

Summer 2006 Black Fallout Incidents in the City of Hamilton

Report of Findings

November 29, 2006

Ministry of the Environment

Protecting our environment.



Ontario

Executive Summary

During the weekend of July 29-30, 2006 the ministry responded to complaints of a black material that had been deposited over an area generally south and east of the City's industrial core and undertook immediate sampling and analysis. In addition to the immediate sampling that was undertaken, additional sampling was then undertaken at a number of locations on August 10-11, 2006 as significantly more incidents of black fallout were reported to the ministry following the August 3, 2006 media coverage of the July 29-30th event. In order to address the community's concerns and enable the ministry to determine appropriate actions, we have been working towards determining whether the events of the July 29-30th weekend were out of the ordinary in terms of the composition and/or amount of fallout. This analysis is necessary to determine the cause and source of the fallout that was experienced. This report is an interpretation of data that has been collected to date both as a result of the July incident, along with data collected through ongoing monitoring activities by the ministry and industry. It should also be noted that additional sampling and monitoring is underway and results will be added to the already extensive air quality monitoring that is undertaken in the City of Hamilton.

The first part of the report has taken reported complaint locations and compared them to wind and general weather information that is recorded on a continuous basis. By comparing this information against locations where black fallout was reported, it is possible to identify potential source(s). Winds were generally from the north or northwest and therefore could have carried dust from a number of industrial sources towards the complainant's properties.

The second part of the report deals with the results of microscopic analysis of fallout samples that were taken after the initial incident; samples taken over a wider area on August 10-11th, along with monitoring information that is routinely being collected by the ministry and industries. Dust fall sample information that has been collected for years in the north end of the city was used as a comparison against the sample results obtained after July 29-30th. On a typical day samples will likely contain carbon-based material such as coal, soot and kish together with any other materials that may be specific to that property such as vegetative matter. These are considered the urban background. The sample results that were obtained from sampling undertaken after the July 29-30th and then on August 10-11th are presented in the report. No single type of contaminant above the urban background is dominant in any of the samples.

The final part of the report details the additional monitoring that the ministry is undertaking in partnership with the Hamilton Air Monitoring Network (HAMN) and McMaster University. The monitoring will be used to identify when and where impacts are reported should any incidents occur during this additional monitoring period. In the event that none of the area industries experience a malfunction that results in emission incidents, the data will increase our understanding of particulate dispersion throughout the east end of the City.

Key Conclusions

- Reported incidents of black fallout after July 29-30, 2006 can be attributed to the industries and related activities in the industrial north end of the City of Hamilton as the predominant winds during this time period were from the northwest through to the northeast and therefore capable of transporting particulate to properties to the south;
- Weather conditions support the observation that multiple sources contribute to fallout at properties to the south. However, continuous monitoring equipment strategically located adjacent to major industrial facilities in the area did not detect any significant increases in any ambient particle concentrations that would indicate an equipment malfunction or abnormal release that could be responsible;
- Analysis results showed that no single type of contaminant was dominant in the samples taken and that the samples were comprised of a range of materials that are typical of urban dust fall. Analyses did not show that any one particular component was present in significantly greater quantity than any other; and
- Carbon black was present in varying proportions (from non-detect to 20%) in the analysed samples. Due to the nature of carbon black, it is less detectable to the eye in an undisturbed state. However, when the particle structure is broken as would occur due to wiping, sitting on furniture or touching objects, the carbon black becomes a greasy residue that gives the impression that more of the material is actually present. Accordingly, even small amounts of this material create high soiling potential.

Ministry Initiatives

The sampling and analysis to date is part of ongoing efforts being undertaken by the ministry in partnership with the industrial community as represented by the Hamilton Air Monitoring Network (HAMN) and the Hamilton Industrial Environmental Association (HIEA) to develop a monitoring and sampling plan that will assist in identifying sources of future fallout incidents that may have an industrial source.

The City of Hamilton has one of the most highly monitored air sheds in this province. Air monitoring stations targeting industrial sources are strategically located to ensure that the collection of data is relevant to identifying air quality and determine when incidents occur. In the fall of 2004, a not for profit corporation known as the Hamilton Air Monitoring Network (HAMN) was formed and includes twenty one industrial partners and the City of Hamilton. The air monitoring stations in HAMN have measured a variety of pollutants including sulphur dioxide, total reduced sulphur, and oxides of nitrogen, volatile organics, particulates and polycyclic aromatic hydrocarbons since 2003 when HAMN took over the operation of former ministry stations which had been monitoring a variety of pollutants since the 1970s. An 11th station in Stoney Creek was

added to the monitoring network this summer. The ministry continues to have access to HAMN real-time monitoring data and receives regular reports of all data.

The ministry has been working with Clean Air Hamilton and several large companies in the industrial zone to implement fugitive emission and dust control plans to reduce particulate matter emissions. A workshop has been scheduled for December 11, 2006 to identify and promote strategies to address this issue.

In addition to the data collection that is taking place, the ministry continues in its role as a regulator of all facilities that have the potential to result in emissions to air, water or land. Regular inspection programs to ensure compliance with approvals, requirements for industries to develop pollution control strategies and responsive actions to specific emission incidents are all part of the regular ministry business.

These efforts are having positive results and have led to improvements in air quality. Levels of sulphur dioxide have decreased 10-30% in the last decade. Levels of suspended particulate matter have decreased 15-20% since 1995. Levels of benzene, naphthalene and polycyclic aromatic hydrocarbons (PAHs) such as benzo(a)pyrene (BaP) (known cancer causing substances) near the two steel mills have decreased by 70-80% between 1994 and 2005. Improved coke oven controls and procedures have also resulted in decreased levels of Total Reduced Sulphur (TRS) which is the cause of the “rotten egg” odour sometimes experienced near large industrial facilities

In terms of the ministry’s ongoing efforts to deal with fallout incidents, we will continue to:

- Inspect local industry and regulate them to ensure they meet our stringent regulations to reduce air pollution, and work with the large industries to create and implement plans to reduce dust and fugitive emissions, including sponsoring a Fugitive Dust Emission Workshop this December;
- Respond to any fallout incidents reported to us, and report back to the residents on the outcome of these investigations. The Ministry has also implemented a response program to ensure that all incidents are dealt with as expeditiously as possible;
- Take samples and obtain more detailed air quality information from the area using traditional and new specialized equipment. In partnership with the Hamilton Air Monitoring Network, the ministry installed new specialized equipment for measuring carbon. In conjunction with traditional samplers this will help to sample any dust fall and help to find sources. The ministry placed samplers on some residential properties where the owner has concerns with ongoing fallout. Also, the ministry is conducting an air survey using specialized monitoring equipment at the Winston Churchill High School to obtain more air quality information in the neighbourhood; and,
- Work with Environment Hamilton, to have all the industrial stacks labelled on their web site to facilitate identification of sources of emissions for the residents.

We are committed to continue working with the residents, the City of Hamilton and the Hamilton Air Monitoring Network in improving air quality across Hamilton.

Analysis of Wind Data for July 30 Hamilton Black Soot Incident and Subsequent August Incidents

The complaints received about fallout of black soot on Sunday/Monday July 30 and 31 2006, prior to the newspaper articles, were predominantly between Kenilworth Ave and Parkdale Ave extending from the residential area north of Barton Street nearly 3 km south to homes south of King Street. Further complaints expanded the area of impact further east to near Gage Ave as shown in Figure 1. With the very light wind speeds and clear skies, dispersion conditions would have been very stable with limited mixing during the night of July 29/30. Since the impacts (complaints) of the release were seen to about 4 km from the industrial area, the release was likely not at or near ground level (such as a coal pile) which would result in most of the deposition occurring closer to the release. A stack release was likely.

A total of about 30 formal complaints were initially registered and more arrived after publicity in early August. A number of these complaints were suitable for wind data analysis as they provided some timelines of useful information. The following describes those observations and their analysis. Wind data was available in 5 minute averaged format from MOE station 29026 – Woodward and also from a Columbian Chemicals wind vane. As details of the Columbian installation were not known, it was decided to primarily use the Woodward data for wind rose analysis of the 5 minute information. A wind rose is a cross-tabulation by wind direction/wind speed. Hourly wind speed frequencies for five degree wind sectors are illustrated in the aerial photos in Figures 2-15. The bars indicate the direction the wind was blowing *from* in various speed ranges during the time period studied. The size of the bars is proportional to the number of 5 minute periods that fell in that range for that directional sector. Thus, the bars point to the sources that may be affecting the location in question.

As a forerunner, prior to 19:00 (7 PM) on Sat July 29th the winds were from the southwest through to the west which would not impact the main complaint area. There were no complaints in the areas to the northeast and east except at Lakeland Pool where visitors noted black fallout on July 30 (but reported several days later). Winds then turned from the northeast for the period from 19:00 on July 29th to 20:00 on July 30th. Wind speeds were generally light with wind directions ranging from northwest through to easterly. After 19:00 on July 30th, the winds turned again to come from the southwest and remained in that direction for the next 3 days. The Lakeland Pool observations may indicate that the emission causing the fallout began some time before or after the Pool closing at 1800 on Sat July 29.

The following complaints were analysed based on the following criteria:

- 1) immediate to event as possible and/or gave relevant timelines
- 2) spatial variation across complaint area

Glennie Ave

This was among the first complaints to SAC and prompted a visit to the home to take dust samples G1 and G4 by the duty emergency response (ERP) officer on July 30. Figure 2a shows the wind rose from Woodward for the period of 1800 July 29 (after the switch to northeast wind) to the time of this complaint in July 30. The rose is placed onto the Glennie address and shows the mainly northeast wind pattern. The same rose using the Columbian wind data (station

29165) is shown also on the drawing (but not at the Glennie address) and shows mostly all northeast winds and does not include northwest periods as Woodward does. The northwest periods are critical as they indicate potential for Dofasco emissions to have contributed. The northwest winds occurred mostly during 0130 to 0330 with very light wind speeds under 3 km/hr. The Columbian wind speeds were slightly higher at over 5 km/hr and were northeast during these times. The primary northeast directions indicate Columbian Chemicals as a source. The fewer northwest periods (at Woodward only) indicate some potential for Dofasco as a source but the low wind speeds render these directional indications less reliable.

Also in Figure 2a is a rose for the period from July 28/29 when winds were from the southwest blowing almost directly from Columbian to Lakeland Pool. There were no dust complaints noted at the pool during Saturday, which was well attended (Hamilton Conservation Authority consulted). Figure 2b shows the wind rose for just the Saturday period of 1745 (just before pool closing) to 1850 when the winds shifted. The rose points mostly westerly and west southwest, indicating potential for both Dofasco and Columbian as sources. The Lakeland Pool observations were only called in to the Ministry on Aug 3rd after extensive publicity of the fallout problem. It is unknown if fallout was present earlier Saturday during opening hours and was either not observed or not seen as a problem by the people there.

Roslyn Ave

The same Woodward rose as in Figure 2a is placed onto this address in Figure 3 and points at Columbian, Dofasco and Stelco. The northwest wind bars are not as reliable due to low wind speeds.

Newlands Ave

The same Woodward rose as in Figure 2a is placed onto this address in Figure 4 and points at Columbian, Dofasco and Stelco. The northwest wind bars are not as reliable due to low wind speeds.

Strathearne Ave N

The caller advised they had cleaned up the original fallout on July 30th and now it was back on the 31st. Winds remained northeast only until 1900 on the 30th so a rose was prepared for a 3 hour period from 1600-1900 in Figure 5. The rose points most strongly at Columbian with smaller wind frequency from Dofasco.

Roosevelt Ave

The same Woodward rose as in Figure 2a is placed onto this address in Figure 6 and points at Columbian, Dofasco and Stelco. The northwest wind bars are not as reliable due to low wind speeds.

Glennie Ave

The caller advised they had cleaned up the original fallout from July 30th and now it was back on the Aug 3. Winds became northwest, then northeast only 5 hours previous to the call and a rose was prepared for the period from 0500-1000 in Figure 7. The rose points at Columbian, Dofasco and Stelco.

Fairfield Ave

The caller advised of a new soot fallout event on Aug 10. This address was part of the original complaints. Winds had been from the northeast off and on since Aug 8 and Figure 8a displays the wind rose for this extended two day window. It points at Columbian, Dofasco and Stelco. A rose in Figure 8b depicts the conditions for the last distinct northeast wind period which occurred prior to the call and it points exclusively at Columbian.

McAnulty Ave

The caller advised of a different type of fallout on Aug 11 of shiny particles, which are presumed to be kish. Kish is flakes of an amalgam of iron oxide and graphite (carbon), produced primarily as a byproduct when molten metal cools during the casting of molten iron and slag from a steel mill blast furnace. When the molten iron and slag contact air, particulate emissions are generated including kish. These particles tend to be of large diameter and very visible.

Winds had been northeast for the previous 24 hours and the wind rose in Figure 9 points at Dofasco and Stelco.

McAnulty Ave

The caller advised of similar shiny particle fallout on Aug 12 of, which are presumed to be kish. Winds had been north or northwest for the previous 24 hours and the wind rose in Figure 10 points at Dofasco and Stelco.

McAnulty Ave

The callers advised of shiny particle fallout on Aug 13, which are presumed to be kish. Winds had been northeast for the previous 24 hours and the wind rose in Figure 11 points at Dofasco and Stelco.

McAnulty Ave

The caller advised of soot fallout on Aug 19 on his vehicle. Winds had been north or northeast since midnight and the wind rose in Figure 12 points at Dofasco and Columbian.

Benson Ave

The caller advised of soot fallout on Aug 19. Winds had been north or northeast since midnight and the same wind rose as previous item in Figure 12 points at Dofasco and Columbian.

Benson Ave

The caller advised of soot fallout on Aug 24. Winds had been north or northeast since the previous evening and the wind rose in Figure 13 points at Dofasco and Columbian.

Tuxedo Ave

The original July 30 event is shown here in Figure 14 as another spatial indication of the event. The same Woodward rose as in Figure 2a is placed onto this address in Figure 14 and points at Columbian, Dofasco and Stelco. The northwest wind bars are not as reliable due to low wind speeds.

Auburn Ave

The original July 30 event is shown here in Figure 15 as another spatial indication of the event. The same Woodward rose as in Figure 2a is placed onto this address in Figure 15 and points at Columbian, Dofasco and Stelco. The northwest wind bars are not as reliable due to low wind speeds.

Summary of Wind Analyses

- 1) The original July 30 fallout event seemed to point most strongly at Columbian Chemicals, with Dofasco a secondary possibility.
- 2) Secondary soot fallout events occurred on Aug 3, 8-10, 19 and 24 and could have been from Columbian or Dofasco, although one refined assessment indicated Columbian.
- 3) Kish fallout events in late August could have been due to either Stelco or Dofasco.

Results of Microscopic Analyses of Fallout Samples

The attached data table and associated map summarizes the microscopic identifications of 18 dust fallout samples collected on July 30, Aug 10 and 11. These data should be compared to routine analysis of one dustfall jar in the Hamilton industrial zone shown below, at Burlington and Leeds Ave, close to Stelco. The station is remote from Columbian. The 2005 results of 30 day (approximately) exposures (given in percentages) of materials found in the insoluble fraction of samples can be considered typical of the area and has been constant for a number of years. As can be seen, carbonaceous materials comprise most of the samples, with coke dominant. Thus, when fallout samples in the area are collected from special events, they will include some of the normal base.

SUBSTANCE	JAN 2005	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
COAL	4	2	2	2	T			2	3	2	4	2
COKE	67	71	79	46	64	66	100	70	45	64	30	41
SOOT				2	2	8					30	
KISH	8	4			8	2		8	2	8		5

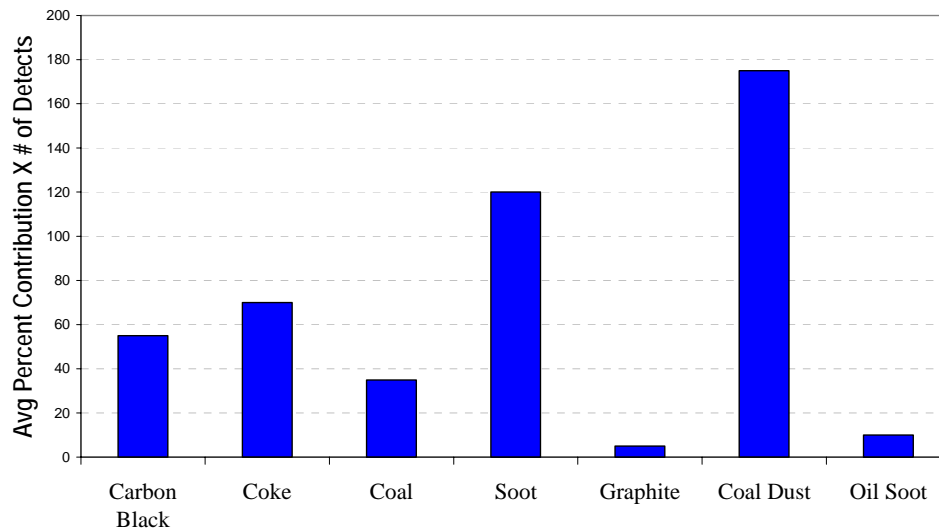
T- trace

TOTAL LOADING	7.5	7.4	14.4	14.4	11.6	10.0	8.0	7.8	9.7	10.0	10.8	7.3
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Grams/sq metre/30 days Monthly Objective: 7.0

The fallout samplings included carbon black from 5-20%, coke 5-20%, coal 5-20%, soot 5-20%, and coal dust 5-30%, in samples where detections occurred.

**Relative Abundance of Carbons in 18 Complaint Samples
July 30 and Aug 10-11**



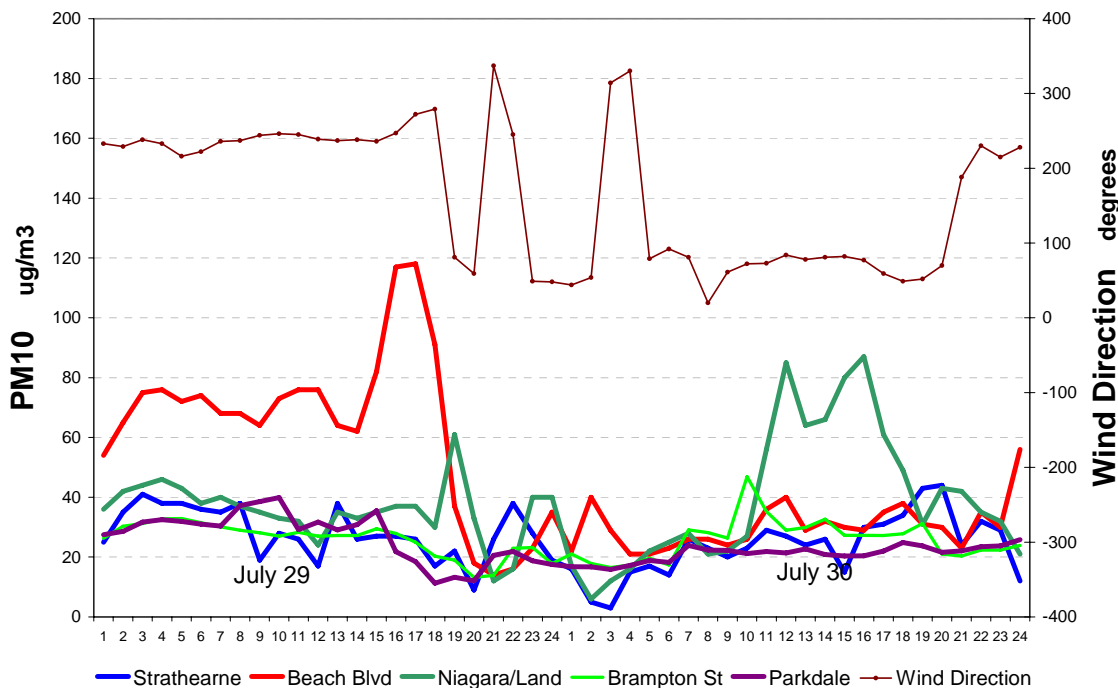
The prominent presence of coal and coal dust indicates that long-term accumulations of particles masked the presence of new fallout in the events of July 29-30 which were caused by stack emissions, not fugitive ones such as coal piles.

Results of Particulate Monitoring During July 30 Event

There were 5 continuous particulate monitors operating during the initial fallout event on the weekend of July 29-30. The following displays the hourly PM₁₀ concentrations measured:

Hour/Day	PM ₁₀ Concentrations on July 29-30, 2006 $\mu\text{g}/\text{m}^3$													
	29565 Strathearne		29102 Beach Blvd		29567 Niagara/Land		G 1 Brampton		G 2 Parkdale		29026- Woodward Wind			
	29	30	29	30	29	30	29	30	29	30	WS	WD	WS	WD
1	25	16	54	22	36	17	26	21	27	17	9	233	2	44
2	35	5	65	40	42	6	30	18	29	17	7	229	2	54
3	41	3	75	29	44	12	31	17	32	16	10	238	2	314
4	38	15	76	21	46	16	33	17	33	17	9	233	1	330
5	38	17	72	21	43	22	33	20	32	19	6	216	5	79
6	36	14	74	23	38	25	32	17	31	18	7	222	5	92
7	35	26	68	26	40	28	30	29	30	24	11	236	4	81
8	38	23	68	26	37	21	29	28	37	22	12	237	4	20
9	19	20	64	24	35	22	28	26	39	22	12	244	7	61
10	28	23	73	26	33	27	27	47	40	21	13	246	8	72
11	26	29	76	36	32	56	28	35	29	22	12	245	12	73
12	17	27	76	40	24	85	27	29	32	21	14	239	15	84
13	38	24	64	29	35	64	27	30	29	23	16	237	14	78
14	26	26	62	32	33	66	27	33	31	21	17	238	14	81
15	27	15	82	30	35	80	30	27	35	20	17	236	14	82
16	27	30	117	29	37	87	28	27	22	20	17	247	11	77
17	26	31	118	35	37	61	25	27	19	22	16	272	8	59
18	17	34	91	38	30	49	20	28	11	25	12	279	5	49
19	22	43	37	31	61	31	19	31	13	24	10	81	3	52
20	9	44	18	30	33	43	13	21	12	22	7	59	4	70
21	26	24	14	23	12	42	14	20	21	22	5	337	4	188
22	38	32	16	35	16	35	23	22	22	23	3	245	7	230
23	28	29	23	30	40	32	23	22	19	24	2	49	6	215
24	19	12	35	56	40	21	18	24	18	26	5	48	5	228

Hourly Particulate (PM10) Readings During Event



The three numbered stations belong to the HAMN monitoring network which is operated by consultants for local industries. The two “G” samplers were MOE samplers which were in the midst of a short term monitoring survey in the area. There were no strong peaks measured during the two days except for one two hour event at 29102- Beach Blvd just before the wind shifted from west/southwest to northeast on the 29th. Hourly PM₁₀ levels of 118 and 117 $\mu\text{g}/\text{m}^3$ were measured. However, there were no fallout complaints from the station area and this level of concentration is routinely measured at this station during these wind directions without complaints being received. The peak may possibly be related to the black fallout event, but likely it is not. It should be noted that some of these instruments may be subject to some interferences and other technical limitations which may not always allow them to detect particle fallout. Because of these findings there is no quantitative assessment of the amount of fallout materials that fell on the area. All findings are qualitative in nature.

August 19 Columbian Release

On Aug 19, Columbian Chemicals experienced a brief accidental release of carbon black due to a leak at a furnace heat exchanger. The release lasted 10 minutes starting after 11:00 am and was reported promptly by the company to the Ministry. One fallout complaint was subsequently reported from the Benson St area and a fallout samples were later collected by the Ministry at nearby Grenfell Ave. These samples contained 30% coke, 20% carbon black, 5% coal and 5% graphite in one, and the second contained 30% coke, 10% carbon black, and 20% coal. Figure 16 shows the path of release using Woodward 5 minute wind data and the path of travel did go near the complaint area with the leading edge of the plume arriving in about a 10 minutes.

New Air Sampling

In response to this issue, the Ministry has initiated new air sampling in the area to help detect further incidents, should they occur. The locations of these monitors are shown in Figure 17.

- 1) Passive filters – glass fibre filters will be exposed passively (no active air flow) to capture any fallout for microscopic analyses. Initially these were placed at McAnulty Boulevard and will be located at other residences in the neighbourhood upon request. Two samples have been exposed by homeowner to date, one of which was in downwind conditions. Soot and carbon black traces seen. It should be noted that carbon black traces, soots and coal were also seen in *upwind* passive sample.
- 2) Continuous air sampling will be undertaken by the Ministry of the Environment's Environmental Monitoring and Reporting Branch mobile bus. The bus is planned to be stationed at Sir Winston Churchill Secondary School and will measure hourly concentrations of a variety of parameters including particulate matter.
- 3) Carbon Analyser – an experimental carbon analyser was installed at HAMN station 29565- Strathearne alongside the PM₁₀ monitor which already operates there. Both instruments are telemetered and provide real time concentration levels of particulate. The carbon analyser is specific to various forms of elemental carbon. The sampler commenced operations on September 8 and the results of the first weeks of operation are illustrated in a pollution rose in Figure 18. The pollution rose is similar to the wind roses presented earlier, with pollutant concentrations instead of wind speeds being classified by wind direction. Highest concentrations to date have occurred with north, east and southwest winds. The highest hourly concentration measured to date has been 3.9 µg/m³. The rose indicates about equal contributions from industrial and non-industrial directions. The elemental carbon concentrations being measured are less than elemental carbon measured in 24 hour exposure filters historically. As such it is uncertain what carbons are being measured. No large peak events have been observed to date.

McMaster University Analysis of Fallout Samples for Columbian Chemicals

A small number of samples from two locations were analysed for PAH compounds by McMaster University - Dr. Brian McCarry for Columbian Chemicals. These compounds acted as tracers for carbon black. One sample was a particulate dusting sample which could be analysed directly for thiacyronene, which had previously been designated as a suitable surrogate to estimate the percentage of carbon black in a sample compared to known samples of production runs at Columbian. The sample was estimated to contain only 0.05% carbon black which would not be sufficient to cause soiling problems.

Six other swipe samples in materials such as soiled serviettes underwent alternate analysis for PAH compounds. A ratio of two pairs of PAH were used for estimation of carbon black because these ratios are different in carbon black compared to other sources for which archived information was available. These sources included historical filter samples, coal and

coke breeze from steel mills, steel mill baghouse dusts, street dust samples, and diesel exhaust information. It was concluded that none of these residential samples showed measurable carbon black.

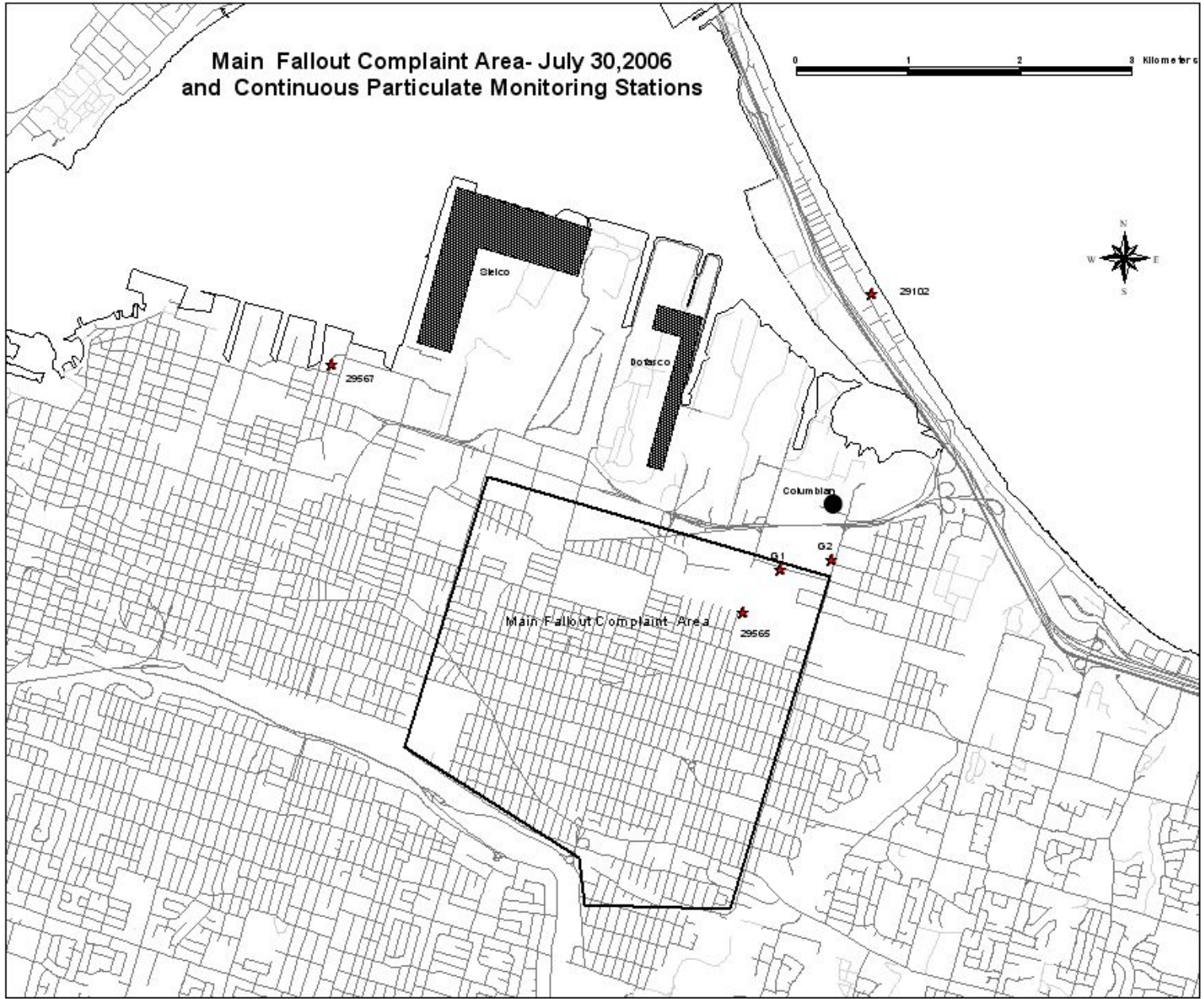
It should be noted that of the two locations where samples were taken, one coincided with a Ministry sampled site where carbon black *was* seen microscopically, and the other site was in a location where the nearest Ministry samples showed no carbon black detection microscopically.

Ministry dust samples were provided to Dr. McCarry for the thiacyanone analysis, but there was not enough material present for analysis. Some MOE swab samples from July 30 were also provided and showed non-detect results (of carbon black) at the initial two complaint locations using the PAH ratio technique. There was limited comparison to MOE. Only one of these samples was a direct comparison to MOE results and there was disagreement. MOE identified carbon black up to 20%, McMaster did not.

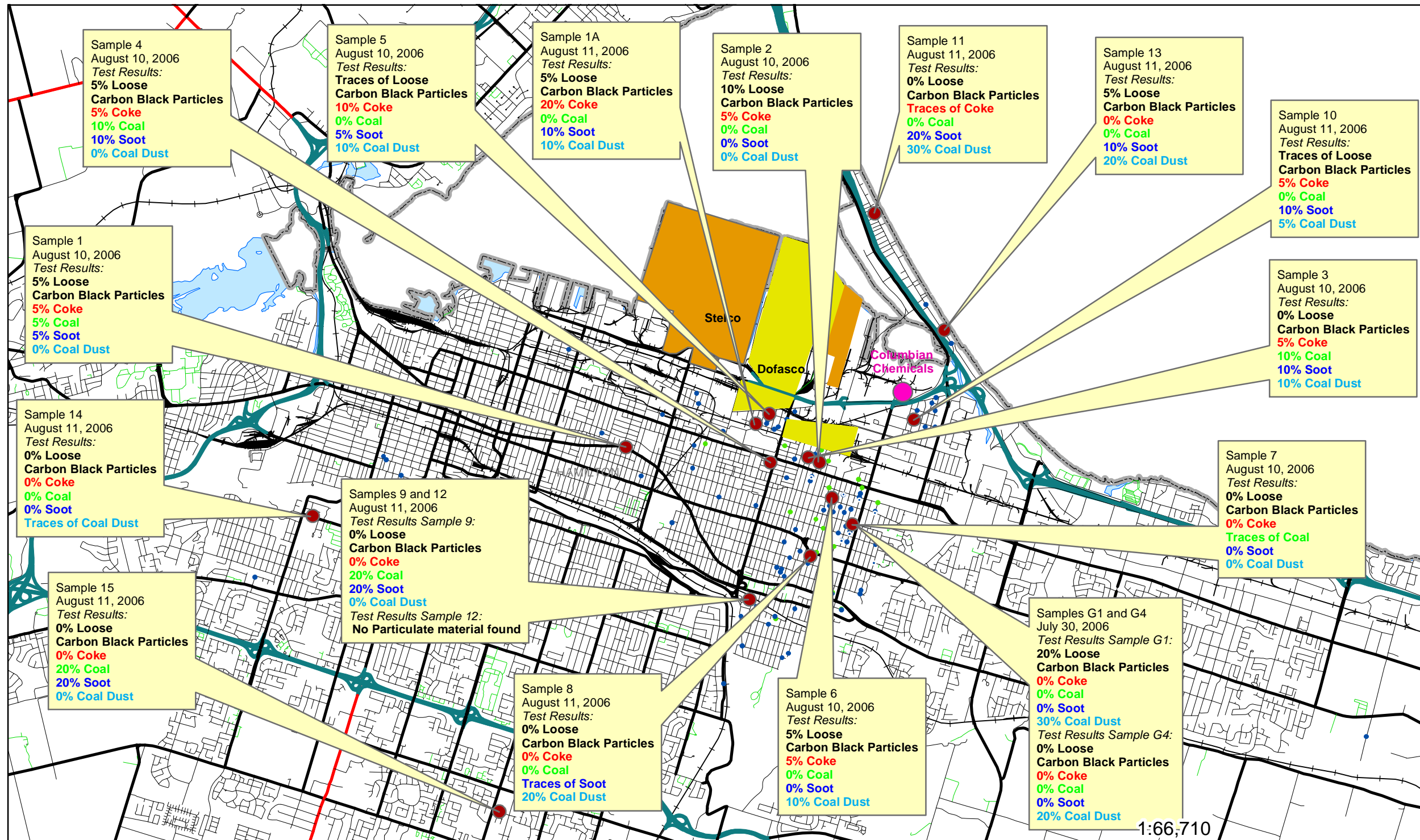
Key Conclusions

- Reported incidents of black fallout after July 29-30, 2006 can be attributed to the industrial north end of the City of Hamilton as the predominant winds during this time period were from the northwest through to the northeast and therefore capable of transporting particulate to properties to the south;
- Weather conditions support the observation that multiple sources contributed to fallout at properties to the south, but continuous monitoring equipment strategically located adjacent to major industrial facilities in the area did not detect any significant increases in any ambient particulate concentrations that would indicate an equipment malfunction or abnormal release that could be responsible. There is no quantitative assessment of the amount of fallout materials that fell on the area. All findings are qualitative in nature;
- Sample results showed a wide range of materials in each of the samples. Analysis did not show that any one particular carbon component was present in significantly greater quantity than any other; and
- Carbon black was present in varying proportions (from non-detect to 20%) in the analysed samples. Due to the nature of carbon black, it is less detectable in an undisturbed state. When the particle structure is broken as would occur due to wiping, sitting on furniture or touching objects, the carbon black creates a greasy residue that gives the impression that more of the material is present. Small amounts of this material create high soiling potential.

**Main Fallout Complaint Area- July 30,2006
and Continuous Particulate Monitoring Stations**



Black Soot Complaints - Sample Locations & Test Results



Legend

Roads

- Expressway
- Principal Highway
- Secondary Highway
- Major Road
- Local road
- Trail
- Ferry Route/Ice Road
- Railway
- Highways

WCR Districts

- Major Lakes
- Columbian Chemicals
- Dofasco
- Stelco
- Black Soot Complainants July 30 and 31, 2006
- Black Soot Complainants August 1 to 4, 2006
- Black Soot Sampling August 10 & 11, 2006

3 1.5 0 3 Kilometers

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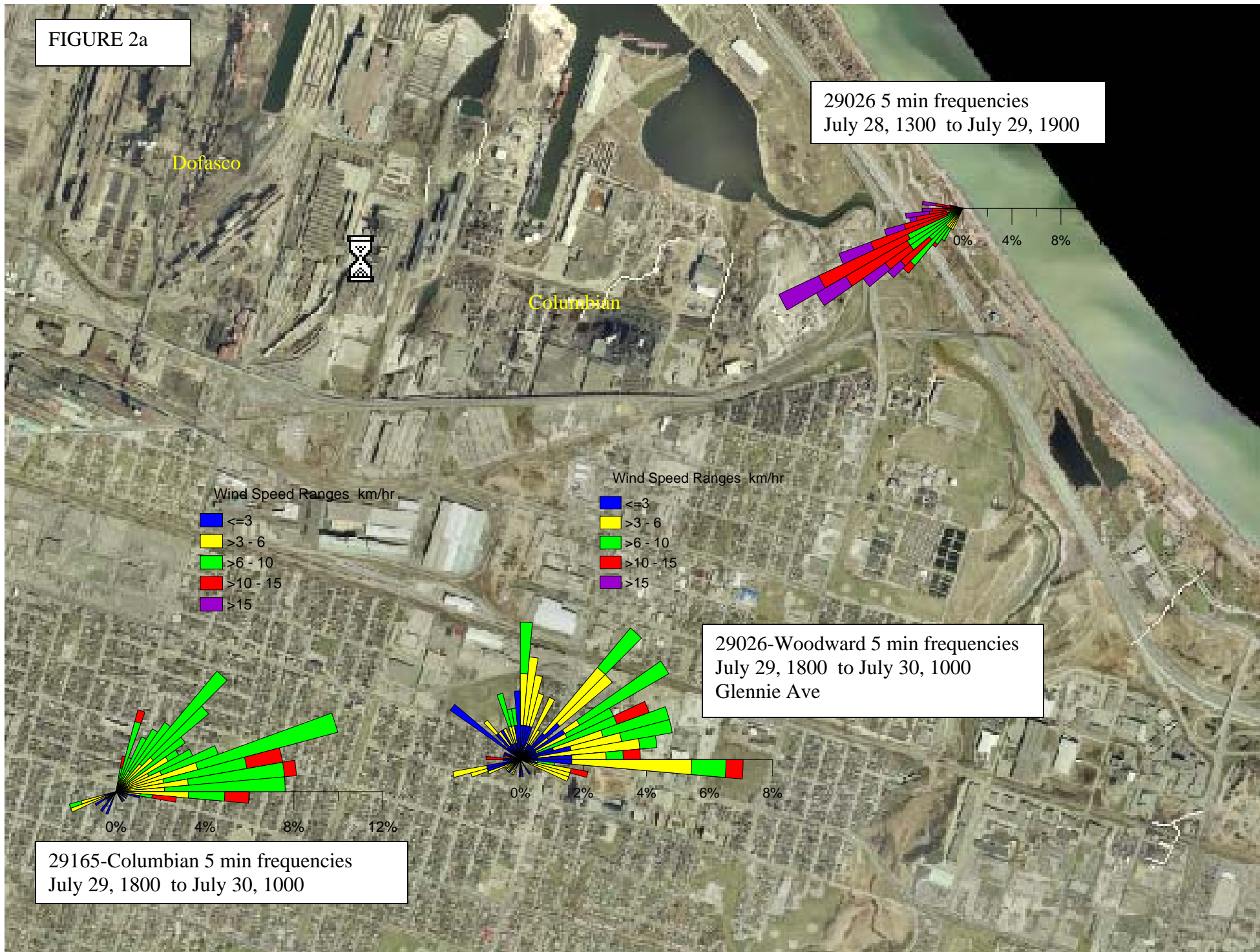
Ministry of the Environment
Hamilton District, West Central Region

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North American Datum 1983
Universal Transverse Mercator
(6 degree) projection, Zone 17

August 24, 2006

FIGURE 2a



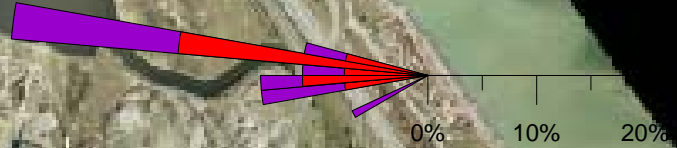
Steleo

FIGURE 2b



Dofasco

Columbian



29026 5 min frequencies
July 29, 1745 to 1850 mostly after
Lakeland Pool closing

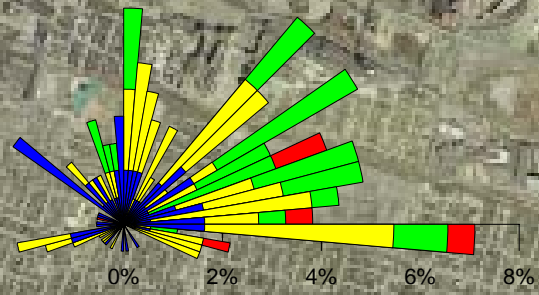


FIGURE 3

Stelco

Defasco

Columbian



Wind Speed Ranges km/hr

- <=3
- >3 - 6
- >6 - 10
- >10 - 15
- >15

29026-Woodward 5 min frequencies
July 29, 1800 to July 30, 1000
Rosslyn Ave

FIGURE 4

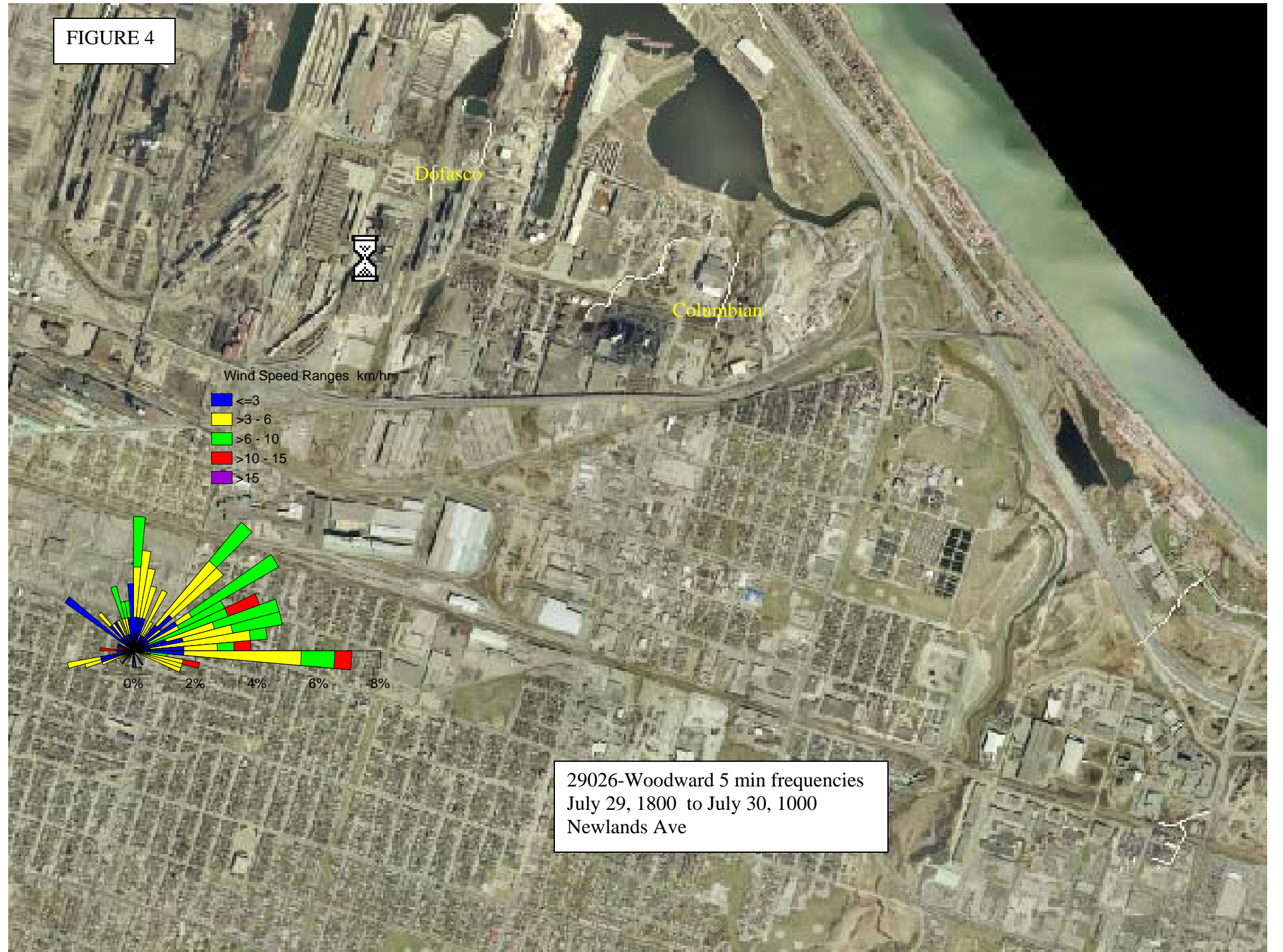
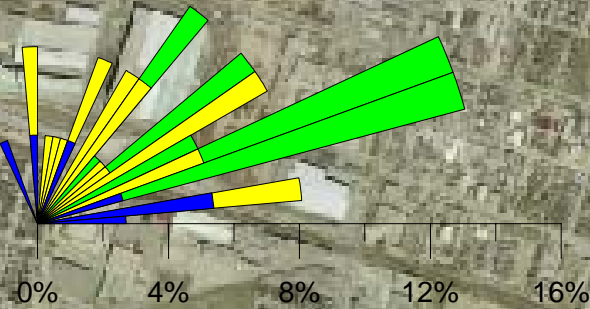


FIGURE 5



Dofasco

Columbian

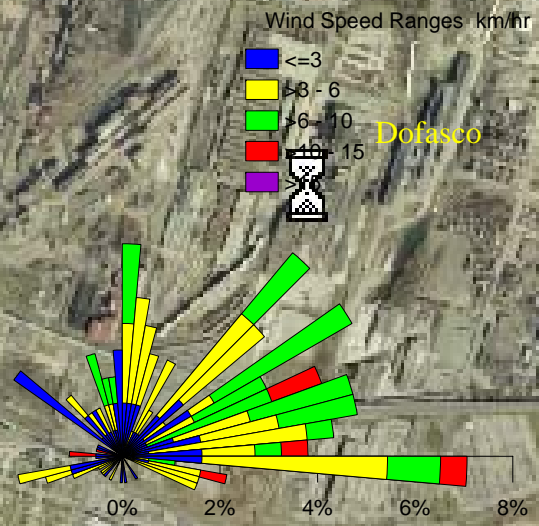


29026-Woodward 5 min frequencies
July 30, 1600 to 1900 after cleaning
Strathearne Ave N

Wind Speed Ranges km/hr

- <=3
- >3 - 6
- >6 - 10
- >10 - 15
- >15

FIGURE 6



Dofasco

Colambian

29026-Woodward 5 min frequencies
July 29, 1800 to July 30, 1000
Roosevelt Ave

FIGURE 7

Stelco

Dofasco

Columbian

29026-Woodward 5 min frequencies
Aug 3, 0515 to 1000 after cleaning
Glennie Ave

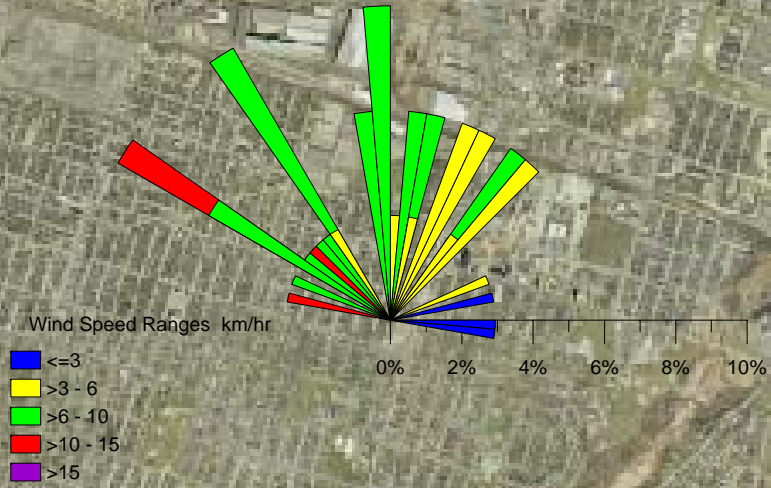
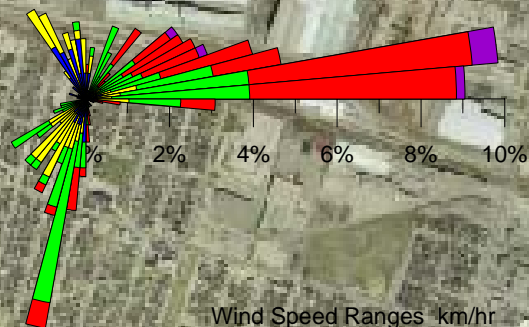


FIGURE 8a

Dofasco

Columbian



29026-Woodward 5 min frequencies
Aug 8, 0900 to Aug 10, 0900 second soot event
Fairfield Ave

Wind Speed Ranges km/hr

- <=3
- >3 - 6
- >6 - 10
- >10 - 15
- >15

FIGURE 8b



FIGURE 9

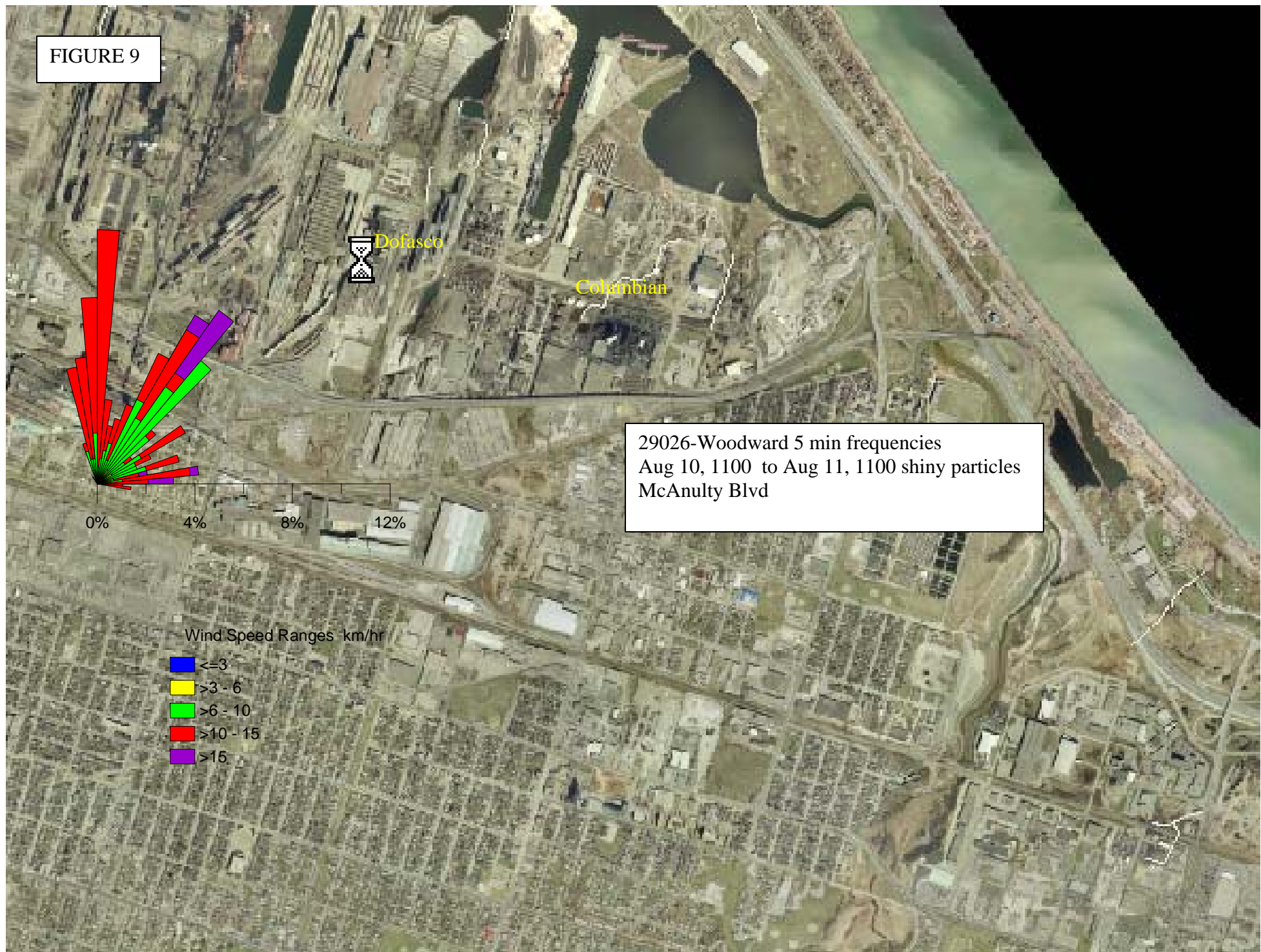


FIGURE 10

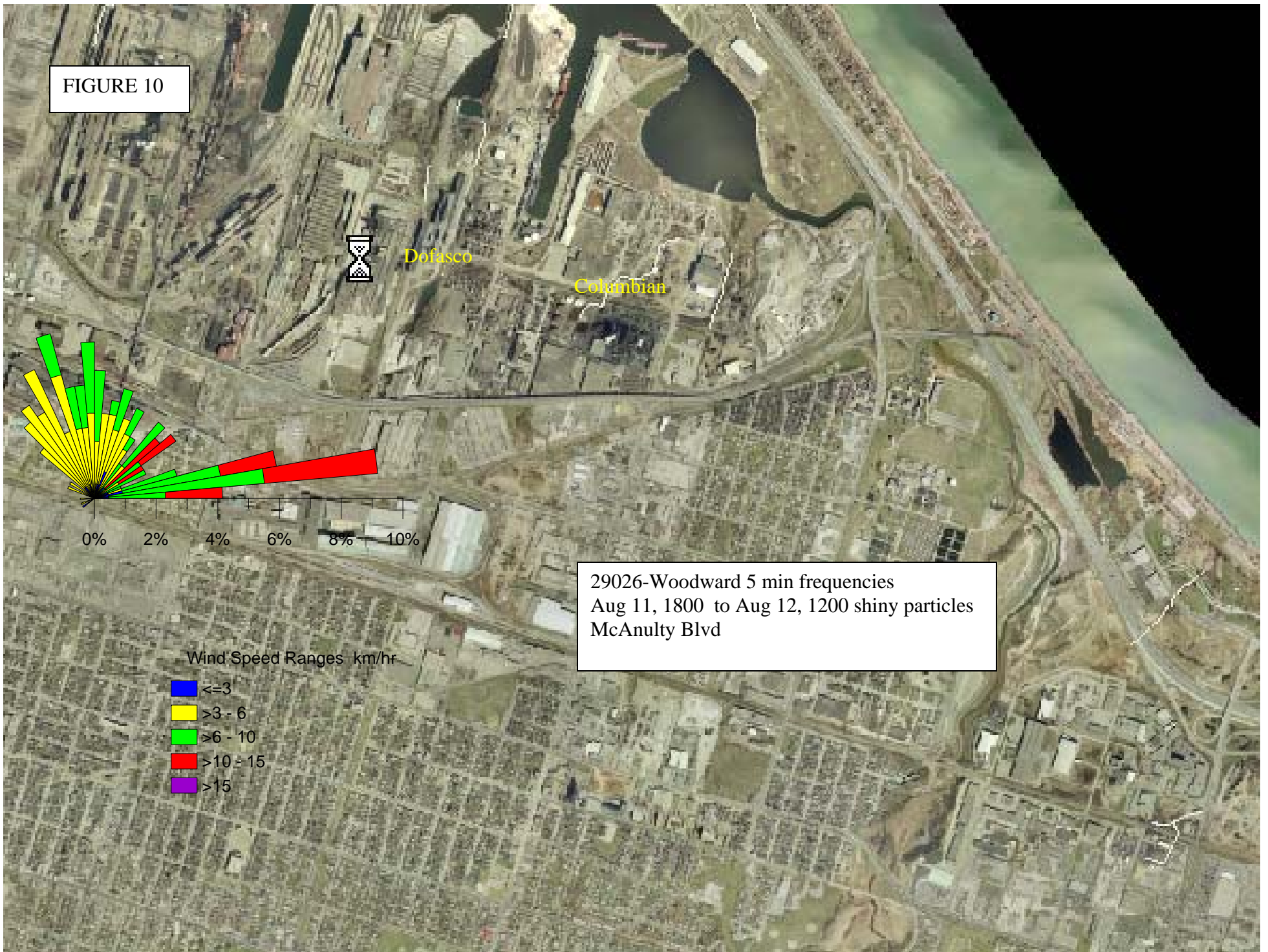
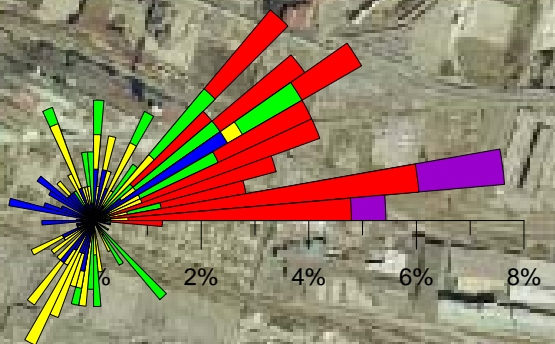


FIGURE 11

Dofasco
Columbian

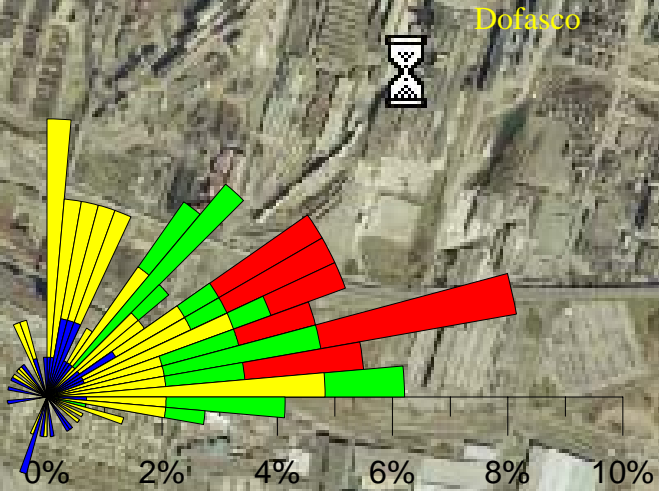


Wind Speed Ranges km/hr

- < 3
- > 3 - 6
- > 6 - 10
- > 10 - 15
- > 15

29026-Woodward 5 min frequencies
Aug 12, 1200 to Aug 13, 1400 shiny particles
McAnulty Blvd

FIGURE 12



Dofasco

Columbian

29026-Woodward 5 min frequencies
Aug 19, 0000 to 1200 soot fallout
Benson Ave and McAnulty Blvd

- Wind Speed Ranges km/hr
- <=3
 - >3 - 6
 - >6 - 10
 - >10 - 15
 - >15

FIGURE 13



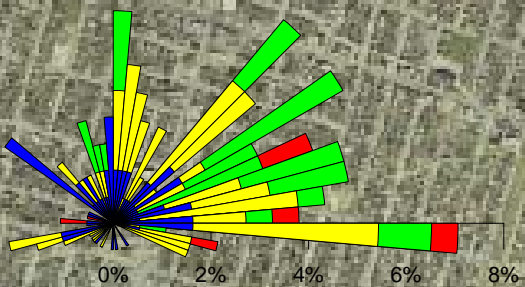
FIGURE 14

Dofasco

Columbian

Wind Speed Ranges km/hr

- < 3
- > 3 - 6
- > 6 - 10
- > 10 - 15
- > 15



29026-Woodward 5 min frequencies
July 29, 1800 to July 30, 1000
Tuxedo Ave N

FIGURE 15

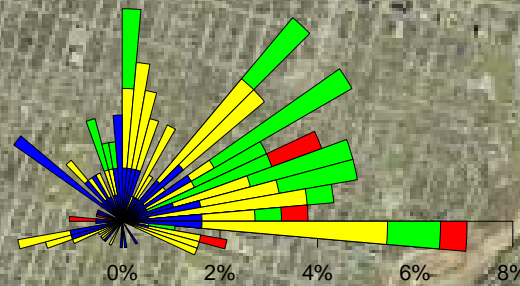
Stelco

Dofasco

Columbian

Wind Speed Ranges km/hr

- <=3
- >3 - 6
- >6 - 10
- >10 - 15
- >15



29026-Woodward 5 min frequencies
July 29, 1800 to July 30, 1000
Auburn Ave

FIGURE 16



Columbian

Complaint- Benson Ave

Track of Columbian Plume

5 min wind trace
Aug 19/06 Columbian Heat
Exchanger Leak @ 1110 EDT

FIGURE 17

Passive Filter
McAnulty

Carbon Analyser
Station 29565

Churchill SS Bus



FIGURE 18

29565-Strathearne – Pollution Rose
Carbon 5 min Concentration Frequencies
Sept 8 – Nov 28, 2006

