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3 November 2023

Attn: Rebecca Jackson
Team Leader Consents (Acting)
Otago Regional Council

by email: Rebecca.Jackson@orc.govt.nz

Project name: Green Island Landfill Consent Applications
Project no: IS452400

Subject: RM23.185 – DUNEDIN CITY COUNCIL – TECHNICAL AUDIT RESPONSES; AIR DISCHARGES

Dear Rebecca

Jacobs New Zealand Ltd (Jacobs) was engaged by Otago Regional Council (ORC) to complete a technical audit of a Resource Consent application for air discharges submitted by Dunedin City Council (DCC) for the extension and closure of the Green Island Landfill.

Further information was requested in accordance with Section 92 of the Resource Management Act to enable us to make a full assessment of the application, and was supplied by the DCC in four tranches over the period July-September 2023.

In conducting this audit, we have reviewed the technical information related to air discharges from the landfill as detailed in the following reports:

- Waste Futures – Green Island Landfill Closure – Air Quality Assessment, Rev01; report prepared by GHD dated 13 March 2023 (herein referred to as the "AQ Report Rev01").
- Waste Futures – Green Island Landfill Closure – Air Quality Assessment, Rev02; report prepared by GHD dated 27 September 2023 (herein referred to as the "AQ Report Rev02").

We have also referred briefly to the following documents but have not conducted a full review as that is beyond the scope of the air quality assessment:

- Landfill Gas Masterplan Green Island Landfill, version 3; report prepared by Tonkin & Taylor Ltd dated September 2023 (herein referred to as the "LFG Masterplan")
- Green Island Landfill Development and Management Plan, September 2023; prepared by Stantec (herein referred to as the "LDMP")

Jacobs has not reviewed the landfill gas (LFG) modelling and production forecasts, and assumes that the design and operation of the landfill gas (LFG) collection system at the landfill is sufficient to maximise the collection of LFG as far as practicable. Similarly, we have assumed that the engine and proposed new flare have sufficient capacity (at 800 m^3/hr) to handle all LFG collected at peak generation as well as any digester gas from the Green Island Wastewater Treatment Plant (GIWWTP) that would be blended with the LFG for combustion.

Our technical audit of the air discharge consent application is detailed on the following pages, following the question and response framework requested by ORC.

General	
Q1:	Is the technical information provided in support of the application robust, including being clear about uncertainties and any assumptions? Yes, or no. If not, what are the flaws?

Yes, for the most part the technical information provided in support of the application, including the S92 responses, is robust. In our opinion, there are a small number of issues that were raised in our S92 request that have not been adequately dealt with, however none of these issues are sufficiently significant to prevent us from completing our technical audit. These issues are described in the following sections of this letter where relevant. In addition, the following comments are noted:

- AQ Report Rev02 contains no substantive changes compared to Rev01, such as the inclusion of the two sensitive receptors located within the landfill designation area, despite the S92 information [response to question 84] saying this would be included.
- Errors in the AQ Report Rev01 acknowledged through the S92 process have not been rectified in Rev02, such as:
    - reference to NSW OEH guidance in Section 4.4.3,
    - reference to a 500m^2 working face area in Section 6.1.1 which DCC advised was an error that would be corrected in the Rev02 update to the AQ Report, but has not been rectified.
- The update to the AQ Report from Rev01 to 02 presented the opportunity for the applicant to provide and analyse a further eight months of onsite meteorological data and another year of complaint data, however this was not included.
- The S92 response to question 88 about the applicability of AERMOD in complex terrain is not correct, as there is complex terrain between the site where the LFG is combusted and the receptors.

Q2:	Are there any other matters that appear relevant to you that have not been included? Or is additional information needed? Please specify what additional info you require and why [please explain]

No further information is required.

Q3:	If granted, are there any specific conditions that you recommend should be included in the consent?

Yes, Jacobs recommends some specific conditions as well as edits to the proposed conditions. This question will be addressed at the end of this letter.

Air Quality	
Q4:	Has the applicant accurately assessed odour effects associated with the operation and management of the landfill?

Sources of odour emissions at the landfill are appropriately identified in Section 3.1 of the AQ Report Rev02.

The odour assessment methodology focused on a risk assessment approach, considering the FIDOL factors (frequency, intensity, duration, offensiveness and location) to identify receptors at highest risk of odour impacts. The FIDOL assessment was conducted for the existing operations, and also with a range of additional management and mitigation measures in place. This approach is considered to be appropriate, albeit with the need to acknowledge that the FIDOL assessment approach is qualitative and identifies relative risk rather than absolute risk of occurrence of offensive or objectionable odours.

Existing odour effects were reviewed primarily by analysing complaint history from July 2017 - August 2022. Complaint frequencies peaked in 2018 and 2019, and DCC attributes this to installation of new landfill gas extraction wells and receipt wastewater treatment plant sludges (for which onsite management practices were subsequently reviewed to reduce odour emissions). It is plausible that these activities could have caused an increase in complaints.

Complaint numbers provided in the AQ Report Rev01 for 2022 were only for the first 7-8 months of the year, and were higher than received in 2020 and 2021. This data was not updated in the AQ Report Rev02, so the total number of odour complaints attributed to the landfill in 2022 (or in 2023 to date) is not known. However, the increase in complaints in 2022 does indicate that the existing odour impacts from the landfill are ongoing. This is also supported by the community odour survey results reported in Section 5.3 of the AQ Report Rev02, where the latest odour survey conducted in 2022 indicates a high level of annoyance from landfill odours in the Clariton Avenue area.

The frequency part of the FIDOL assessment detailed in Section 5.4 of the AQ Report Rev02 takes wind speed and direction frequency data measured at the landfill (a small dataset of 11 months) and applies a classification from an odour assessment guideline published by EPA Victoria in 2022 to identify likelihood of impact. This classification scale proposed by EPA Victoria in an impact assessment context is a new concept that is untested in New Zealand and still being tested in Victoria. The frequency analysis in Section 5.4 of the AQ Report implies a "low" likelihood of receptors around the Receptor 1 cluster (Clariton Avenue) being impacted by odour – however this area does report a high annoyance to odour impacts as evidenced by the 2022 community odour survey. In addition, the frequency analysis does not account for meandering winds under low wind speeds due to the variable terrain around the landfill and offsite to the east of the landfill, which may increase the effective frequency of exposure to odour from the landfill for receptors to the east. This meandering wind was observed by Jacobs during the site visit with pockets of stronger odour being observed near the eastern boundary of the landfill under light wind speeds.

The intensity, duration, offensiveness and location parts of the FIDOL assessment detailed in Section 5.4 of the AQ Report Rev02 were reviewed by Jacobs, and are considered to be appropriate.

Jacobs agrees with the conclusion in the AQ Report Rev02 that a range of mitigation measures (existing and new) are required to manage future odour impacts.

The new mitigation measures proposed are described in Section 6.1.2 and Table 7.1 of the AQ Report Rev02. Jacobs agrees that these measures are appropriate and should be adopted at the site as soon as possible to reduce odour emissions.

The proposed mitigation measures are grouped by source and assessed using the FIDOL approach in Table 7.1 of the AQ Report Rev02 to provide a qualitative assessment of how the mitigation measures will aid in reducing emissions and impacts. Jacobs agrees with this qualitative assessment.

Jacobs agrees with the statement in the AQ Report Rev02 Section 7.1.2 that "based on the implementation of the proposed mitigation measures, odour discharges will reduce in terms of both intensity, frequency and duration". However, Jacobs does not agree that the assessment has demonstrated the statement in the last paragraph in that section that "While odours may still be detectable on occasions at or near the site boundary,

providing the proposed mitigation measures are rigorously implemented, the likelihood of off-site odours being considered offensive and objectionable is low. Consequently, odour discharges are unlikely to cause more than a minor effect."

Overall, Jacobs considers that whilst the proposed measures should result in a reduction in the frequency, duration and intensity of odours noticed by sensitive receivers, evidence has not been provided to demonstrate that off-site odour impacts will reduce to the extent that there is no offensive or objectionable odour effect due to landfill activities. Due to the nature of landfill activities at the site, it is unlikely that such evidence could be provided.

Q5:	Have the effects on air quality including specific effects on neighbouring landowners been appropriately identified and assessed?

Potential air pollutants and their potential air quality effects are appropriately identified in Section 2.3 of the AQ Report Rev02. In essence these potential air quality effects are:

- Amenity effects from discharge of odour or dust from the landfill (discussed above in response to Q4), and
- Human health effects from discharge of combustion gases from the energy centre at the GIWWTP where the LFG is burned in the engine and flare.

The methodology for assessment of combustion gases relies on the use of atmospheric dispersion modelling to assess downwind ground level concentrations of discharged pollutants nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM_{10} and $PM_{2.5}$). Jacobs has reviewed the methodology used in the AQ Report Rev02 to conduct the modelling and assess the results, and the following comments are noted:

- Meteorology setup for model:
    - The meteorology for AERMOD was established using the upper air estimator tool included in the Lakes AERMOD modelling program, however no analysis of the suitability of the outputs from this tool was included in the air quality assessment.
    - Wind direction data in AERMET is rounded to the nearest 10 degrees rather than the common convention of randomizing the last digit of the direction to avoid stratification of model results.
    - All surface data in AERMET (wind, temp and RH) is specified at 10m above ground level, rather than the usual convention of specifying wind at 10m and temp/RH at 2m. In addition, the surface station primary met tower base elevation is set at zero metres. These settings may affect the upper air estimator tool outputs.
    - Wind speed and direction is based on Dunedin airport measurements, rather than the onsite data due to the short duration of the onsite dataset. It is noted that by the time AQ Report Rev02 was published sufficient data would have been available for a 12-month dataset to compare with the Dunedin airport data and this would have helped resolve some uncertainty in the model interpretation due to the meteorological inputs.
- Sulphur dioxide (SO_2) assessment using AERMOD
    - SO_2 emissions were calculated assuming a hydrogen sulphide (H_2S) maximum concentration in the biogas of 500ppm, which DCC advised is based on testing of LFG from the Green Island

landfill for the Smooth Hill consent application where a typical H_2S concentration of 400-500 ppm was observed. No data was provided by DCC to support this advice. DCC did not advise whether this testing also included H_2S contributed by the biogas from the GIWWTP which could increase the overall sulphur content of the biogas mix.

- "US NAAQS special processing" was not disabled in the AERMOD setup, which means that model results are based on daily maximum 1-hour values across the year rather than considering all 1-hour values which is not appropriate for New Zealand. However, as the highest rank of 1-hour concentrations was extracted from the model, the use of US NAAQS special processing does not affect the assessed model results.

- 24-hour averages for SO_2 are reported as 99.9th percentiles. The usual convention for reporting 24-hour averages is to use the 100th percentile. This means that the incremental or "site contribution" SO_2 concentrations listed in Table 7.9 of the AQ Report Rev02 for 24-hour averages are under-reported by up to 37%, based on Jacobs' own replication of the GHD model from the model files supplied by GHD.

- The assessment criteria adopted for SO_2 are listed in Table 4.2 of the AQ Report rev02. The source of the assessment criteria is the National Environmental Standards for Air Quality (NESAQ) and the New Zealand Ambient Air Quality Guidelines (NZAAGQ). Whilst the NESAQ and NZAAQG are currently the prevailing regulations and guidelines in New Zealand, the health advice now provided by the World Health Organisation (WHO, 2021 Global Update) recommends a lower assessment criteria for 24-hour average SO_2 of 40 µg/m^3 with 3-4 exceedances allowed per year (rather than the value of 120 µg/m^3 in the NZAAQG).

- New Zealand has not currently moved to revise the NESAQ and NZAAQG in response to the WHO recommendations, however other countries internationally including Australia have done so. If the model results for 24-hour average SO_2 in Table 7.9 of the AQ Report Rev02 were assessed against the WHO criteria of 40 µg/m^3, and taking into account that the listed 24-hour concentrations are 99.9th percentile which accommodates some exceedances, one would still conclude that the risk of adverse effects is minor because the predicted cumulative concentrations at a sensitive receptor are less than one third of the WHO recommendations.

- However, overall it is noted that there are uncertainties in the predicted model results because of the limitations in the meteorology used in the model (as described above), the assumed H_2S composition of the LFG, the use of assumed background concentrations, and the use of AERMOD in complex terrain. Jacobs considers that the sensitivity of the model results to these uncertainties is unlikely to result in predictions of ground-level cumulative concentrations exceeding either the WHO or NZAAQG/NESAQ assessment criteria, however some control on the concentration of H_2S in the biogas burned in the engine and flare is appropriate.

- It is therefore recommended that the concentration of sulphides (expressed as H_2S) in the blended gas burned in the engine and flare be limited to 500 ppm as a consent condition. This would include mixtures of biogas combining LFG from the landfill and digester gas from the GIWWTP.

- Nitrogen dioxide (NO_2) assessment using AERMOD

  - In the AQ Report Rev02, NO_2 emissions were assumed to comprise 100% of the NO_X emission. This provides a very conservative approach to assessing NO_2. The predicted

incremental and cumulative NO_2 concentrations are well below the assessment criteria adopted in the report.

  - The assessment criteria for NO_2 are adopted from the NESAQ and NZAAQG, however as with SO_2 these criteria are now quite large in comparison to criteria recommended by WHO and adopted overseas for 24-hour and annual averages. The NO_2 concentrations now recommended by WHO for air quality guidelines are 10 and 25 µg/m^3 for annual and 24-hour averages respectively (compared to values of 40 and 100 µg/m^3 respectively adopted in AQ Report rev02).

  - Adopting the WHO-recommended annual and 24-hour concentrations for this assessment would be problematic, because the assumed background concentrations are higher than the WHO-recommended concentrations for both annual and 24-hour averaging periods. However, the incremental concentrations from site contribution are much smaller than the assumed background, and also conservatively assume that 100% of the NO_X is converted to NO_2.

  - Therefore, Jacobs agrees with the conclusion in the AQ Report Rev02 that there is limited potential for adverse effects on the environment due to NO_X emissions.

- Carbon monoxide (CO) assessment using AERMOD

  - Incremental carbon monoxide ground-level concentrations predicted by the AERMOD model are very small relative to background and the assessment criteria.

  - Jacobs agrees that the potential for adverse health effects associated with CO emissions is expected to be low.

- PM_{10} assessment using AERMOD

  - Site contributions to ground-level PM_{10} concentrations are very low relative to background concentrations, the assessment criteria, and the requirements in Regulation 17 of the NESAQ. This finding is unlikely to change even taking account of the limitations to the meteorology described above under the discussion for SO_2.

  - Jacobs agrees that the potential for adverse health effects associated with PM_{10} emissions is expected to be low.

- $PM_{2.5}$ assessment using AERMOD

  - Site contributions to ground-level $PM_{2.5}$ concentrations are very low relative to background concentrations and the assessment criteria. This finding is unlikely to change even taking account of the limitations to the meteorology described above under the discussion for SO_2.

  - Jacobs agrees that the potential for adverse health effects associated with $PM_{2.5}$ emissions is expected to be low.

Q6:	If monitoring of the air quality is required, where should monitoring be undertaken, how should monitoring be undertaken, what parameters should be monitored, and how often?

LFG monitoring at Energy Centre

- Monitoring of gas flow rates to the engine and flare(s) should be conducted continuously, including separate monitoring of LFG and biogas from the GIWWTP.

- Monitoring of H_2S composition of the combined LFG/biogas feed to the engine and flare should also be carried out. For the Tirohia Landfill consent applications and appeals, Waste Management proposed a condition (which was adopted in the recommended consent conditions for the appeal) to monitor the concentration of hydrogen sulphide (ppm) in the blended LFG prior to combustion at least weekly. Jacobs recommends a similar consent condition for Green Island.

Odour monitoring

- Jacobs agrees with the proposal by DCC to monitor odour at the site boundary by odour scouts. However, the methodology described in the S92 information response (Tranche 4, question 108 response) indicates that the monitoring would be conducted by on-site staff. These staff would not be independent and are likely to have a low sensitivity to interpret findings of landfill odour and therefore any findings of "no odour" or "weak odour" would have low credibility.

- The application is unclear about the frequency of odour surveys that would be carried out. In the AQ Report Rev01, "regular odour scouting" is identified as a proposed mitigation measure for irregular odorous activities. In the S92 request, the applicant was asked to clarify whether scouting would be used regularly or just for irregular loads. No response to this question was provided and there was no change to the text in the AQ Report Rev02. Odour scouting is not mentioned in the LDMP, but the Tranche 4 response to Question 108 says that it would be included in the LDMP if consent is granted, which provides no certainty about frequency and methodology for scouting.

- Jacobs considers it appropriate to have some independent odour scouting in addition to the site-sourced odour scouting proposed by the applicant. Consent conditions are recommended to incorporate this requirement, following a similar structure to that agreed with Waste Management for the Tirohia Landfill.

Landfill surface monitoring

- The AQ Report Rev02 recommends the following frequency of landfill surface monitoring:

    - instantaneous surface monitoring (ISM) on a quarterly basis until closure (increased regularity to existing operations) to identify any areas of capping that need to be remediated.

    - monthly walk-over inspection of the landfill cap/cover to identify any damage to the cover system and to monitor the effectiveness of the mitigation measures.

- Jacobs agrees with the use of these monitoring measures, but disagrees with the recommended frequency. Monitoring of the landfill cap is important to minimize opportunities for fugitive emissions of odour, both before and after closure.

    - Jacobs recommends using ISM on a monthly basis until closure, and then quarterly after closure.

    - Jacobs also recommends conducting walk-over inspections of the landfill cap/cover on a weekly basis until closure, and then monthly after closure.

- The integrity of the cover system will need to continue to be monitored after closure for some period of time until ORC is satisfied that the risks of LFG migration or cap deformation with associated fugitive emissions of LFG are minimal.

Q7:	Have the cumulative effects of the activity been appropriately assessed? Yes/no

Combustion gases

- Jacobs understands that the LFG engine at the adjacent GIWWTP can burn biogas sourced either from the landfill or from the GIWWTP. This is referred to both in the AQ Report Rev02 and in the LFG Masterplan. It is also understood that the GIWWTP also burns biogas generated at the GIWWTP in boilers.

- The emissions from all biogas and LFG combustion at the GIWWTP should be assessed cumulatively as the activities are essentially one site. The respective generation rates for digester gas from the GIWWTP and LFG from the landfill and the interaction between these two gas sources as feedstock for the engine (and flare) have not been detailed by the applicant, despite a request for further information (Question 106). In the response to this question in Tranche 2, DCC stated that "Combustion of biogas from the WWTP was not included in the modelling undertaken for the engine and flare as it is a separate operation to combustion of landfill gas. Emissions from the biogas boilers have not been assessed."

- Emissions of CO, NO_X, PM_{10} and $PM_{2.5}$ from the biogas boilers are likely to be much smaller than the emissions from the engine due to the type of combustion device, and therefore including these emissions in the AERMOD simulations would have been unlikely to change the assessment conclusions.

- However, emissions of SO_2 from the boilers are unknown because the H_2S content of the biogas is not known. In addition, discharges from the boilers are likely to be of lower temperature than the emissions from the flare and engine and therefore may have different dispersion behaviour.

- Therefore, Jacobs considers that the cumulative effects of SO_2 emissions from the GIWWTP energy centre have not been appropriately assessed. A concentration limit of 500ppm sulphides (expressed as H_2S) in the combined biogas feed to the engine and flare is recommended as a consent condition.

Odour

- The cumulative assessment of odour emissions does take into account odour emissions from the GIWWTP, but does not consider odour emissions from future proposed composting operations on the site. Cumulative effects including the future proposed composting operations will be considered under the consent application for the proposed Resource Recovery Park.

Q8:	Has the applicant accurately assessed the combustion emissions associated with the operation and closure of the landfill associated with flaring of LFG and operation of vehicles and machinery onsite

The assessment of combustion emissions associated with LFG is addressed under question 5 above.

The assessment of combustion emissions associated with operation of vehicles and machinery onsite is provided in Section 3.3 of the AQ Report Rev02 and is appropriate.

Q9:	Has the Applicant correctly assessed the requirements of the NESAQ, with particular regard to Regulations 17, 26, and 27?

In Jacobs' opinion, Regulation 17 of the NESAQ has been correctly assessed.

Regulation 26 is referred to in Section 4.3.1 of the AQ Report Rev 02, although it has not been directly addressed in the AQ Report Rev02 other than to defer to the LFG Masterplan. Consent conditions should ensure that monitoring is appropriate to ensure that any discharge of gas from the surface of the landfill does not exceed 5000 parts of methane per million parts of air. The AQ Report Rev02 states that this monitoring by a commonly used technique known as instantaneous surface monitoring or "ISM" is currently conducted annually, and recommends that this monitoring should be done quarterly. However Jacobs is aware that many landfills are required to conduct ISM monitoring monthly. Given that this monitoring can also detect fugitive odour emissions from the landfill and allow these to be remedied in a timely manner, a monthly frequency is recommended by Jacobs.

Regulation 27 is also referred to in Section 4.3.1 of the AQ Report Rev02, and also defers to the LFG Masterplan as evidence that the site complies with Regulation 27. Whether the flare at the GIWWTP can be regarded as a principal flare for the purposes of Regulation 27, and whether the proposed new flare complies with the design requirements in Regulation 27, is beyond the scope of Jacobs' review.

Q10:	Has the applicant accurately assessed the effects from dust associated with the operation and closure of the landfill?

Sources of dust emissions at the landfill are appropriately identified in Section 3.2 of the AQ Report Rev02.

The assessment of dust impacts is provided in Section 7.2.2 of the AQ Report Rev02. GHD states that they are not aware of any historic complaints in relation to dust from the landfill, and similarly Jacobs is not aware of any complaints nor any other anecdotal evidence of off-site issues related to dust emissions. Given the absence of existing impacts, Jacobs agrees with the conclusion by GHD that based on the operational activities of the landfill, it is unlikely that operation dust emissions will cause any adverse effects beyond the site boundary.

Jacobs also agrees with the dust mitigation measures outlined in Section 6.2 of the AQ Report Rev02 and considers that these measures are appropriate for the site.

Q11:	Do you consider that the mitigation measures proposed by the applicant are appropriate? Please explain.

Yes, Jacobs agrees with the mitigation measures proposed by the applicant for both odour and dust. Our reasons for this conclusion are outlined in the relevant sections above.

No mitigation measures are recommended for combustion gas emissions, and no measures are considered to be necessary by Jacobs other than the proposed consent condition limiting the sulphide concentration in the blended gas fed to the engine and flare.

Q12:	Do you agree with the Applicant's conclusions as to the level of adverse effects on air quality?

Jacobs agrees in part with the applicant's conclusions, for reasons elaborated in the previous sections of this letter. To summarise:

- Jacobs agrees with the applicant's conclusions regarding the potential impacts of dust emissions.
- Jacobs agrees with the applicant's conclusions regarding the potential impacts from combustion emissions from the engine and flare; provided that the condition that the permitted concentration of sulphides (expressed as H_2S) in the blended gas feed to the engine or flare is limited to 500 ppm or less.

- Jacobs does not agree with the applicant's conclusion regarding the potential impacts of odour emissions, insofar as we are not able to agree that the impacts from odour emissions after the implementation of recommended mitigation measures are unlikely to cause more than a minor effect. In our opinion, whilst the proposed measures should result in a reduction in odour emissions, the applicant has not established that off-site odour impacts will reduce to the extent that there is no offensive or objectionable odour effect due to landfill activities.

Q3:	If granted, are there any specific conditions that you recommend should be included in the consent?

Jacobs recommends specific conditions relating to the following:

- Monitoring of the sulphide content of the biogas feed
- Monitoring of gas flow rates to the engine and flare
- Monitoring of stack discharges from the engine
- Monitoring of odour at the site boundary and at sensitive receptors by odour scouts, both by independent contractors and by site-staff, with adaptive management of on-site operations and mitigation measures in response to monitoring outcomes.
- Restrictions on the size of the working face
- Periodic independent review of landfill operations
- Maintaining wind monitoring at the site
- Ensuring that the full range of mitigation measures detailed in AQ Report Rev02 are carried through into the LDMP.

In addition, some modifications to the wording of some of the proposed conditions (version supplied with the application in April 2023) are recommended, and we will provide these recommendations as well as recommended wordings for the items listed above in a tracked-changes version of the latest proposed conditions once that can be supplied.

Yours sincerely,

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