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MEMORANDUM

INTRODUCTION

Pattle Delamore Partners Limited (PDP) has engaged JS Ecology Ltd to undertake a review of the application to the Hawkes Bay Regional Council by Ravensdown Limited for renewal of resource consents required for the operation, upgrading and maintenance of the Ravensdown Napier Works Fertiliser Plant as it relates to effects on vegetation. The location of the site at which the proposed activity is to occur is 200 Waitangi Road, Awatoto, Napier 4110.

The application contains a range of reference reports, assessment reports, proposed resource consent conditions and management plans of which the following have been reviewed for relevance to vegetation and ecology:

1. Ravensdown Limited Sustainable Site Project: Resource Consent Applications and Assessment of Environmental Effects by Mitchell Daysh (March 29 November 2021).
2. Part E: Proposed Consent Conditions: Discharge to air
3. R4 – Air Discharge Strategy by Andrew Torrens, Ravensdown Limited (November 2021a)
4. A1 - Air Discharge Dispersion Modelling and Air Quality Effects Report by Richard Chilton, Tonkin + Taylor (November 2021)
5. A2- Vegetation Effects by Stephen Trolove, Plant & Food Research (*November 2021*).
6. M1: Source Control Management Plan

This review considers whether the proposed activity and resource consent conditions sought by Ravensdown Limited as set out in their application and supporting documents is likely to result in adverse effects on terrestrial vegetation surrounding their Awatoto fertiliser plant based on the information provided in the Application and supporting documents and whether that information is complete.

1 ASSESSMENT OF ENVIRONMENTAL EFFECTS

1.1 Background

The Assessment of Environmental Effects (AEE) has been prepared by Mitchell Daysh.



Key aspects relating to terrestrial vegetation are:

- The application for a discretionary consent for discharges to air.

The AEE provides a useful overview of the existing environment and surrounding landuse, meteorology and topography.

Ravensdown Limited (“Ravensdown”) undertakes the manufacture, storage and sale of sulphuric acid and phosphate fertilisers which requires the import of bulk materials and the production of sulphuric acid.

Ravensdown currently holds a suite of Resource Consents issued by the Hawkes Bay Regional Council and Napier District Council covering discharges to air, discharges to water, water take and land use.

The current water and air discharge permits are due to expire on 31 May 2022 and 21 Oct 2022 respectively.

Discharges of fluoride (F), acidic oxides of sulphur and dust to air from the fertiliser manufacturing process can cause harm to vegetation.

1.2 Existing environment

The AEE describes the site location and surrounding land use.

The Napier Works is located at the southern extent of the Main Industrial Zone at Awatoto. It lies adjacent to the foreshore on the eastern side with the land to the west being mainly rural zoned land with pastoral farming and horticulture / viticulture being the main land uses.

The Waitangi Regional Park and the Waitangi Estuary, lies on the southern side of the Napier Works boundary. The Waitangi Estuary is listed as a Significant Conservation Area (“SCA”) in the Regional Coastal Environment Plan. The Waitangi Regional Park has been developed by the HBRC in conjunction with mana whenua in recognition of the significant cultural, historical, biodiversity and recreational values in the area. It is noted as being one of the top 10 wetlands in the region requiring protection and enhancement and it supports a significant population of birds within wetland and coastal environments.

Fluoride gas emissions and acidic aerosol discharges can impact sensitive horticultural crops, conservation vegetation and other amenity vegetation.

Several areas of fluoride-sensitive perennial crops have been identified to the west of the Napier Works within 3km (Figure 1) and the Waitangi Regional Park is located in close proximity to the Ravensdown Works on its southern boundary.

Prevailing winds come from the northeast and southwest quarters with the strongest winds prevailing from the northeast quarter.

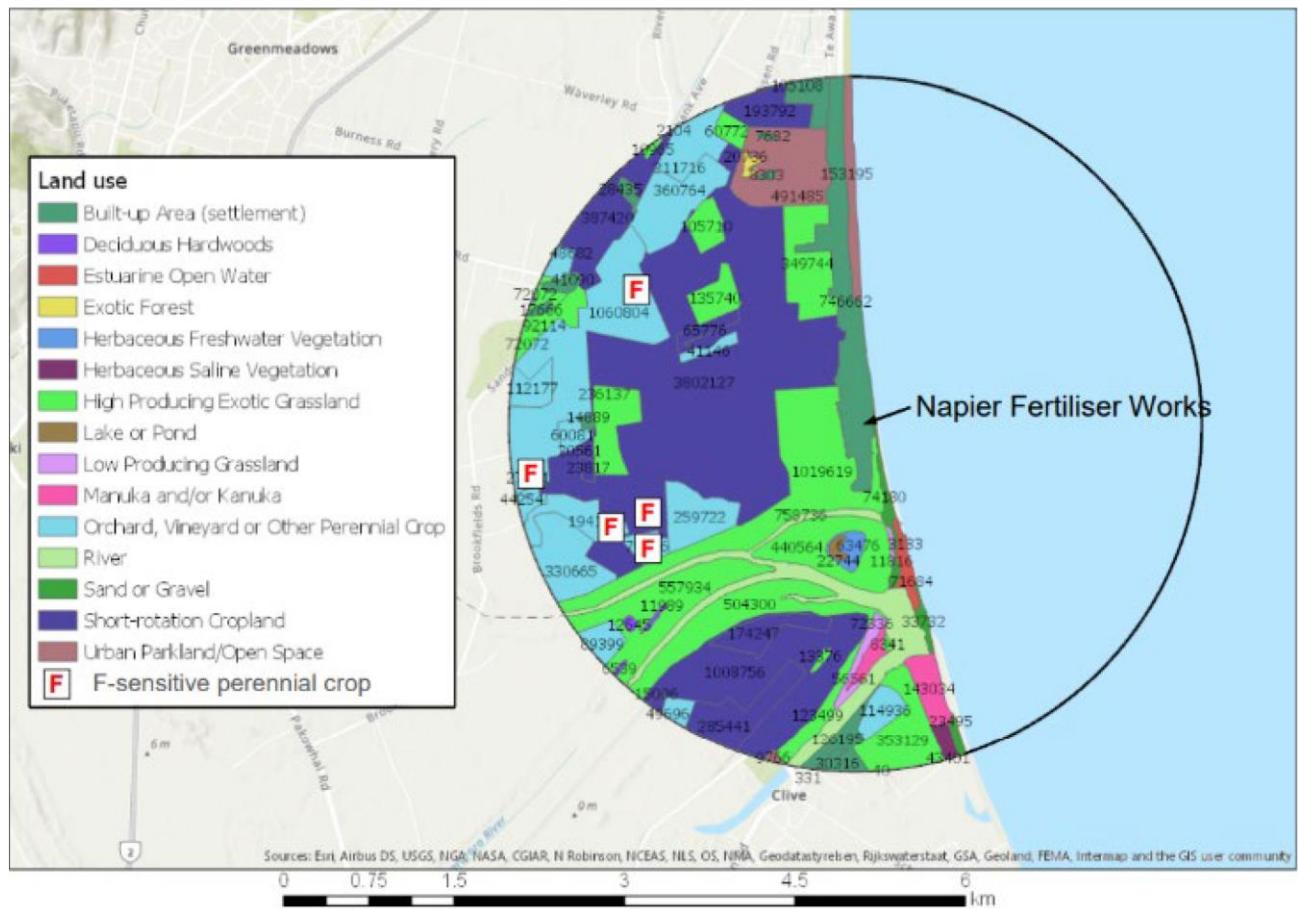


Figure 1: Landuse and distribution of vegetation within 3km of the Ravensdown Napier Works (presented as Figure 5 in the AEE).

1.3 Climate change

The AEE notes the potential effects of climate change on vegetation based on a report on climate change projections prepared by NIWA for the Napier District Council entitled “*Climate Change Projections and Impacts for Tairāwhiti and Hawke’s Bay, NIWA Report No. 2020298AK, November 2020*”.

The report notes that increasing temperatures due to human-induced climate change are likely to impact primary sector activities through increasing the incidence of pests and diseases. Increased temperatures can also affect plant growth and result in increased incidence of drought and intense rainfall events. Such climate-related effects may cause stress to vegetation and result in greater susceptibility to other stressors such as air emissions.

1.4 Air Discharge Strategy

Ravensdown has developed an Air Discharge Strategy that sets out measures being adopted to reduce air discharges across its site.

Ravensdown has commenced implementation of this strategy by committing to the replacement in 2023 of the existing Den Scrubber System and the Acid Plant Converter Tower. The replacement of

these assets and increased onsite source control measures will result in improvements to both stack discharges and fugitive emissions from the site which are reflected in the proposed consent conditions.

1.5 Air Quality Effects Assessment

An assessment of air quality effects was undertaken and is discussed in a report prepared by Tonkin + Taylor (T + T): Air Discharge Dispersion Modelling and Air Quality Effects Report by Richard Chilton (November 2021).

Main discharges to air from the site that may potentially affect vegetation are:

- Fluoride and acid mist from the Manufacturing Plant
- Sulphur dioxide (SO_2) and acid mist from the Acid Plant
- Dust generated from the Brady Mills.

Discharges of fluoride, SO_2 and dust have been assessed using air dispersion modelling to predict contaminant ground level concentrations enabling an assessment against relevant air quality criteria for sensitive ecological systems. This has been combined with a review of available ambient monitoring data¹.

The assessment evaluates the existing site configuration as well as proposed changes to the plant in line with Ravensdown's Air Discharge Strategy, most notably associated with the new Den scrubber and the new Acid Plant converter.

In relation to effects on vegetation, the air quality assessment provides an evaluation of predicted fluoride and SO_2 concentration against ambient air quality guidelines for sensitive ecosystems and the results are used to further inform a separate assessment by The New Zealand Institute for Plant & Food Research Limited.

The predicted concentrations are well within the relevant MfE guidelines for the protection of sensitive ecosystems except for land to the immediate east of the site (former Winstone site and foreshore). Further consideration of vegetation effects is provided by The New Zealand Institute for Plant and Food Research Limited.

Dispersion modelling has shown that the planned new Manufacturing Plant stack and proposed reduction in maximum fluoride emission will lead to a reduction in fluoride ground level concentrations (GLC) compared with the existing plant configuration.

Predicted SO_2 concentrations from the normal operation of the site are well within the relevant assessment criteria for vegetation impacts. Concentrations are expected to reduce further as a result the replacement of the Acid Plant converter.

¹ A calibration issue was identified for the continuous gas flow meter in the Acid Plant stack in the review of the Acid Plant undertaken by Chemetrics. Tonkin & Taylor was not aware of this issue and modelling of emissions from the Acid Plant may have to be re-run using updated emission rate information.

Isolated events have occurred where high concentrations of SO₂ have been measured offsite to the east at the Winstone monitoring site. These events have historically been associated with start-up of the Acid Plant, although more recently fires associated with the sulphur melter also resulted in high concentrations. Ravensdown has implemented changes to the Acid Plant start-up procedures to reduce SO₂ emissions and has increased the height of the start-up stack from 3m to 18m to improve dispersion of those emissions – no monitoring exceedances at the Winstone site have been attributed to start-up conditions since this time.

Ravensdown continues to investigate measures to minimise emissions associated with start-up conditions and has implemented measures to minimise the likelihood of a melter fire occurring in future. Ravensdown is progressing plans for its replacement in line with international industry best practice.

Given the above, T+T considers the adverse effects associated with the discharge of SO₂ from the site is low, and effects will reduce further with the proposed convertor replacement. On this basis they consider the potential SO₂ effects to be less than minor.

Dust (PM10 & PM2.5) was assessed as not being problematic in relation to vegetation except at the former Winstone Aggregates site directly to the east of the Ravensdown Works. There is currently no sensitive vegetation in this area.

Overall, based on air discharge modelling, the ongoing potential for adverse air quality effects described above is assessed as being less than minor. Notwithstanding this, several improvements to the site are proposed that will reduce air discharges in line with Ravensdown's Air Discharge Strategy (Ravensdown 2021).

1.6 Vegetation Effects

An assessment of the effects of air emissions on vegetation was undertaken and is discussed in a report prepared by the New Zealand Institute for Plant and Food Research (“**Plant & Food Research**”) (*Trolove S: Reviewed by Searle B, Clothier B, Doley D. November 2021. Effects of emissions-to-air from the Ravensdown Napier Fertiliser Works on vegetation*).

1.7 Community Engagement

Ravensdown formed a Technical Focus Group (TFG) made up of representatives from a diverse range of key stakeholder groups to engage with Ravensdown during the consent project. The purpose of the TFG was to provide advice and input to Ravensdown as part of a two-way information sharing process for the preparation of the resource consent application package. Key stakeholders with specific interests in the effects of the proposal on vegetation represented in the TFG were:

- Ravensdown clients from the horticultural and agricultural sectors,
- The Department of Conservation,

- Mana Whenua and
- Forest and Bird²
- Napier City Council Environmental Team and
- Hawke's Bay Regional Council -Operations Focus

Ravensdown has gained insight into the community's views in relation to the Napier Works and intend to work alongside stakeholders to strengthen and maintain these relationships.

Ravensdown is planning to hold an Open Day at the Napier Works during the submission period to provide members of the public with an opportunity to discuss the project and resource consent application with Ravensdown, their independent experts and members of the TFG. This will enable potential submitters to become familiar with the step change proposed to site operations before preparing a submission.

Engagement of stakeholders appears to be good, providing opportunity for key stakeholders such as horticulturalists and conservationists to understand the potential effects of the Ravensdown emissions to air on surrounding sensitive vegetation.

1.7. AEE Conclusions

The AEE provides an assessment of the actual and potential effects associated with the proposal and provides an overall conclusion that any adverse effects will be minor or less than minor and can be managed through the proposed consent conditions and management plans. With regard to vegetation effects it provides an overall summary of the content and the conclusions of the report on vegetation effects by Plant and Food Research.

2 RAVENSDOWN AIR DISCHARGE STRATEGY

2.1 Background

The Napier Works Sustainable Site Project Air Discharge Strategy 2021 (Andrew Torrens) has been prepared by Ravensdown as a cornerstone document underpinning a complete review of emission management on the Site looking forward to the replacement of the company's resource consent to discharge contaminants into the air from the Site which expires on 21 October 2022.

While the company currently operates within reasonable compliance with its existing resource consents it is recognised that positive and significant improvement will form the basis for requesting a long term (35 year) discharge consent to secure the future of the site.

2.2 Baseline Air Quality Environmental Assessment

Tonkin + Taylor ("T+T") has undertaken dispersion modelling of all major air emissions from the Site assessing the monitoring data from the key contaminant emissions from the current stack configuration associated with operation of the site. T+T's assessment of potential air quality

² Representative from Forest and Bird withdrew after TFG Meeting 3 due to a change in role

effects of the discharges includes impacts on vegetation (fluoride, SO₂ and acid mist). In relation to vegetation effects it concludes that:

- The predicted concentrations of fluoride and SO₂ are well within the relevant MfE guidelines for the protection of sensitive ecosystems (in regard to the effects on vegetation).
- There will be a significant reduction in fluoride ground level concentrations from the proposed combined Manufacturing Plant stack compared with the existing plant configuration.

2.3 Determination of Air Discharge Targets

The air discharge strategy and targets which are proposed as consent conditions have been developed following consideration of the relevant regulatory standards and guidelines, the existing monitoring data and advice of the Ravensdown project technical team.

Key air discharge targets relating to vegetation are:

Fluoride

Following the installation of the new Den Scrubber and combined stack the currently consented 1.5kg/hr emission of fluoride will be reduced to 1kg/hr under the proposed resource consent conditions. New scrubber technology will enable Ravensdown to meet new reduced discharge conditions with certainty.

Sulphur dioxide

Emissions from the Acid Plant main stack will be reduced from 60kg/hr to 40kg/hr. New converter technology will enable Ravensdown to meet new reduced discharge conditions with certainty. Emissions from the Manufacturing Plant stacks have no limit under the current consent conditions. A new emission rate limit of 10kg/hr as a 1hr average is proposed as a new standard because there is a sulphur dioxide discharge from this stack.

Acid mist and sulphur trioxide

The existing discharge limit from the Acid Plant main stack of 0.5kg/hr for acid mist and sulphur trioxide is proposed to be retained as the existing conditions are consistent with the process capability of the plant and known best practice.

Overall comments on the Ravensdown Air Discharge Strategy as it relates to vegetation effects

The air discharge strategy clearly sets out the type and source of emissions from the Ravensdown Works. It sets out how reductions in both stack emissions and fugitive emissions will be achieved and what the maximum levels of current and future stack emissions are. It also explains that fugitive emissions are not measured or captured.

This report provides a useful summary for understanding key issues relating to vegetation effects.

3 EFFECTS ON VEGETATION OF EMISSIONS TO AIR FROM THE RAVENSDOWN NAPIER WORKS.

Plant and Food Research have provided a report entitled “Effects of emissions-to-air from the Ravensdown Napier Fertiliser Works on vegetation” written by S Trolove (November 2021).

This section examines the appropriateness and adequacy of the investigations undertaken by The New Zealand Institute for Plant and Food Research (“Plant and Food Research”) and considers whether valid conclusions have been reached based on the results obtained. The appropriateness of the recommended approach to address vegetation effects is also discussed.

3.1 Executive Summary

The executive summary provides the clearest and most readable section of the report as reproduced below:

The key findings of the report are summarised below:

The main contaminants discharged to air from the Napier Works that have the potential to harm plants are fluoride (F), sulphur dioxide (SO_2), acidic aerosols and dust. The potential effects of these at high concentrations are:

- Fluoride: leaf deformities, yellow or dead patches on leaves, reduced fruit-set and reduced plant growth.
- Sulphur dioxide: leaf damage.
- Acidic aerosols: leaf deformities, burn-like symptoms and impaired stomatal behaviour.
- Dust: reduced photosynthesis, blocked stomata, increased leaf temperature and water loss.

The assessments undertaken to investigate the risk of harm included:

- Investigating any complaints made to Ravensdown over the current resource consent period (2007–2021).
- Conducting field walks of the Waitangi Regional Park, and leaf testing to investigate the cause of possible damage from emissions.
- Examining the leaf F monitoring data collected by Plant & Food Research from 2007–2021.
- Comparing modelled F and SO_2 concentrations with guideline concentrations for vegetation published by the Ministry for the Environment (MfE).
- Reviewing the scientific literature for recommended concentrations in the case of acidic aerosols, where MfE guidelines did not exist.

The results of these assessments were:

- No cases of damage to vegetation during the current resource consent period that could be attributed to the Napier Works.
- Dust was considered to have negligible effect on vegetation outside of the Napier Works’ boundary.
- There were no high leaf F concentrations that may indicate loss of marketable yield (i.e. loss of yield or quality that may affect grower returns).
- Modelled concentrations of F and SO_2 were below concentrations likely to cause economic damage to crops in the Awatoto–Meeanee area, given the current distribution of crop species.

- The F emissions may be a cause for concern if F-sensitive species are planted closer than 1.0 km to the Napier Works Manufacturing Stack, and Ravensdown emit F at the maximum rate of 1.0 kg/h for approximately 12 h or more.
- The literature review indicated that a pH of >2.7 for Manufacturing Stack emissions should be generally appropriate to avoid damage to vegetation and fruit from acidic aerosols. However, there might be a very low risk of some damage arising from regular, intermittent exposure to acidic emissions of pH ≤4.0 (depending on the crop species and growth stage) under misty or highly humid conditions without significant rainfall (≤ 0.2 mm), where the wind is fluctuating back and forth across orchards for several hours. This risk may be greater during flowering in spring. There have been no reports of damage under such conditions during the current resource consent period.

Suggested approach for effects identified were:

The low risk of potential damage if a F-sensitive crop was planted closer than 1.0 km to the Manufacturing Stack would be mitigated by:

- Improved management of fugitive emissions via the proposed Source Control Plan leading to reduced fugitive emissions.
- Normal factory operations release F at much lower rates (an average of 0.07 kg/h) than the 1.0 kg/h rate for 12 h used in the model.

The very low risk of damage from acidic aerosols at pH <4.0 with repeated exposure could be mitigated by:

- Adjusting the Manufacturing Stack emissions to pH >4.0 under misty or very humid conditions where the wind was blowing towards an orchard for a period greater than 30 minutes. These weather conditions are described in condition 39 of the current consent: i.e., the pH should be adjusted to >4.0 when the wind speed is <3m/s and the wind direction is between 030°-155° (i.e., on-shore) and the temperature is >22°C, it is dark and the relative humidity is >70%. This condition would only hold during the growing season for pip and stonefruit (late August to end of April). For the growing season outside of the flowering period (i.e., for the months of November to April) the risk is only for multiple exposures, so emission pHs of <4.0 on up to three different days should not be considered a breach of resource consent.

No other significant risks were identified.

3.2 Introduction

The purpose of the report was to determine whether the emissions from the Napier Works are currently causing damage to vegetation, and also to assess the risk of future damage.

An earlier report prepared by Plant and Food Research (Effects of air emissions from the Napier Superphosphate Works on vegetation, and influences of proposed stack modifications by S Trolove) in October 2020 was reviewed by Bioresearches as part Ravensdown's application to vary

their existing resource consents to allow for modification of emission stacks. The current Plant and Food Research report contains much of the information covered in the earlier report in relation to the general effects of fluoride and sulphur dioxide emissions on plants.

3.3 Airborne pollutants emitted from the Napier Works

This section describes the sources and species of airborne pollutants emitted from the Ravensdown Works that may be likely to damage vegetation.

There are three sources of airborne pollutants at with the potential to damage vegetation. These are:

- (i) The Manufacturing Plant, which makes superphosphate fertiliser from phosphate rock;
- (ii) The Acid Plant, which produces concentrated sulphuric acid; and
- (iii) The Bradley mills and rock and superphosphate storage sites, which produce dust.

Manufacturing plant

Fluoride is the key pollutant emitted from the Manufacturing Plant with the potential to harm vegetation. Key chemical species emitted are gaseous silicon tetrafluoride (SiF_4), hydrogen fluoride (HF) and fluorosilicic acid (H_2SiF_6), all of which are acidic. Low amounts of sulphur dioxide, sulphuric acid and phosphoric acid are also emitted.

This section states that emissions from the Manufacturing Plant are mainly acidic vapours and aerosols, and various fluoride (F) species. It then states almost all species emitted are F-containing acids. It is not clear if the F species are also acidic vapours and aerosols, however I have assumed this is the case.

Acid Plant

The main pollutant emitted from the Acid Plant is SO_2 gas, with much smaller amounts of sulphur trioxide (SO_3) and sulphuric acid aerosols (Chilton 2021).

The amount of acid emitted from the Acid Plant is low compared with that emitted from the superphosphate Manufacturing Plant (Den scrubber stacks). The report states that a 2005 study by Trail and Murray found that emissions from the Acid Plant were only 1% of those from the Manufacturing Plant.

Identification of Acid Plant monitoring issue: It is noted that the review of the Acid Plant by Chemetics (R3) highlights in Section 4.3.1 of its report, that it appears that the continuous gas flow meter in the acid plant stack has been incorrectly calibrated for a period of time, and consequently the plant had been under-reporting emission rates until the error was identified and corrected in July 2021. Due to this issue Chemetics multiplies all the monitoring results by 1.7 when undertaking its analysis. Tonkin & Taylor were not aware of the issue or the correction being applied when preparing their Air Discharge Dispersion Modelling and Air Quality Effects report. It has since been suggested by the reviewer of the Air Discharge report that the emissions from the Acid Plant may require re-modelling to reflect updated emission rate information. In terms of vegetation effects however the adjustments to the model may not alter the scale of effects if acid emissions from the Acid Plant are very low compared to the Manufacturing Plant.

Pollutants from storage sites and Bradley mills

This arises from the Bradley mills, which grind the phosphate rock, and from wind erosion of the storage piles of phosphate rock and superphosphate. Other sources include vehicle movements and the loading and unloading of materials.

3.4 Pollutants: their effects, and are they a cause for concern?

Assessment methods:

Acidic aerosols

3.1.1 Effects on vegetation

Acidic mists or aerosols may cause acute damage to vegetation although acute damage should not occur from acidic rainfall. Acidic mists can cause leaf deformities and burn-like symptoms on leaves where the droplets coalesce and settle. Damage to fruit can also occur. Young leaves are more susceptible to damage from acidic mists as are plants under nutrient stress. Plants exposed to acidic mists may also be more susceptible to frost damage.

3.1.2 Are acidic emissions from the Napier Works a cause for concern?

Acid emissions come mainly from the Manufacturing Plant, predominantly as F-acid species. Acidic aerosols of SO_3 and H_2SO_4 from the Acid Plant are low according to recent long-term average emission rates modelled by the Air Quality Assessment (T & T 2021).

- There is no MfE standard for the pH of acidic emissions to air and therefore a literature review was undertaken.
- The findings of the literature review are very difficult to follow as they are not organised in any way. Key conclusions appear to be that:
 - A pH of >2.7 for stack emissions should be generally appropriate to avoid damage to vegetation and fruit by acidic aerosols, as is required by the current resource consent conditions.
 - There are two situations where there is a small risk of damage occurring at a pH of 2.7:
 - When wind carrying acidic aerosols at pH 2.7 is blowing over the orchards during flowering
 - Under misty or highly humid conditions without significant rainfall ($\leq 0.2 \text{ mm}$) with regular, intermittent exposure to wind carrying acidic aerosols at pH 2.7.

It is further concluded that since the pH of the Den-scrubbers was increased to 2.7 damage to vegetation has not been documented, suggesting that either these meteorological conditions are extremely rare, or that the pH of ≥ 2.7 is sufficient to avoid damage in the crop varieties planted in the Awatoto–Meeanee area. Stack emission pH has now been adjusted to 3.7 and F- emissions will be further reduced with the commissioning of the proposed 50m Manufacturing Plant stack giving increased confidence that damage to vegetation will not occur.

Sulphur Dioxide

Air quality modelling indicated that the highest SO_2 concentrations will be less than one-tenth of

the 30 µg/m³ MfE annual guideline for agricultural crops, and less than one-quarter of the annual guideline for the most sensitive vegetation. The highest levels of SO₂ emitted are less than the critical concentrations for 1 and 24 hours given in the MfE guidelines. The modelling assumed that the Napier Works was operating at peak production rates (at the 99.9th percentile), whereas most of the time the concentrations will be lower than this. Planned upgrade of the Acid Plant converter will lower SO₂ emissions even further and therefore SO₂ emissions are not considered to be a cause for concern, a conclusion that is supported by earlier studies by Doley (2005 & 2006a).

It is noted that locations marked A (1 -20) shown in Figures 4 & 5 are sensitive receptors for vegetation identified by the Air Quality Assessment but these sites are not necessarily the same as the monitoring sites used for the Plant and Food Research F leaf analyses.

Fluoride

3.3.5: Effects of fluoride on perennial crop species

The effects of atmospheric F on plants have been described in detail in earlier reports. Effects can occur on leaves, flowers and the whole plant. They include leaf yellowing, stunting and necrosis, reduced fruit set and inhibition of growth of the plant. Indirect effects can include increased susceptibility to insect attack or disease.

Air quality guidelines for fluoride: The New Zealand Ambient Air Quality Guidelines (NZAAQG) for plants provides maximum allowable concentration (critical level) of fluoride (F) for selected averaging times (MfE 2002).

Different crops and types of vegetation have different sensitivities to F with conservation vegetation considered the most sensitive. Coastal species are exposed to relatively high concentrations of fluoride in sea spray under natural conditions however and they are consequently not considered to be sensitive to F. The General Use guidelines have therefore been adopted for vegetation within the Waitangi Regional Park rather the more stringent guideline for conservation vegetation. This is supported by the conclusions of an expert consultant (Doley 2020).

Distribution of F-sensitive vegetation: Various horticultural and agricultural vegetation has a range of sensitivities to airborne F. Analysis of the Awatoto airshed area shows that of the 2503.7ha of vegetation within it only 20.8ha or 3.3% consists of F-sensitive perennial crops such as grapes, stonefruit and *Pinus radiata*.

Leaf Monitoring data: Regular monitoring of vegetation and foliar F in perennial crops is required under the current resource consents and has been undertaken since 2007. Currently 10 sites are monitored by Plant and Food Research.

A limit of 20mg/kg of leaf dry matter is considered the minimum concentration at which symptoms of F damage may be observed in sensitive varieties of perennial crops and 80mg/kg is considered the minimum concentration at which economic effects on yield might occur. Analysis of leaf monitoring data collected between 2008 and 2021 shows that the 20mg/kg limit was only exceeded at sites closer than 2km from the Ravensdown Works and the 80mg/kg critical limit for

economic effects on yield has never been exceeded for any of the monitored sites. No instances of leaf damage due to F-toxicity have been observed since 2008 however. The closest F- sensitive perennial crops are 1.9km from the Manufacturing Plant stacks.

No damage due to F has been recorded for native conservation planting or exotic amenity planting, although some damage due to salt-laden winds in the coastal zone have been observed.

Air dispersion modelling done by T & T as part of the Air quality Assessment used the maximum emission rate of 1kg F/hr proposed in the Air Discharge Strategy and proposed resource consent condition.

- The model predicts that atmospheric F concentrations will not exceed the critical concentration for General Land-Use beyond the site boundaries except to the east of the Napier Works, where no agricultural or horticultural land exists.
- The 12 hour limit for Special Land Use will however be exceeded for the area within 1km of the Ravensdown Works and within the northern part of the Waitangi Regional Park. This has implications for any F-sensitive crops planted within 1km of the site and for F-sensitive native species which may be planted in the northern part of the park such as tarata (*Pittosporum eugenioides*), flax (*Phormium tenax*) and cabbage tree (*Cordyline australis*). Proposed Manufacturing Stack modifications will result in a decrease in Ground Level Concentrations (GLC) of F.

Although the likelihood of exceedance of the F limits for Special Land Use is low, the possibility does exist.

The vegetation effects report concludes that atmospheric modelling at the maximum permissible rate, leaf sampling, site monitoring and complaints investigations all indicate that F emissions to air from the Napier Works have not been a cause for concern to the vegetation surrounding the Napier Works since the current resource consent was granted, given the current distribution of crop species. However F emissions could be a cause for concern if F-sensitive crops or vegetation is planted within 1km of the site and the proposed maximum emission rate was maintained for 12 hours or longer.

Dust

3.4.1 Effects on vegetation

Possible effects of high concentrations of dust on vegetation include: an increase in water loss, blocked stomata, an increase in leaf temperature and a decrease in photosynthesis.

3.4.2 Are dust emissions from the Napier Works a cause for concern?

Emissions of PM₁₀ dust particles have been modelled to fall well below the 50 µg/m critical limit for ecosystems. There have been no complaints made to Ravensdown or to Crop and Food relating to dust emissions from the Ravensdown Works and the report concludes that dust emissions are not

of concern in relation to vegetation effects.

The T & T report provides a more detailed analysis of dust emissions and concludes that they are not an issue for vegetation.

3.5 Incident investigations

Since 2008 when new limits were imposed on emissions from the Ravensdown Works there have been only two allegations of damage to vegetation caused by emissions from the Ravensdown Works. Both of these were fully investigated by Crop and Food and found to be due to causes other than the Ravensdown emissions.

The expert opinion of Dr Doley is that no scientifically defensible link can be found between emissions from the Ravensdown Works and any occurrences of injury to crop or ornamental species since emission limiting procedures were instituted by Ravensdown.

3.6 General conclusions

Most of this section reflects the points summarized in the Executive Summary, however the conclusion that there is some (low) risk of damage under certain conditions and the statement that “there may be a reduction in pollination or fruit set upon exposure to emissions of pH <2.75–4.7 (depending on crop species and variety), but that this does not necessarily result in a loss of yield” does not give confidence that sensitive vegetation will be protected from damage due to acidic emissions.

Is there potential for damage from this pollutant given that the proposed consent condition (18) stipulates a minimum pH of 4 during the flowering season (period August to September) while the results of the literature survey gave a range of pH 2.75 – pH 4.7 for potential effects on pollination and fruit set? Is there evidence to show that a pH of 4 – 4.7 will not adversely affect pollination and fruit set?

JS Ecology does not consider it satisfactory to claim that any reduction in pollination or fruit set is “not likely to result in a decrease in yield since most fruit crops require thinning”. Other environmental stressors such as drought, disease, nutrient stress and frost are all mentioned in the report as having synergistic effects with emissions. The possibility of these factors combining with acidic emissions to cause a larger effect than the acidic emissions alone has not been considered. If there is a reduction in pollination or fruit set due to acidic emissions and in addition, other stressors are operating, for example drought, then acidic emissions could contribute to a reduction in yield.

3.7 Recommendations

The following are noted:

- F emissions could be a cause for concern if F-sensitive crops or vegetation is planted within 1km of the site and the proposed maximum emission rate was maintained for 12 hours or longer. To avoid effects on any F sensitive of crops within 1km of the plant there need to be specific conditions in place to address this possibility. If the land is zoned for

horticultural or conservation use then there is always the potential for F-sensitive crops to be planted there.

- It is not clear what is meant by “Avoiding extreme operating conditions”. What specific conditions are being referred to?
- Recommendations for Waitangi Regional Park are supported, particularly since the northern part of the park is within 1km of the Ravensdown site and could potentially be affected by F emissions.

4 FURTHER INFORMATION REQUIRED

JS Ecology considers further information is necessary in order to clarify following issues:

1. Acidic aerosols:

- a) Climate change effects: Referring back to the AEE comments on climate change and also comments within the Vegetation Assessment itself, it seems that climate-related effects such as drought or pests and diseases which cause stress to vegetation can result in greater susceptibility to other stressors such as air emissions. Please provide a discussion of this aspect and assessment of potential effects on both horticultural and conservation vegetation, including effects on pollination and fruit set.
- b) Multiple exposures to acidic emissions: The Executive Summary states: “For the growing season outside of the flowering period (i.e. from November to April) the risk is only for multiple exposures, so emission of pH of <4.0 on up to 3 different days should not be considered a breach of resource consent.” There does not appear to be any data or references within the body of the report to support the number of exposures stated as being acceptable. Please provide supporting data and discussion of potential effects.
- c) Please discuss the discrepancy between the findings of the literature survey that potential adverse effects on pollination and fruit set can occur for emissions of pH 2.75 – pH 4.7 and proposed consent condition (18) which stipulates a minimum pH of 4 during the flowering season (August to September). Is condition 18 sufficiently rigorous to safeguard vegetation during the flowering period of horticultural crops? Please also consider potential effects of acidic emissions on flowering and fruiting of conservation vegetation which does not necessarily flower between August and September.

2. Fluoride emissions:

- a) The report states that F emissions could be a cause for concern if F-sensitive crops or vegetation is planted within 1km of the site and the proposed maximum emission rate was maintained for 12 hours or longer. Please discuss what these concerns are and how the proposed mitigating factors will address those concerns.

3. Synergistic effects

- a) Mixtures of pollutants: The range of emissions from the Ravensdown Plant that have the potential to cause adverse effects on surrounding vegetation (fluoride, sulphur dioxide, dust & acidic aerosols) have been modelled separately and discussed in the technical reports as separate effects. Section 3.1.2 (P11 para 4) raises the possibility of the combined effects of acidic aerosols and fluoride emissions with other chemicals that may be applied to horticultural crops. Discussion of the potential for combined or synergistic effects of these pollutants acting together with each other or with horticultural or agricultural chemicals is needed.

4. Former Winstone's site and foreshore reserve:

- a) The Crop and Food report does not discuss the implications of fluoride and dust emissions that are above MfE guideline values for the former Winstone Aggregate site and foreshore reserve to the immediate east of the Ravensdown Works. Although the former Winstone's site is currently zoned as Industrial, there is potential for that area to be re-zoned and rehabilitated and restored for conservation and recreational use. If conservation vegetation were to be planted along this stretch of the coast there may be issues with damage to vegetation and difficulties in getting restoration planting established. This possibility requires some discussion given the proposed 35 year life of the air discharge consent being sought.

5. Sulphur dioxide modelling:

- a) If SO₂ emissions are re-modelled by Tonkin & Taylor to take account of historic discrepancies with measurement of the acid plant discharge flowrates please provide an updated assessment of the results of the modelling for SO₂.

4 SUMMARY

- Key emissions to air from the Ravensdown Fertiliser Plant that have the potential to adversely affect surrounding vegetation are: fluoride compounds, sulphur dioxide, acidic aerosols or mists and dust:
- Susceptible vegetation types present within the airshed area of the Ravensdown Plant include horticultural crops such as fruit tree crops and vineyards, market gardening crops and native vegetation within the Waitangi Regional Park.
- Fluoride and acid mist are produced from the Manufacturing Plant, sulphur dioxide (SO₂) and acid mist from the Acid Plant, and particulate matter/dust from the Bradley Mills, raw material and product handling.
- The Air Quality Assessment prepared by Tonkin & Taylor (October 2021) found that dispersion modelling predicted concentrations for all airborne pollutants that will be well within the relevant MfE guidelines for the protection of sensitive ecosystems with the

exception of land to the east of the site (former Winstone site and immediate foreshore). There is currently no sensitive vegetation present at this location, however there is potential for the status of this area to change in the future.

- An issue with the measurement of the acid plant discharge flowrates was not known about when the Air Discharge modelling was undertaken by Tonkin & Taylor and the SO₂ emissions may need to be re-modelled to take account of this issue. The likelihood of the remodelled emissions showing effects on vegetation is low however.
- Concentrations of fluoride and sulphur dioxide are expected to reduce further as a result the replacement of the Acid Plant converter and the commissioning of the planned new Manufacturing Plant stack.
- The Air Quality Assessment and other technical reports generally support the conclusions of the Vegetation Assessment of Effects in relation to emissions of fluoride, SO₂ and dust.
- A literature review was used to assess potential damage from acidic aerosols in the absence of a national standard for this pollutant.
- The report relies on circumstantial evidence including reporting of complaints and records of potential damage to plants to further support its conclusions.
- There are a number of issues regarding the Vegetation Assessment of Effects report by Crop and Food that require further discussion and assessment as set out under “**Further information required**”.
- The proposed conditions for the HBRC Air Discharge Consent by Mitchell Daysh generally contain appropriate conditions for the management and monitoring of emissions of fluoride, sulphur dioxide, acidic aerosols and dust to prevent adverse effects on vegetation. However, further refinement of the conditions or additional conditions are required to address:
 - Multiple exposures to acidic emissions of pH 2.75 – pH 4 during the flowering season (August – September)
 - Measures to protect any F-sensitive crops or conservation planting that may be planted within 1km of the site.
 - Inclusion of the Waitangi Regional Park as part of the vegetation monitoring programme (Condition 40)
 - Potential interaction between emissions and the effects of climate change on vegetation.
 - Any further matters arising out of the issues raised in “**further information required**”.

OVERALL CONCLUSION

This report is written in a conversational, non-technical style and in parts it is difficult for the reader to follow the arguments and conclusions drawn.

The other supporting documents for the 2021 application to renew the resource consents for the Ravensdown Works (AEE, the Air Quality Assessment and the Air Discharge Strategy) provide

sufficient information on emissions that JS Ecology are satisfied that the conclusions of the Vegetation Assessment are in fact correct as they relate to fluoride, sulphur dioxide and dust emissions.

The conclusions of the report contain some areas of uncertainty as to whether adverse effects could result from:

- Acidic aerosols under certain atmospheric conditions and at pH up to 4.7
- Proximity of sensitive horticultural and conservation vegetation to within 1km of the Ravensdown Works

I am comfortable that fluoride and SO₂ emissions are unlikely to result in adverse effects on vegetation surrounding the Ravensdown Works, other than at the former Winstone Aggregates site to the east of the Ravensdown Works and for sensitive vegetation within 1km of the site. Currently the Winstone's site is almost devoid of vegetation and there is no sensitive vegetation located within 1km of the Ravensdown Works however.

Similarly I am satisfied from Section 3.4 of the Vegetation Assessment and from information given in the Air Quality Assessment that dust from the Ravensdown Works will not adversely impact vegetation, other than at the former Winstone Aggregates site to the east of the Ravensdown Works.

It should not be assumed however that current vegetation distribution patterns will remain unchanged over the life of the resource consent (35 years). The land surrounding Ravensdown is zoned for rural landuse and its utility for growing crops should not be constrained by emissions from Ravensdown. This is particularly important as good quality arable land becomes ever scarcer.

Similarly the potential rehabilitation and restoration of the former Winstone Aggregates site and coastal foreshore to the east for conservation and recreation purposes should not be discounted.

Therefore any potential effects on vegetation from emissions must be addressed, even for vegetation growing relatively close to the site.

While I accept that the risks of damage to vegetation posed by acidic aerosols are generally low, there remain some points of doubt that require further exploration and clarification.

Jennifer Shanks MSc Hons MEIANZ



16.02.2022

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