

Submitted to the North Saanich District Council  
by  
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## **Executive Summary**

The purpose of this work is to improve the quality of life in North Saanich in two ways: first, to better understand the controversial issue of backyard burning, and second, to find a way for our community to work together in addressing this issue.

The hazard from smoke should be viewed with the same awareness as the hazard due to fire itself. Residents respect burning restrictions when dry weather conditions point towards a risk of fire. Similarly, residents deserve information regarding backyard burning, as smoke from these fires also has a negative impact. [It should be remembered that 'where there's fire, there's smoke'.]

The results of analysing the ventilation index, and wind speed data, from January 1999 to June 2003, reveal that about 90 percent of the smoke complaints occurred when there was information available to show that good smoke dispersal was unlikely. Residents who use this environmental information as a guide will find that suitable burning conditions occur frequently, allowing them to burn more often, with less chance of bothering their neighbours.

Providing useful information to all residents is the key to reaching a resolution. A brochure explaining the main findings of this report is to be distributed in the Fall of 2003, with the full report available at the District Hall and via the District website. It is expected that access to the ventilation index and the local wind speed will be accessible via the District website, is presently available through Environment Canada (telephone and internet), and in the future will be offered as part of the environmental information on Shaw TV cable 11.

It is expected that applying the findings of this project will not only lessen the negative impacts of backyard burning but will also promote a greater awareness of ways that we can become better stewards of our environment.

## **Acknowledgements**

It is with much pleasure that I acknowledge the help of Fire Chief Gary Wilton, Councillor Heather Goulet and Mayor Ted Daly. Not only did they provide expertise on how things work in the North Saanich, but as importantly showed that by getting together on projects like this we can improve our community.

I also extend my appreciation to the staff at the District Hall who answered my questions and provided information.

This project was funded by a SuperPages 'Make it Real' scholarship. Jim Townley has been a great person to work with and make this project happen.

I would finally like to acknowledge those residents of North Saanich who were concerned enough about the issue of backyard burning to make a call, or write a letter. Without their voices this project would not have come into being.

Kate Chandler  
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## 1. Introduction

The much-prized rural character of North Saanich includes a history of residents using backyard burning as a means to dispose of both house and yard waste. Although our Official Community Plan supports reduction, reuse and recycling initiatives and composting alternatives, the practise of backyard burning continues. Many people view backyard burning as a positive activity: it allows them to reduce the amount of waste on their property in a way that is convenient and inexpensive, a fire also provides significant satisfaction as it is built, lighted and tended. In North Saanich there is general compliance with observing a fire ban during dry weather, and in burning only approved material in an appropriate manner.

Backyard burning of household garbage is typically carried out in a 55-gallon steel drum (the burn barrel), where volatile organics like benzene, fine particulate matter, poly aromatic hydrocarbons (PAH), and heavy metals are released into the air. For many of these pollutants, the principal pathway into humans is directly from inhalation of smoke from burning garbage (Canadian Centre for Pollution Prevention, 2003).

The burning of manufactured wood products, garden and yard waste also releases fine particulate matter into the atmosphere. High concentrations of these fine particulates are particularly harmful to children, the elderly, and people with asthma, lung disease, bronchitis and respiratory disorders (BC Ministry of Water, Land and Air Protection, 1997).

Some municipalities in the Capital Regional District, such as Sidney, Victoria, Esquimalt, Oak Bay, have addressed the issue of backyard burning by prohibiting the activity. They offer residents the option of a drop-off site or a limited pick-up service. Saanich has identified an urban containment boundary within which there is no backyard burning, but outside of this burning is regulated to certain times (sunrise to sunset Friday and Saturday (until noon) from October to April). Other municipalities have adopted some type of regulation typically restricting burning to daylight hours and excluding Saturday afternoon, Sunday and statutory holidays. Colwood and Langford distribute cards identifying the burning days for each year.

Throughout the Capital Regional District there is a total ban on backyard burning for periods in the year due to weather conditions associated with a high fire hazard. The smoke hazard from

backyard burning, which is also controlled by weather conditions, is largely ignored when deciding how to regulate this backyard burning.

This report compares the complaints of backyard burning in North Saanich with the coincident weather conditions to provide suggestions for an cost-effective way of dealing with backyard burning that takes into account the well-being of our residents and our environment.

## **2. Smoke Complaints**

All residents of North Saanich have the right, and the responsibility, to voice concern with activities that they feel diminish the quality of life in our community. Complaints of smoke in the neighbourhood often stem from a distress with the negative impact that smoke has on the environment, and on people's health.

### ***2.1 North Saanich Fire Department Data***

Chief Gary Wilton of the North Saanich Volunteer Fire Department keeps a logbook of all calls and correspondence that relates to fire and burning in the District. Complaints specific to smoke, and verified by a site visit, are logged by date, time, and location and since January 1999 there have been 280 entries. As there are undoubtedly occasions where residents have been bothered by smoke, but not bothered enough to make a complaint, it can be assumed that these 280 records represent a lower limit. Complaints prior to 1999, collected under a different system, have not been included in order to avoid confounding the statistics.

### ***2.2 Distribution of Complaints by Location***

The location of the smoke complaints are known by street address but this level of detail has not been included in this report because a) the Fire Chief considers it important to preserve the anonymity of the correspondents, and b) a regional distribution is suitable for the analysis. Using the quadrant criteria for North Saanich (where the intersection of Mills X Road and West Saanich Road is the centre-point) Figure 1 below shows the distribution of smoke complaints since 1999 by location.

Clearly the residents in the Southeast Quadrant have the most to say about the ill effects of backyard burning. There are several possible explanations; there is a greater population density that leads to more burning, and a closer proximity to neighbours; there is the topographic influence of Mount Newton, which keeps smoke trapped closer to the ground; the prevailing weather conditions may be such that smoke is slower to disperse on this side of the peninsula. There is no evidence to suggest that the residents here are less aware of how to burn properly, are less sensitive to the comfort of their neighbours, or have much more waste that needs to be burned.

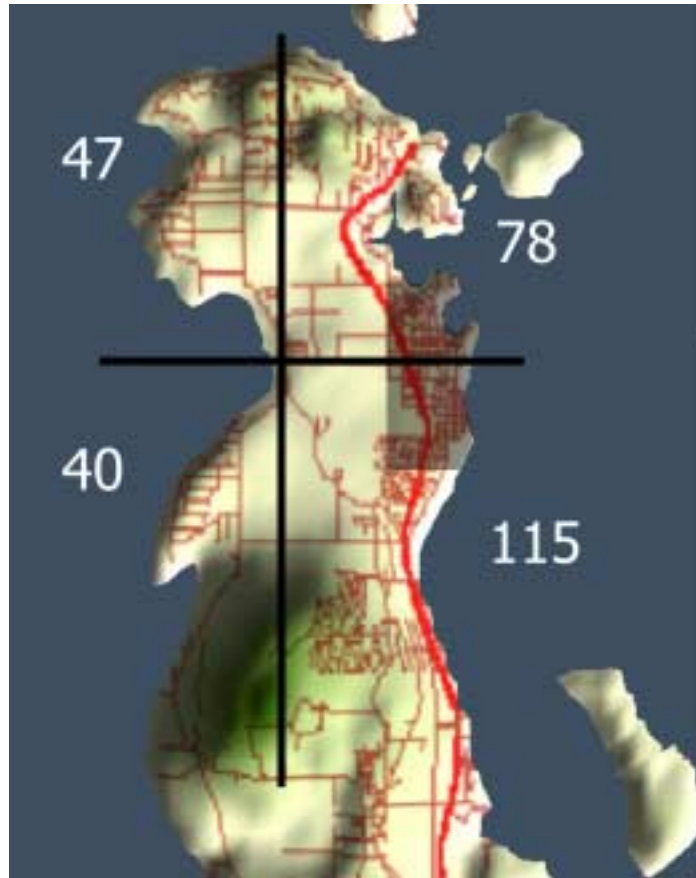


Figure 1. Distribution of smoke complaints in North Saanich from January 1999 to June 2003 (source North Saanich Fire Department).

### ***2.3 Distribution of Complaints over Time***

Of interest is that smoke complaints have been recorded at all hours of the day and night. Figure 2 shows that the mid-morning to evening period is generally the time when smoke complaints are made. This reveals that most residents are either burning, or are in a position to be aware of smoke in the air, during daylight hours.

Similarly the distribution of complaints through the week given in Figure 3 indicates that weekend burning is prevalent, reflecting the tendency for those who are not at home during daylight on the weekdays to burn on the weekend. The weekly distribution of smoke complaints shows that over 60 percent of the complaints occur between Friday and Sunday.

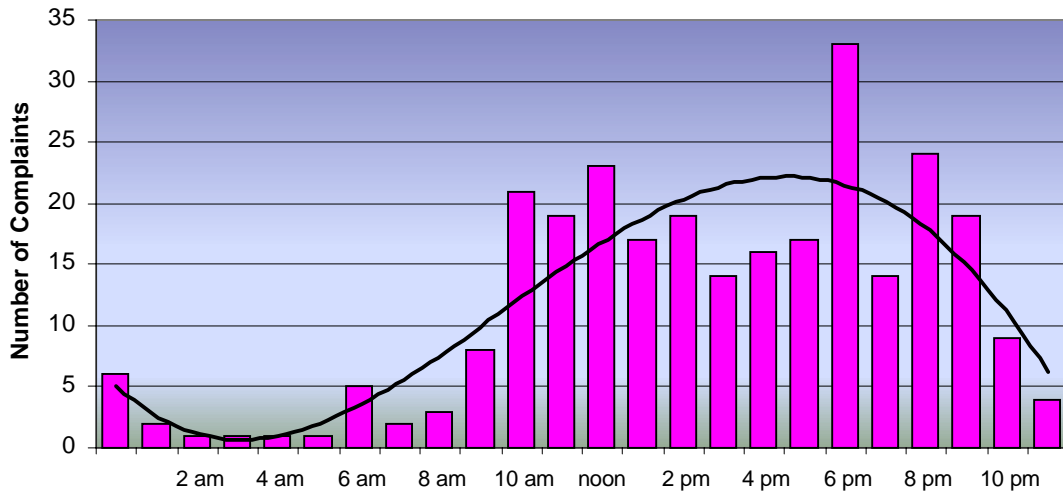


Figure 2. Distribution of smoke complaints in North Saanich from January 1999 to June 2003 by time of day (source North Saanich Fire Department).

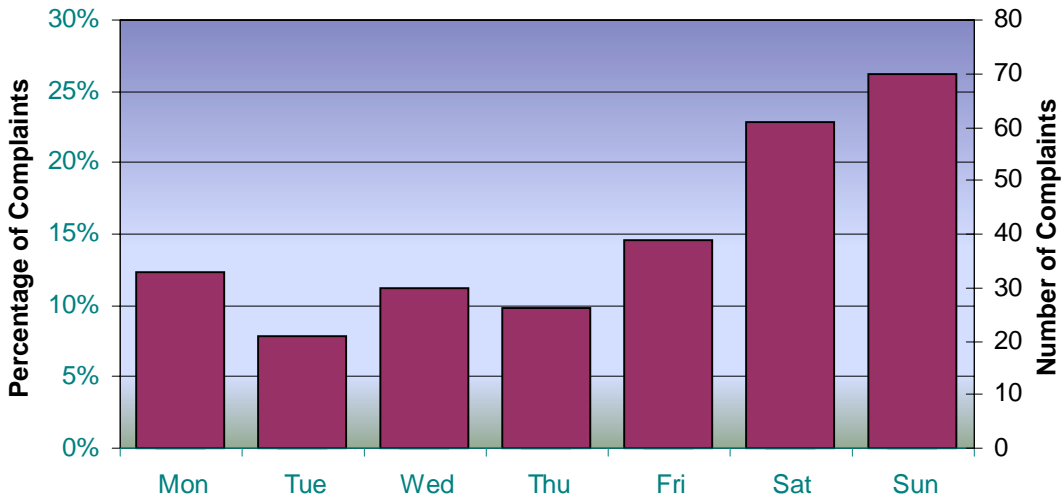


Figure 3. Distribution of smoke complaints in North Saanich from January 1999 to June 2003 by day of the week (source North Saanich Fire Department).

### **3. The Ventilation Index**

#### **3.1 Background**

Environment Canada originally developed the ventilation index to assist the BC Forest Service in their management of smoke during planned burns of forestry waste (slash burns). The ventilation index is expressed as a number between 0 and 100 that relates the weather conditions to the potential for air pollution due to smoke from burning. The higher the ventilation index number, the less risk of air pollution. The BC Ministry of Water, Land and Air Protection extended this approach to regulate the open burning of land clearing debris, and several municipal governments now use the ventilation index to promote local burning in a safe and environmentally sound manner.

#### **3.2 Science**

The ventilation index uses atmospheric conditions to provide a measure of how well and how rapidly smoke will disperse. There is both vertical and horizontal motion to consider and thus atmospheric stability, mixing height, and transport winds are key factors used to determine the ventilation index.

How rapidly smoke at ground level will rise reflects the atmospheric stability; the more stable the atmosphere the less likely the smoke will be lifted away from the ground. Typically the atmosphere is less stable during the afternoon when heating from the sun causes the air near the ground to warm, expand and rise. Bright sunshine, clear skies, high, puffy clouds, and gusty breezes are all indicators of unstable conditions and rapid vertical mixing. A stable atmosphere is generally characterized by low clouds, low winds, and generally poor visibility. After sunset, atmospheric conditions are nearly always stable, and smoke in the air stays close to the ground. When you want smoke to disperse quickly unstable conditions are much better than stable conditions.

There is a layer of atmosphere close to the surface of the earth where the air is well-mixed and there is little impediment to vertical movement; this is known as the mixed layer. The height of this mixed layer is of practical importance to smoke dispersion as it represents a lid that keeps the smoke below this elevation. The higher the mixing height the higher the smoke can rise and

disperse. A low mixing height traps the smoke closer to the ground, and horizontal transport winds become more important in reducing the smoke concentration.

The transport winds represent the average horizontal wind speed and direction within the mixed layer. There is, however, considerable variability in this wind field in both speed and direction. For example, surface friction causes winds near the ground to be slower than those at higher elevations. Topographic features can steer winds in directions quite different from those only a few kilometres away. These local wind conditions may allow smoke to disperse more quickly in some regions, or conversely cause it to converge or linger in certain areas.

The southern Vancouver Island ventilation index as posted on the Environment Canada website ([http://www1.weatheroffice.com/wxhealth/smoke/forecast\\_e.html?Smoke=YYJ](http://www1.weatheroffice.com/wxhealth/smoke/forecast_e.html?Smoke=YYJ)) is calculated using the mixing height and transport winds from upper air soundings made from Quillayute on the Olympic Peninsula in Washington State. This information can also be acquired 7:30 AM to 5 PM PST -- Monday through Friday from the Nanaimo office of the BC Water, Land and Air Protection Branch, (1-250-751-3100, to avoid the long-distance charge call Enquiry BC at 387-6121 and they will transfer you toll-free). Environment Canada (toll call at 1-900-565-5000) provides the information at all hours. The Province of BC associates the ability of the atmosphere to disperse smoke to the following three levels of the ventilation index:

Less than 34	Poor
34 - 54	Fair
More than 54	Good

For example, conditions with a mixing height of 1000 m and a wind speed of 15 km/h would give a ventilation index of approximately 63 and therefore a 'good' rating.

As the ventilation index is not specifically designed to assess smoke dispersion from small fires in a limited location (such as backyard burning in North Saanich), its primary purpose is to indicate rather than measure. The physics of smoke dispersion used to calculate the ventilation index are the same as those that govern smoke behaviour generally. The advantage of using the ventilation index as a proxy for assessing backyard burning conditions in North Saanich is that it is readily available (via the internet, telephone or TV) on a daily basis.

Figure 4 shows the average monthly ventilation index over the time period January 1999 to August 2003. The lower curve represents the ventilation index calculated from the morning conditions, and the upper curve corresponds to afternoon conditions. The error bars show the range that the mean value could fall within at a 95 percent confidence level. Clearly the statistics show that during the afternoon there is a higher ventilation index, and thus a greater potential for smoke to disperse. Both curves follow an annual cycle with the most favourable months for smoke dispersion being from February to July. The ventilation index ratings of 55 for good and 34 for fair are also shown and indicate that only the afternoon monthly averages of March through June remain within the good rating. Overall, the morning ventilation index is poor 61 percent of the time, (fair 21% of the time, good 18% of the time), the afternoon ventilation index is poor 33 percent of the time, and fair or good 26 and 41 percent of the time, respectively. Again, the ventilation index is seen to provide evidence that the afternoon as a better time to burn.

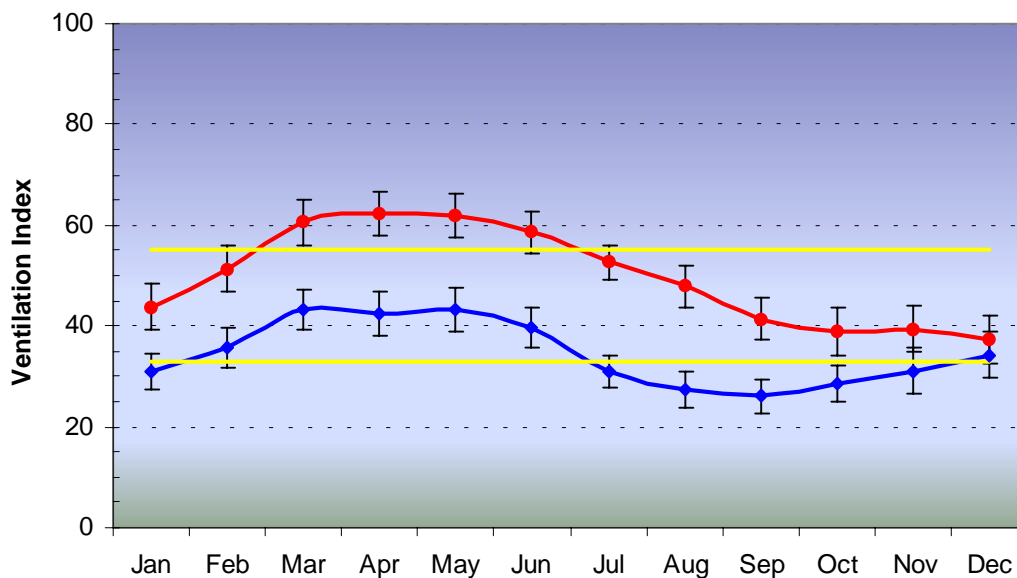


Figure 4. The mean monthly ventilation index for southern Vancouver Island. The red curve represents afternoon values, and the blue curve the morning values. The yellow lines show the threshold of good (rating of 55), and fair (rating of 34) (source Environment Canada).

Examining the ventilation index on a daily basis, which is how backyard burners would use it, the statistics reveal that there is a 54 percent chance that the ventilation index will be less than good on any given morning or afternoon. However, conditions change as easily as the weather; there is a 75 percent chance that conditions will be good within one day, a 15 percent probability of waiting for a week for an appropriate burning time. There is only a 10 percent chance that a burn

needs to be postponed for more than one week. It is clear that burning when the ventilation index is good provides plenty of opportunities, but timing is important.

## **4. Meteorological Data from Victoria Airport (CYYJ)**

### **4.2 Background**

Environment Canada collects a variety of meteorological data at Victoria International Airport for use in weather forecasts. These data are processed to ensure a high standard of quality, and then archived in order to be available for future analysis. The airport is located near the geographical centre of North Saanich, and the wind anemometer is located on the infield near the geographical centre of the airport. The wind speed and direction data gathered here on an hourly basis therefore represent typical wind conditions experienced by the district, although it is recognised that topographic features such as Mount Newton (approximately 300 m elevation), Cloak Hill (160 m) and Horth Hill (140 m) modify the local wind field.

Although there are approximately 50 weather parameters observed at the Victoria Airport meteorological station the three most relevant to smoke dispersion are wind speed and direction, and ceiling; the former characterizes the horizontal transport of smoke, and the latter addresses the height of the mixing layer. These data were used to correlate local weather conditions with the ventilation index for southern Vancouver Island; this information was also used to identify any pattern in the weather conditions coincident with smoke complaints.

### **4.2 Wind Speed and Direction**

The Environment Canada wind speed and direction data are collected hourly at Victoria airport at a location in the infield about 20 m above ground level, openly exposed to the wind from all directions. Based on 50 years of data (1940 – 1990) the wind climate in this region is characterised by:

- Winds with a (monthly) mean direction from the west from November to April, which shifts southerly and then southeasterly from May to August, and then back to westerly by November.
- Winds with a mean monthly speed above 10 km/h from November to April, and below 10 km/h from May to October.
- June and July are months with the greatest likelihood of calm conditions (about 100 h per month compared to less than 30 h per month in February).
- Although most winds are westerly (about 40 percent between west-southwest to west-northwest) some of the strongest winds (over 50 km/h) are from the southeast.

Figure 5 shows the annual cycle of monthly winds observed at Victoria airport.

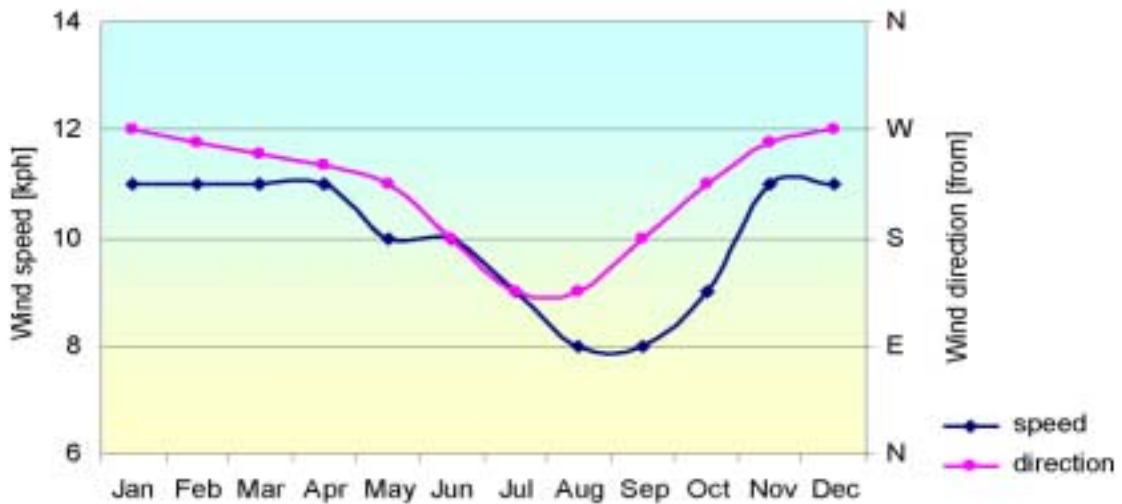


Figure 5. The mean monthly wind speed and direction observed at Victoria airport from 1940 to 1990 (source Environment Canada).

## 4.2 Ceiling

As a meteorological term the ceiling is the altitude of the lowest layer of clouds and thus represents an apparent height at which convective vertical mixing is significantly diminished. This can also be interpreted as a level around which there is little vertical movement of air and so smoke would have difficulty moving higher than this layer. The lower the ceiling the less volume of air available to disperse the smoke, and the greater the potential for smoke complaints.

Ceiling data from Victoria airport collected from 1993 to 2003 have been examined and show that conditions of unlimited ceiling (i.e. no discernable cloud layer) occurred 45 percent of the time, marginally more often during the afternoon than other times of the day. A ceiling of less than 3000 m (Mount Baker is 3285 m) comprised about 40 percent of the observations.

## 5. Data Analysis and Results

### 5.1 Comparison of Smoke Complaints and Ventilation Index

For every smoke complaint registered by the North Saanich Fire Department from January 1999 to June 2003 (274 complaints) the coincident ventilation index was determined. A ventilation index of good occurred on just 13 percent of these days, a fair rating on 19 percent, and a poor rating was given 68 percent of these days. Close to nine out of ten complaints occurred when the ventilation index predicted conditions for smoke dispersal were not good.

Examination of the ventilation index for the period following a smoke complaint reveals that good ventilation conditions occurred within one day in close to half the incidents (43 percent), and that a wait of three days would provide a good ventilation index in 73 percent of the incidents. In less than 10 percent of the reported complaints did the ventilation index remain below the good rating for over seven days.

Figure 6 shows the distribution of ventilation index ratings at the time of smoke complaints on a monthly basis. The tendency to burn at times of poor ventilation conditions is evident at all times of the year, but especially in October. An initiative by the fire department to conduct a Halloween bonfire may reduce the occurrences of backyard burning during this month. Figure 7 shows the same data on a percent scale.

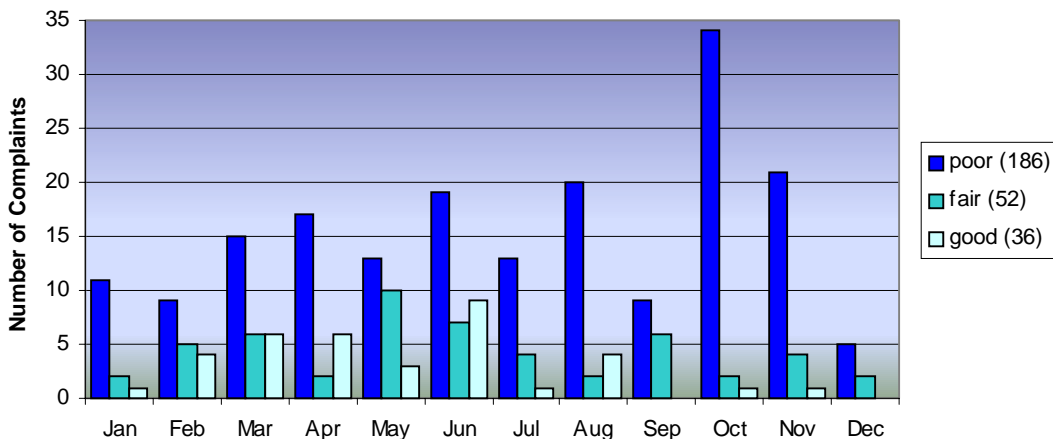


Figure 6. Ventilation index rating at time of smoke complaint (source Environment Canada and North Saanich Fire Department).

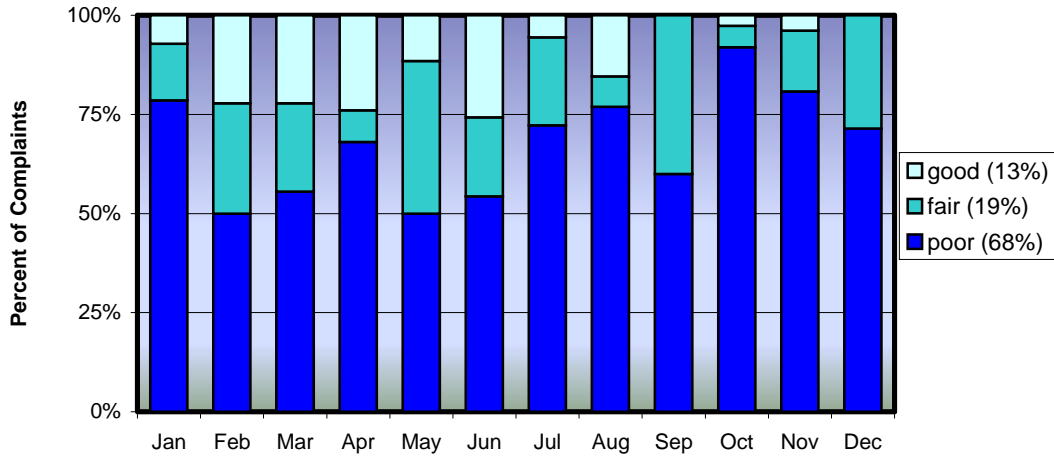


Figure 7. Percent distribution of ventilation index rating at time of smoke complaint (source Environment Canada and North Saanich Fire Department).

### 5.2 Comparison of Ventilation Index and Meteorological Data

As seen in the previous section the extent of smoke complaints may have been significantly reduced if burning had been confined to those times when the ventilation index was good. However, there were still examples of smoke complaints during times when the ventilation index was good, and as discussed previously this index is not specific to North Saanich conditions. An analysis of the wind speed and direction and ceiling data observed at Victoria airport an analysis was undertaken to correlate local meteorological conditions with the ventilation index to derive a more site specific smoke dispersal parameter.

A comparison between the wind speed and the ventilation index is shown in Figure 8, which plots the wind speed using the bottom scale, and the coincident ventilation index using the scale along the side. The hourly wind speed data were averaged from 7 - 11 am to compare with the morning ventilation index, and from 1 – 5 pm to compare with the afternoon ventilation index. Although the scatter in the plot reinforces the fact that the ventilation index consists of more than wind speed information, although there is a positive correlation indicating that the wind speed and the ventilation index vary in a similar fashion (a linear relationship with a correlation number of 0.37). Using this relationship a straight line has been drawn through the data points giving the two lines shown in Figure 8, the cyan line for the morning values, and the magenta line for the afternoon values. This line is considered a best fit as it minimizes the error (i.e. how far off is the

data point from the line). Accepting this relationship holds it can be determined that to exceed a ventilation index of 55 the morning wind speed should be greater than 20 km/h, and the afternoon wind speed greater than 15 km/h. In North Saanich this may provide backyard burners a useful backup to the ventilation index. For example, if the ventilation index is posted as fair, and the wind speed is less than 15 km/h, it may be prudent to delay the burn.

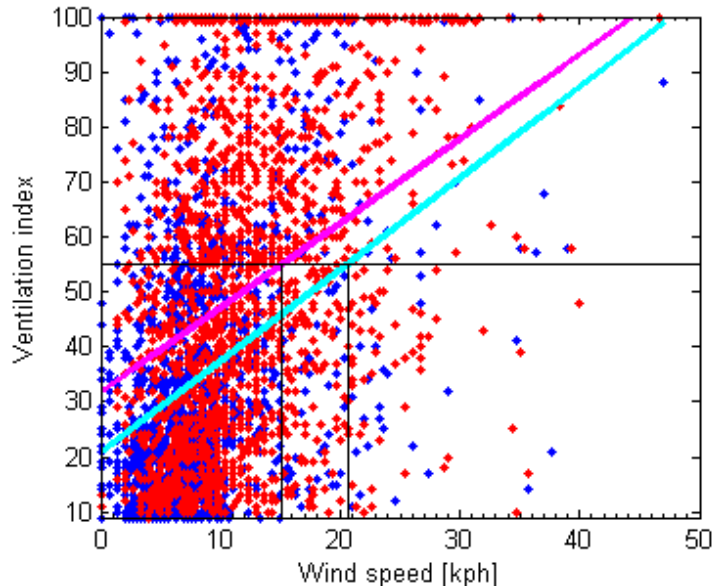


Figure 8. Scatter plot of wind speed observed at Victoria airport and the corresponding ventilation index from 1999 to 2003. Red points represent afternoon conditions, and blue points represent morning conditions. The magenta line is a best straight line fit through the afternoon data, and the cyan line is the corresponding best fit through the afternoon data (source Environment Canada).

The comparison between the local wind direction and the ventilation index revealed a very low correlation between these two parameters. This does not mean that wind direction is irrelevant to smoke dispersal; it simply means that the ventilation index for southern Vancouver Island does not vary in the same way as the wind direction at Victoria airport.

A comparison was made between the mixing height used to calculate the ventilation index and the elevation of the ceiling observed at the Victoria airport. The results show that the local ceiling is nearly always higher than the corresponding ventilation index mixing height, and therefore

caution is necessary to avoid overestimating the height of the mixing layer (and thus the ventilation index) when using the local ceiling conditions.

## **6. Conclusions and Recommendations**

Backyard burning in North Saanich is an issue that has had proponents and protesters arguing their positions for several years. There is a general consensus of an acceptance with the practise of backyard burning, but also an attendant recognition that it should not hazard the environment, nor be a bother to other residents. A District survey in 2000 (with 22% return) indicates that residents in high-density neighbourhoods (specifically Dean Park) are the most opposed to backyard burning.

The North Saanich Fire Department is active in this issue. Proposed changes to the Burning Bylaw (962) in 2003 alter the burning times from sunrise to sunset all days except Sunday and statutory holidays, to Thursdays and Fridays (sunrise to sunset) and Saturdays (sunrise to 4 pm). There are also bi-annual district bonfires at which residents can drop yard and garden waste at the Deep Cove Fire Hall where it is burned under controlled conditions.

The aspects of the issue that appear to be least understood are the health hazards presented by concentrated smoke, and the how to access the relevant environmental information that indicates when to burn.

The results of this study show that regulating burning to prescribed calendar days, without attention paid to the environmental conditions, will likely concentrate the smoke complaints, and the smoke hazard.

Based on smoke complaints reported from January 1999 to June 2003 compliance to burning only during times when the ventilation index is good and the local wind speed is over 15 km/h in the afternoon (20 km/h in the morning) may have reduced the number of complaints up to 90 percent.

It is recommended that information documenting the health hazards due to smoke, and the use of the ventilation index and wind speed to determine when to burn, be provided to all residents. The North Saanich Fire department is the obvious choice to lead this campaign, and to suggest how the regulations should be written, implemented and enforced. It is further recommended that a brochure be included in the Fall 2003 water bill that is sent to all residents that provides this information.

## 7. References

Canadian Centre for Pollution Prevention, 2003. [www.c2p2online.com/main.php3](http://www.c2p2online.com/main.php3)

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