Study Summary: Monitoring of Residential Wood Burning Emissions in the Cowichan Valley Regional District

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Background

From a human health perspective, fine particulate matter (PM2.5) has been identified as the air pollutant of most concern in British Columbia. One of the largest cumulative sources of outdoor fine particulate matter is widely considered to be residential wood burning. PM2.5 (containing particles of 2.5 micrometers in diameter or less) is highly detrimental to human health as it is respirable and able to penetrate deep into the lungs. Not surprisingly, it is the air pollutant most strongly associated with increases in illness and death rates - even more so than pollutant gases. Pre-school aged children are especially susceptible to smoke because their lungs and airways are still developing. According to the Canadian Lung Association, asthma is the number one cause of emergency room visits for children and accounts for 25% of absences from school; PM2.5 aggravates the symptoms of asthma. Wood smoke also increases cardiovascular problems like angina, particularly in older people.

New technology stoves can significantly reduce wood smoke by up to 90%, increase energy efficiency, and consequently reduce the amount of wood needed to heat a home. The Ministry of Environment has estimated that 25% of wood burning appliances in our region are older (pre-1994) conventional wood stoves that do not meet current EPA standards; amongst our population of 77,000 (2006 census), approximately 4700 old technology stoves are in need of retirement. Provincial legislation (*Environmental Management Act*) specifies that these older, inefficient models can no longer be sold in the wholesale or retail market in British Columbia.

Although air quality in the Cowichan Valley is generally regarded to be “Good” (the Annual Average PM2.5 concentration is well below the Provincial Air Quality Objective of 8 ug/m3), there are areas where relatively higher numbers of wood stoves are in use. In addition, temperature inversions and air drainage restrictions influenced by topography prevent wood smoke from being dispersed. This keeps the smoke right where citizens live and breathe, polluting neighborhoods for days or even weeks. It is also worth noting that the Cowichan Valley has become very urbanized in the past several years. This has resulted in high urban-rural interface in many areas, in which smoke complaints have become common.

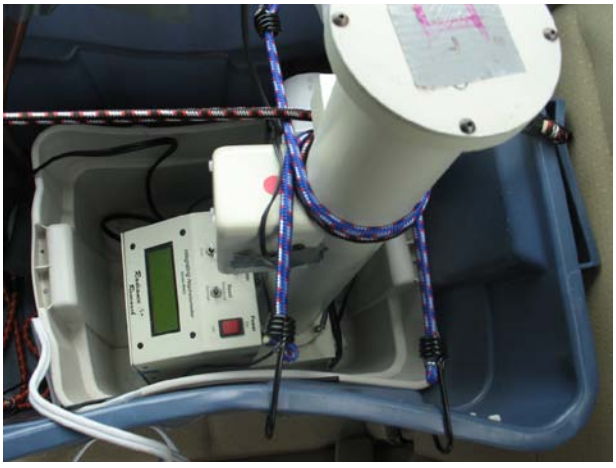
In addition to administering the 2010 Provincial Woodstove Exchange Program in conjunction with the Municipality of North Cowichan and the City of Duncan, the Cowichan Valley Regional District (CVRD) agreed to take part in a mobile PM2.5 air quality study. This collaborative project between the CVRD, Municipality of North Cowichan, Ministry of Environment (MoE), Vancouver Island Health Authority (VIHA), and the University of Victoria (UVic) aimed to map out potential hotspots throughout the region, where wood smoke tends to settle and accumulate, by using a mobile Nephelometer and associated GPS device. The results of the study would provide a means to assess where targeted marketing was needed to generate interest for the wood stove exchange program, and also to provide an invaluable baseline data set to which future improvements in air quality could be compared.

Methods

A three hour driving route for PM2.5 air quality sampling in the Cowichan Valley Regional District was created by considering a variety of interrelated factors. The following variables were all taken into account whilst selecting a driving route for the mobile Nephelometer: wood smoke complaints, residential clustering of older homes, topographical locations suspected of trapping smoke, hospitals, old age facilities, pre-schools/elementary schools, and outdoor sports facilities operating in the winter. The route chosen was approximately 103 km in length and was driven at the posted speed limit (please refer to the Appendix for specific driving route directions). It should also be stressed that the route was selected to be representative of the region in general, and to demonstrate areas where wood smoke accumulation tends to be higher.

CVRD staff spent a day in training at the University of Victoria's Spatial Sciences Research Laboratory with Dr. Eleanor Setton. A M903 Radiance Research Nephelometer (to measure light scatter) and a Garmin GPS Map 60Cx (to record longitude and latitude) were borrowed from UVic for the duration of the project. The Nephelometer was operated from the back seat of a 2008 Honda Civic Hybrid (with the exception of one night, where a 1997 Ford Escort Wagon was used), with an intake tube extending from a slightly open window. The hybrid vehicle was chosen to minimize the potential of exhaust interfering with the Nephelometer readings.

As PM2.5 is a product of combustion (primarily caused by the burning of fuels), examples of sources include power plants, vehicles, wood burning stoves and wildland fires. For this reason, our sampling was done at night time, after rush hour, to avoid the data confounder of exhaust fumes. However, it is not possible to separate PM2.5 due to residential heating from PM2.5 due to traffic or burning yard waste. The data collected therefore represent total PM2.5 from all possible sources. However, it should also be taken into consideration that the City of Duncan has a year round ban on backyard burning and the Municipality of North Cowichan prohibits backyard burning between mid-November and mid-March. The dominant source of PM2.5 during January and February in these areas is therefore wood stove smoke. There are currently no backyard burning restrictions in place in CVRD Electoral Areas during the winter months.



We planned to make ten identical runs of the chosen Nephelometer route on cold, clear evenings over the course of January and February, 2010. However, weather conditions were sometimes less than ideal, as light rain was encountered on several occasions. Although it is possible to sample in any amount of rain, heavy rain will generally result in lower readings due to the wash-out effect that precipitation has on particulate matter. The route was driven in the same direction and had the same start and stop location each time (CVRD main office at 175 Ingram Street in Duncan).

The Nephelometer came equipped with a fan for the intake of outside air, and a heater to keep the intake air at a constant temperature and humidity. Higher PM2.5 concentrations in the air result in larger light scatter readings. An equation developed from studies in Seattle, Washington was used to convert light scatter into PM2.5 concentrations in micrograms per cubic meter: PM2.5 (ug/m3) = ((100,000 x light scatter value) – 0.01) / 0.28. This formula was also used in a University of Victoria study on backyard burning in the Capital Regional District by Dr. Setton.

The Nephelometer was set to log average back scatter values every 15 seconds at 0, 15, 30, and 45 seconds for each clock minute. The GPS was also set to log every 15 seconds, but starting from the time it was turned on and had obtained satellite signal. Consequently, the maximum time differential between the Nephelometer and GPS was 7 seconds. Because of this, the GPS, for example, could log at 4, 19, 34, and 49 seconds or any variation of a 15 second interval. After each run, the Nephelometer data was downloaded in text format using the program HyperTerminal. The Garmin GPS data was downloaded and converted to text format using the Garmin program Mapsource. The Nephelometer and GPS data were then imported into Microsoft Excel. The backscatter formula was applied to the Nephelometer data, which was then matched up by time with the GPS data.

Since we were interested in the spatial distribution of PM2.5 concentration over the study area, the Nephelometer data was mapped out for each run using the geographic information system ArcMap. These maps were then analyzed for recurring hotspot patterns throughout the study.

Results

Table 1: Observations taken during sampling.

Date	Start Time	End Time	Weather Conditions	Vehicle Used
20 January	18:21	21:17	Partly cloudy	2008 Honda Civic Hybrid
22 January	18:01	21:06	Partly cloudy	2008 Honda Civic Hybrid
26 January	17:28	20:30	Partly cloudy / light showers at start	2008 Honda Civic Hybrid
28 January	17:24	20:33	Overcast	2008 Honda Civic Hybrid
1 February	17:27	20:39	Cloudy/ light rain showers	2008 Honda Civic Hybrid
9 February	17:40	20:14	Clear with a few clouds	2008 Honda Civic Hybrid
10 February	17:21	20:14	Cloudy with intermittent showers	2008 Honda Civic Hybrid
16 February	17:26	20:29	Clear with a few clouds	2008 Honda Civic Hybrid
18 February	17:27	20:30	Clear	1997 Ford Escort Wagon
24 February	17:34	20:35	Light rain showers	2008 Honda Civic Hybrid

Table 2: Environment Canada weather conditions from “North Cowichan” meteorological station, located at 175 Ingram Street, Duncan, BC.

Date	Time	Temp (°C)	Wind Speed (km/h)	Wind Direction - Blowing From (deg)
January 20	18:00	8.2	4	40
	19:00	6.6	2	140
	20:00	8.4	9	10
	21:00	7.9	7	20
January 22	18:00	3.3	Calm	N/A
	19:00	2.4	2	10
	20:00	1.4	2	330
	21:00	0.7	Calm	N/A
January 26	17:00	5.7	2	330
	18:00	4.9	Calm	N/A
	19:00	5.0	2	350
	20:00	4.9	4	360
January 28	17:00	5.8	Calm	N/A
	18:00	4.8	2	360
	19:00	4.4	Calm	N/A
	20:00	4.2	Calm	N/A
February 1	17:00	5.9	6	350
	18:00	5.9	6	350
	19:00	5.8	4	360
	20:00	5.8	6	360
February 9	17:00	5.5	2	210
	18:00	3.2	Calm	N/A
	19:00	2.0	Calm	N/A
	20:00	1.2	Calm	N/A
February 10	17:00	5.1	2	340
	18:00	4.9	2	310
	19:00	4.9	2	340
	20:00	4.8	2	350
February 16	17:00	9.1	6	340
	18:00	7.3	2	250
	19:00	5.0	Calm	N/A
	20:00	3.5	Calm	N/A
February 18	17:00	7.1	2	310
	18:00	3.0	2	280
	19:00	0.9	2	10
	20:00	-0.4	Calm	N/A
February 24	17:00	5.5	4	150
	18:00	4.0	4	220
	19:00	3.5	4	190
	20:00	3.2	4	190

Sampling observations are located in Table 1, along with corresponding data from the Environment Canada meteorological station located at the CVRD Building at 175 Ingram Street (Table 2). Maps were created in ArcGIS for each of the ten sampling nights and can be found in the Appendix in chronological order. It may be necessary for readers to consult the Appendix route directions and have a map of the Cowichan Valley available to understand the description that follows. On January 20th, it can be seen that the highest values for the run (up to 58.96 ug/m3) were obtained on the Trans-Canada Highway between Hutchinson Rd. and Cobble Hill Road. Another area that stood out that night, with a grouping of higher PM2.5 readings, is that of Renfrew Rd. and continuing into the Shawnigan Beach Estates route loop (Ravenhill Rd., McIntosh Rd., Meadowview Rd.). January 22nd yielded several areas of interest, notably the north-western portion of the route comprised of the loop from Gibbins Rd. through to Cairnsmore Street. Also worthy of note were Heather St., in addition to Sycamore St., Glen Rd. in Cowichan Bay, and Mill Bay Rd. along the waterfront. The night of January 26th had some of the most pronounced hotspot definition of all the sampling nights. Higher groupings of PM2.5 were identified at: Shawnigan Beach Estates (with readings consistently in the 30-50 ug/m3 range), Shawnigan Village (in the vicinity of Jersey Rd., Wallbank Rd., Wilmot Ave.), Cobble Hill (near Braithwaite Dr., and also Hutchinson Rd.), Cowichan Bay (near Wilmot Rd., Pavenham Rd., Glen Rd.) and groupings along Heather St., Sycamore St., and Allenby Road. January 28th depicted mid-range PM2.5 clusters on the Maple Bay waterfront and Valley View Road. February 1st had relatively low readings overall with the exception of a cluster on Kingsview Rd. in Maple Bay. February 9th had several areas of interest including the Gibbins Rd. to Cairnsmore St. loop, Pavenham Rd. area, Allenby Rd., and Shawnigan Beach Estates. The evenings of February 10th and 16th exhibited predominantly very low PM2.5 readings. February 18th had two areas of higher PM2.5 readings: Trans-Canada Highway between Hutchison Rd. and Deloume Rd. (with consistent readings in the 40-50+ ug/m3 range), and about half way along Shawnigan Mill Bay Road. February 24th demonstrated very low PM2.5 readings for the most part.

Discussion

The Ministry of Environment operated a stationary PM2.5 E-Sampler at the CVRD monitoring site in downtown Duncan from the spring of 2008 until the fall of 2009 (when a new air quality monitoring station was created on Cairnsmore Street, with a BAM PM2.5 monitor). Data collected with the E-Sampler indicated that PM2.5 levels are elevated during the fall and winter months. This is likely associated with poor dispersion meteorology at that time of the year and the addition of fall open burning and winter wood heat as local sources of fine particulate (wood smoke). Anecdotal evidence points to emissions from wood stoves in the valley as the main contributing factor during the winter season. In addition to the previously mentioned backyard burning restrictions, it should further be noted that the open burning of land clearing debris was banned in CVRD Electoral Areas in late 2009; also, forest companies cannot burn under provincial legislation (*Environmental Management Act's* Open Burning Smoke Control Regulation) during the winter months as the Venting Index is generally poor, thus wood smoke from open burning is less likely to be a contributing factor.

PM2.5 concentrations are generally low (Good Air Quality) during the spring and summer months in relation to the BC ambient 24-hour PM2.5 Air Quality Objective of 25 ug/m3. However, during the winter months in 2008, one 24-hour period was recorded where PM2.5 concentrations exceeded the Provincial Objective. It was also discovered that four 24-hour exceedances of the Health Reference Level of 15 ug/m3 occurred in the winter of 2008. This is a level that was identified by a working group reporting to Health Canada during the development of the Canada-Wide Standards as the lowest level at which a statistically significant negative health outcome was observed. It is noteworthy that the exceedances occurred during the wood heating season. However, it is necessary to recognize that there

are no thresholds for the health effects of PM2.5 as they can occur at any level depending on the sensitivity of the individual.

By averaging hourly BAM (Beta-Attenuation Mass Monitor) PM2.5 data from the new Cairnsmore station site, it was found that there were six 24-hour exceedances of the Health Reference Level, at that location, during the 10 sampling nights of our Nephelometer study. With the exception of February 1st (when the system was down), the 24-hour exceedances that occurred at the Cairnsmore site, that corresponded with our study nights, were: January 20 (16.0 ug/m3), January 22 (17.5 ug/m3), January 26 (17.8 ug/m3), January 28 (17.8 ug/m3), Febrary 9 (19.6 ug/m3) and February 10 (16.4 ug/m3).

In considering the results of our Nephelometer study, conversations with the Regional Air Quality Meteorologist (Earle Plain at the Ministry of Environment, whose comments on this study have been included in the body of this discussion) revealed that hourly PM2.5 values of greater than 20 ug/m3 are generally good indicators of wood smoke. Also, as the Nephelometer readings are only snap-shots in time and space (15 second averages), the values cannot be directly compared to ambient air quality objectives which are based on longer averaging periods (24 hours). Levels can change considerably on any given day, depending on who is burning at the time and the prevailing meteorology. For this reason, mobile Nephelometer data is not useful for establishing exact levels at a specific location. However, this data is useful to examine relative patterns in the region on a given day or over a number of days. The 2009 Nanaimo Nephelometer study exhibited consistent readings of greater than 50 ug/m3 in areas where wood stoves were known to be a problem. In general, even on a relatively clean day, the same locations in the Nanaimo study area were coming back with higher values than the rest of the route. However, it should also be noted that the Nanaimo study occurred during a year of colder temperatures and above average snowfall, whereas our study took place during a relatively mild winter (El Nino).

Low level smoke impacts over much of our route were especially evident on days when winds were calm and there was no precipitation. Rain showers on February 1st, 10th and 24th seemed to have a real cleansing effect. However, even during those dates, PM2.5 was elevated (relative to the rest of the route) in Duncan and Cobble Hill. When winds were light or calm (in Duncan), PM2.5 levels generally increased (began to build up) over larger geographic areas. Note the difference between spatial patterns you see on a relatively calm evening (eg. February 9th) versus an evening when there were light to moderate breezes (February 1st). On the 9th, moderate levels of particulate air pollution were more widespread than on the 1st (precipitation on the 1st likely had a cleansing effect, as well). It should also be noted that the wind speed information from Duncan would not be applicable in more sheltered areas such as Shawnigan Lake. A good example of this is the January 20th map where wind speed was moderate in Duncan (relatively clean there) but wood smoke impacts were evident in Shawnigan Lake. Another factor to consider is that the south-end sampling of our driving route was taking place a couple of hours later than the majority of the northern portion. As some residents stoke up their wood stoves upon returning home from work, it is possible that the south-end readings could be higher as these residents would have had their stoves running for a longer period of time, potentially accumulating greater smoke pollution in the area.

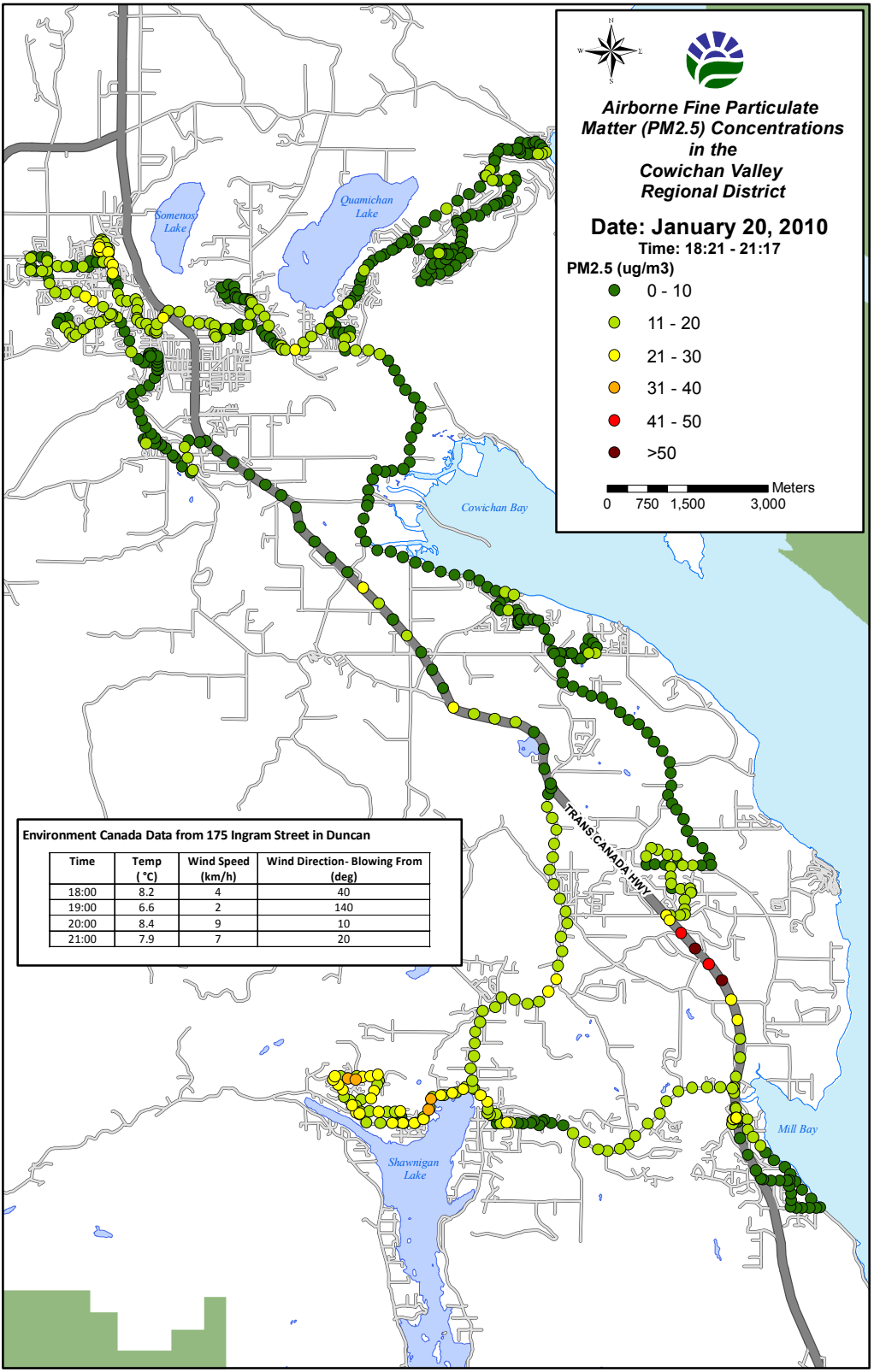
As stated before, although air quality in the Cowichan region is generally good, this study did demonstrate that there were certain areas where wood smoke tends to accumulate, settle, and linger. It is safe to say that we picked up smoke impacts from wood stoves in every community sampled during our campaign- especially during the month of January. However, there were certain areas that showed up on a more consistent basis as potential hotspots. Looking at individual populated areas in terms of elevated readings relative to the rest of the route on any given night: potential hotspots were observed

in Duncan (8 out of 10 nights); Shawnigan Lake (6 out of 10); Cobble Hill East side of Hwy 1 (5 out of 10); Hwy 1 South (3 out of 10); Cowichan Bay (3 out of 10); Maple Bay and above Quamichan Lake (2 out of 10); and Mill Bay (1 out of 10). A contributing factor could be that the homes in these areas are generally older and the presence of outdated wood burning appliances is likely. Also, surrounding topography can cause residential wood smoke to drain from higher regions into lower regions and this can add to the burning in the immediate area. During the evening hours, smoke slowly drains downhill through the valley aided by localized land-sea breezes.

Historically speaking, the Cowichan Valley is a rural logging community in which wood burning has always been an integral part of local culture. Despite a growing awareness of the deleterious health effects of wood smoke in the general population, many residents continue to view wood as a natural and cost-effective form of home-heating. Income may well be a factor contributing to greater wood stove use in some areas. Additional factors contributing to increased PM2.5 levels could also be improper burning techniques or the burning of wet wood that hasn't been properly seasoned.

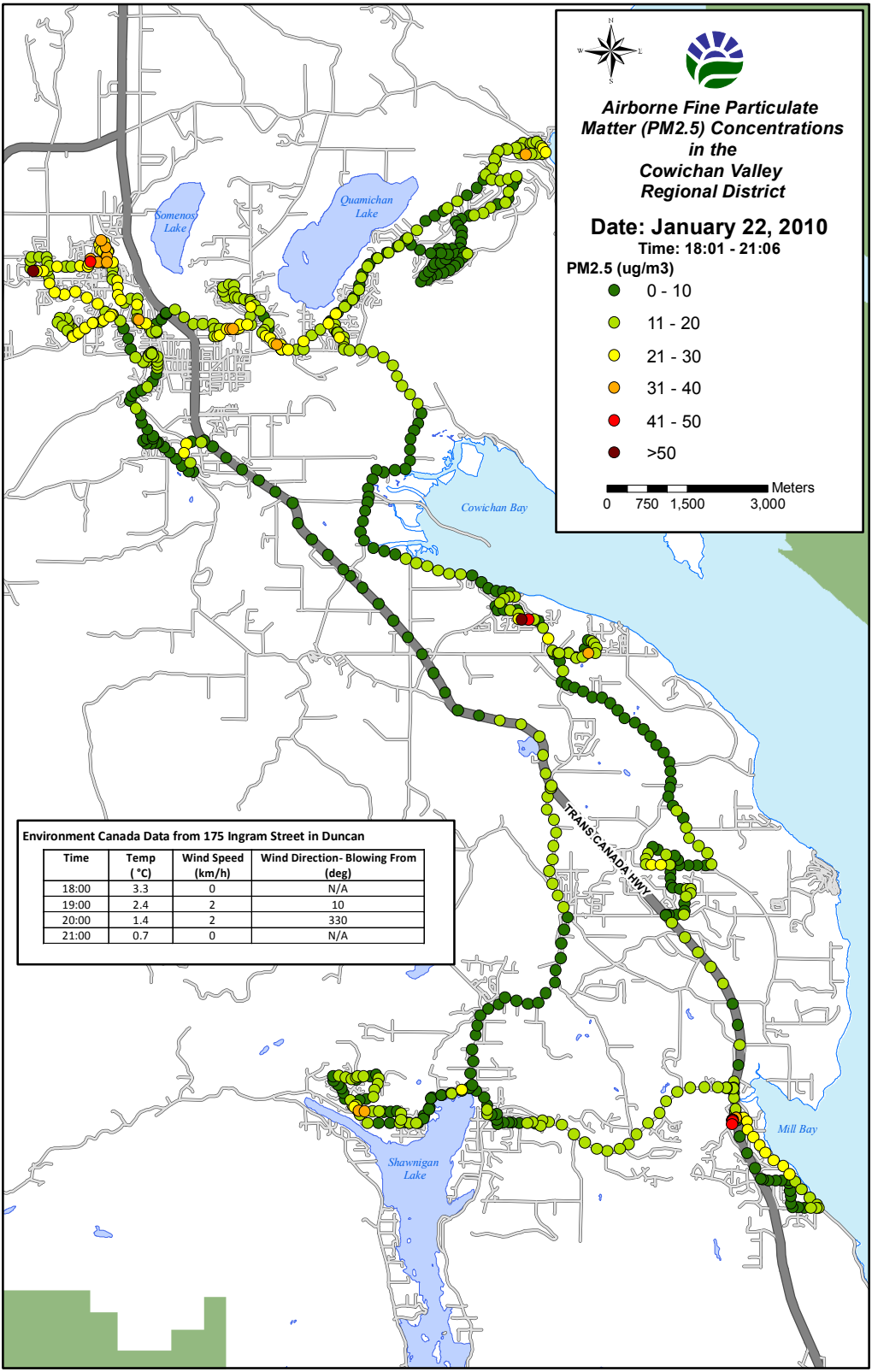
Final Comment

The use of a mobile Nephelometer has provided the Cowichan Valley Regional District with meaningful spatial PM2.5 information that can be used to inform local air quality initiatives. It has also reiterated the important community health benefits of facilitating a wood stove exchange program as a concrete effort to reduce PM2.5. Identified hot spots can be focused on in future educational efforts surrounding possible subsequent wood stove exchange programs. The residents of these areas, in particular, would profit from "Burn it Smart" workshops to learn about the benefits of efficient, safe, smoke-free wood burning practices. Further possible wood stove exchange programs would again offer financial incentives to residents to entice them to switch out their older, conventional wood burning appliances in favor of new technology, EPA-certified stoves.



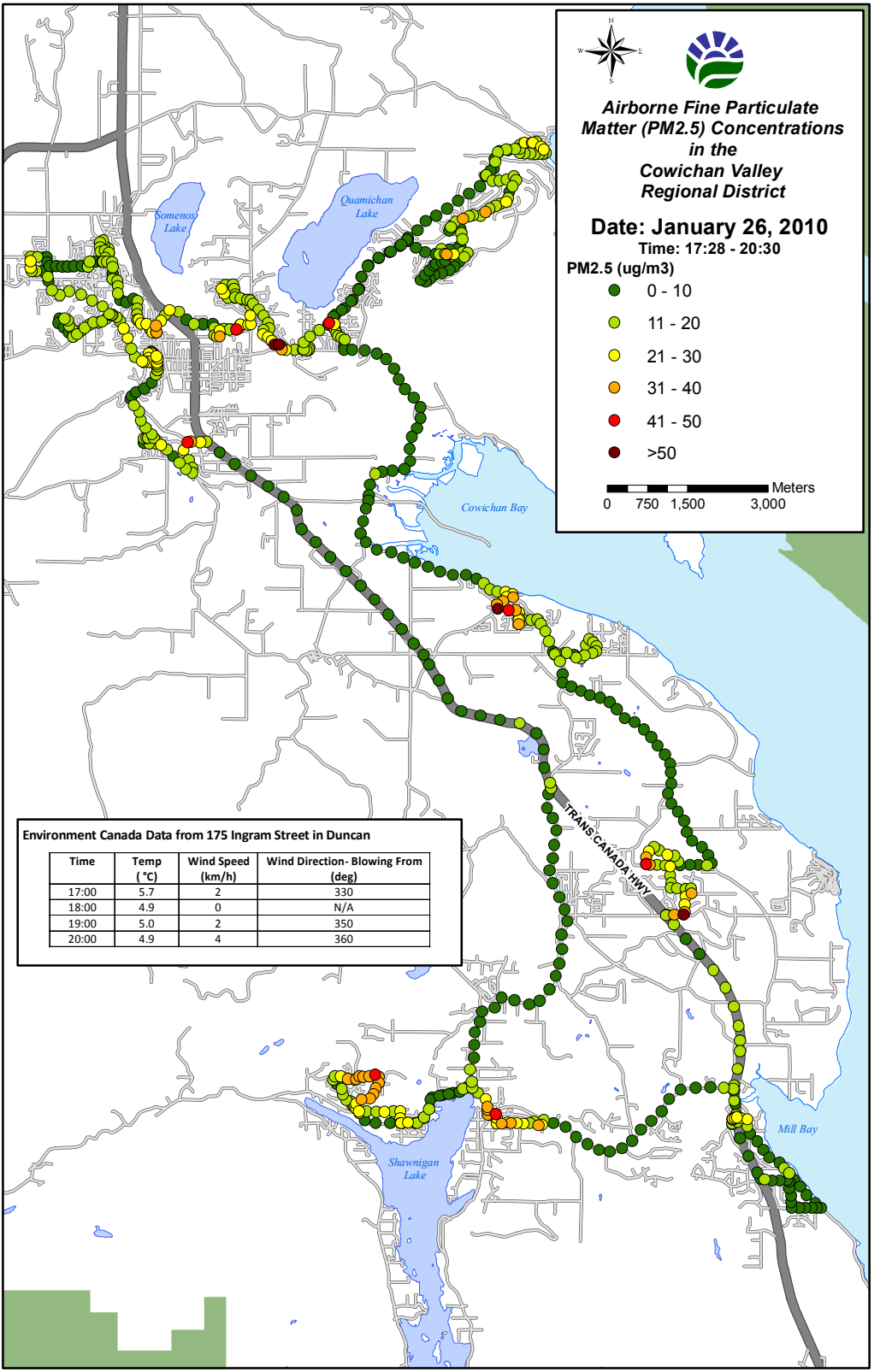
Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
18:00	8.2	4	40
19:00	6.6	2	140
20:00	8.4	9	10
21:00	7.9	7	20



Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
18:00	3.3	0	N/A
19:00	2.4	2	10
20:00	1.4	2	330
21:00	0.7	0	N/A



Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
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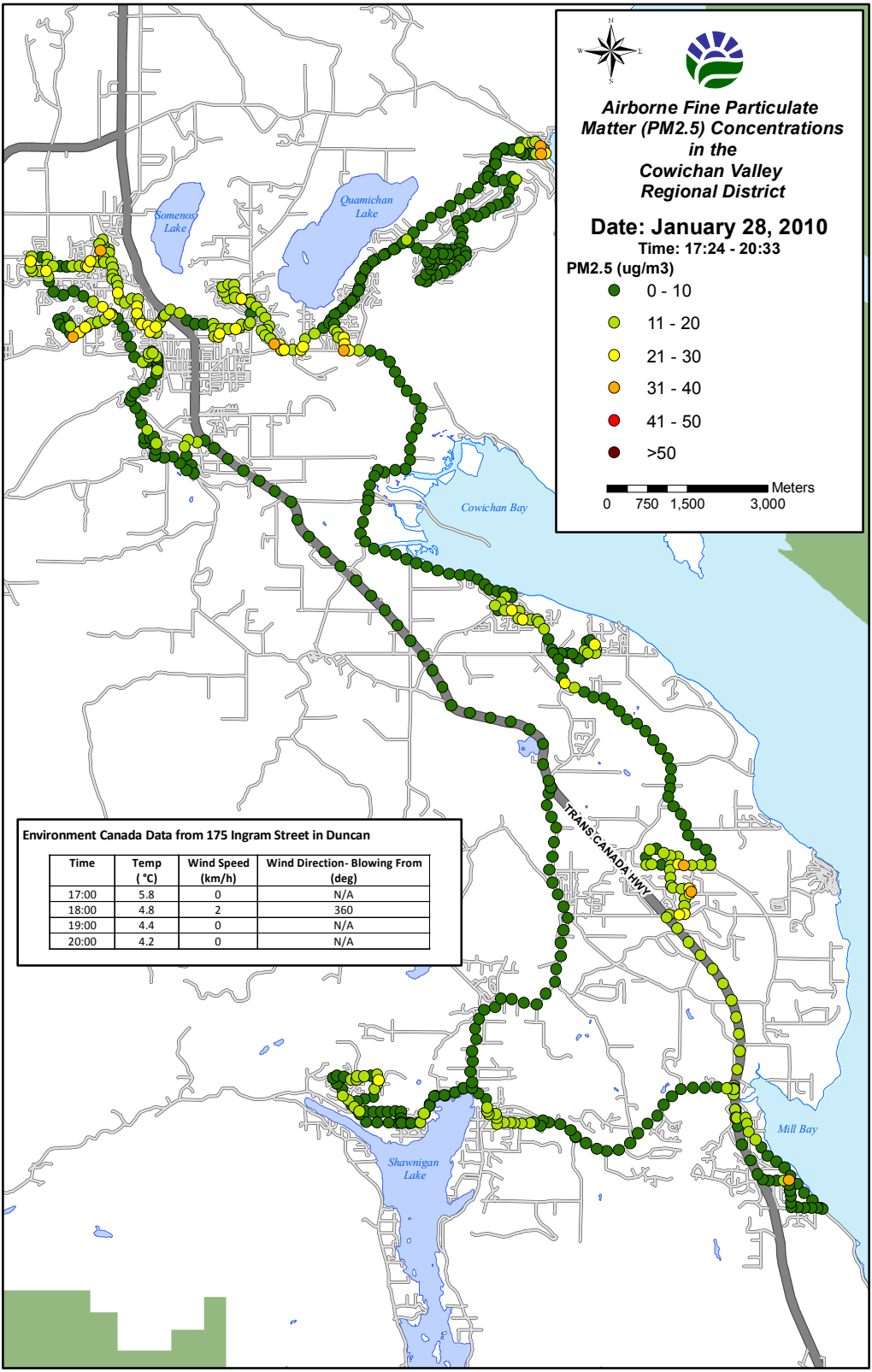
18:00	4.9	0	N/A
19:00	5.0	2	350
20:00	4.9	4	360



Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
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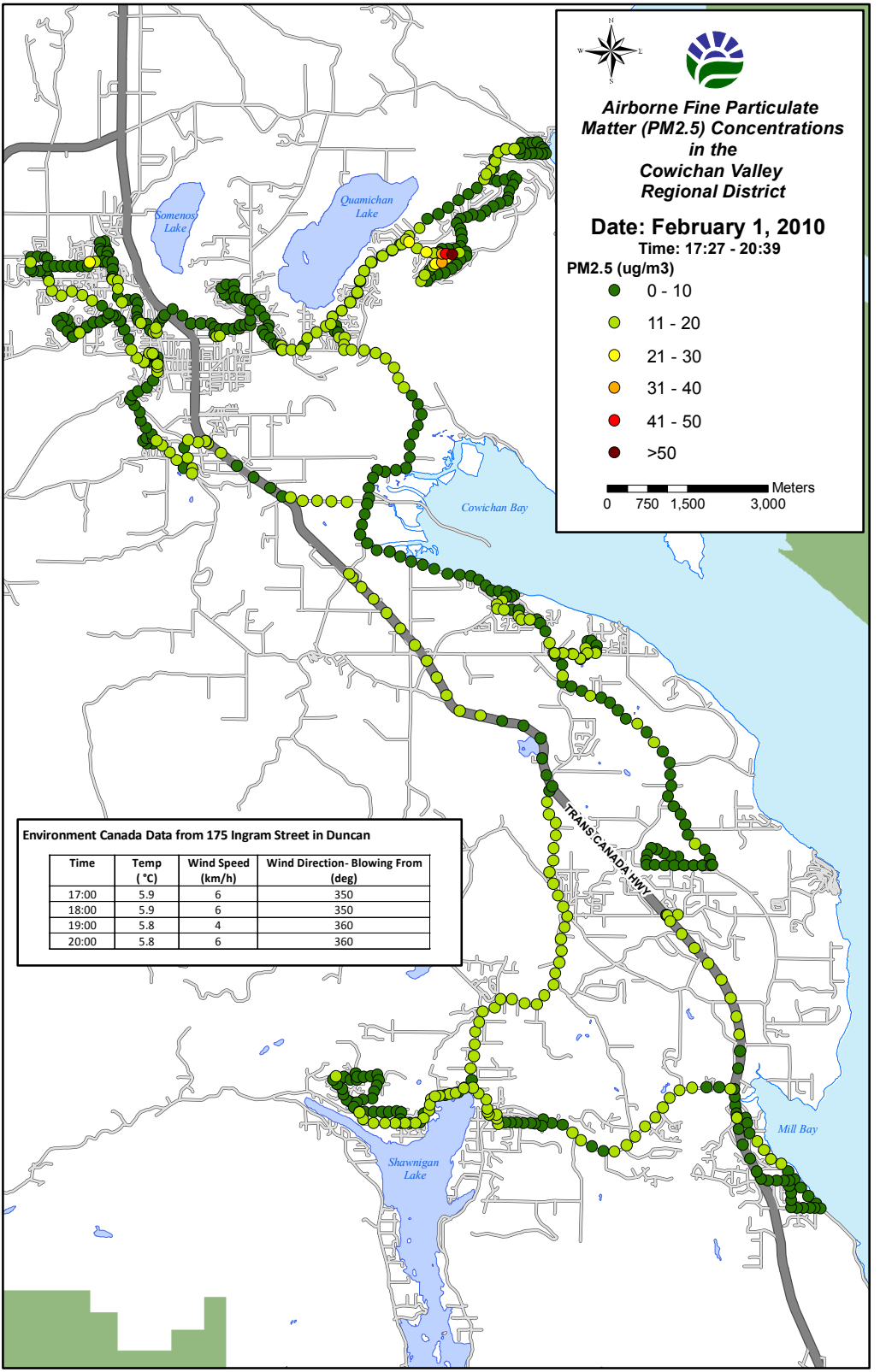
20:00	4.2	0	N/A



Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
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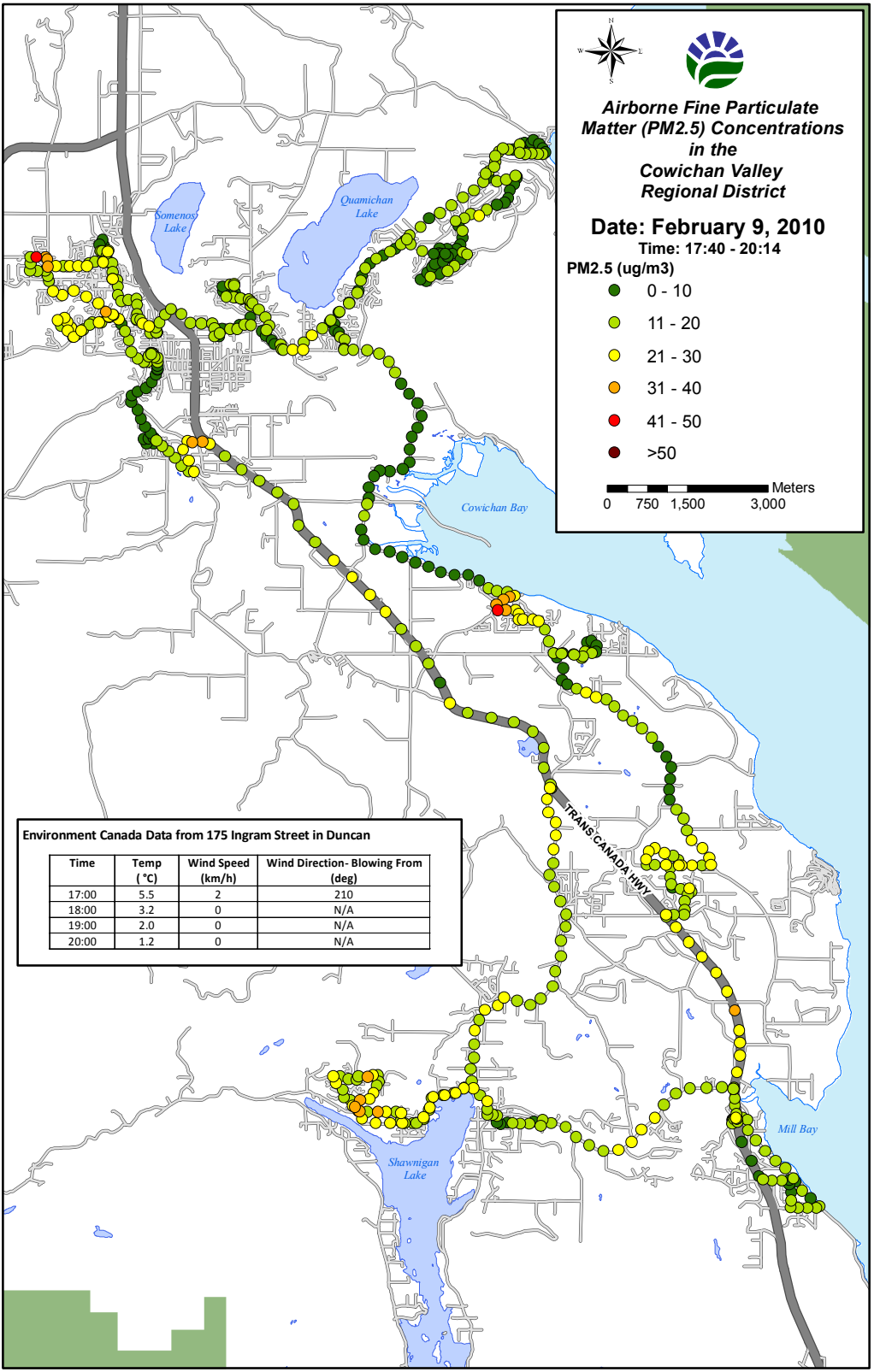
18:00	5.9	6	350
19:00	5.8	4	360
20:00	5.8	6	360



Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
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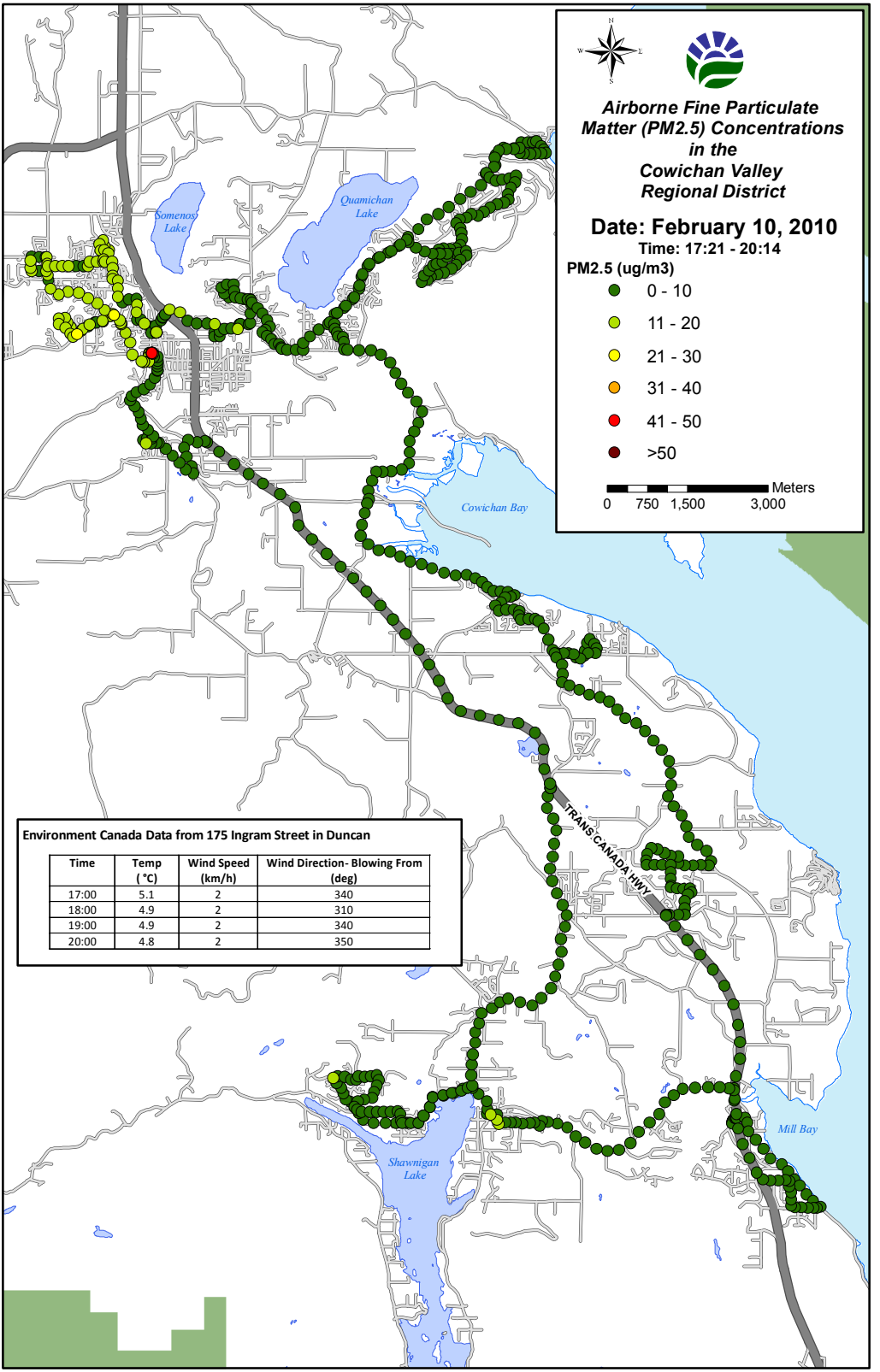
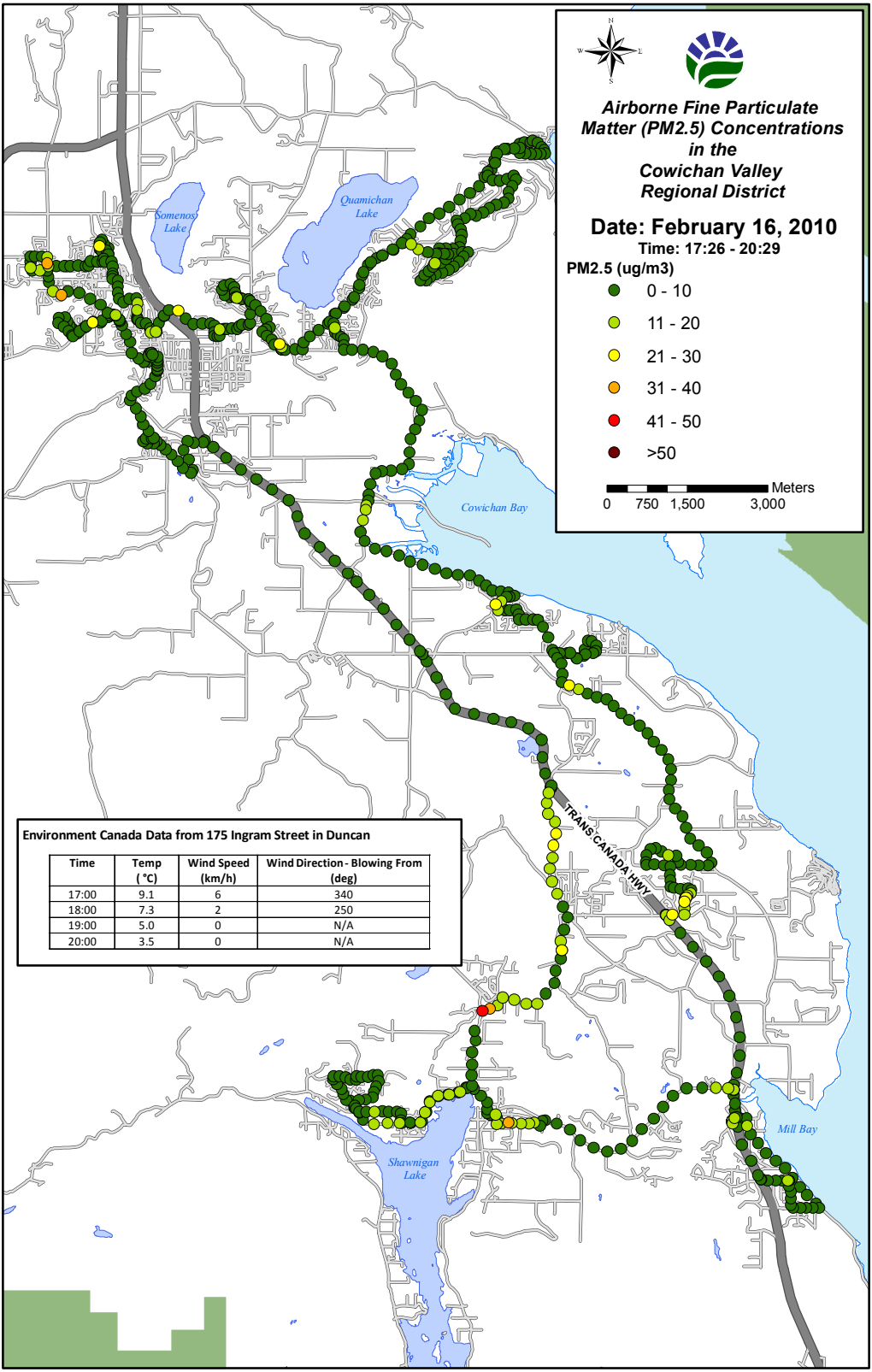
19:00	2.0	0	N/A
20:00	1.2	0	N/A



Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
17:00	5.1	2	340
18:00	4.9	2	310
19:00	4.9	2	340
20:00	4.8	2	350



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Time	Temp (°C)	Wind Speed (km/h)	Wind Direction - Blowing From (deg)
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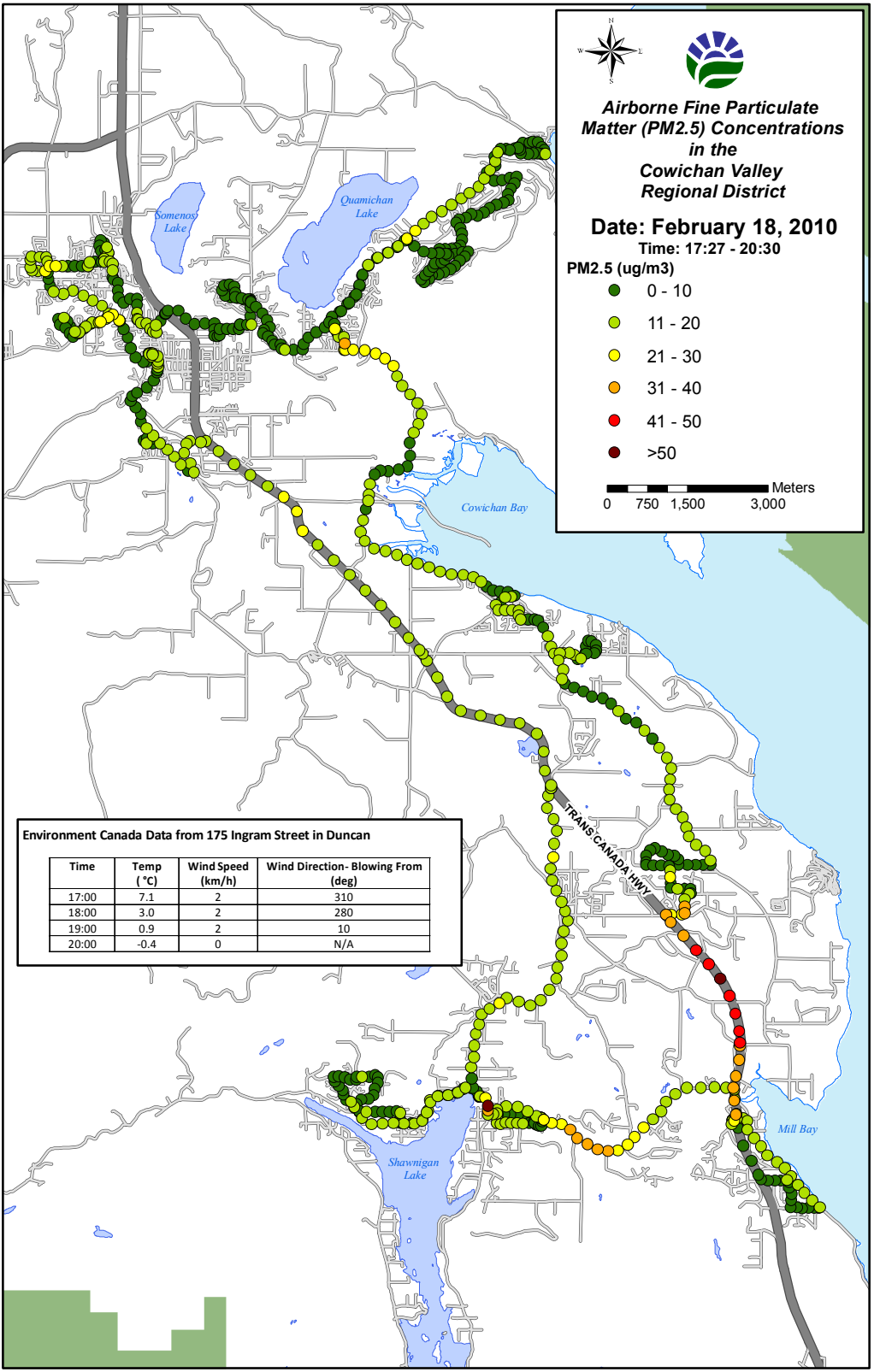

Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
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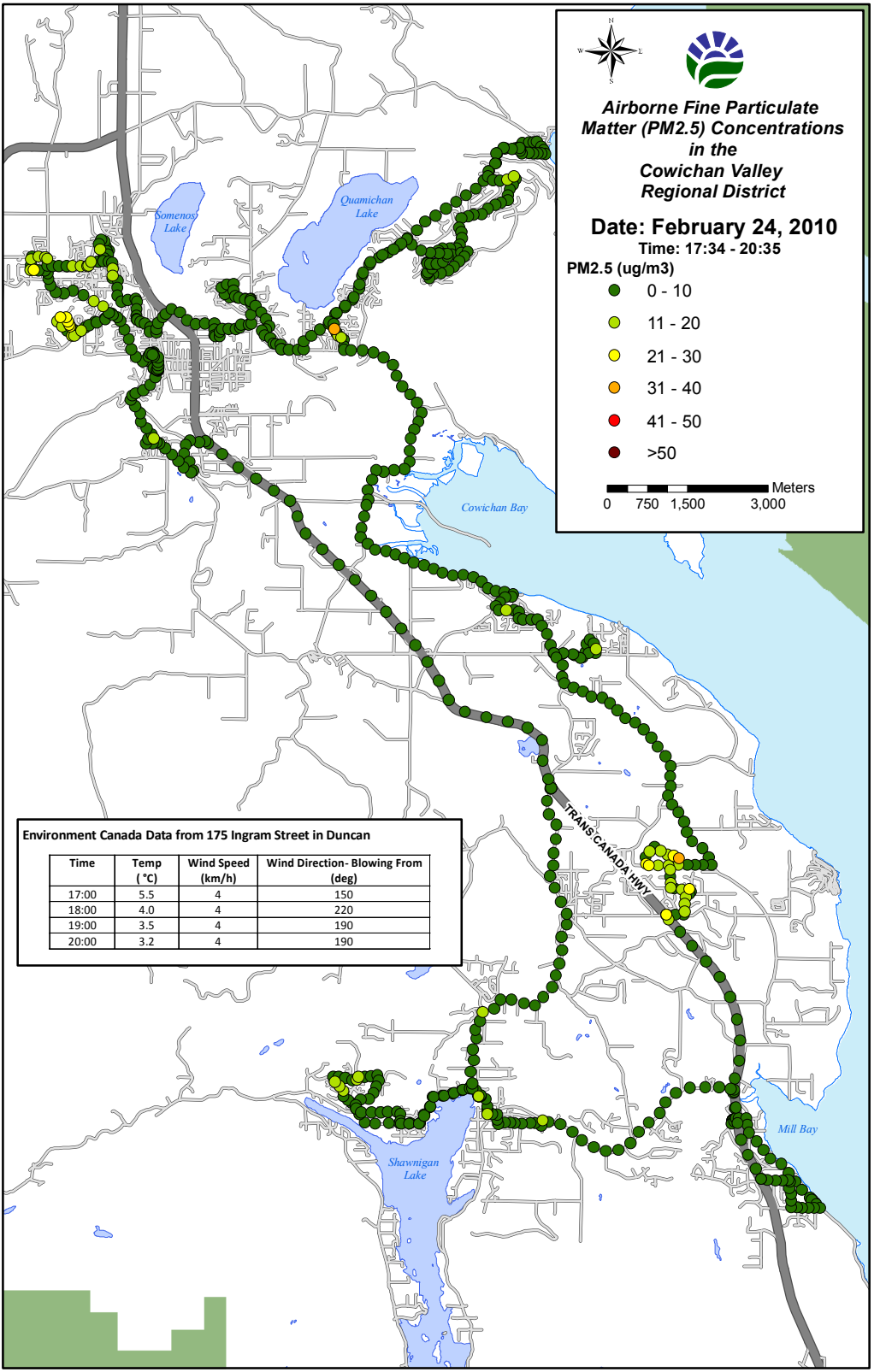
18:00	3.0	2	280
19:00	0.9	2	10
20:00	-0.4	0	N/A



Environment Canada Data from 175 Ingram Street in Duncan

Time	Temp (°C)	Wind Speed (km/h)	Wind Direction- Blowing From (deg)
17:00	5.5	4	150
18:00	4.0	4	220
19:00	3.5	4	190
20:00	3.2	4	190

Appendix: Mobile Nephelometer Driving Route

Start -> 175 Ingram Street (CVRD building)

1. Head West on **Ingram Street**
2. Left on **Jubilee St**
3. Right on **Kenneth St**
4. Right on **Government St** (~1km to next turn)
5. Left on **Gibbins Rd** (roundabout)
6. Right on **Highland Ave**
7. Left on **Hillwood Rd**
8. Turns into **Upland Ave**
9. Left on **Gibbins Rd**
10. Left on **Cowichan Lake Rd** (roundabout)
11. Straight through onto **Somenos Rd** (roundabout)
12. Left on **Limerick Rd**
13. Right on **Marsh Rd**
14. Right on **Auchinachie Rd**
15. Right on **Somenos Rd**
16. Left on **Moorefield Rd**
17. Left on **Lane Rd**
18. Right on **Westview St**
19. Left on **Fairview Way**
20. Left on **Westview St**
21. Right on **Grieve St**
22. Left on **Sherman Rd**
23. Right on **Mary St**
24. Turns into **Phillip St**
25. Right on **Islay St**
26. Left on **Cairnsmore St**
27. Right on **Cavell St**
28. Left on **Jubilee St**
29. Left on **4th St**
30. Left on **Canada Ave**
31. Right on **Beverly St**
32. Cross the Highway (~1km to next turn)
33. Right on **Howard Ave**
34. Left on **Dingwall St**
35. Left **Chesterfield Ave**
36. Right on **Heather St**
37. Right on **Beverly St**
38. At the roundabout left on **Lakes Rd** (~0.5km to next turn)

39. Left on **Trillium Ter**
40. Right on **Timbercrest Dr**
41. Right on **Wisteria Way**
42. Left on **Trillium Ter**
43. Cross Lakes Rd to **Jaynes Rd** (~0.5km to next turn)
44. Right on **Birch Rd**
45. Turns into **Sycamore St**
46. Left on **Rosewood St**
47. Right on **Brier Ave.**
48. Left on **Tzouhalem Rd.**
49. At the roundabout go left on **Maple Bay Rd** (~5.5km to next turn)
50. Left **Considine Rd**
51. Right on **Manley St**
52. Left **Herd Rd**
53. Quick right **Drummond Dr**
54. Veers Right into **Beaumont Ave**
55. Right on **Redcap St**
56. Right on **Considine Rd**
57. Left on **Maple Bay Rd** (~0.9km to next turn)
58. Left on **Osprey Dr**
59. Right on **Nevilane Dr**
60. Right on **McKenzie Drive**
61. Left on **Donnay Dr**
62. Left on **Highwood Dr**
63. Right on **Crestwood Dr**
64. Veers Right into **Algonkin Rd**
65. Left on **Kingsview Rd**
66. Right on **Chippewa Rd** to **Lower Chippewa Rd**
67. Right on **Belcarra Rd**
68. Left on **Kingsview Rd**
69. Left on **Maple Bay Rd** (~2km to next turn)
70. Left on **Frances St**
71. Turns Right into **Deborah Dr**
72. Right on **Sandra Pl**
73. Right on **Valleyview Rd**
74. Left on **Tzouhalem Rd** (From here to Cowichan Bay Village is ~8km)
75. Turns into **Cowichan Bay Rd** at West Can Terminal
76. Stay on Cowichan Bay Rd and go through the village
77. Right on **Wilmot Rd**
78. Left on **Pavenham Rd**
79. Right on **McGill Rd**
80. Left on **Glen Rd**

81. Right on **Cowichan Bay Rd** (~0.7km to next turn)
82. Left on **Cherry Point Rd**
83. Left on **Lanes Rd**
84. Right on **Greenbrier Rd**
85. Right on **Cherry Point Rd**
86. Left on **Cowichan Bay Rd**
87. Left on **Telegraph Rd** (~5km to next turn)
88. Right on **Braithwaite Dr**
89. Right on **Rolmar Cres**
90. Left on **Brithwaite Dr**
91. Right on **Farnsworth Rd**
92. Left on **Christina Dr**
93. Right on **Braemar Rd**
94. Right on **Cowerd Rd**
95. Right on **Hutchinson Rd**
96. Left on **Trans Canada Hwy** (head South) (~4.5km to next turn)
(**Pit Stop @ Mill Bay Intersection****)**
97. CROSS HWY towards water on **Deloume Rd**
98. Right on **Mill Bay Rd** (~2.2km to next turn)
99. Right on **Noowick Rd**
100. Right on **Huckleberry Rd**
101. Left on **Frayne Rd**
102. Right on **Trans Canada Hwy** (head North) (~1.8km to next turn)
103. Left on **Shawnigan/Mill Bay Rd** (~4km to next turn)
104. Left on **Forsyth Way**
105. Right on **Wilmot Ave**
106. Left on **Jersey Rd**
107. Right on **Wallbank Rd**
108. Left on **Wilmot Ave**
109. Right on **Shawnigan Lake Rd**
110. Veer Left on **Renfrew Rd** (~2.5km to next turn) (go straight past Masons Beach)
111. Right on **Gregory Rd**
112. Left on **Terrace Rd**
113. Right on **Ravenhill Rd**
114. Left on **Gregory Rd**
115. Quick Right on **McIntosh Rd**
116. Right on **Meadow View Rd**
117. Left on **Gregory Rd**
118. Left on **Mckean Rd**
119. Right on **Worthington Rd**
120. Left on **Renfrew Rd** (~1.5km to next turn)
121. Left on **Shawnigan Lake Rd (**From here to Trans Canada Highway is ~7km)

122. Turns into **Cobble Hill Rd**
123. Left on **Trans Canada Hwy** (head North) (~9km to next turn)
124. Left on **Allenby Rd**
125. Left on **Koksilah Rd**
126. Right on **Miller Rd**
127. Left on **Eagle Heights Rd**
128. Right on **Mountain View Cres**
129. Left on **Miller Rd**
130. Veer Right on **Indian Rd** (towards bridge)
131. Turns into **Allenby Rd**
132. Turns into **Craig St**
133. Left on **Ingram St**

Finish -> 175 Ingram St