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AIR QUALITY IMPACTS OF OUTDOOR BURNING IN THE OTAGO REGION

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1 INTRODUCTION

Air quality management of outdoor burning in polluted airsheds in New Zealand has typically focused on winter time contributions to daily average PM_{10} concentrations. As a result, restrictions on outdoor burning activities have often been restricted to the months of May to August, to coincide with the timing of breaches of the NESAQ for PM_{10}. Whilst this reduces the potential for impact from source at times when meteorological conditions are most conducive to elevated pollution, outdoor burning at other times of the year can contribute to annual average $PM_{2.5}$ concentrations. Over the last decade it has been established that long term exposures (i.e., the annual average indicator) has the greatest health impacts. Thus, the impacts of outdoor burning outside of the winter months is of greater concern than was realised at the time most air plans were developed.

Additionally, most first generation Air Plans typically included restrictions within the "airshed" or air quality management area and did not consider contributions from areas outside of the airshed.

In our view, the two key areas for improvement in the management of polluted airsheds in second generation Air Plans are:

- The management of the contribution of outdoor burning outside of the winter months.
- The contribution of outdoor burning in rural areas to adjacent airsheds.

Otago Regional Council are reviewing their air plan and require advice on rules relating to outdoor burning. In particular they require advice on the dispersion of outdoor burning including the potential for outdoor burning outside of the airsheds to contribute to PM_{10} and $PM_{2.5}$ concentrations inside the airsheds.

The objectives of this report are to:

- Provide an overview of the science of outdoor burning including dispersion and the implications for air quality management.
- Illustrate the impacts of outdoor burning in the Region and provide commentary on the relationship between visual pollution and $PM_{2.5}$ concentrations.
- Evaluate the existing air plan rules for outdoor burning in the context of the above evaluation.

This information will be used to inform review of the air plan. This report does not examine issues relating to land use practices such as stubble burning or high country burning. It considers only the potential impacts of outdoor burning of all types (i.e., including stubble burning and high country burning) on air quality. This report does not evaluate the impacts of outdoor residential open fires or outdoor cooking activities on air quality.

2 AIR QUALITY IMPACTS OF OUTDOOR FIRES

2.1 Air quality data – impacts of outdoor burning

Use of air quality monitoring data or source apportionment methods to determine the impacts of outdoor burning on ambient air quality can be challenging as monitoring data, including receptor modelling source apportionment, are typically unable to distinguish between wood burning for domestic home heating and vegetation burning. Outdoor burning contributions can occur as a result of compliant burning on properties within the airshed, compliant activities (e.g., open fires, braziers etc) within the airshed as well as contributions from outside of the airshed.

Figure 2.1 (Alexandra $PM_{2.5}$ data 2022/ 2023) shows that $PM_{2.5}$ concentrations are largely influenced by the meteorology and daily variations in emissions over the winter months and highlights the difficulties in using monitoring data to understand source contributions. Outdoor burning is typically prohibited for fire risk reasons during the summer months.

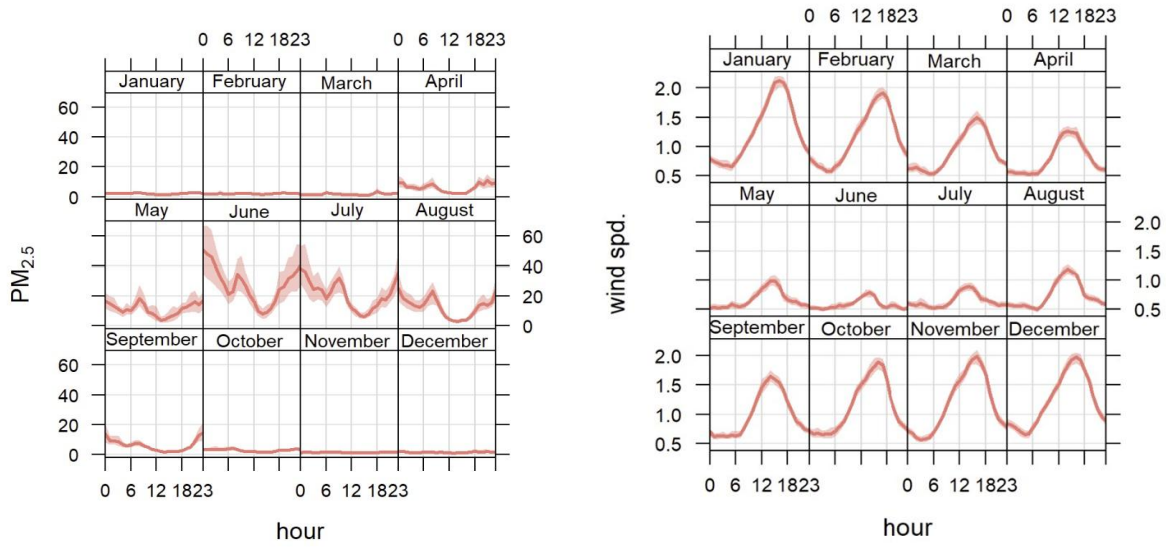

Figure 2-1: Daily variations in $PM_{2.5}$ concentrations and wind speed in Alexandra (2022/2023) by month

Emission inventories can capture contributions of outdoor burning[1] by households to emissions during different seasons for burning within the inventory area which typically aligns with the airshed area. Thus, contributions from outside of the airshed are not able to be assessed. Whilst surveying could increase information on the prevalence modelling would need to be undertaken to assess the likely dispersion and this will depend on fire characteristics[2], which vary from burn to burn, as well as distance of the burn from the airshed.

This type of assessment has been undertaken using proxy fires for a number of other Councils to determine potential impacts of burning outside of the airshed on air quality in the airshed.

[1] The question in the inventory studies includes burning materials such as garden waste in the open or in a drum or incinerator but does not include use of braziers, outdoor open fires or pizza ovens.

[2] For example, factors such as fire size, green versus seasoned material, wood density, flammability, type of material all impact on the combustion efficiency.

2.2 Dispersion gradients for outdoor burning

Somervell (2013) carried out modelling of outdoor burning in Blenheim to assess the dispersion profile from outdoor burning outside of the Blenheim airshed to gauge the likelihood of dispersion prior to reaching the urban area. Her findings show highest concentrations of particulate within a 500 metre radius of the fire and a tapering dispersion gradient at four kilometres (that is not much difference in dispersion between four and five kilometres from source) under stable conditions. The tapering of the dispersion profile indicates the potential for impact at a distance much greater than the maximum five kilometres modelled in that study.

The concept of a tapered dispersion gradient is supported by Pearce et al., (2012) which show $PM_{2.5}$ concentrations from outdoor burning greater than 25 µg/m^3 at a distance of just under ten kilometres from source with minimal decrease in concentrations between five and ten kilometres.

Emissions assessments and modelling was also carried out in the Hawke's Bay to identify the potential contributions of horticultural burning outside of the airshed areas on the airzone areas (pers comm Kathleen Kozyniak, 2022).

2.3 Visual images of outdoor fires in Otago

The studies cited above indicate that once the initial dispersion from the smoke source occurs, under stable conditions the plume can travel significant distances with minimal subsequent dispersion. This concept is illustrated in several images captured of smoke dispersal from outdoor burning in the Region.

Smoke plumes are visible because of the scattering of light by very small particles (less than 2.5 microns in diameter). There is a correlation between the amount of scattering and the concentrations of particles but visibility is also impacted by other variables such as illumination. Additionally, we cannot rely on visibility to evaluate the presence or absence of particles at lower, but still potentially problematic concentrations, as our ability to detect the loss of light transmission is not sensitive enough. Thus, there is a minimum, variable and unquantified threshold of $PM_{2.5}$ required before it becomes visible to the naked eye. As smoke disperses the number of particles reduces reducing the ability of the eye to detect the scattering of light.

Table 2.1 shows images of outdoor burning in the Otago Region. A high-country fire beyond Lake Wānaka travels more than 15 kilometres to create a visual haze and associated increase in concentrations of $PM_{2.5}$ over the township. In the second image an outdoor fire creates a thin layer smoke plume persisting for at least five kilometres in the Whakatipu basin prior to increased vertical dispersion owing to changes in topography.

Wanaka fire beyond Cattle Flat observed from Peninsula Bay

Plume from fire is visible over Wanaka township


Cattle Flat
Diamond Lake
Conservation Area
>15 kilometers
Beacon Point
Glendhu Bay
Roys Peak Lookout
#ThatWanaka
Wānaka

Above - Whakatipu basin as viewed from the Crown Range
Below – Rural burning on the outskirts of Alexandra and extent of consequent haze in Alexandra

3 MANAGEMENT OF OUTDOOR BURNING OUTSIDE OF THE OTAGO REGION

To understand the existing management of outdoor burning a selection of six air plans were examined for management of outdoor burning with a focus on regulatory methods.

3.1 Tasman Air Plan

In Tasman the approach to managing outdoor burning in areas outside of the airsheds is to define a separate fire ban area (Richmond and Motueka) and fire sensitive areas (other smaller urban areas). The Tasman Resource Management Plan (TRMP) does not allow open burning of garden waste or burning in the outdoors in incinerators in fire ban areas of Richmond and Motueka. Exclusions from this exist for:

1. Fireworks.
2. Small fires used for food cooking purposes such as barbecues, hangis, and small camp fires that are no bigger than $1m^2$ at the base.
3. Candles, lamps or similar small-scale burners or tools.
4. Outdoor fireplaces, including braziers or fires for ahi ka purposes.
5. Celebratory fires in Open Space Zone or Recreation Zone.
6. Any forge or kiln.
7. Burning during the months of October to April on properties larger than $5000m^2$ with a resource consent.

In fire sensitive areas outdoor burning is not permitted during the months of June to August except where: (i) the presence of disease on a horticultural crop requires that plant waste be burnt to manage the risk of the disease spreading; or (ii) the discharge is from any of the exceptions listed in points 1-6 above.

Wilton, (2023) carried out an evaluation of the extension of the zonings for fire based on contributions to ambient airshed $PM_{2.5}$ in Motueka and Richmond. The recommendations included extension of the fire ban area including to a distance of around eight kilometres in a downwind direction from these towns for the prevailing contributing wind.

3.2 Hawke's Bay Air Plan – operative plan 2012

From May to August it is prohibited to burn outdoors on a property within the Napier and Hastings airsheds.

There is an exception for disease control on horticultural land.

From September to April outdoor burning is permitted subject to conditions including materials that may be burnt, not causing offensive or objectionable odour or noxious or dangerous gas or deposition of particulate beyond the property boundary and compliance with FENZ regulations.

At all times during the year, fires for cooking (barbecues, hangi, umu) can legally be used in urban areas.

3.3 Marlborough Environmental Plan

The only airshed in Marlborough is Blenheim. Outdoor burning is not permitted in the Blenheim airshed. Some restrictions exist for outdoor burning outside of the airshed but this is permitted, subject to compliances with conditions in most zones.

Discharges to air within the Blenheim Airshed from outdoor burning in a brazier or a fire used exclusively for the cooking or smoking of food for non-commercial purposes is permitted when the following are complied with;

- A brazier must not be used during the months of May, June, July or August.

- Only wood with a moisture content of 25% dry weight or less is burnt, and no rubbish or prohibited materials are burnt.
- All reasonable steps are taken to minimise the amount of smoke discharged.

3.4 Nelson Air Plan

An air emission inventory conducted in 2000 found outdoor burning was contributing to degraded air quality in Nelson (Wilton & Simpson, 2001). Nelson City Council opted to manage outdoor burning in the Nelson Air Plan (operative 2008). In the urban area and the high density small holdings area in the rural zone outdoor burning is a restricted discretionary activity for properties greater than 2 hectares in the urban area (or one hectare if in the urban area but zoned rural[3]), during the months September to April. Some materials including wood with a moisture content of more than 25% are prohibited. Burning during the months May to August in these areas is prohibited. Exclusions exist for specific cooking activities, ahi kaa within a papakainga area and fireworks. Braziers and small craft fires are also permitted subject to meeting conditions, during the non-winter months.

3.5 Southland Air Plan

Rules for outdoor burning within and outside of the Invercargill and Gore Airsheds are detailed as follows:

3.5.1 Outdoor burning outside of the Invercargill and Gore Airsheds

The discharge of contaminants into air from the outdoor burning of vegetative matter, paper, cardboard and untreated wood is a permitted activity outside the Invercargill and Gore Airsheds provided the following conditions are met:

(a) Burning shall only consist of vegetative matter, paper, cardboard and untreated wood generated on the same property, or a property under the same ownership;

(b) At or beyond the boundary of the property on which the burning is carried out, or on any public land, the discharge shall not result in adverse effects from any:

i. objectionable deposition of particulate matter on any land or structure;
ii. noxious or dangerous levels of airborne contaminants;
iii. offensive or objectionable smoke or odour ;
iv. smoke or water vapour that reduces visibility on any road or in any aircraft flight path; or
v. corrosion of any structure;

(c) If the property on which the burning is carried out is less than two hectares in area, the material burned shall not exceed 2 cubic metres in any 24 hour period;

(d) If the property on which the burning is carried out is more than two hectares in area, and more than 2 cubic metres of material is being burnt, the burning must not occur within 100 metres upwind or 50 metres in any other direction, of any residential unit that is not located on the site where the burning is occurring unless written permission has been obtained from the occupier(s) of the residential unit.

3.5.2 Outdoor burning in the Invercargill and Gore Airsheds

The same requirements apply inside the airsheds, with the additional requirement that burning is permitted only during the months from September to April with exceptions for where the discharge is:

i. for food cooking purposes such as in a barbeque, smoker or pizza oven;
ii. from an outdoor open fire or brazier with a base no bigger than 1 square metre;

[3] Except in the Higher Density Small Holdings area

3.6 Canterbury Air Regional Plan

The Canterbury Air Regional Plan, operative October 2017, contains comprehensive policies and rules relating to outdoor burning. Policies have been replicated here to provide an example of the key policy considerations with regards to outdoor burning for plan review purposes. A summary of the rules is also provided. The Canterbury Air Regional Plan includes a note that there may also be rules or bylaws to comply with under district, city or rural fire authorities as well as air plan rules.

3.6.1 Policies for outdoor burning

6.18 Minimise adverse effects of discharges into air from *outdoor burning* of organic material by establishing standards for this activity, including when burns are allowed and requirements for the preparation and implementation of a smoke management plan.

6.19 Avoid *outdoor burning* of non-organic material (other than incidental amounts) except where the burning is for fire fighting research and training, munitions, ammunition and pyrotechnic disposal or occurs in accordance with tikanga Māori.

6.20 Minimise adverse effects on *townships* of discharges into air from *outdoor burning* of organic material, particularly where Crop Residue Burning Buffer Areas have been identified on the Planning Maps.

6.21 Allow discharges into air from outdoor cooking and *outdoor burning* of organic material for community and cultural events.

3.6.2 Rules for outdoor burning

Burning for firefighting or deflagration is a permitted activity subject to conditions which include who is eligible, distance from National Grid, notification of neighbours and a restricted discretionary activity during the months April to September in Clean Air Zones.

Burning of crop residue is regulated under the Air Plan. The plan identifies crop residue burning buffer area maps in the plan and classifies crop residue burning outside of the buffer area as permitted or non-complying and burning within as controlled. Permitted activity conditions include amongst other things a smoke management plan, requirements for which are detailed in the Air Plan.

Burning of vegetation, paper, cardboard or untreated wood is permitted on properties larger than 2 hectares subject to the following conditions:

- The quantity of any liquid fire accelerant used does not exceed 10 litres; and
- The burning does not occur within 100m of any National Grid power line or substation unless permission has been obtained from the owner of the infrastructure; and
- The material to be burnt is located at least 100m upwind and 50m in any other direction of any sensitive activity that is not located on the property where burning occurs unless permission has been obtained from the occupier of the place or area where the sensitive activity is occurring; and
- The material to be burnt is dry and the moisture content is unlikely to exceed 25% dry weight; and
- **If within 4 km of any township or Clean Air Zone,** burning only occurs when the wind direction will cause smoke to disperse away from the township or Clean Air Zone; and
- Burning is only of material sourced from no more than 2 adjoining properties and burning is undertaken on one of those properties; and
- If the discharge is likely to continue for 3 days or more, a smoke management plan has been prepared in accordance with Schedule 3 and the discharge is managed in accordance with that smoke management plan; and
- Any smoke management plan required under condition 8 above is supplied to the CRC on request; and
- Within a Clean Air Zone, the burning does not take place during May, June, July or August, except that in the Geraldine, Ashburton, Waimate and Rangiora Clean Air Zones, burning may take place in the month of May between the hours of 8am and 4pm.

Outdoor burning for the purpose of cooking, including in a hangi, barbeque, pizza oven or other small scale or domestic outdoor cooking device, is a permitted activity.

Outdoor burning of vegetation and untreated wood as a part of a community or cultural event is a permitted activity provided the following conditions are met:

- Within a Clean Air Zone, the discharge does not take place during May, June, July or August; and
- The burning does not occur within 100m of any National Grid power line or substation unless permission has been obtained from the owner of the infrastructure; and
- The material to be burnt is dry and the moisture content is unlikely to exceed 25% dry weight.

Outdoor burning for the purpose of controlling unwanted organisms or disease control and that is undertaken as a requirement of the Biosecurity Act 1993, is a permitted activity.

The discharge of contaminants into air from outdoor burning of animal carcasses and offal is a permitted activity provided the following conditions are met:

- The discharge is on a property greater than 2ha in area; and
- The burning does not occur within 100m of any National Grid power line or substation unless permission has been obtained from the owner of the infrastructure; and
- The discharge does not occur within 100m of a property boundary.

Outdoor burning that does not comply with conditions is generally a restricted discretionary activity[4].

3.7 Summary

The drift of smoke from burning in rural areas has been regulated in a number of areas, particularly where horticultural activities are located close to urban areas (e.g., Richmond, Napier, Hastings). The approach taken is typically use of larger airsheds (including rural areas in the airshed/airzone) or creating additional zonings to address fire issues. The Canterbury Regional Air Plan includes the requirement that burning within a 4 kilometer radius only be carried out when the wind direction would direct the smoke plume away from the clean air zone.

With the exception of the Canterbury Regional Air Plan which does not permit burning on properties less than 2 hectares anywhere in the Region most regulations aim to minimise outdoor burning contributions during May to August. Whilst this coincides with the period when meteorological conditions are most conducive to poor dispersion and elevated $PM_{2.5}$ concentrations the transition of air quality management towards to improvements in annual average particulate concentrations (as detailed in Wilton, 2023a) increases the significance of the potential contributions during non-winter months.

The evaluation of approaches to outdoor burning in a range of air plans provides an overview of considerations or tools used for its management. These include:

- Inclusion of a note reminding users that there may be other regulations pertaining to outdoor burning.
- Use of distance from urban area as a tool for managing the contribution of outdoor burning from outside of the airshed.
- Use of a second area, based on catchment or distance, within which additional regulations apply to outdoor burning.

[4] Some conditions are excluded in the rule

- Consideration of additional management for stubble burning and high country burning. The latter is an issue that may require consideration in the Otago Region owing to the proximity of high country areas to urban areas.
- Use of size of the fire, specific meteorology, time of day, time of year and smoke management plans in conditions to minimise impacts.
- Potential permitted activity requirements for fire fighting, biosecurity, disease control, offal burning.
- Range of examples of exclusions from restrictions for cooking, braziers, cultural activities etc.
- Ensuring list of prohibited materials for combustion include those prohibited under the NESAQ.

4 EXISTING OTAGO REGULATORY AND NON REGULATORY METHODS

4.1 Outdoor burning regulations

Existing regulations prohibit burning in airzones 1 and 2 areas if the fire is within 100 metres of the property boundary for production land and for residential land if the fire is within 50 metres of the property boundary. This effectively prohibits outdoor burning on most residential lots within urban areas that are within airzones 1 and 2. Outside of airzones 1 and 2 outdoor burning is permitted subject to conditions.

Where outdoor burning is permitted the types of materials that can be burnt are restricted. Materials that may be burnt include untreated wood, paper, cardboard and vegetation (provided it is not green). These restrictions on materials that can be burnt do not apply to production land in Airzone 3. The Council provides an extensive list of materials that can not be burnt.

4.1.1 Comment

The effect of the regulation is appropriate in that it results in significant restrictions on outdoor burning in urban areas of airzones 1 and 2. It is useful with respect to managing contributions to annual average concentrations as it is not limited to the winter months. However, we would recommend that the activity be a straight restricted discretionary activity, rather than having distance based rules and that consideration be given to applying it to a wider range of urban areas of the Region. Setting a distance rule was a historical approach to outdoor burning and has a basis in the assumption that the impacts are localised and that effects can be mitigated with distance. Modelling shows high concentrations within 500 metres of the fire and tapered dispersion. The ambient air impacts cannot be mitigated by a separation distance of 50 or 100 m. Outdoor burning is not just a localised issue and any discharges within an airshed and their surrounds can contribute to degraded air quality that impacts on health of residents.

4.2 Good practice burning guidance

The ORC website provides guidance around burning and notes that if burning permitted material is your only option, you should reduce smoke and burn safely and considerately.

- Burn as far from your property boundary as possible.
- Check that the wind is predicted to be away from built-up areas for the duration of the fire.
- Postpone the lighting of your fire if there's already smoke from other fires in the air.
- Make smaller fires.
- Use dry fuel and stack it loosely.
- Don't let the fire smoulder.
- Avoid burning in the early morning or late afternoon/evening (breezier daytime conditions help to disperse the smoke).
- Avoid burning when there is an inversion layer.
- Be prepared to put the fire out if conditions change or you discover that you are causing a nuisance.
- Ensure burning on the property is permitted under the Air Plan.

The air plan also includes the following guidance in Schedule 5 Good Management Practices to Prevent or Minimise the Discharge of Smoke from Burning Vegetation

General burning practices

- Except in the case of tree stumps or standing dead vegetation or crop stubble, vegetation that is to be burned (such as trimmings, pruning, or fellings cut from active growth) should, as a general guide, be allowed to dry for at least four weeks in summer or six weeks in winter, prior to burning.
- Where practicable, the place of burning should be located as far away from roads and state highways as possible and burning should take place when wind will dissipate smoke away from roads and state highways. • When starting to burn, the direction and strength of wind should be such that smoke is carried away from the areas most likely to be adversely affected.
- In cases of vegetation previously treated by spray with any agrichemical, any manufacturer's instructions, as on the label of any container in respect of the burning of treated vegetation, must be observed. • Prior to burning, assess whether the vegetation is sufficiently dry to burn, without unnecessarily exacerbating any risk of an uncontrolled fire.
- Vegetation should be stacked loosely rather than compacted to aid drying and the circulation of air for efficient burning.
- For piles of vegetation, a small fire, started with the driest material first, with further material continually fed on to it once it is blazing, is preferable to burning all of the material at the same time in one large pile.
- Once started, a fire should not be left unattended.

These general practices do not apply to high country vegetation burning.

High country vegetation burning

- No fire should be lit if weather conditions indicate that the presence or discharge of smoke or ash is likely to be prolonged.
- Seek advice from a meteorological service prior to burning, on the expected weather conditions, including wind speed and direction.
- Burning should be carried out only when winds will carry smoke and ash away from any operational ski field or other areas of high public use.
- The Cardrona, Treble Cone and Waiorau ski fields should be notified at least 24 hours prior to burning in the Wanaka Basin.

4.3 Issues

Issues with the current rules include:

- Smoke drift and in particular the contribution of burning outside of an urban area to an airshed or urban area.
- Potentially a lack of impact of guidance material (burning takes place when other options are available, conditions include inversions, any time of day etc).
- Proximity of larger properties to (and potentially within) urban areas (e.g, orchards around Cromwell)

Smoke drift from outdoor burning in rural areas to urban areas increases concentrations of $PM_{2.5}$ and PM_{10} in urban areas and has adverse health impacts. Surveying in Wanaka, Cromwell and Clyde during 2017 suggests outdoor burning is particularly prevalent around Cromwell. Photographic evidence also shows outdoor burning on the outskirts of Alexandra and Wanaka creating a haze across the township.

5 RECOMMENDATIONS

5.1 Increased regulation

Increased regulation of outdoor burning to improve annual average $PM_{2.5}$ concentrations in urban areas is recommended.

Outdoor burning, except for situations that are deemed permitted[5] (e.g., for cooking and cultural purposes), should be a restricted discretionary activity or prohibited in Alexandra, Arrowtown, Cromwell, Clyde, Milton and Mosgiel and potentially other urban areas of the region.

In addition to regulation within an airshed we recommend outdoor burning within 10 kilometres of an airshed be more stringently regulated. In our view the most effective approach would be a restricted discretionary activity status on outdoor burning (excluding activities that have been deemed permitted owing to scale or cultural reasons). A less stringent approach might be the inclusion of a condition such as in the Canterbury Regional Air Plan relating to the wind direction (in a direction away from the urban area) for the duration of the burn and the limiting of the months of permitted burns within this area to non-winter months.

We propose that exceptions be made for the burning for disease control purposes. We recommend that the latter be a controlled activity to give Council the opportunity to ensure that only diseased material is being burnt. We recommend the following conditions of controlled activity:

- Burning of diseased material can only be carried out between the hours of 10am and 4pm.
- No burning may be carried out when the wind speed at one metre above ground level is less than 2 ms^{-1} (hourly average).

5.2 Justification

Residents are subject to regulation regarding home heating devices. Outdoor burning impacts are disproportionate relative to domestic heating (one fire equals many burners). In our view reliance on good practice material has an inconsistent effect.

The quantities of particulate produced by outdoor burning is significant. Smoke plumes travel for long distances with minimal dispersion. A key contaminant of these plumes ($PM_{2.5}$) has significant adverse health impacts and there is no threshold below which effects do not occur. Updated WHO guidelines for $PM_{2.5}$ are set at a level that is much lower than previous standards. Regulations targeting domestic home heating result in costs for households and it would be inequitable to allow burn offs with more significant per household effects to contribute to pollution in these airsheds. There are viable alternatives to burning in most situations.

In other regions where restrictions on outdoor burning include rural areas with horticultural activities (e.g., Hawke's Bay and Tasman), orchardists and Horticulture New Zealand have submitted on the need for burning of small quantities of material for disease control. The requirement that this burning be carried out when winds are greater than 2 ms^{-1} and during the daytime hours of 10am to 4pm would help avoid burning at times when meteorological conditions are most conducive to elevated concentrations. A wind direction criteria could also be applied.

Outdoor burning in rural areas neighbouring airsheds has the potential to increase $PM_{2.5}$ concentrations within the airsheds. A distance of 10 kilometres from an airshed boundary is proposed as a pragmatic approach to managing the contribution from neighbouring areas. The alternative more technical solution would be to identify a second airzone area based on an air catchment approach for each airshed and apply the rule within that area. This would be more resource intensive however and we recommend the more pragmatic 10 kilometre approach.

[5] We have not assessed the justifications for continuing with these activities rather assumed that ORC would continue with the status quo.

The area managed in other plans ranges from around six to nine kilometres (e.g., Canterbury, Hawke's Bay and Tasman). However, meteorological conditions in many areas of the Otago Region are extremely conducive to minimal dispersion and plumes have been noted as visible more than 15 kilometres from source. We also note that the Otago towns have a higher susceptibility to degraded air quality (meteorological conditions extremely conducive to elevated pollution) than many other urban areas of New Zealand and consequently more extensive mitigation is likely required. We further note that a regulatory approach should be equitable between sources and that the impact of more stringent measures for domestic heating might be undermined to some extent by softer rules for outdoor burning contributions.

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