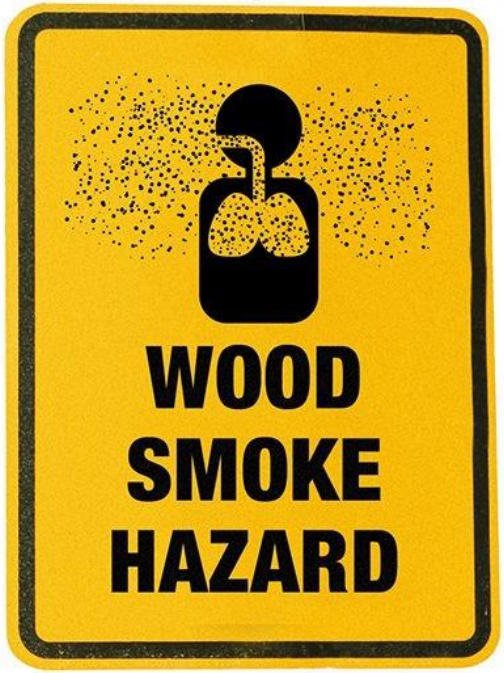

THOMPSON RIVERS UNIVERSITY

Wood Smoke And The Atmospheric Commons

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Department of Geography and Environmental Studies
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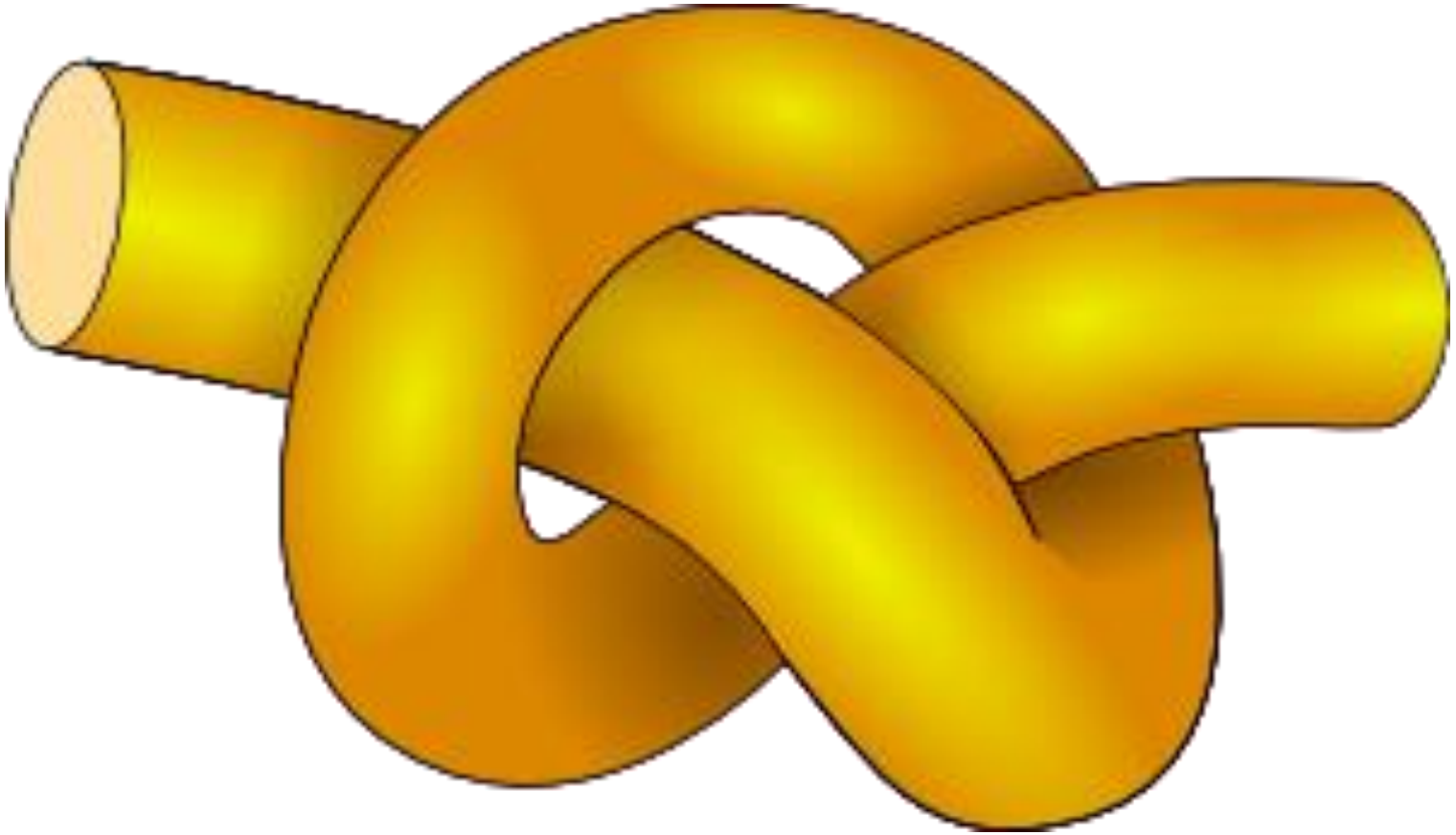
We Can’t Trust Our Senses, And Our Culture And Tradition Impair Understanding Of This Risk Issue. Counter-Messaging Predominates.

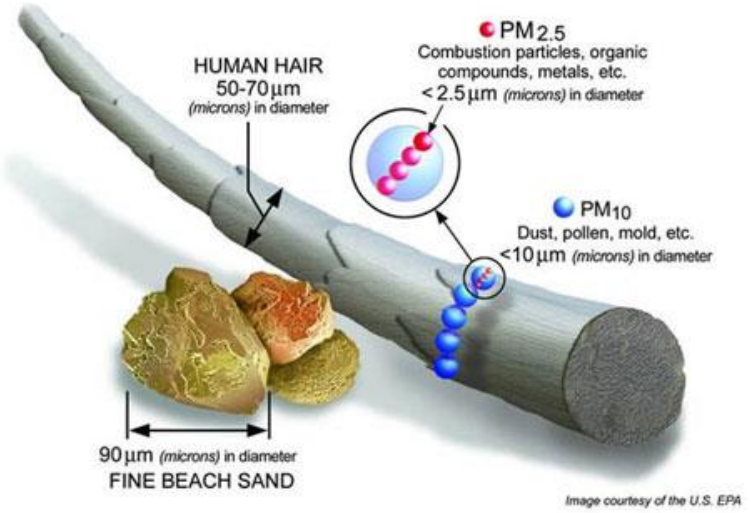


Yet we have a well-established and understood parallel risk issue that can be drawn upon.

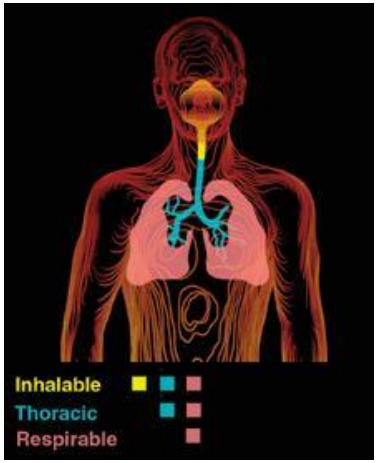
Actual background photo from the
Village of Cumberland BC [Comox Valley]

What Is PM2.5?

- Toxic organic or heavy metal particles usually associated with combustion or smelting.
- The major components of PM are sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water. It consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air.
- Size=2.5 micron range (1 millionth of a m)
- Sometimes called the “invisible killer.”

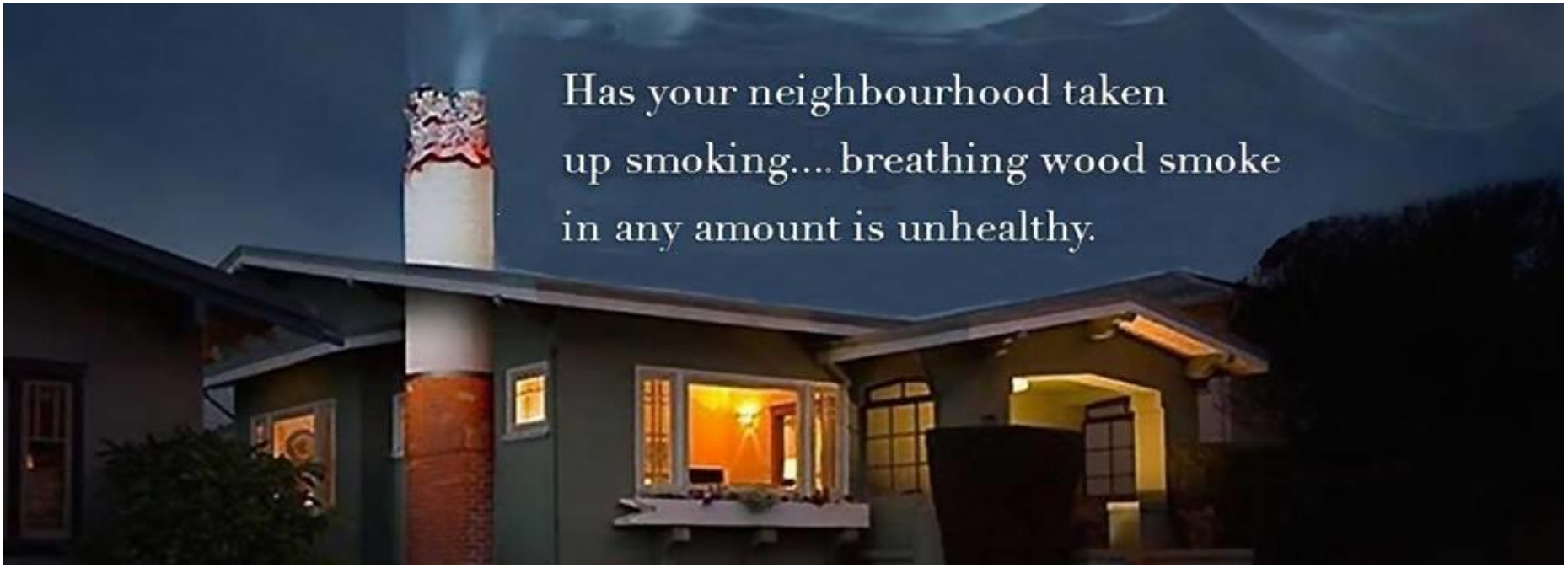


It is also known as respirable particles because it penetrates the respiratory system deeper than larger particles.



<u>Cardiovascular, pulmonary and lung cancer:</u>
Relationship is somewhat linear [every 10 micrograms/m^3 increases mortality by 14%]
<u>Spikes:</u> acute stroke in healthy people

*Children, elderly and those with lung disease most at risk. Fetal development adversely affected.



"Wood smoke is not evenly distributed throughout the air shed. Severe hot spots of pollution and 'local victims' are created."

Unlike most other sources of pollution, wood-burning emissions in a home are released directly into the area where people spend most of their time, at an elevation that does not promote dispersion.

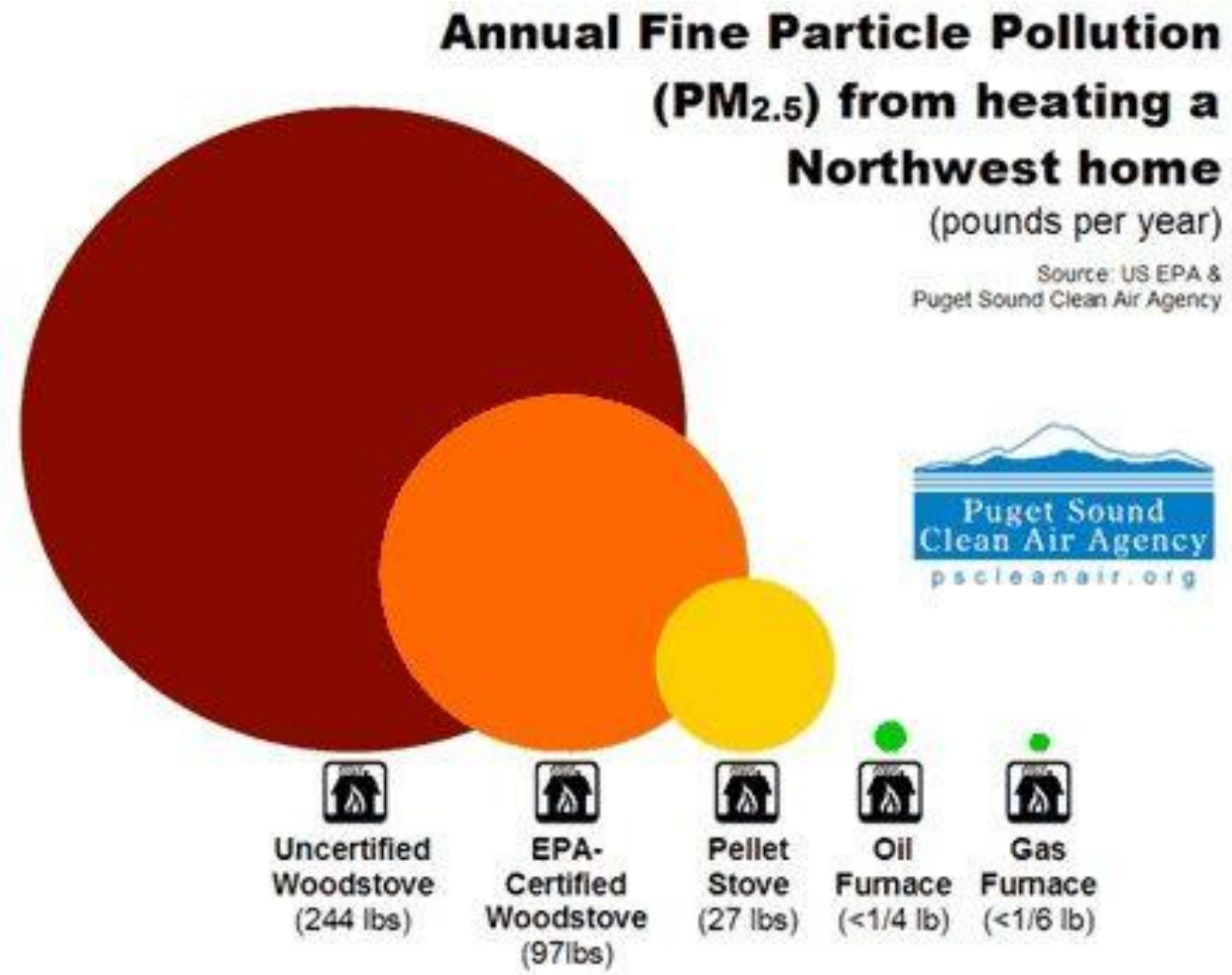
Utah Physicians For A Healthy Environment
http://uphe.org/wp-content/uploads/2016/01/UPHE-wood-smoke-report-2016-update-PDF.pdf

Smoke released from unapproved stoves and open hearth fireplaces emit as many fine particles in 9 hours as driving a mid-size automobile 18,000 km (Environment Canada).

Certified appliances are cleaner, but are not the solution.

There are tens of thousands of pre-1994 EPA-approved (CSA B415.1) woodstoves and open hearth fireplaces in BC.

Scenario: If 1000 of these are operating in Kamloops for 7 months/year and 9 hours/day, we have the equivalent of: 210,000 extra vehicles driving 18,000 kms each.

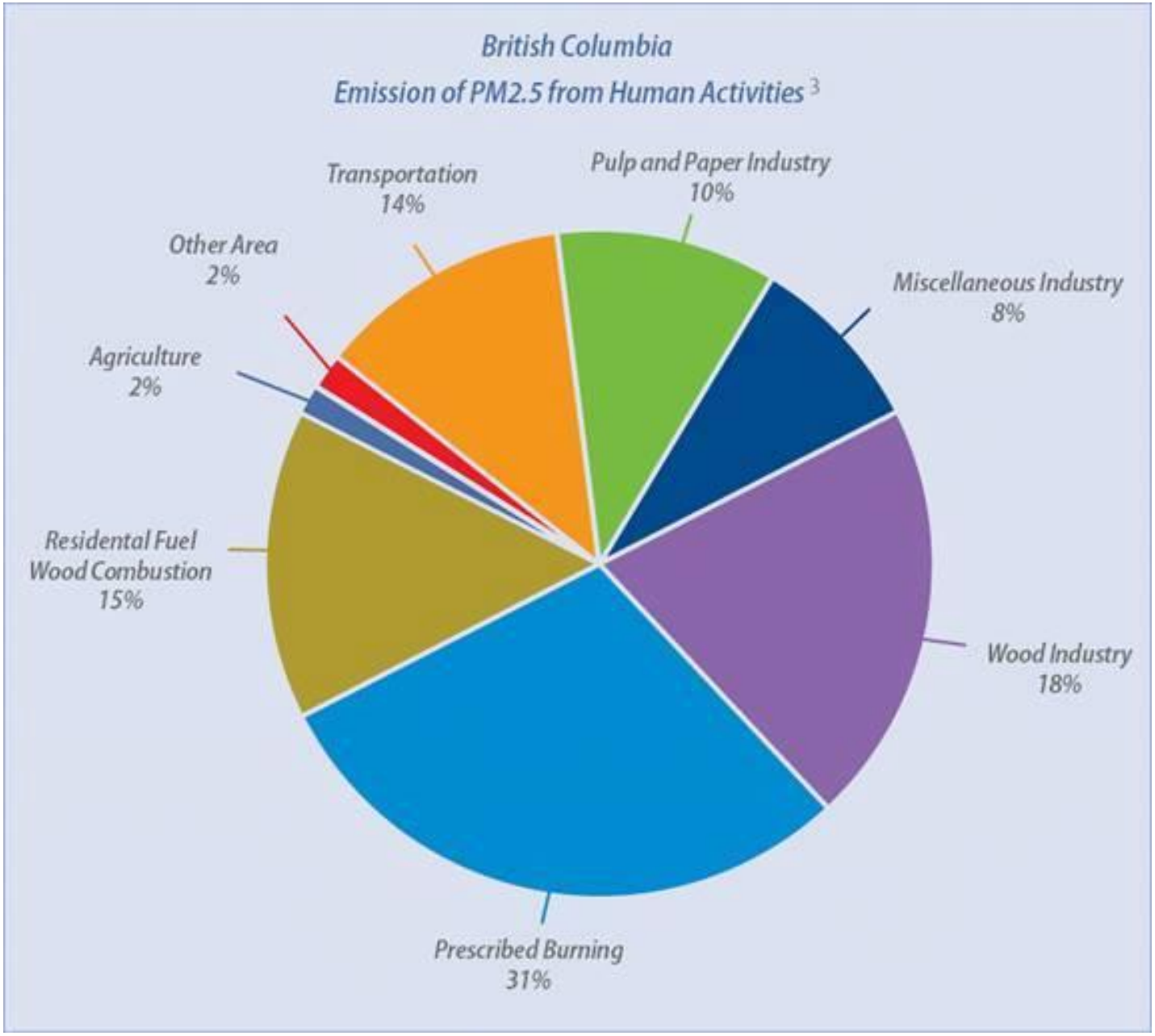


EPA-certified wood stoves emit at least 169 times more fine particles than a gas furnace and far more than an electric ductless mini-split heat pump. EPA-certified wood stoves have not been shown to reduce emissions of dioxins, furans, or other air toxics – they actually increase these toxic releases.

Wood burning accounts for 97% of PM2.5 emissions associated with heating in B.C. and accounts for 10% of heating needs.

"In Golden the "wood smoke" and "winter heating" fractions of PM collectively account for 60% of measured PM2.59; an airshed modelling study in Quesnel determined that the "residential sector" (including wood stoves and backyard burning) contributes up to 62% of PM2.5, depending on location; in Williams Lake wood heating was the largest PM2.5 contributor at 7 out of 15 sites."

http://www.env.gov.bc.ca/epd/codes/solid-fuel/pdf/intentions-paper.pdf


British Columbia
Emission of PM2.5 from Human Activities 3
Transportation
14%
Pulp and Paper Industry
10%
Other Area
2%
Miscellaneous Industry
8%
Agriculture
2%
Residental Fuel
Wood Combustion
15%
Wood Industry
18%
Prescribed Burning
31%

2010

Parksville, BC

YET THE BC LUNG ASSOCIATION AND MANY LOCAL GOVERNMENTS SUPPORT SWITCHOVER PROGRAMS TO EPA APPLIANCES

Wood stove exchange programs don't work.

- EPA stoves create more pollution than burning coal.
- They generate highly toxic chemicals like dioxins and furans.
- They never perform in the real world like they do in the lab.
- They pollute more as they get older.
- They give a false sense of comfort and encourage more people to burn wood.

Air pollution nine-times deadlier than car crashes, UBC researchers say University of B.C. researchers in an article published Monday in the Canadian Medical Association Journal.

About 21,000 Canadians die prematurely from the ill effects of air pollution each year, compared to 2,400 from traffic crashes.

http://www.vancouversun.com/health/pollution+nine+times+deadlier+than+crashes+researchers/9061897/story.html

New estimates from the Global Burden of Disease project and the World Health Organisation state that between 5.5 and 7 million people die from air pollution every year.

That's more than die from malaria and HIV/Aids put together.

In the next 10 years we can expect as many people to die from breathing poisonous air as were killed in the second world war.

http://www.who.int/quantifying_ehimpacts/global/source_apport/en/

Understanding The Numbers

There are two national PM2.5 indicators: an annual average indicator that is based on the annual average concentrations (to capture prolonged or repeated exposures over longer time periods or chronic exposure), and a peak 24-hour indicator that is based on the top 98th percentile 24-hour concentrations (to capture immediate or acute, short-term exposures).

In 2013, the annual average concentration of PM2.5 in the air in Canada was 7.3 micrograms per cubic metre (µg/m3), 16% higher than in 2012. The annual peak (98th percentile) 24-hour concentration of PM2.5 in 2013 was 20.0 µg/m3.

In British Columbia*, the annual average concentration of fine particulate matter (PM2.5) in 2013 was 6.0 µg/m3. The annual peak (98th percentile) 24-hour indicator of PM2.5 was 16.2 µg/m3.

* Recorded at 13 monitoring stations.

https://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=029BB000-1#r5

New Provincial Ambient Air Quality Criteria for $PM_{2.5}$

Criteria	Level	Averaging Period
Air Quality Objective	25 µg/m3	24 hours[1]
Air Quality Objective	8 µg/m3	Annual
Planning Goal	6 µg/m3	Annual

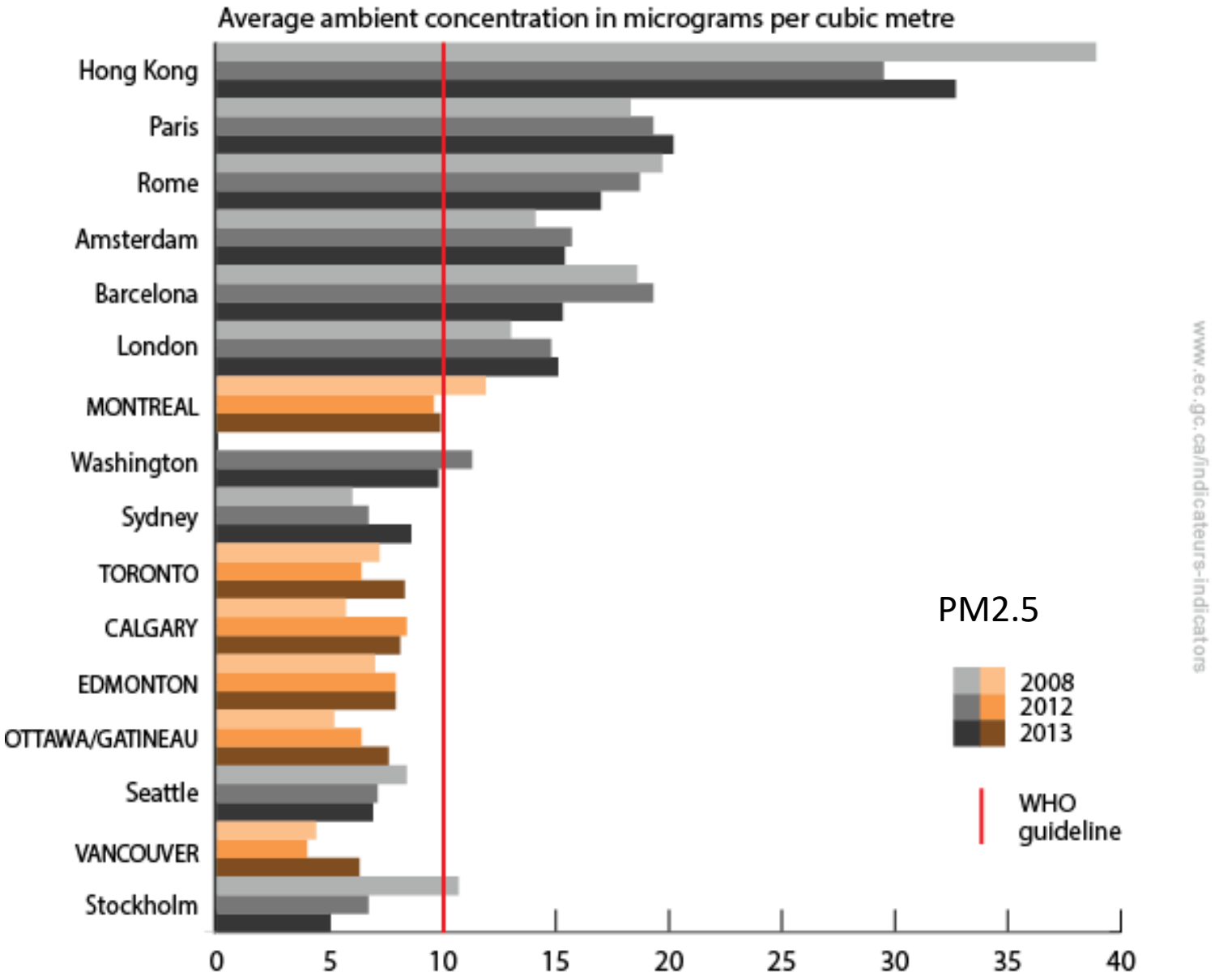
1. Achievement based on annual 98th percentile value.

Kamloops: The mean annual value of PM 2.5 for 2015 was 8.5 micrograms per cubic metre (Peter Tsigaris and Robert Schemenauer, 2016).

http://www.bcairquality.ca/regulatory/pm25-objective.html

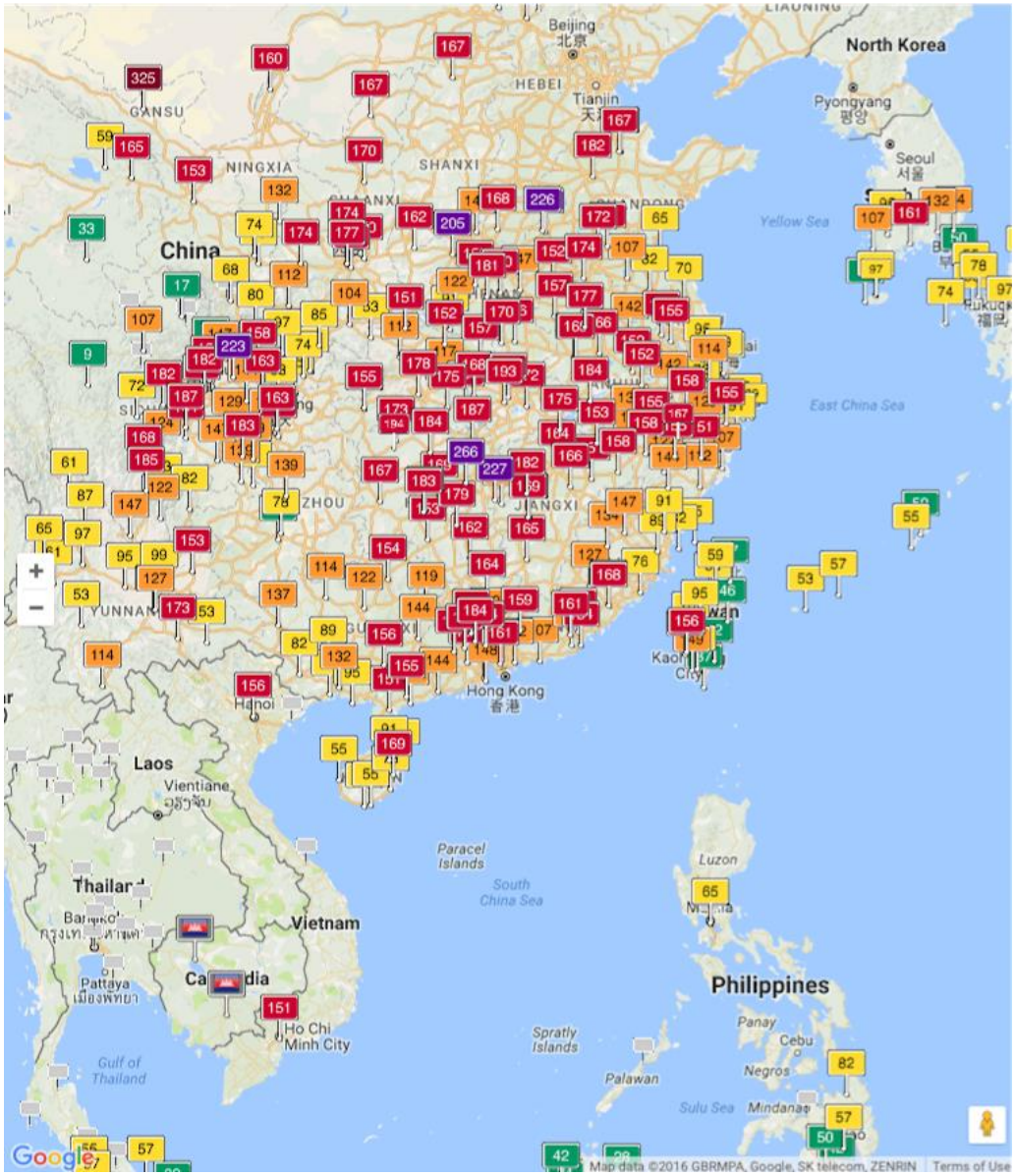
World Health Organisation Recommendations For Long-Term Exposures

	PM10	PM2.5	
Air quality guideline (AQG)	**20**	**10**	These are the lowest levels at which total, cardiopulmonary and lung cancer mortality have been shown to increase with more than 95% confidence in response to long-term exposure to $PM_{2.5}$



https://www.ec.gc.ca/indicateurs-indicators/FDBB2779-F991-4F2D-B846-4FBCA2E58B7D/ICUAQ_PM25_EN.gif

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*..air quality conditions are:*	*...as symbolized by this color:*
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon



Example: September 30, 2016

China pollution: First ever red alert in effect in Beijing

8 December 2015 | China

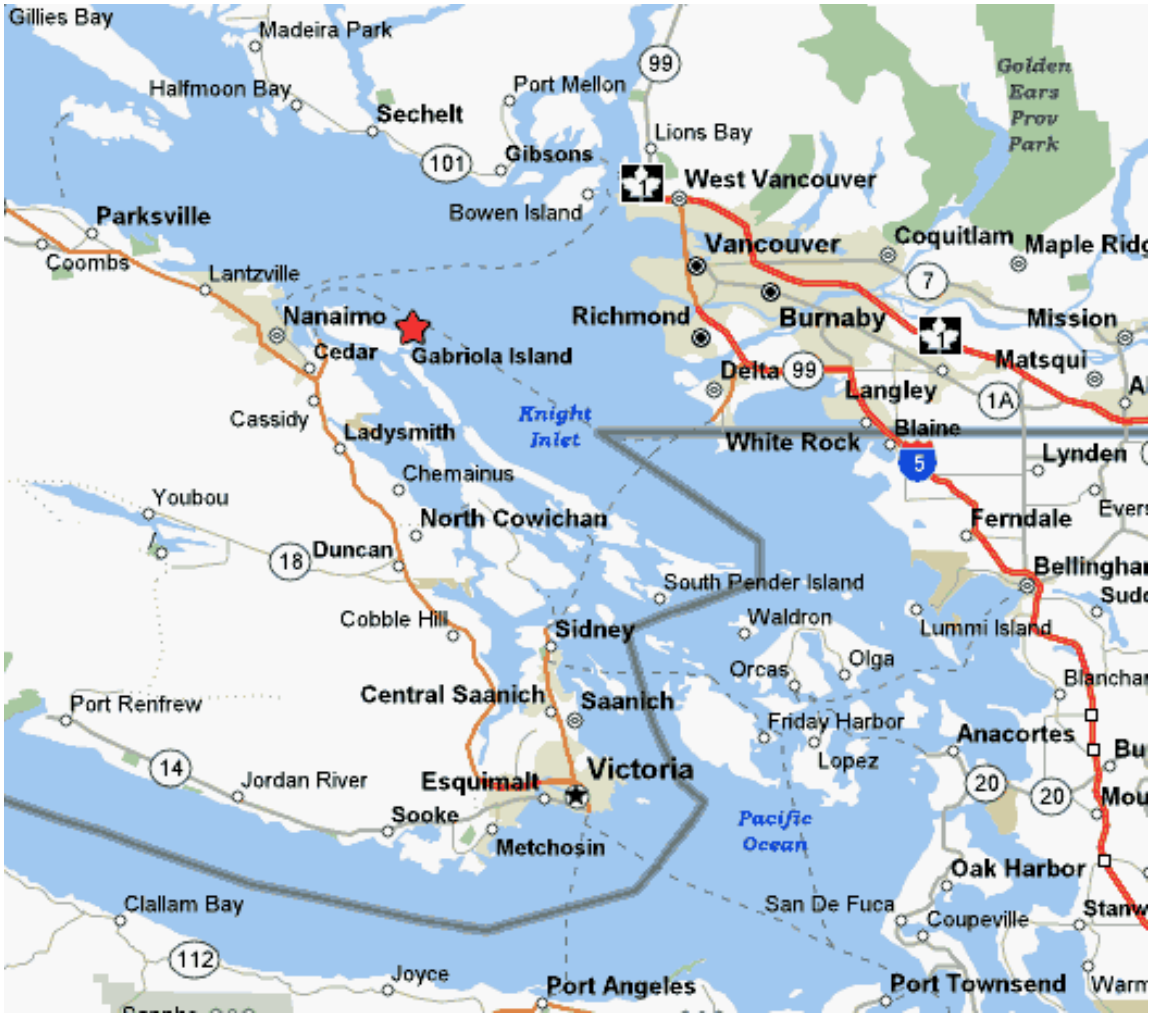
Share

Although it is the first time a red alert has been issued, pollutio
the city

At 07:00 local time on Tuesday (23:00 GMT on Monday), when the alert came into effect, the US Embassy's **air pollution monitor** in Beijing reported that the intensity of the tiny particles known as PM 2.5 was at **291** micrograms per cubic metre.

Example: September 30, 2016

When It Comes To Air Quality, Reality Does Not Match Perception In Rural BC



December 22, 2014 between 2-3PM (Gabriola Island, BC)

Same Time, Same Day: An Irresponsible Combustor

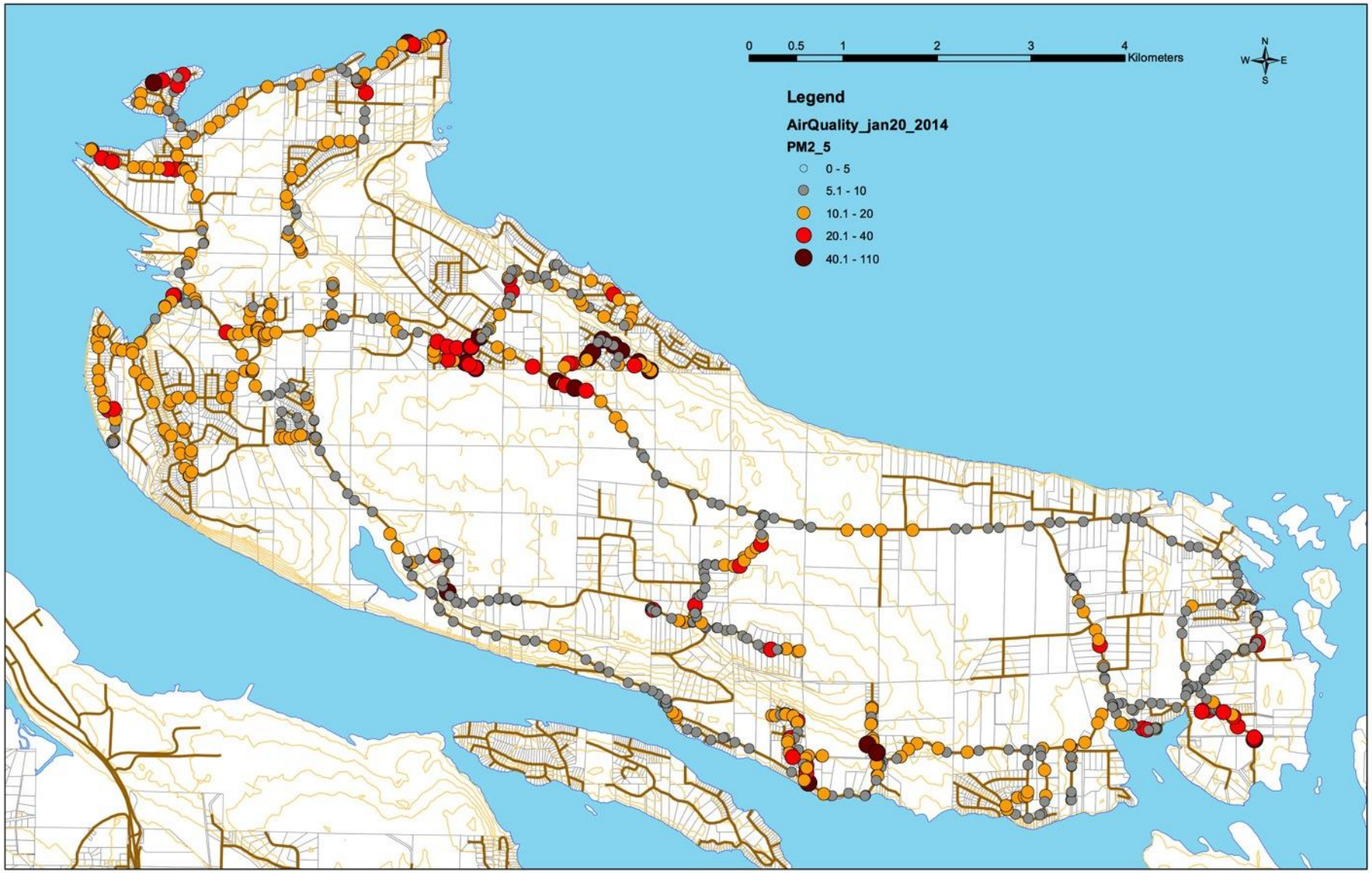
The particulate matter in wood smoke is so small that windows and doors cannot keep it out — even the newer energy-efficient weather-tight homes cannot keep out wood smoke.

80-90% of outdoor air gets inside your house!

Nephelometric Data: M903 Radiance Nephelometer

- Procedure developed by University of Victoria's Spatial Sciences Research Lab
- Data analysis approach based on studies from Seattle.
- Same instrument used for Nanaimo PM2.5 studies.

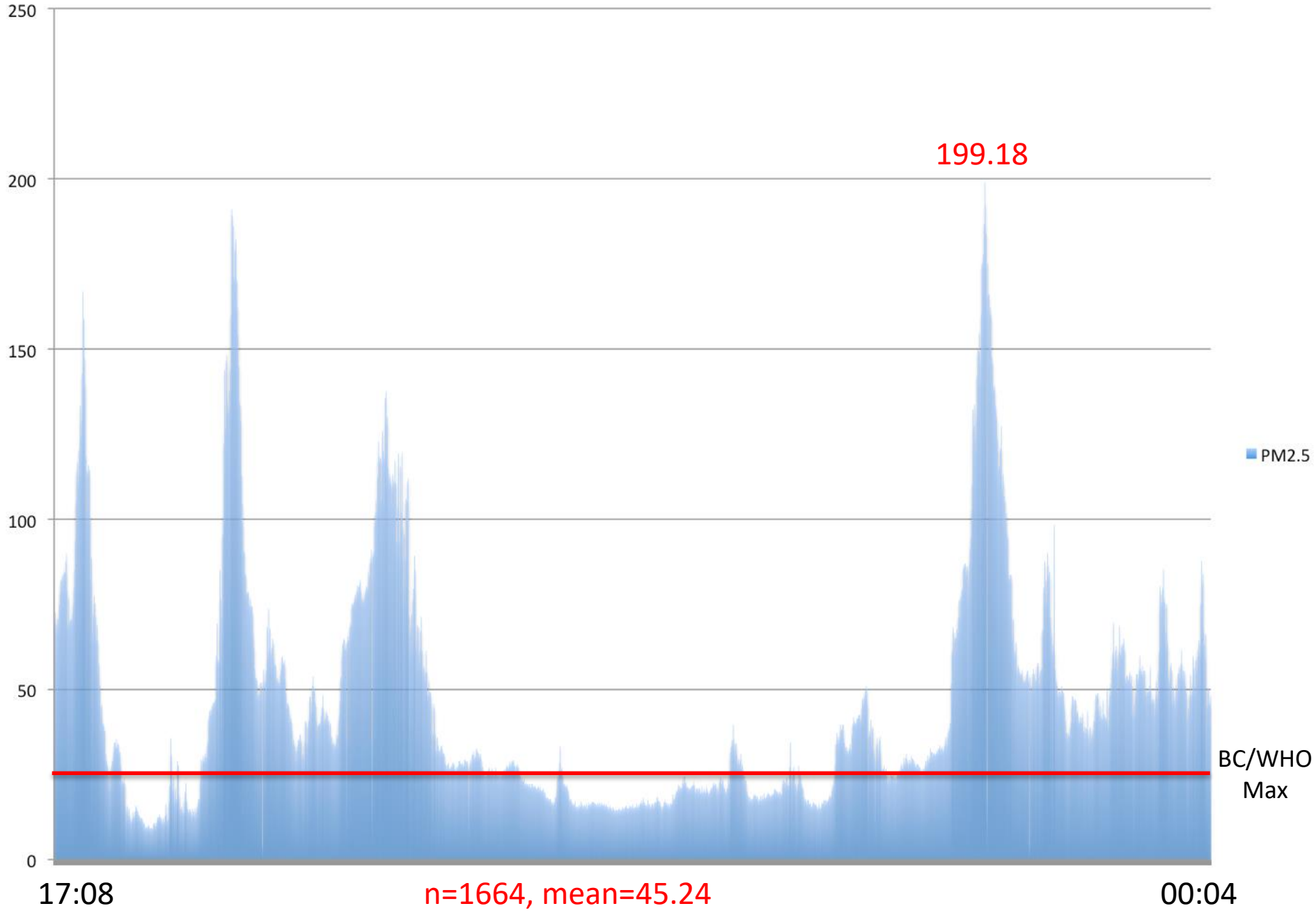
Spatial distribution and hotspots - Monday January 20 2014 between 18:15-21:30



n=766, mean=12.66

PM2.5

Stationary test: January 24 2014, 17:08:15-00:04:15, 733 Berry Point Road, Gabriola island)



A New Non-Profit Society Was Formed In July 2015

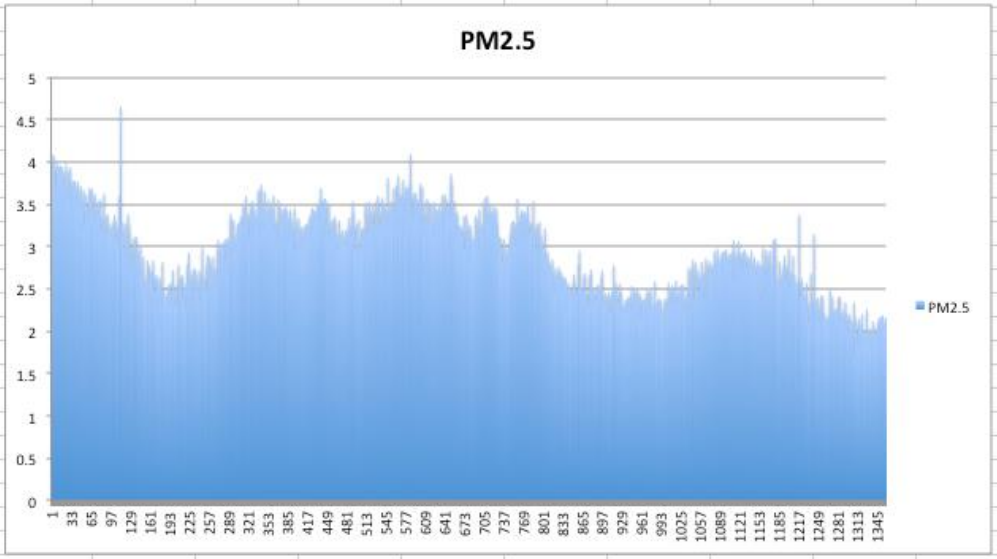
www.gabriolacleanair.ca

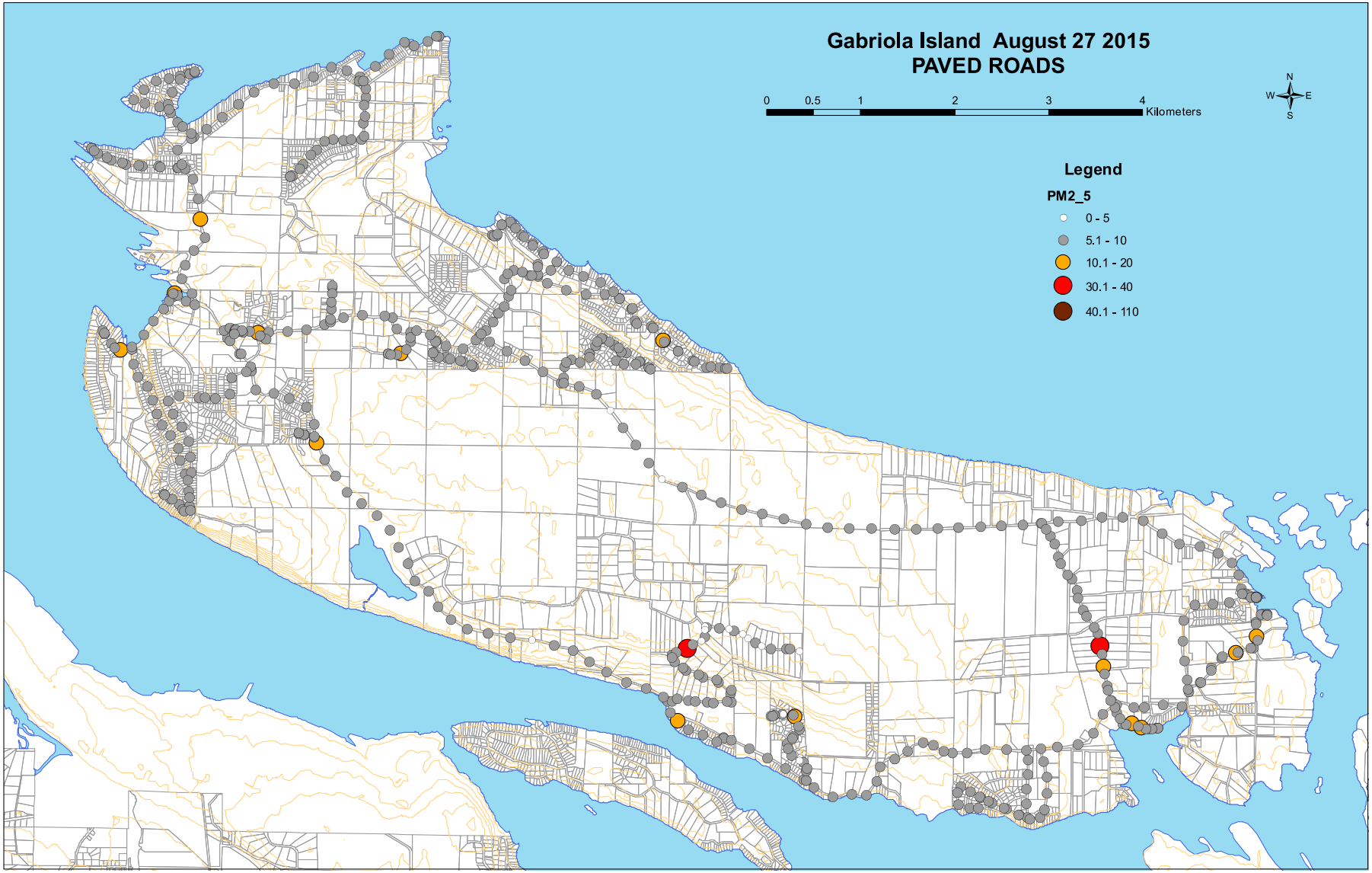
How Clean Are The PM2.5 Emissions From A Newer Model V8 SUV?

	A	B	C	D	E	F	G	H	I	J	K
1	Year	Month	Day	Hour	Minute	Second	Backscatter	PM2.5	Mean	Max	Min
2	15	8	17	12	53	0	1.20E-05	4.24285714	3.60884821	11.7892857	2.79785714
3	15	8	17	12	54	0	1.17E-05	4.13928571			
4	15	8	17	12	55	0	1.20E-05	4.23571429			
5	15	8	17	12	56	0	1.16E-05	4.08928571			

Summer Air Quality on Gabriola Island: August 18/19 2015

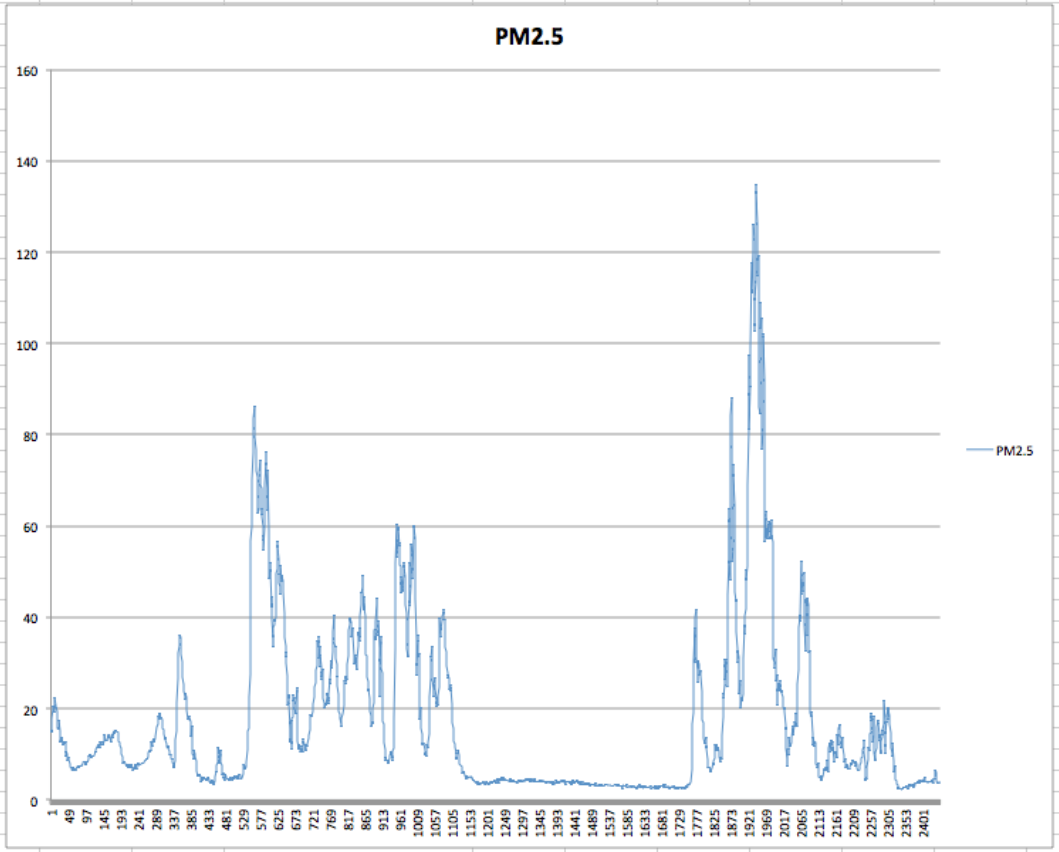
Year	Month	Day	Hour	Minute	Second	Backscatter	PM2.5	Mean	Max	Min
15	8	18	14	20	0	1.08E-05	3.82857143	2.88629963	4.65357143	1.71785714
15	8	18	14	21	0	1.12E-05	3.95714286			
15	8	18	14	22	0	1.16E-05	4.09285714			
15	8	18	14	23	0	1.15E-05	4.05714286			
15	8	18	14	24	0	1.06E-05	3.76071429			
15	8	18	14	25	0	1.08E-05	3.81071429			
15	8	18	14	26	0	1.04E-05	3.66785714			
15	8	18	14	27	0	1.05E-05	3.70714286			
15	8	18	14	28	0	1.11E-05	3.93214286			
15	8	18	14	29	0	1.13E-05	3.98571429			
15	8	18	14	30	0	1.11E-05	3.94285714			
15	8	18	14	31	0	1.10E-05	3.88571429			
15	8	18	14	32	0	1.11E-05	3.93928571			
15	8	18	14	33	0	1.05E-05	3.69642857			
15	8	18	14	34	0	1.12E-05	3.95714286			
15	8	18	14	35	0	1.09E-05	3.86785714			
15	8	18	14	36	0	1.11E-05	3.94285714			
15	8	18	14	37	0	1.08E-05	3.80357143			
15	8	18	14	38	0	1.08E-05	3.83571429			
15	8	18	14	39	0	1.05E-05	3.71428571			
15	8	18	14	40	0	1.10E-05	3.88214286			
15	8	18	14	41	0	1.08E-05	3.83214286			
15	8	18	14	42	0	1.07E-05	3.77857143			
15	8	18	14	43	0	1.12E-05	3.97857143			
15	8	18	14	44	0	1.07E-05	3.78214286			
15	8	18	14	45	0	1.00E-05	3.54642857			
15	8	18	14	46	0	1.10E-05	3.9			




Gabriola Island August 27 2015
PAVED ROADS
0 0.5 1 2 3 4
Kilometers
N
W E
S
Legend
PM2_5
0 - 5
5.1 - 10
10.1 - 20
30.1 - 40
40.1 - 110

Wood Burning Appliances Have Turned A Clean Summer Location Into A Winter Nightmare

Year	Month	Day	Hour	Minute	Second	Backscatter	PM2.5	Mean	Max	Min	n=2248 on 20 second intervals	Dec 28 2015 9:17PM to Dec 29 2015 10:52AM
15	12	28	21	17	0	4.32E-05	15.3928571	17.5149568	134.964286	2.15357143		
15	12	28	21	17	20	4.12E-05	14.6785714					
15	12	28	21	17	40	4.21E-05	15					
15	12	28	21	18	0	5.01E-05	17.8571429					
15	12	28	21	18	20	5.58E-05	19.8928571					
15	12	28	21	18	40	5.60E-05	19.9642857					
15	12	28	21	19	0	5.84E-05	20.8214286					
15	12	28	21	19	20	5.88E-05	20.9642857					
15	12	28	21	19	40	5.36E-05	19.1071429					
15	12	28	21	20	0	5.84E-05	20.8214286					
15	12	28	21	20	20	6.04E-05	21.5357143					
15	12	28	21	20	40	6.31E-05	22.5					
15	12	28	21	21	0	5.77E-05	20.5714286					
15	12	28	21	21	20	5.75E-05	20.5					
15	12	28	21	21	40	5.59E-05	19.9285714					
15	12	28	21	22	0	5.71E-05	20.3571429					
15	12	28	21	22	20	5.46E-05	19.4642857					
15	12	28	21	22	40	5.28E-05	18.8214286					
15	12	28	21	23	0	5.19E-05	18.5					
15	12	28	21	23	20	4.40E-05	15.6785714					
15	12	28	21	23	40	4.30E-05	15.3214286					
15	12	28	21	24	0	4.40E-05	15.6785714					
15	12	28	21	24	20	4.92E-05	17.5357143					
15	12	28	21	24	40	4.95E-05	17.6428571					
15	12	28	21	25	0	4.19E-05	14.9285714					
15	12	28	21	25	20	3.52E-05	12.5357143					
15	12	28	21	25	40	3.62E-05	12.8928571					
15	12	28	21	26	0	3.71E-05	13.2142857					
15	12	28	21	26	20	3.74E-05	13.3214286					
15	12	28	21	26	40	3.65E-05	13					
15	12	28	21	27	0	3.86E-05	13.75					
15	12	28	21	27	20	3.87E-05	13.7857143					
15	12	28	21	27	40	3.38E-05	12.0357143					
15	12	28	21	28	0	3.40E-05	12.1071429					
15	12	28	21	28	20	3.40E-05	12.1071429					
15	12	28	21	28	40	3.64E-05	12.9642857					
15	12	28	21	29	0	3.55E-05	12.6428571					
15	12	28	21	29	20	3.60E-05	12.8214286					
15	12	28	21	29	40	3.42E-05	12.1785714					
15	12	28	21	30	0	3.62E-05	12.8928571					
15	12	28	21	30	20	3.10E-05	11.0357143					
15	12	28	21	30	40	2.66E-05	9.46428571					
15	12	28	21	31	0	3.00E-05	10.6785714					
15	12	28	21	31	20	3.03E-05	10.7857143					
15	12	28	21	31	40	2.84E-05	10.1071429					

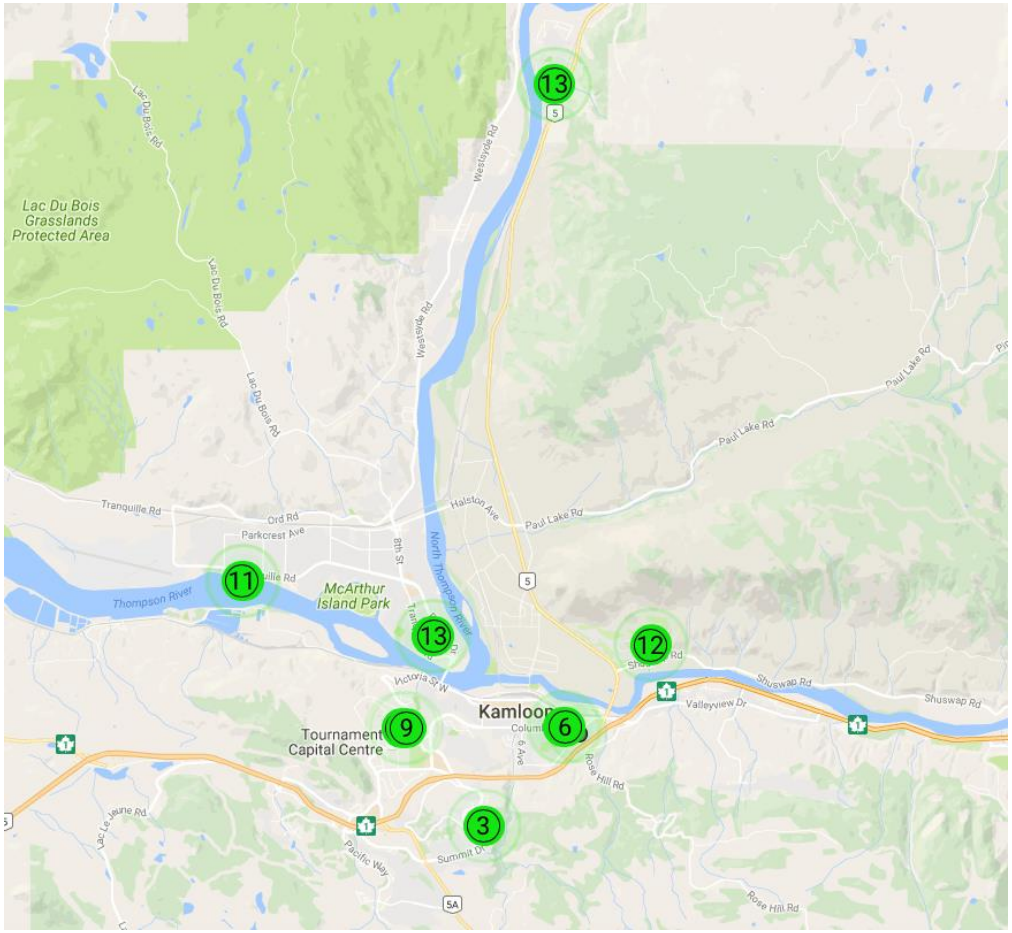


December 28, 2015

PurpleAir

250+ sensors in North America

PM (0.3 to 10 microns)
Temperature + Humidity

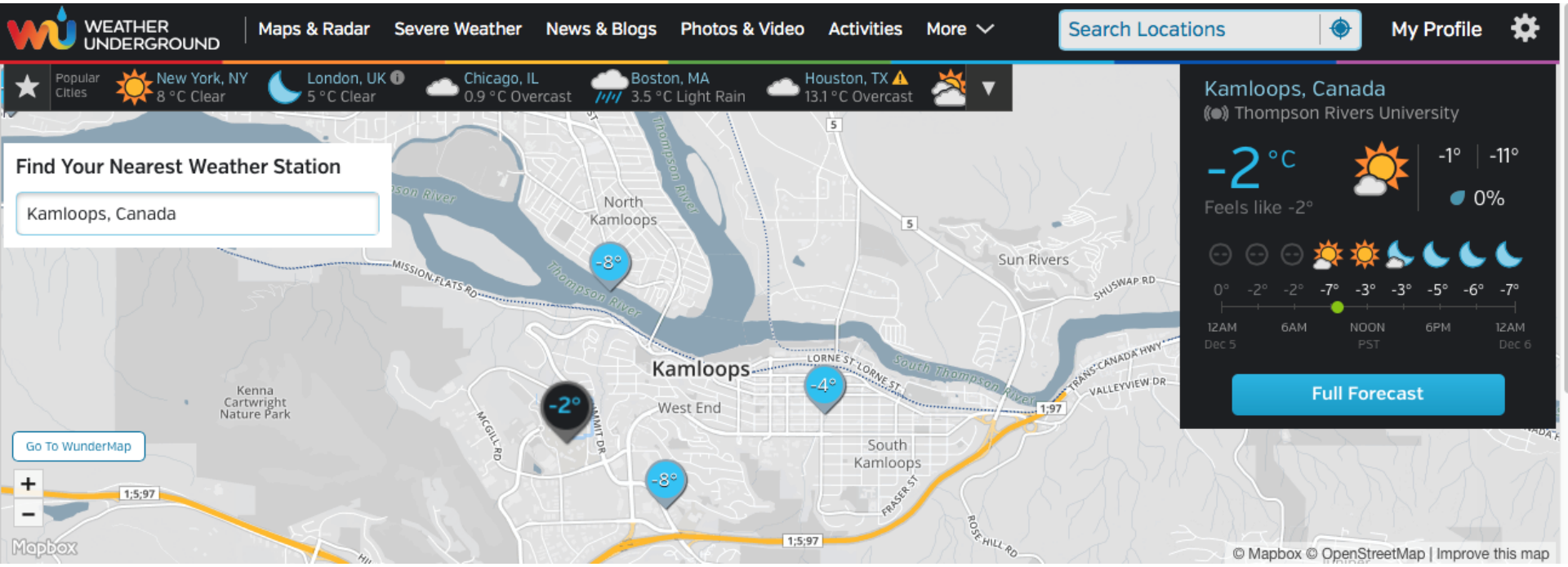


Kamloops = 8

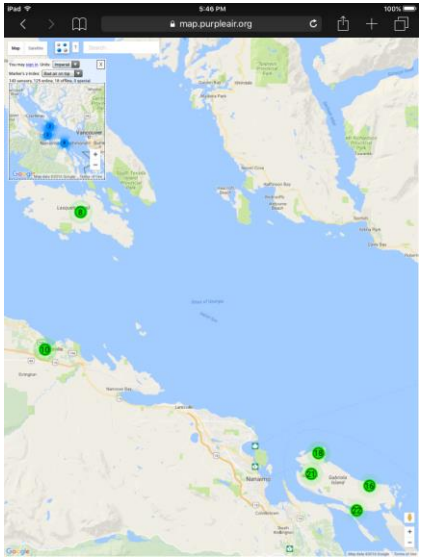
Several others on Gabriola Island, Parksville, Lasqueti Island, Victoria, Vancouver, and Prince George

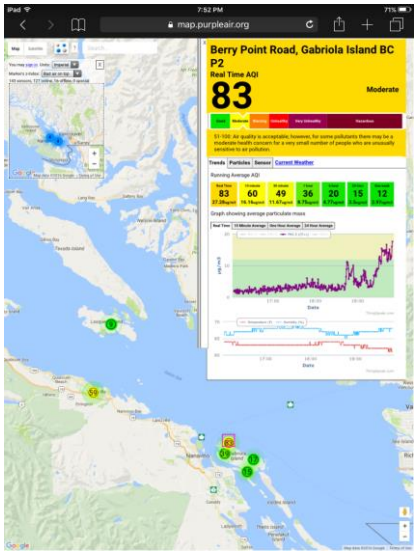
map.purpleair.org

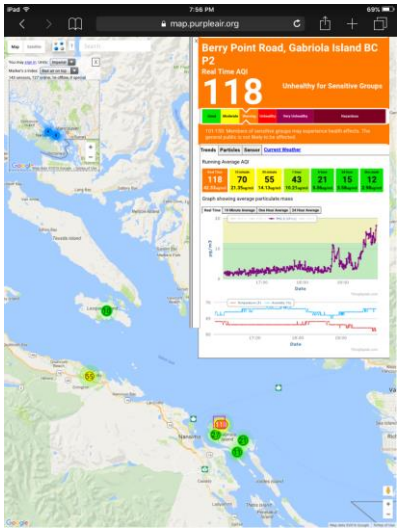
PurpleAir Sensors Can Also Be Connected To Weather Underground

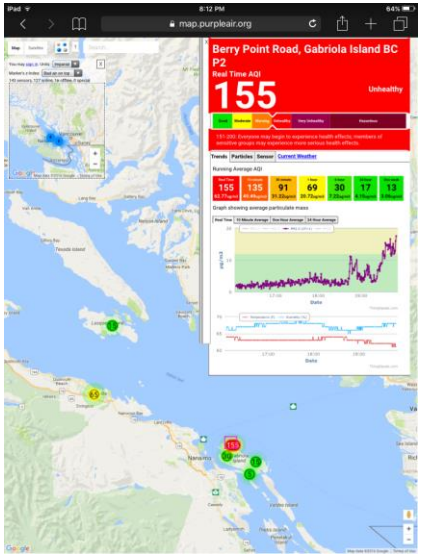


The Anatomy Of A Public Health Crisis



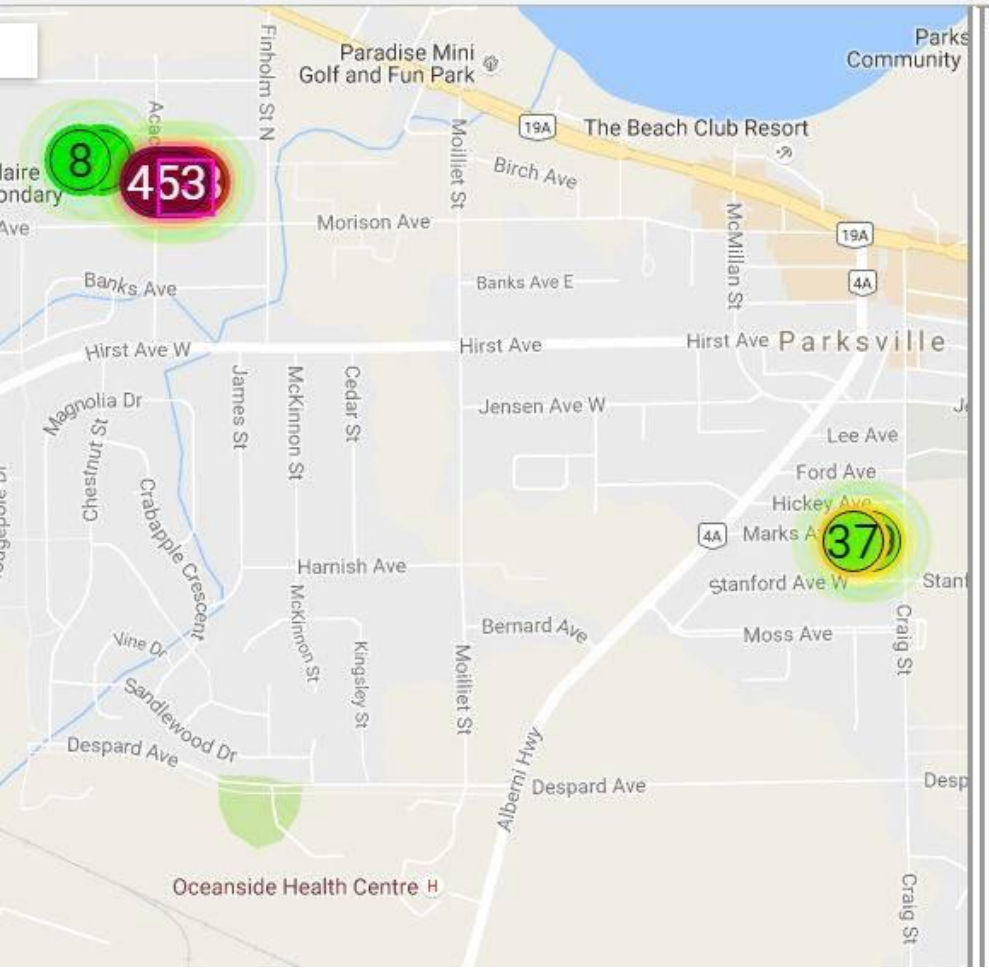






PurpleAir screen captures from October 2, 2016 from a new EPA wood stove burning very dry wood.

9:20AM: November 1, 2016



X

Acacia Street North, Parksville, British Columbia P2

Real Time AQI

453

Hazardous

Good	Moderate	Warning	Unhealthy	Very Unhealthy	Hazardous

>401: Health alert: everyone may experience more serious health effects

Trends | Particles | Sensor | Current Weather

Running Average AQI

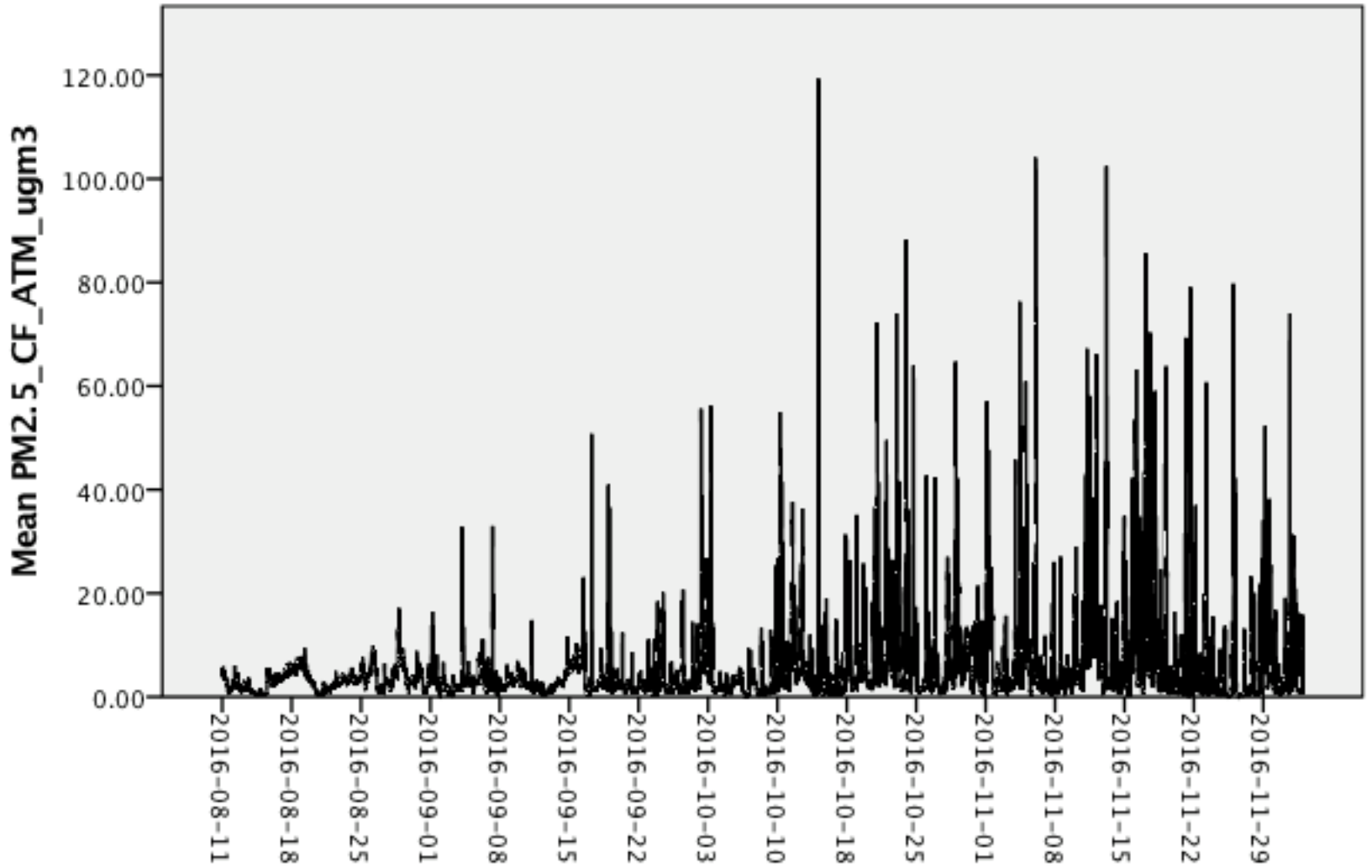
Real Time	10 minute	30 minute	1 hour
453	203	159	115
428.93ug/m3	152.57ug/m3	70.83ug/m3	41.21ug/m3

6 hour	24 hour	One week
43	26	46
10.27ug/m3	6.29ug/m3	11.07ug/m3

Graph showing average particulate mass

November 24, 2016

Gabriola Island BC (Berry Point Road sensor data): August 11, 2016 – December 2, 2016



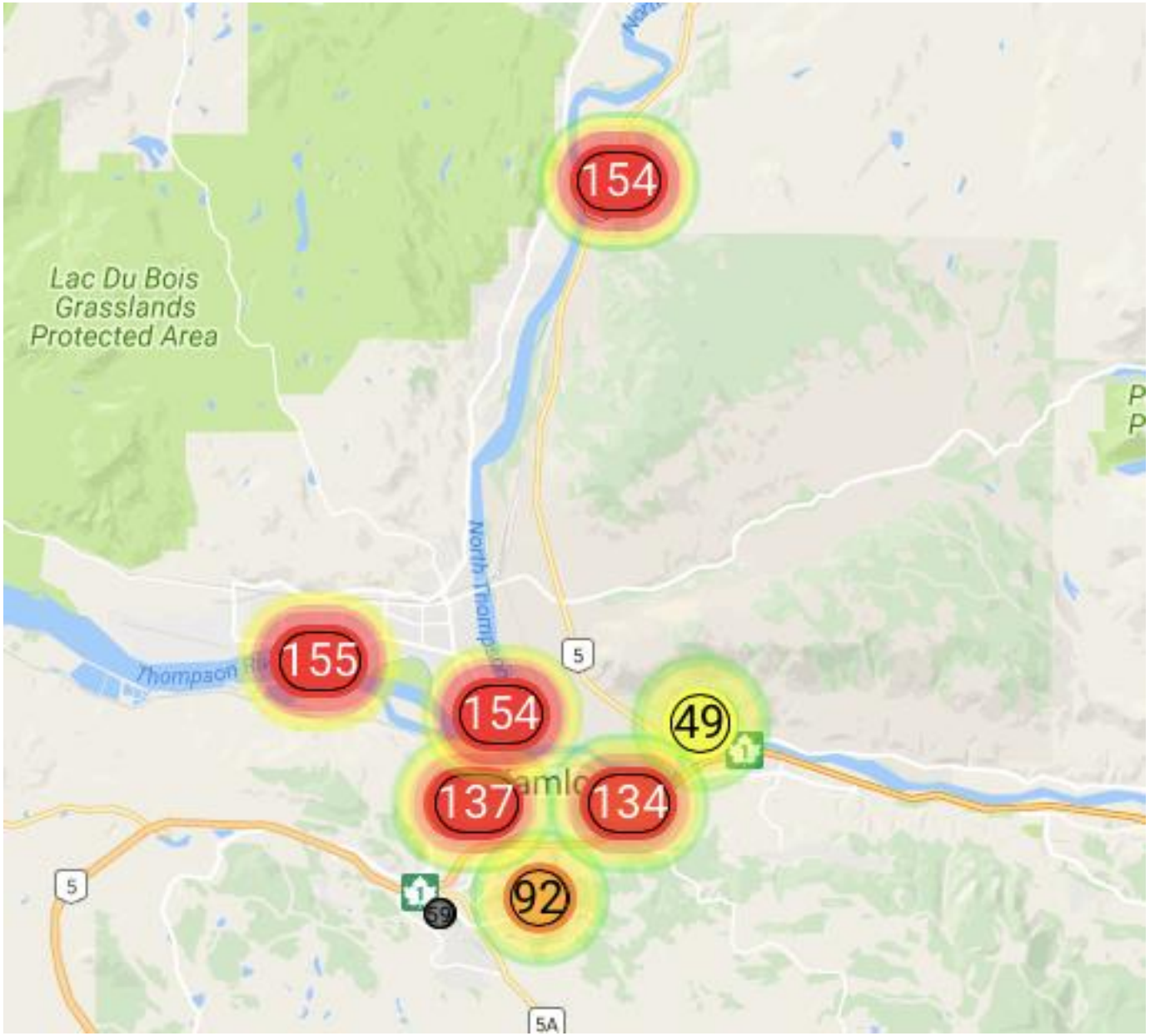
8:13AM: November 1, 2016

A pattern is emerging and clean, safe-to-breath air in rural communities is an illusion.

4:30PM: October 29, 2016.
North of Vernon BC

Valleyview area in Kamloops
December 4, 2016

Dufferin area in Kamloops
December 2, 2016



November 17, 2016

Conclusions

- Woodstove change-out program do not work and may increase emission levels.
- At a minimum, bylaws should be developed based on a nuisance approach.
- Place limits on excessive smoke (higher than 20 opacity, example Bay Area Air Quality Management District).
- Develop air quality advisories and restrict all burning when in effect.
- Consider prohibiting wood burning appliances in all new builds and a phase out period for all other homes.

THIS IS NOT AN ISSUE SUITABLE FOR A REFERENDUM OF ANY KIND. We don't vote on health matters when the evidence is unambiguous and conclusive. Example: Removal of lead in gasoline.

This issue does NOT belong at municipal level.

While industry spends millions of dollars/year on pollution control, and faces liability for air quality infractions, residential burning is the wild west.

Known poor air quality can limit opportunities for economic growth, impact real estate value, generate conflict, expose government to liability, and significantly impact health.