfill subject to total and differential settlement. It is stated the proposed GCLs can elongate between 15% and 50% before failure, indicating their tolerance of differential settlement causing tension and strain in the capping GCL. It then outlines potential remedial measures should severe settlement occur.

> *Q34. Please provide information including any calculations on the permeability of the GCL at strains less than the ultimate value to assess whether longitudinal shear stress and/or strain in the GCL affect permeability at values less than ultimate.*

Section 11 of the Draft LOMP and associated Drawings 1016, 1017 and 1018 outline the methodology for constructing the base liner and the connection between a GCL inclusive liner and non-GCL inclusive liner.

There appears to be an absence of information as to the methodology of how the GCL liner will be extended from cell to cell, for example will a portion of liner around the margin of the cell be left clear of waste for connection to an adjacent future cell without the need to double handle waste and how would this liner portion be cared for in the interim.

> *Q35. Please provide information on the methodology of extending and joining the GCL liner from cell to cell.*

2.4 Landfill Gas

The documents referred to include the Drawings, the AEE Section 4.4 and Section 8.8, Appendix J Landfill Gas Technical Memo (LGTM), Appendix R Draft Landfill Gas Management Plan (Draft LGMP), AB Lime – Winton Landfill GAS Flare Sampling Results – Consent Number 201351, and the AECOM 2018 Monitoring Report 4 – ABL Gas Flare Data.

Commentary and Questions

Lithium battery use in consumer products and electric vehicles is like to increase over time and therefore issues associated with them in waste disposed at landfill is also likely to increase. Lithium batteries have been linked a possible cause for two recent fires in New Zealand (Hampton Downs and Puwera Landfills) as well as many fires in landfills overseas – refer to:

1. https://app.croneri.co.uk/feature-articles/dealing-waste-lithium-batteries-1?product=139,
2. https://www.theverge.com/2020/2/28/21156477/recycling-plants-fire-batteries-rechargeable-smartphone-lithium-ion,
3. https://kval.com/news/local/the-dangers-of-lithium-batteries-and-why-they-dont-belong-in-your-trash and
4. https://sciencing.com/what-do-batteries-do-to-the-environment-if-not-properly-recycled-12730824.html).

Landfill fires are a serious problem as they can result in emissions of hazardous air pollutants and potentially increase the risk associated with lateral migration of landfill gas. While the application does discuss the possibility of landfill fires within the landfill and potential management options, the application does not adequately describe measures which could be taken to prevent the fire from starting nor does it discuss the potential health effects of such fires.

Q36. Please provide further information on what risks that lithium batteries contained in waste pose to the landfill, on-site and off-site receptors and what control measures the applicant believes are appropriate to mitigate those risks.

Currently, only the AECOM 2018 Gas Flare Monitoring Report has been provided. This report identifies non-compliance with the Resource Management (National Environmental Standards for Air Quality) Regulations 2004 regulation 27 (f) that the principal flare must be designed and operated so the gas is burnt at a temperature of at least 750°C. Copies of all the monitoring reports are needed to verify consent compliance.

Q37. Please provide all landfill gas monitoring reports and copies of all AB Lime Gas Flare monitoring reports, as well as identifying what actions have been undertaken to correct any issues identified in these reports.

The rationale for Resource Management (National Environmental Standards for Air Quality) Regulations 2004 regulation 27 (f) to specify a temperature of no lower than 750°C to destroy any dioxins/furans that may have formed during the combustion of the landfill gas. The AECOM 2018 report notes flare temperatures as low as 450°C in February 2017 which indicates conditions may have been conducive of dioxin/furans formation.

Q38. Please provide an indication of the frequency and accumulative time that the ABL Gas Flare operated at temperature below 750°C. What was the reason for the low flare temperature and what corrective action has been undertaken to prevent this from re-occurring?

Q39. Please provide an assessment of the potential for dioxin and furan formation as well as other hazardous substances during low temperature operations of the gas flare and what were to potential risks to off-site receptors.

It is unclear whether it is the centre of the landfill, current boundary of the waste or the final edge of refuse once filling has been completed. Clarification is required on how the distance to the nearest receptor has been measured.

Q40. Please confirm that the distance of nearest receptors outlined in AEE Table 5 (Location of nearest receptors) from the nearest boundary of the landfill once all the filling has been completed.

There is insufficient information on the potential risks (if they exist) of landfill gas migration and the potential hazard/risk to off-site receptors. The AEE notes that the geology consists of rolling lime hills, pock marked with sinkholes and tomos are noted within the area. Therefore, due to the nature of karst limestone geology it is important to know if there are any fractured or any horizontal/vertical sub-surface features that could act as preferential pathways for landfill gas.

Q41. Please provide an assessment of the maximum probable distance that landfill gas could migrate from the landfill under worst case conditions.

Q42. Is it possible that landfill gas could migrate to any of the residential houses surrounding the landfill?

Q43. Does the geology surrounding the landfill (karst limestone) provide an opportunity for preferential pathway to exist and what investigations have been undertaken to identify any potential preferential gas pathway?

Section 4 of the LGTM outlines some potential change to landfill gas management resulting from a removal of a tonnage limit for waste acceptance criteria. However, it does not provide an estimate on the increase quantities of potential uncontrolled gas emissions and what affect they may have on off-site receptors. Further information is required to assess if these effects are acceptable and whether the proposed mitigation measures will be effective.

Q44. Please provide all landfill gas and surface walkover monitoring data for the existing landfill.

Q45. Please provide further information for the landfill gas migration monitoring probes, including:

a) *Depth of each monitoring probe.*
b) *Maximum and minimum depth of groundwater in each monitoring probe.*
c) *Screen interval of the probes.*
d) *Borehole logs for the probes.*
e) *Rationale for monitoring well spacing and whether the spacing meets or exceeds international best practice (i.e. Construction Industry Research and Information Association CIRIA C665).*

Q46. Please provide further information on how the expected changes to landfill gas generation will impact on-site and off-site receptors?

Climate change could change the amount of precipitation and temperature experienced by the landfill, thereby affecting the rate which landfill gas is generated. No information has been provided on the sensitivity of landfill gas generation to potential climate change.

Q47. Please provide further information on how climate change may affect landfill gas generation rates given the LGTM (which discusses the predicted lifespan and capacity of the AB Lime Landfill) indicates that the landfill lifespan with the revised waste acceptance condition could run to 2065.

The information does not provide adequate justification for the values used for modelling and there is some indication within the LGTM the actual gas flow is much less than the predicted gas flow. The estimated organic carbon used for modelling is also very different to the organic carbon estimate presented in the Solid Waste Analysis Protocol (SWAP) audit report in Attachment 6 of the LGTM. The estimated L_O does not appear to have been derived using the Intergovernmental Panel on Climate Change (IPCC) methodology and no rationale has been supplied within the report for using a L_O of 100.

There are varying gas rate consent (k) values used which the LGTM does not present how the values were derived, nor does there appear to be any attempt to verify them using empirical data from the site. Therefore, the reliability of assumptions used to determine landfill gas generation cannot be verified.

Q48. Please provide justification for parameters used in the landfill gas model, including:

a) *L_O - ultimate gas generation potential.*
b) *K- gas rate constant.*
c) *Total organic carbon.*

Section 4.1 of the LGTM, presents several possible different reasons why there might be a low landfill gas flow rate at the principal flare. Several of possible reasons relate to poor design of the landfill gas extraction system and/or capping design. If these issues are not fixed, then increasing the waste disposal rate may make the problem worse and result with non-compliance with the requirements of the Resource Management (National Environmental Standards for Air Quality) Regulations 2004 Regulation 26.

Q49. Please confirm if the backup flare has been installed in June 2020 as indicated by the report.

Q50. Please provide an assessment on predicted landfill gas versus measured extracted gas at the flare time series from installation of the gas extraction system until present day.

Q51. Please provide information on what testing has been undertaken to identify the radius of influence for the gas wells and extraction efficiency of landfill gas extraction system.

Q52. Please provide further information on what investigations have been undertaken to identify the reasons for low landfill gas flow rate at the principal flare.

The ratio of methane to carbon dioxide from the decomposition of cellulose material results in the production of a gas containing approximately 65% to 66% methane and 33% to 35% carbon dioxide. This ratio can change via several process including dilution with atmospheric air or removal of carbon dioxide though dissolution with water. However, the gas within the landfill appears to be enriched with carbon dioxide and it is unclear why this is occurring. The issue here is that certain enrichment processes may result in carbon dioxide gas being generated outside of the footprint of the landfill and it may change the risk profile to residential properties nearby. Understanding what is causing the enrichment in carbon dioxide in the landfill gas would be helpful to eliminate this possible risk.

Q53. Please provide an explanation of why the ratio of carbon dioxide is elevated within the extracted landfill gas, and whether there is a possibility this could pose a risk to off-site receptors.

Landfill Gas System Design and Construction

Q54. Please provide further information regarding durability of design/material selection with regards to the landfill gas extraction system.

Q55. Please provide information on the construction quality assurance programme associated with the landfill gas extraction system.

Q56. Please provide information on how the design of the landfill gas collection system allows for differential settlement with respects to condensate management.

Q57. Please provide details on how the design of the landfill gas extraction system will ensure proper sealing around the wellhead given the LGTM indicates that poor sealing around wellhead gas extraction may be occurring.

Q58. Please provide detail calculations of pipe sizing (taking into account pressure drop) to verify proposed design and sizing of plant.

2.5 Landfill Leachate

The documents referred to include the Drawings, the AEE Section 4.5 and Section 8.7, Appendix H Landfill Leachate Technical Memo (LLTM), and Appendix S Draft Landfill Leachate Management Plan (Draft LLMP).

Commentary and Questions

Effect of climate change on landfill leachate generation/production and management.

> *Q59. Please provide qualitative and quantitative information of how climate change has been considered with respect to landfill leachate management (generation/production, treatment, and disposal).*

Section 2.1 of the LLTM notes that currently there are no piezometers or other method of measuring the level of leachate in the base landfill. Section 4.2.4 of the Draft LLMP also provides some discussion on leachate levels.

> *Q60. Please provide comment on how the current practice complies with existing consent conditions for monitoring, reporting, and measuring leachate levels.*

Section 3, Figure 2 of the LLTM documents the quantities of leachate produced per annum stating the quantities in tonnes.

> *Q61. Please confirm the unit of measure for leachate quantities.*

Section 3 of the LLTM notes that rainfall data from 2018 indicates higher than usual levels of precipitation, which is likely to be a contributing factor to increased leachate. Additionally, further investigations into other potential contributing factors are ongoing.

> *Q62. Please provide qualitative and quantitative information to explain the quantity of leachate in 2018.*

> *Q63. Please provide further information on the further investigations including any other potential contributing factors.*

> *Q64. Please provide information from any site records, monitoring reports and/or annual report for site stormwater management during 2017/2018 including breaches (if any) or malfunction of the stormwater system (e.g. diversion bund overtopping/breached).*

Section 3 of the LLTM states that with the exception of 2018, there has been a reduction in leachate production volumes since 2015. Figure 2 Annual Quantities of Leachate Production provided shows a significant leachate production increase of around 37% in 2018 against the highest previously recorded annual leachate production volume in 2015, with annual results from 2016, 2017 and 2019 (partial results only) showing similar leachate production volumes to the 2007 to 2014 data set.

> *Q65. Please provide the full annual result of leachate production for 2019.*

> *Q66. Please provide further evidence to support the conclusion that leachate production volumes at the landfill are decreasing.*

Q67. Please provide a drawing/plan of the landfill base grades for the entire landfill footprint including proposed leachate collection pipe network. Also, please quantify the base area and sidewall area of the entire landfill.

2.6 Site Stormwater

The documents referred to include the Drawings, the AEE Section 3.9, Section 4.9 and Section 8.5, Appendix W Site Stormwater Management Technical Memo (SSMTM), and Appendix X Draft Site Stormwater Management Plan (Draft SSMP).

Commentary and Questions

Effect of climate change on-site stormwater management.

Q68. Please provide qualitative and quantitative information on consideration of the effects of climate change on site stormwater management (system design, treatment, and disposal).

Section 2.2 of the SSMTM states that the existing stormwater pond is designed to contain at least the 1:50-year rain event.

Q69. Please provide information including calculations to confirm what Annual Exceedance Probability (AEP) event the existing pond has been designed to accommodate?

For permanent stormwater ponds, the WasteMINZ Guidelines 2018 recommend the ponds are designed for a 1:100-year event.

Q70. Please provide information including rationale or reasons for departure from the recommended criteria?

Section 4 Table 2 of the SSMTM assesses expected changes in stormwater management with respect to activities as a result of removal of tonnage limits on waste acceptance quantities. It notes an expected increase in stormwater flow rates and suspended sediment due to accelerated capping, increased quarry exposure, possible stockpiling, and increased traffic. It concluded the existing system should overall be able to cope.

Q71. Please provide information including calculations which supports this statement and demonstrates the stormwater system has been specifically designed to accommodate these additional loads and is consistent with the relevant New Zealand recognised technical guideline (e.g. Auckland Council GD05 or equivalent)?

Section 4 Table 2 of the SSMTM assesses expected changes to stormwater management with respect to activities as a result of the removal of tonnage limits on waste acceptance quantities. In terms of quarry and stockpiling the memo notes that the increased rate of waste acceptance may lead to an acceleration of quarrying to create the necessary airspace in a timely manner. As the quarried material may not be sold at a quicker rate this may necessitate the need to stockpile quarried material on-site.

Q72. Please provide information including identification of likely scenarios and quantification of stockpiling within the site under these scenarios, any likely constraints, and systems to manage the stormwater effects of this as a review of recent aerial images shows no obvious existing stockpile areas.

2.7 Groundwater Quality

The documents referred to include the AEE Section 3.8 and Section 8.6, and Appendix L Groundwater Quality Technical Memo (GQTM).

Commentary and Questions

Section 8.7 of the AEE notes that at present the generation and disposal of leachate at the landfill does not give rise to any adverse effects.

Section 3.5.3 of the GQTM notes that the southernmost monitoring well (SKM108) on the downgradient boundary currently provides the best indication of groundwater quality discharging off-site. The GQTM notes that environmental lower-response limit/warning (Trigger Level TL1) criteria and environmental upper-response limit/alarm (TL2) criteria are exceeded in this well as follows: elevated sulphate, copper, nickel, manganese and ammoniacal nitrogen concentrations exceeding TL1 warning criteria; zinc and copper exceeding TL2 alarm criteria. The GQTM notes that these concentrations may be reflective of very dilute leachate concentrations; they are low when compared to drinking water standards.

While assessment against the Resource Management (National Environmental Standard for Sources of Human Drinking Water) Regulations 2007 is relevant to potential abstractors and users of groundwater in the region, the more immediately relevant assessment is potential environmental impact (Australia New Zealand Guidelines for Fresh and Marine Water Quality 2018, or ANZG, and the USEPA National Recommended Water Quality Criteria (Aquatic Life) 1999.

> *Q73. As relevant environmental quality criteria show some impact from landfill leachate on groundwater down-gradient, please confirm whether the statement in Section 8.7 of AEE stating no adverse effects is correct.*

2.8 Monitoring

The documents referred to include the Drawings, the AEE Section 5, Water Quality Monitoring Reports (July 2016, January 2017, July 2017), and Leachate Reports (June 2014, December 2014).

Commentary and Questions

> *Q74. Please provide the following consent compliance documents for leachate quality and water quality monitoring to date:*
>
> - *All six-monthly water quality monitoring reports (excepting July 2016, January 2017, and July 2017, which have already been made available by ES).*
> - *All six-monthly leachate dissolved oxygen, quality, and recirculation reports (excepting June 2014 and December 2014 which have already been made available by ES).*
> - *All independent peer review reports and minutes.*

2.9 Landfill Rehabilitation and Aftercare

The documents referred to include the Drawings, the AEE Section 4.6, and Appendix T Draft Landfill Concept, Landscape, Rehabilitation and Aftercare Plan (Draft LCLRAP).

Commentary and Questions

Effect of climate change.

> *Q75. Please provide information on how the effect of climate change has been considered in the rehabilitation and aftercare of the landfill.*

Section 3.4.1 of the Draft LCLRAP outlines proposed growing mounds approximately 1.5m high placed on the final cap surface. Deep rooting vegetation including pine trees are proposed for planting in the mounds.

> *Q76. Please provide information on whether the implied surcharge loading of these mounds could induce differential settlement in the underlying landfill and possibly cause distress to the cap in the vicinity of the margins of the mound.*

Section 3.6 of the Draft LCLRAP outlines environmental monitoring of the landfill in accordance with the various management plans with respect to surface water, groundwater, leachate, landfill gas and nuisance. There appears to be an absence of long-term monitoring with respect to cap deformation (e.g. settlement, cracking, landsliding) and possible damage to the capping materials, for example in response to landscaping elements.

> *Q77. Please provide information on whether monitoring of the cap surface and its condition is part of the aftercare plan and confirm if any triggers are assigned or to be assigned and what these triggers are.*

2.10 Environmental Management

The documents referred to include the Drawings, the AEE Section 4.2 and Appendix P Draft Environmental Management Plan (Draft EMP).

Comments and Questions

> *Q78. Please provide comment whether the Draft EMP would benefit from stating a purpose of the EMP is to operate the landfill consistent with industry accepted best practice guidelines.*

2.11 Others

The documents referred to include the drawings and the Landfill Geotechnical Engineering Technical Memo (LGETM).

Commentary and Questions

Drawing 1017 notes the side slope against the liner is 1(V):2(H) or greater.

> *Q79. Please provide information including rational on whether there is a maximum angle upon which the liner can be safely placed.*

Drawing 1018 shows the liner on a 1(V):2(H) slope which appears inconsistent with that shown on drawing 1017 which has additional material.

> *Q80. Please provide confirmation including revised drawings to clarify which of the liner options is proposed for the side slope.*

Section 2.1.2 of the LGETM for the alternative GCL capping design notes the proposed EnviroFix X800 to X2000 range is most likely to have a permeability of between 1.8 to 2.6 x 10^{-11}m/s. It is understood that normal stress is required on the GCL to achieve the target permeabilities. The proposed capping will have a small thickness of knap rock and topsoil which may only apply a pressure of some 8kPa.

Q81. Please provide information on the expected normal force and the effect this may have on the proposed GCL and whether permeabilities in this range can be achieved in such a situation.

Section 2.1.2 of the LGETM refers to a Landfill Capping Design Concept Design Memo, however, this does not appear to be included within the supplied information.

Q82. Please provide a copy of the referred Landfill Capping Design Concept Design Memo to enable a review of the proposed capping.

Section 2.1.2 of the LGETM, along with drawing 1017, outline knap rock is to be placed either side of the proposed GCL. Knap rock is described as sandy gravel with some silt and minor clay and derives from crushed weather limestone. This is proposed to be placed near the surface.

Q83. Please provide information regarding the solubility of this material near surface, where it will likely be exposed to alternate wetting and drying cycles.

Section 2.1.2 of the LGETM concludes risks associated with the alternative capping system can be satisfactorily mitigated through good design and management practices.

Q84. Please provide information as to the robustness of the proposed alternative capping system to periods of little to no maintenance that may exceed recommended intervals. In such a situation, please confirm whether the capping layer will meet the recommended minimum requirements outlined in Table 5-8 of the WasteMINZ Guidelines 2018.

Section 2.2.2 of the LGETM outlines that, amongst other aspects, the issue of cation exchange potential in the GCL has been considered within the Landfill Capping Design Concept Design Memo (which is not provided, as noted above). Cation exchange within the clay in the GCL can lead to increased permeabilities. It is noted for the liner GCL that SmecTech had previously recommended a minimum of 1m thickness of select waste to provide the necessary confining stress to avoid cation exchange. In addition, Note 7 of Drawing 1018 includes a minimum of 500mm immediate cover over the liner GCL. By contrast the GCL in the proposed capping has a cover of 450mm.

Q85. Please provide information on the ability of the GCL in the capping layer to avoid or have acceptable cation exchange when the confining stress is less than that recommended for the liner.

Section 2.2 of the LGETM notes that leachate has previously broken out through the original final cap because of a leaking recirculation pipe. There appears to be no detail of the arrangement between the proposed GCL capping system and the leachate recirculation plumbing.

Q86. Please provide a drawing(s) illustrating the relationship between the leachate recirculation plumbing and proposed GCL liner and comment whether the risk of this occurrence being repeated is reduced, increased or similar.

Section 3 of the LGETM predicts the rate at which final capping is implemented will increase. There is no comment if the rate of temporary and intermediate capping will also increase.

> *Q87. Please provide information on whether temporary and intermediate capping are also expected to increase in rate. If so, please provide confirmation of the availability of suitable material on site to form these caps.*

Section 6.1.2 of the LGETM outlines the maximum allowable gradient in 1(V):4(H) and this provides an acceptable Factor of Safety for stability. There does not appear to be any evidence presented which supports this recommendation.

> *Q88. Please provide quantitative and qualitative evidence to support the statement that 1(V):4(H) will provide an adequate Factor of Safety for the waste and final capped layer. This should include the assessed and target Factors of Safety.*
>
> *Q89. Please also provide commentary on the potential effect of the GCL on stability, with respect to the thin cover possibly leading to breaking of the fabric bond and possible ooze through the fabric which could create a plane of weakness.*

Drawing 1017 shows knap rock directly overlying the proposed GCL. Figure 5-8 of the WasteMINZ Guidelines 2018 indicates a 200mm to 300mm thick drainage layer over the GCL.

> *Q90. Please provide information to support the variation from the WasteMINZ recommendation.*

3.0 Limitation

This report has been prepared solely for the benefit of Environment Southland as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Recommendations and opinions in this report are based on third party supplied information. The nature and continuity of conditions are inferred, and it must be appreciated that actual conditions could vary considerably from the assumed model.

Yours faithfully
RILEY CONSULTANTS LTD

Prepared by:	Prepared by:	Reviewed and approved for issue by:
Steven Price **Principal – Engineering Geologist**	Marcus Herrmann **Principal – Contaminated Land**	Arthur Amputch, ONZM **Technical Director – Civil, CPEng**

20 July 2020

Bruce Halligan
Principal Consents Officer
Environment Southland
Private bag 90116
Invercargill 9840

Our ref: 12533703

Your ref:

Dear Bruce

AB Lime Landfill - RMA Consent
Consent Application Geotechnical Peer Review

1 Introduction

GHD Ltd has been engaged by Environment Southland to undertake technical peer review of the Resource Consent Application APP-20202200 , APP -205862-01-V2 by AB Lime Ltd. The application is seeking new consents with a key element being removal of the cap on volume of 100,000 tonnes per year and to facilitate them receiving waste from across the South Island. AB Lime is not proposing to change the footprint, the final area, or capacity of the landfill. The changes effective through this consent will allow the landfill to be filled at an increased rate, should there be a need to do so.

2 Scope of work

The agreed scope of work is to provide technical peer Review of Resource Consent Application APP-20202200 , APP -205862-01-V2 by AB Lime, and provision of written feedback and recommendations as to whether the content of the document is technically robust and comprehensive, and whether any additional information is required.

This technical review focuses on the following elements of the application document:

- Geotechnical information included in the application
- Seismic information included in the application
- Supporting draft management plan content relevant to the above elements
- Feedback on draft conditions proposed as part of the application relevant to the above elements

The completed report shall be framed and presented suitable for inclusion in a report to decision makers and on the basis that all relevant content is likely to be disclosable in accordance with the relevant provisions of the Local Government Official Information and Meetings Act 1987.

We note that Riley Consultants have been engaged to undertake a review with a landfill engineering focus. At the request of the applicant, GHD and Rileys have agreed not to overlap review effort for the geotechnical component of landfill engineering. The GHD geotechnical focus is:-

- Geotechnical investigations

- Karst geology and limestone
- Foundation conditions and remediation
- Slope stability (except the open landfill working face and capping)
- Groundwater and hydrogeology – ground water underdrains
- Seismic assessment
- Geotechnical aspects of construction

3 Documents Reviewed

This review is based on the following documentation:

- AB Lime Limited Resource Consent Application. Resource Consent Application to Southland District Council and Environment Southland. Prepared By Jacobs Dated 29 May 2020 Ref IZ000400-LFC-NP-RPT-0001 | 1.

In addition, GHD has been provided access to historic documents held by Council from 2014 to 2020 via the Objective Connect work space.

4 Technical Review Commentary

The technical work to support the original consent and development was undertaken in 2002 - 2003, some 17 years ago. This work has not been provided to support this new consent and we have not previously reviewed that work. However, as a previous independent peer reviewer for this site from 2005 to 2017 we are familiar with the site, its operation, its challenges, ground conditions, and construction history. This incite has allowed a more pragmatic approach to this review.

The documentation provided in support of this new application relies heavily on the original technical assessments. Where there is new available data, more modern engineering practices, changes in standards and changes in the landfill design, technical memos have been prepared to support this consent application. These memos are focused on assessing any adverse effect as a result of the restriction on annual waste placement being removed.

The reliance on the original technical assessments is not unfounded given that the landfill footprint, the final area, capacity of the landfill, the proposed slope angles, cell development, foundation treatments are unchanged. However, it does make it problematic for this current technical review to make statements about the technical robustness of the original work which is being relied upon. This has resulted in some of the requests for information presented below.

The review commentary below has been split into topic areas for the geotechnical speciality and reflects the agreed divisions of subject matter between GHD and Riley.

4.1 Geotechnical investigations

This consent application does not present any new geotechnical investigations of the landfill footprint. Neither does it present any of the original work undertaken with regard to investigations, laboratory testing and the development of geotechnical parameters. The development of the final quarry cut limestone faces to the west, east and north of the landfill footprint will form the final side slopes. These faces should be investigated and engineering geological mapped as part of the ongoing design process for each developed cell. This is considered good practice for slope design and is needed to support side wall, cell and under drainage design and independent peer review approval. Mapping is a consent requirement for the floor subgrade and is documented in the management plan. However, there is no requirement for side wall mapping. It is our opinion that this should be written included in the management plan.

In our opinion, the amount of geotechnical investigation completed to date for this landfill is considered minimal. With regard to this consent application there is an absence of relevant geotechnical parameters for the units used to support the design of the landfill (such as strengths, unit weights etc). There is also a lack of commentary on discontinuities such as bedding and jointing and what influence these may have on stability or groundwater tracking. This may have been addressed in the original consent application which has not been cited by this reviewer.

However, the lack of geotechnical investigations will have no impact of the proposed change in the landfill deposition rate and vice versa.

4.2 Groundwater and hydrogeology – water level monitoring and ground water underdrains

A review of the hydrogeology has been undertaken and presented in Appendix I of the consent application. This was completed by Jacobs because, since the original application, there is a large amount of groundwater level data collected from the monitoring wells on site, published geological mapping has been updated and Environmental Southland has defined three ground water aquifers or zones in the vicinity of the site. Appendix I has an indicative groundwater flow to the south west. The Jacobs review concludes that the limestone quarry is located in the Forest Hill Formation and it is assumed by Jacobs that both the Forest Hill and Southland Group Tertiary aquifers will be locally impacted by the works.

The water monitoring for the development shows that there is documented groundwater draw down in wells SKM 104, 106, 108, 203, 204. The most significant draw down attributed to the quarry development is in the up gradient boreholes SKM 104 and 106 (in the order to 3 to 7m). Down gradient there is either draw down attributed to surface drainage development or the quarry and localised increase in levels due to discharge to ground of stormwater.

This is new data. It is not discussed in the Jacobs technical memo whether this quantum of groundwater draw down was anticipated in the original landfill or quarry consent application and the impact that draw down may have. As quarrying progresses east the quantum of drawdown is expected to increase and the zone of influence will extend eastwards and could extend across the AB Lime property boundary. This potential impact and associated risk is not documented. Additional ground water monitoring wells on the north eastern boundary or in the adjacent property may be prudent to check for any adverse draw down effects off the property.

Drawings IZ000400-1000-NG-DRG-1009 to 1011 present long sections with 2004 and 2019 average water tables in conjunction with the original and current topography and proposed landfill final levels. The cross sections suggest that groundwater should be near to or daylighting in the floor of the quarry where new landfill cells are being developed. Based on relevant experience we understand that the groundwater is not currently pumped from the quarry floor, there is little or no seepage from the cut faces and the groundwater underdrain flow has not increased significantly overtime. Thus ground water levels through the landfill may be lower or at grade than as shown on long sections. We agree that seepages identified in the floor of Area 14 may result from upward groundwater pressures. This is a localised issue and has not been consistent across the quarry floor.

It is indicated that there is a 2m thick Marl layer in the middle of the limestone cut face that is considered as a possible barrier to karst formation (i.e. is an aquiclude). By corollary this suggests that there may be a locally perched water table. We recommend ground water monitoring and/or regular observations of the marl/limestone contact in the quarry to see if there is, in fact, a perched water table on this layer. Such a perched water table may influence the requirement for side wall under drainage.

It is proposed that 2 new groundwater monitoring bores are installed down gradient as shown on plan IZ000400-1000-NG-DRG-1008. These are considered appropriate.

The proposed change in the landfill deposition rate will have no material impact on the hydrogeology as the footprint of the landfill has not altered. However, the water level monitoring data is now clearly showing the impact of the quarry development on ground water levels in the aquifer. It would be beneficial to understand if this is as originally predicted and demonstrated in the original landfill consent application. The potential impact of landfill completion and recharge of the groundwater is not demonstrated or discussed. Should it be shown that the water level will rise to above the base of the landfill floor or that there is a perched water table above the marl then transmissivity of the limestone should be reviewed together with underdrainage design.

Current mapping activities of the quarry faces and side walls indicate minimal to no seepage and this is a reflection of the dewatered state of the surrounding ground. As discussed above, post completion of the landfill, ground water is expected to exhibit some recharge. The current documentation does not demonstrate the level of likely recharge and how this is accommodated in the landfill design.

Groundwater underdrainage on the limestone cut slopes needs to accommodate any expected recharge. The current under drainage on the cut slopes is shown to be a 300mm gravel layer (drawing IZ000400-1000-NG-DRG-1017) and no drainage layer on IZ000400-1000-NG-DRG-1018. These two drawings are inconsistent, contradict each other and need amending. It is stated that the side wall liner design was amended in 2003 to have underdrainage only where ground water is observed. Given the new data on the amount and extent of groundwater draw down, it is our opinion that this be reviewed by development of a groundwater recharge model and an assessment of recharge impact on the landfill and liner. The risks of groundwater recharge on areas with no underdrainage would include the development water pressure on the underside of the liner, development of dissolution features under the liner, liner damage or breach.

4.3 Karst geology and limestone – foundations conditions and remediation

A review of the karstification of the limestone has been undertaken and presented in Appendix I of the application. This was completed as potential karst features have been identified and mapped during landfill development and the site is located in the Winton Hill tomos landform as shown on the district plan. The district plan indicates examples of tomos in the region are along ridgelines as small dolines and pitfalls across the region but are otherwise rare in Southland.

The technical memo presents a similar discussion on tomo locations, and also result from groundwater flow and dissolution of the limestone. It is suggested that the groundwater is saturated with calcium and has no capacity for further dissolution. There is no data to support this assumption.

The presence of tomos in the foundation is currently only confirmed by observation and mapping once the landfill floor is established and from any cut slopes. This methodology will not pick up any underground tomos that have not yet broken through to the floor. These unidentified tomos potentially present a risk for the landfill foundation. The technical memo does not present a risk assessment of this scenario and this is recommended. Existing mitigation measures for any identified surficial karst features are documented but not cited by this reviewer. However, there is no apparent methodology that buried tomos will be located and addressed.

The proposed change in the landfill deposition rate will have no material impact on the karst formation or remediation of any identified karst during construction.

4.4 Slope stability (except the open landfill working face)

This discussion focuses on side wall cut and fill stability. The working landfill face and the final capping are to be addressed by Riley.

The side wall slope angles have been defined in the original consent conditions and we assume that there was supporting analysis and reporting at that time. The original slope stability assessments have

not been provided to support this review and no new analyses have been provided in the Appendix I of the application.

Side walls either in limestone cut or structural fill can be 1V:2H or greater and no change is being requested in the consent conditions. However, we are now aware of the quantum of change in the ground water conditions and potential for recharge that warrants a revision of the stability assessments.

It is not possible to state in this review that the slope stability meets static and seismic design criteria without citing either the original or any new quantitative slope stability assessments. GHD is requesting static and seismic slope stability assessments which reflect the temporary groundwater and final post closure ground water regime.

The proposed change in the landfill deposition rate will have no material impact on the side slope stability however the change in the ground water regime might.

4.5 Seismic model assessment

A review of the seismic model for the site has been undertaken by the applicant as there has been a number of developments in the last 17 years with regard to active fault identification, the development of the New Zealand Seismic Hazard model (2010) and NZS1170 (2004).

Southland represents an area of low seismic hazard in NZ and this has not significantly changed. However, there have been new active faults identified and the impact of ground shaking from major fault rupture at distance has been reassessed. The governing ground shaking hazard remains to be from large earthquakes on the Alpine Fault. Based on the national seismic hazard model shaking will be in the order of 0.2 – 0.3g for a 1:500 return period earthquake.

Whilst there have been new active faults identified within 15km of the site, there are none passing through the site and none that represent a significant ground shaking hazard.

We agree with the conclusion of the technical report which indicates that there has been no significant change to the seismic hazard model for the site and there is no evidence to suggest a change in the risk from faulting in the region. Structure and site-specific peak ground acceleration calculations will continue to be calculated for each design case using NZS 1170.5.

4.6 Landfill management plan

This section of the review discusses relevant sections of the landfill management plan.

<u>Section 9.1.2 Ground Water Underdrainage System</u>

The plan indicates that side slope underdrainage will only be placed when a karst feature is identified or groundwater is present. Given the level of drawdown of the ground water due to quarry activities that has now become evident, and the potential for recharge post closure, the lack of visual groundwater seepage is not considered a valid means of determining if groundwater seepage will impact the side wall and liner post landfill closure and recharge.

As discussed above, it is recommended that this is reviewed following the development of a recharge model for post closure. And if required other means of determining if side wall underdrainage is required should be included.

For karst cavities there are two differing treatment methods discussed and the reader is referred to the Area 15 Technical Specification. These treatments are not shown on the consent drawings and the specification has not been provided with the application.

<u>Section 9.1.4 Slope stability</u>

This sections makes comment on current experience and practice at the landfill and indicates that the quarry activity creates benches 5m wide and 5m high and that the side slopes of the landfill are 1V:2H.

There is no commentary in the plan or in the design drawings to indicate show how the benched quarry slopes are amended to become 1V:2H side wall slopes. There should be discussion in the management plan and on the drawings how this is achieved.

Section 9.5 External Permanent Slope

This section refers to the final capping layer. However, there are other areas of external permanent slope on the back side of structural fill embankments such as at Area 13. To maintain the landfill stability these slopes should not be amended or altered. It would be prudent to identify these areas in the management plan to ensure that they are not adversely disturbed.

Earthworks - The management plan is silent on the development and testing criteria for structural fill which forms any fill embankments or is required to reshape quarry walls. As noted above there is no description on how the batters will be formed at 1V:2H. Structural fill requirements should be in the management plan.

Landfill development plan – Apart from the general plan drawings of the fill with some clearly defined cells there does not appear to be plan a presenting landfill development over time. It would be expected that each area has a defined air space and volume capacity. It would be beneficial to understand the development programme against fill rates. From a geotechnical perspective is there an impact of quarry development on the limestone cut slopes and whether a failure could compromise landfill operations and liner integrity.

5 Consent conditions commentary

With regard to the conditions in the Southland District Council land use consent 60/3/02/138/1, this review has no concerns with the proposed amendments or conditions.

With regard to the conditions in the Environment Southland Discharge Permit AUTH-201346-V3, this review has identified the following:-

Condition No 7a) - this condition is amended to state that the leachate containment system for the side slopes is to include a groundwater underdrainage system where required. As discussed in section 4.2 above the determination of the requirement for underdrainage needs further explanation to confirm it is appropriate for a recharged groundwater level. Development of a recharge model and understanding of the transmissivity of ground water through the limestone should be undertaken to establish whether under drainage “where required” is appropriate or should be mandatory.

Potential new condition – Given the evidence of drawdown on groundwater from the quarry operation and potential recharge post landfilling it may be prudent for the consent to stipulate additional water level monitoring wells up gradient at or beyond the property boundary. These should be read monthly.

With regard to the conditions in the Environment Southland Discharge Permit 201347, AUTH -205861-01-v1, this review has no issue with the proposed amendments or conditions.

6 Further Information Requests

To provide more clarity for this review, the following lists request for further information.

1. Please provide a groundwater recharge model post closure of the landfill and a discussion of how the groundwater flows through the limestone e.g. defect and bedding controlled, in order to establish the behaviour of groundwater in the limestone once the landfill is complete and to support an understanding of the need for side wall underdrainage.

2. In view of the outcomes of query 1) above, please provide details of how groundwater underdrainage on the side walls will be addressed if it is shown that recharge will impact the side walls in order to ensure that there will be adverse impact on the liner.
3. Please provide an up to date ground water draw down zone of influence assessment and an assessment of effects related to this zone of influence in order to ensure that the drawdown zone of influence has no adverse effect outside of the property boundary.
4. Please provide a methodology on how the groundwater draw down zone of influence will be monitored over time, in order to ensure that the potential for adverse effects is being addressed.
5. Please provide the technical specification for area 15 in order for this reviewer to review the details of karst remediation specifics.
6. Please amend drawings 1017 and 1018 to consistently show the requirements of underdrainage for the side wall. In the event that a review of the recharge model and the likely groundwater impact of the side wall liner, please amend the drawings to consistently show any revised design.
7. Please provide quantitative slope stability documentation, either from the original consent application or newly developed ground models for all required load cases and the changed ground water regime now and post closure in order to allow satisfactory review of landfill stability.
8. Please provide an identification methodology, risk assessment and mitigation for buried tomos under the floor of the landfill in order to understand the quantum of this potential risk on the landfill.
9. Please provide a reason as to why engineering geological mapping is not a written requirement on the limestone side walls in order to understand if there is the potential for defect related ground water seepage.

7 Limitations

This report has been prepared by GHD Limited for Environment Southland and may only be used and relied on by Environment Southland for the purpose agreed between GHD and Environment Southland as set out in Section 2 this report.

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The drill hole or test pit logs, cone penetration tests, laboratory tests, geophysical tests and similar work performed and recorded by others has been used by GHD in the form provided by others. The responsibility for the accuracy of such data remains with the issuing authority, not with GHD.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances which arise from the issue of the report which have been modified in any way as outlined above

Please do not hesitate to call the undersigned with any queries.

Sincerely
GHD Limited

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