

**Health-Impacting Air Pollutants:
A Mobile Monitoring Study to
Identify and Rank Sources in Hamilton, Ontario**

Performed by

Rotek Environmental Inc.

For

Clean Air Hamilton / City of Hamilton
Ministry of the Environment / Environment Canada / Green Venture

ROTEK

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1. Executive Summary

A mobile air quality monitoring study was undertaken to identify the transient levels of air pollutants in Hamilton, Ontario.

Historical fixed-site air monitoring data and National Pollutant Release Inventory data for Hamilton were used to develop a target list of sources of health impacting air pollutants to be monitored in this study. Five separate industrial areas were identified in the city. A mobile command vehicle was fitted with a GPS detector and modified to support a data acquisition and storage system, along with instruments to measure NO_x (Oxides of Nitrogen), SO₂ (Sulphur Dioxide), PM (Airborne Particulate Matter) and CO (Carbon Monoxide).

Mobile scans for the above pollutants were performed in traverses across the city, at selected industrial areas, at traffic intersections and at a school during student pickup and drop-off times.

Although it might be expected that industrial sources would be responsible for the highest concentrations of pollutants, overall, the highest concentrations were observed near major road intersections and along heavily used roads affected by dirt track-out in the industrial sectors of the city. These high levels are attributed to the impacts of city traffic emissions and the industrial transportation sector, respectively. Industrial point sources still made significant contributions, particularly for SO₂.

This study clearly showed a cumulative effect of city emissions, high ambient levels of combustion emissions from vehicles idling at intersections and from large diesel trucks, as well as very high levels of particulate from dirt track-out onto roads and re-suspension of road dust by large trucks.

Fourteen track-out locations were identified in need of cleanup and an additional fifteen point sources were ranked in order of peak ambient impacts.

Point source impacts did not in all cases agree with NPRI emissions data.

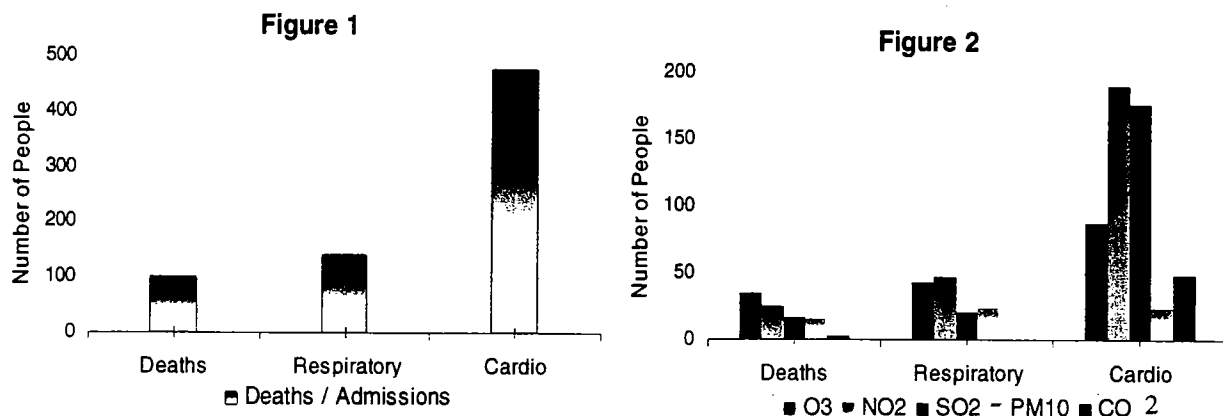
Relatively simple GIS techniques proved very useful and a more sophisticated GIS analysis of the data would be worthwhile.

The data led to a number of specific recommendations.

2. Introduction and Background

Clean Air Hamilton (CAH) has determined that air pollution causes significant morbidity and mortality in the City of Hamilton. In particular, a 2003 report by the McMaster Institute of Environment and Health (Tara Sahsuvaroglu and Michael Jerrett) identified NO₂, SO₂, O₃, PM₁₀ and CO as the pollutants causing most health effects. Except for O₃, all these pollutants have local sources, including the transportation sector.

Air Pollution Health Impacts in Hamilton (Sahsuvaroglu & Jerrett 2003)



Hamilton has been a leader in the development of fixed network air monitoring, building a strong groundwork for long-term evaluation of sources and impacts. However, emission inventories and stationary air monitoring devices may not give complete coverage. Mobile air monitoring can be used to provide air quality data for areas not covered by the fixed monitoring sites.

Previously, a pilot study to identify PM₁₀ sources had been commissioned in 2004 by Clean Air Hamilton and was performed by Rotek Environmental Inc. This study evaluated the feasibility of using the mobile monitoring technique to identify and isolate the impact of previously unexamined sources.

The pilot project focused on the highly industrialized and densely populated section of northeast Hamilton. This area has always posed a difficult challenge for air monitoring, as it is home to more than 400 industries, including steel manufacturing, chemical production, recycling, machining, waste and scrap operations and materials handling. It is uniquely complex in the number and types of emission sources.

In addition to direct emissions, a specific problem in this area was the presence of large quantities of particulate on local roads in the industrialized area. This particulate material was then re-suspended by high volumes of truck and passenger vehicle traffic.

The pilot study was successful in identifying one facility that was a major source of PM₁₀, as well as specific roads and intersections that would require intensive street cleaning in order to reduce road dust levels.

The current study extends these monitoring techniques to a wider area across the city and to other pollutants originating in the city with direct health impacts, i.e., NO_x, SO₂, PM, and CO. Since O₃ does not originate in the city, it was not monitored in this current survey.

3. Study Objective

The objective of this study was to identify and rank sources of NO_x, SO₂, PM and CO in Hamilton, using mobile monitoring techniques.

Sampling was to be performed along city roads, near major traffic intersections, along roads in industrial areas and near industrial point sources. One sampling day was also to be spent at a designated school to investigate the effect of idling vehicles during student drop off and pickup times.

4. Study Outline

- Phase 1:** Review previous data, including MOE (Ontario Ministry of the Environment), HAMN (Hamilton Industrial Air Monitoring Network) and NPRI (Environment Canada National Pollutant Release Inventory) data. Collate NPRI information, including source locations, in Excel tables for each contaminant and rank in order of emission quantity for that contaminant. Discuss data with MOE and Rotek staff to develop target sampling areas.
- Phase 2:** Modify mobile command vehicle to hold rack mounted instruments to measure NO_x, SO₂, PM and CO together with a data acquisition and storage system and a GPS detector.
- Phase 3:** Perform mobile monitoring of target areas, including the designated school.
- Phase 4:** Review preliminary data and prepare an interim report.
- Phase 5:** Refine target areas for second part of monitoring study.
- Phase 6:** Perform second part of monitoring, including different wind regimes and climatic conditions.
- Phase 7:** Evaluate data and prepare final report.

5. Evaluation of Previous Data

NPRI data for the contaminants of concern were downloaded into Excel files. Matching source locations were also downloaded. The information was then sorted in descending order of emissions; see Tables 1 – 5.

Table 1 – PM₁₀ Emission Sources

NPRI ID	Facility Name	Address	PM ₁₀ Tonnes
2984	Stelco	386 Wilcox Street L8N 3T1	964
3713	Dofasco	1330 Burlington Street East L8N 3J5	688
10139	Carmeuse Lime, Dundas	600 Highway 5 West, Gate 1 L9H 3S9	87
2660	Columbian Chemicals	755 Parkdale Avenue North L8H 7M2	73
10059	Lafarge Nebo HMA	669 Nebo Road L0R 1P0	57
161	Bunge Canada	515 Victoria Avenue North L8L 8G7	32
2161	Hamilton Specialty Bar	319 Sherman Ave. N. L8N 3R5	23
1388	Multiserv Stelco	Stelco Wilcox Street Gate L8L 7T5	15
10632	Alcarb Resources	190 Lanark Street L8E 4B3	9
10610	Dufferin Aggregates Flamboro	685 Brock Road L9H 5E4	7.6
1391	Multiserv Dofasco	Gate 10, Burlington St. L8R 3M2	6.7
7134	North American Tillage Tools NATTCO	460 Sherman Avenue North L8L 8J6	6.3
2496	Amcan Castings	10 Hillyard Street L8L 6B1	5.6
5657	PSC Taro Landfill	65 Green Mtn Road West L8J 1X5	4
10017	Lafarge Hamilton Slag	139 Windermere Road L8H 3Y2	4
5685	Regional Die casting	695 Arvin Avenue L8E 5R2	3
10005	Oldcastle Decor-Stoney Creek	682 Arvin Avenue L8E 5R4	2.6
7402	Canadian Liquids Processors	15 Biggar Avenue, L8L 3Z3	2.5
7135	Opta Minerals Waterdown	407 Parkside Drive L0R 2H0	2.4
2057	Rheem	128 Barton Street West L8N 3P3	2.3
10600	McMaster University	1280 Main Street West L8S 4M3	2.2
6750	Transcanada Pipelines Stn 1301	Pt Lot 25 Con 7, Plan 62R-8308 Pts 1-8	1.6
4550	Siemens Westinghouse	30 Milton Avenue L8L 6E6	1.4
7422	Imperial Precast.	294 Fifty Road L8E 5L1	1.3
5904	Orlick 411 Parkdale	411 Parkdale Ave North L8H 5Y4	1.1
4045	Stelwire – Parkdale	690 Strathearne Ave N L8H 7N8	1
7588	Lafarge Hamilton Quality RMC	583 Nebo Road L0R 1P0	1
7015	Dufferin Concrete	886 Nebo Road L0R 1P0	1
7587	Lafarge Hamilton Dock RMC	525 Victoria Ave N L8L 8G7	0.8
10057	Lafarge Ham East HMA	C81 Brockley Road L8P 1K8	0.8
7234	Century Brick	Lawrence Road L8M 3N1	0.6
5906	Orlick Industries- 20 Teal	20 Teal Avenue L8E 3Y5	0.6
7243	Lafarge Stoney Creek Plant	360 Jones Road L8E 5N2	0.4
10042	Lafarge - Ham West HMA	501 Main Street West L8P 1K8	0.4
7001	Robertson Building Systems	61 Burford Road L8N 3B6	0.4
5768	Nelson Steel- Glover Road	400 Glover Road L8E 5X1	0.3
3859	Nelson Steel. – Arvin Avenue	199 Arvin Avenue L8E 2L9	0.1
5954	Greif Bros.	370 Millen Road L8E 2H5	0.04
		Total	2010

Table 2 – NO_x Emission Sources

NPRI ID	Facility Name	NO_x Tonnes
3713	Dofasco	3114
2984	Stelco	2703
2660	Columbian Chemicals	1070
10139	Carmeuse Lime Dundas	649
10672	Hamilton Community Energy – Energy Centre	260
6750	Transcanada Pipelines- Station 1301	198
2161	Hamilton Specialty Bar	76
10600	McMaster University	53
161	Bunge	40
2070	VFT	20
7243	Lafarge – Stoney Creek	2.6
7001	Robertson Building Systems	1.7
10005	Oldcastle Decor-Stoney Creek	0.98
Total		8188

Table 3 – SO_x Emission Sources

NPRI ID	Facility Name	SO_x Tonnes
3713	Dofasco	5035
2984	Stelco	3399
2660	Columbian Chemicals	3130
10139	Carmeuse Lime Dundas	281
7243	Lafarge Stoney Creek	16
2161	Hamilton Specialty Bar	14
2070	VFT	0.12
7001	Robertson Building Systems	0.005
5954	Greif Bros. Canada	0.003
Total		11875

Table 4 – CO Emission Sources

NPRI ID	Facility Name	CO Tonnes
2984	Stelco	23016
3713	Dofasco	6360
2161	Hamilton Specialty Bar	451
10139	Carmeuse Lime Dundas	382
2660	Columbian Chemicals	236
2496	Amcan	58
6750	Transcanada Pipelines Station 1301	49
161	Bunge	34
10600	McMaster University	25
2070	VFT	17
7243	Lafarge Stoney Creek	2.2
10005	Oldcastle Decor-Stoney Creek	1.1
5954	Greif Bros. Canada	0.44
7001	Robertson Building Systems	0.2
Total		30632

Table 5 – Point Source Emissions by Contaminant

	CO	SOx	NOx	PM₁₀
Tonnes	30,632	11,875	8,188	2,010

Table 6 – NPRI Total Emissions by Source Category for Hamilton

Source Category	CO	SOx	NOx	PM₁₀
Industrial	15,987	10,903	8,414	5,430
Fuel Combustion	7,236	308	1,659	1,707
Transportation	47,389	635	12,766	1037
Incineration	365	36	173	2
Miscellaneous	143	0	0	118
Open Sources	0	0	0	21,669
Total Tonnes	71,120	11,882	23,012	29,963

Note: Quantities in Table 6, (source category emissions) do not agree with the other tables due to differences in NPRI search areas for different types of searches as well as data years. Open sources include road dust, construction and agriculture. Transportation sources include air transportation, marine transportation and heavy duty diesel vehicles.

Pollutant concentrations at ground level due to these emissions will vary widely according to a large number of factors, including release height, flow rate, pollutant release temperature, ambient temperature, wind speed and direction. See Fig. 3 below, a diagrammatic representation of emission concentrations being modified by environmental factors.

Modifiers of Point of Impact Concentrations

Emission - Dispersion - Accumulation - Removal

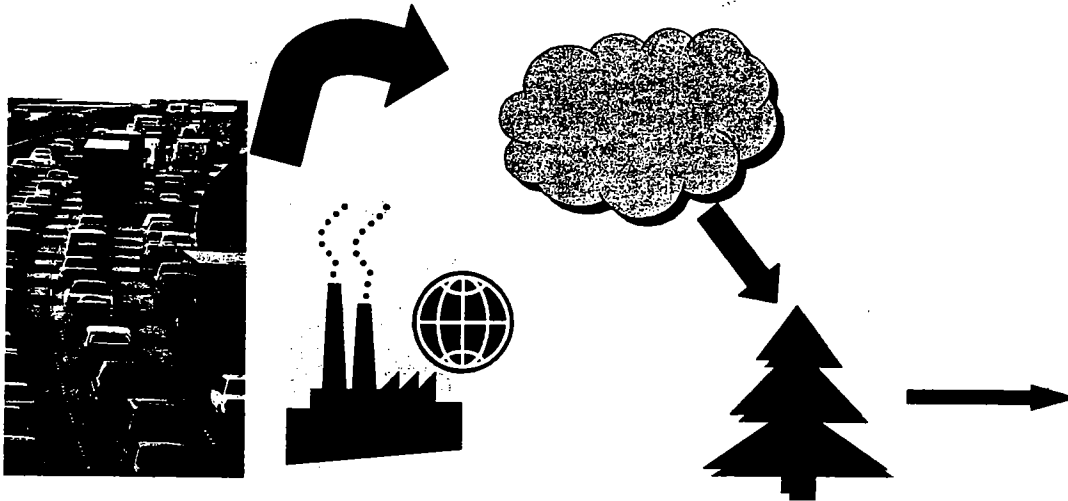


Figure 3

Nevertheless, the raw emissions data suggest that CO is the major contaminant from point sources, at 30,632 tonnes, followed by SO_x at 11,875 tonnes, NO_x at 8,188 tonnes and PM10 at 2,010 tonnes, with the two major steel companies being the largest single contributors.

NPRI Point Source Emissions

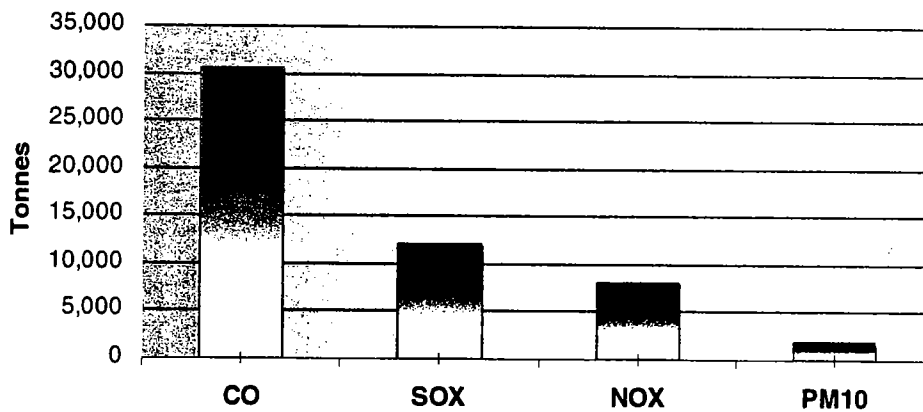


Figure 4

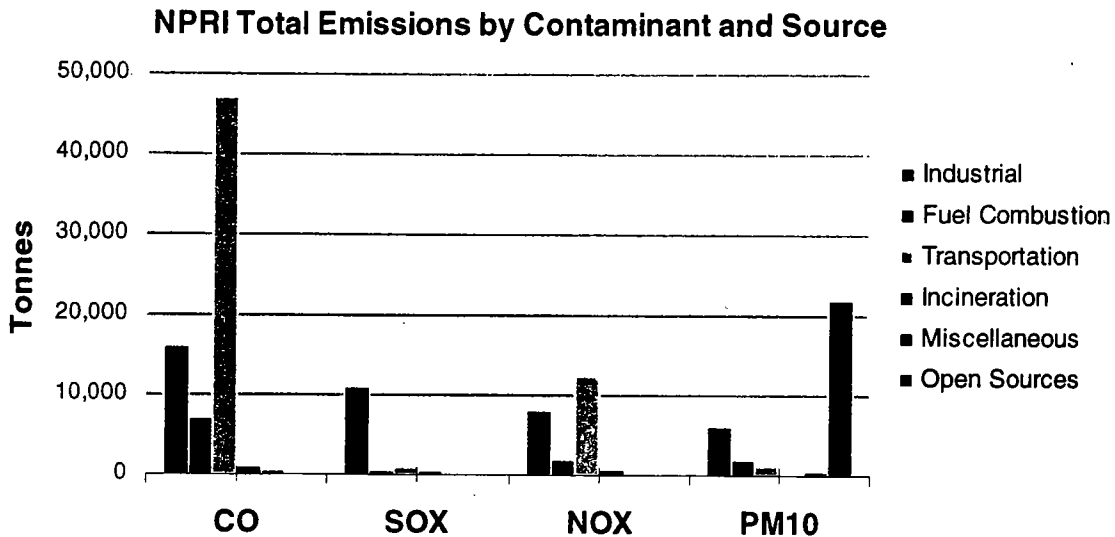


Figure 5

Total (compared to point source) emissions by source category also show CO as the pollutant with the largest tonnage of emissions. Transportation is the largest CO source with three times the emission rate of point source industrial emissions. Open sources (including road dust) are the largest generator of PM₁₀.

Transportation is also the largest source of NO_x (12,766 tonnes), although industrial sources are of similar magnitude (8,414 tonnes). The top three industrial sources, Stelco, Dofasco and Columbian Chemicals account for 6,887 tonnes or 82% of this total.

The top three transportation sources for NO_x are Air Transportation (1,219 tonnes), Marine Transportation (558 tonnes) and Heavy Duty Diesel Vehicles (440 tonnes). Thus, the NPRI data show that industrial NO_x sources exceed heavy duty diesel emissions by a factor of 20.

Overall the NPRI data show 56 point sources of PM₁₀, 14 sources of CO, 13 sources of NO_x and 9 sources of SO₂.

In light of these data, we would expect to measure the following contaminants and attribute their sources as follows:

- **Carbon Monoxide** – 66% Transportation, 23% Industry
- **Sulphur Dioxide** – 92% Industry, 5% Transportation
- **Nitrogen Oxides** – 57% Transportation, 37% Industry
- **PM₁₀** – 73% Open Sources/Road Dust, 18% Industry

The NPRI point sources fell into 5 well defined geographic areas, Flamborough/Waterdown (aggregates), East Mountain (aggregates), West Hamilton/Frid (mixed industrial and university), Northeast Industrial Area (heavy and mixed industrial) and Stoney Creek (mixed industrial and aggregates).

Emission Sources by Regions in Hamilton Area

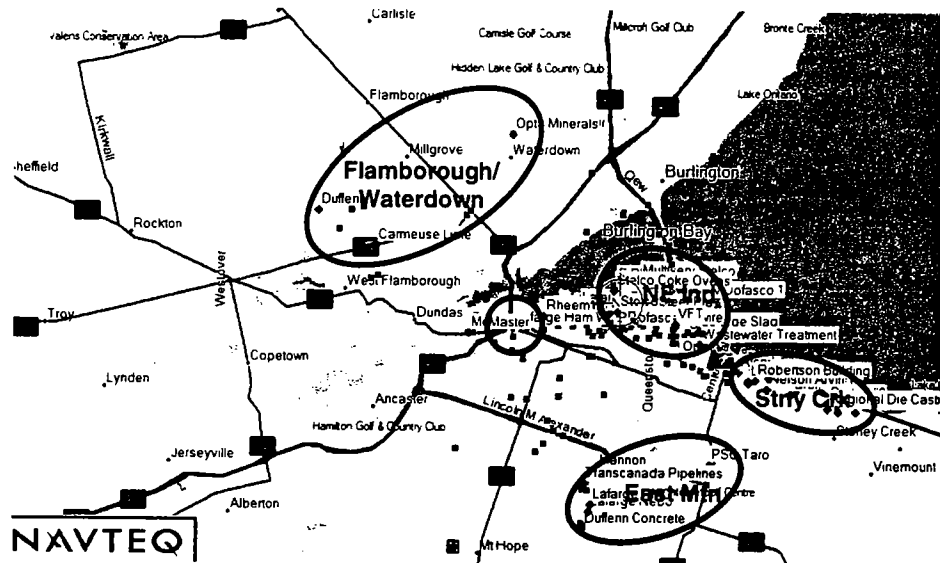


Figure 6

In addition to reviewing the NPRI data, a meeting was held with MOE to discuss previous monitoring as well as abatement and STAC experience in the Hamilton area. The MOE STAC program, Selected Targets for Air Compliance, requires industries to submit detailed emission and modeling data to MOE for evaluation.

MOE staff provided the results of a number of special studies of the industrial area of Hamilton as well as the 2004 Data Summary for the Hamilton area. A list of areas and industries which should be sampled was developed and compared with the NPRI lists, see Table 7.

Table 7 – Sources and Areas Identified for Investigation

Source/Area MOE Sampling Recommendation	Identified Source, NPRI
Stelco	x
Dofasco	x
Multiserv Stelco	x
Multiserv Dofasco	x
FMT	
Lafarge, Victoria N	x
Plaza Environmental	
Triple M	
Waxman	
Poscor 1 and 2	
Hotz	
Lafarge, Eastport Drive	
Bitumar	
City Works Yard, Eastport	
Lafarge Hamilton Slag	x
VFT	x
Hamilton Specialty Bar	x
Lafarge Stoney Creek	x
Alcarb	x
Shell Victoria N	
Beach Strip	
Eastport Drive	

Table 7 includes a number of areas and sources not identified in the NPRI database. Industries, scrap yards and metal recycling operations that have been identified in the past as possible sources of pollutants were included in this table. The previous pilot survey found some of the sources in the table to be generators of PM₁₀, both from direct emissions and re-suspended track out dust.

MOE West Central Region's Air Quality Data Analyst, Mr. Frank Dobroff, provided suggestions for roads to be traversed by the mobile monitoring unit as part of this study.

6. Mobile Sampling Unit

The mobile sampling unit had originally been designed as an MOE command centre and thus required modifications to use as a monitoring facility.



Figure 7 – Mobile Command Centre

Rack mounts were installed to accept continuous monitoring instruments to measure NO_x , SO_2 , PM and CO. Instruments used were a TECO Model 42C NO_x analyzer, a Monitor Labs 8850 SO_2 analyzer, a TECO Model 48 CO analyzer and a Grimm Model 1.107 Dust Monitor. The Dust Monitor is capable of simultaneous measurement of PM_{10} , $\text{PM}_{2.5}$ and $\text{PM}_{1.0}$. A sampling pump was also installed to provide appropriate air flow for the gas analyzers.

The Grimm Dust Monitor was mounted separately, since a straight sampling path to ambient air is required to avoid unwanted particle size selection artifacts during sampling.



Figure 8 – Rack Mounting



Figure 9 – Particle Analyzer

Outputs from the instruments were fed to an analog-to-digital converter connected to an EMC Station Manager data logger. The Station Manager allowed viewing of instantaneous or averaged data for NO_x , SO_2 , CO, PM_{10} , $\text{PM}_{2.5}$ and PM_{10} , while storing one-minute averages of each data stream, identified by pollutant and data collection time (Eastern Standard).



Figure 10 – Analog/Digital Converter, Data Logger, GIS Software

Ambient air for the gaseous analyzers was sampled through a specially constructed gooseneck sampling head which passed through the roof of the vehicle, see Fig.11. A rain shield attachment was added to prevent precipitation entering the system. Sampling intake height was approximately 3 metres above ground level. This sampling height is important to mitigate instantaneous fluctuations in pollutant concentrations due to tailpipe emissions, however, some higher level diesel emissions could still impact the intake. $\frac{1}{4}$ in. diameter Teflon tubing with particle pre-filters was used to distribute the incoming air to the gas analyzers. The sampling system was challenged with NO_x , SO_2 and CO test gases to establish response time of the system. Response time was 1 to 2 minutes. The Grimm Dust Monitor was modified with a 2 metre long sampling intake to reach through the vehicle roof.

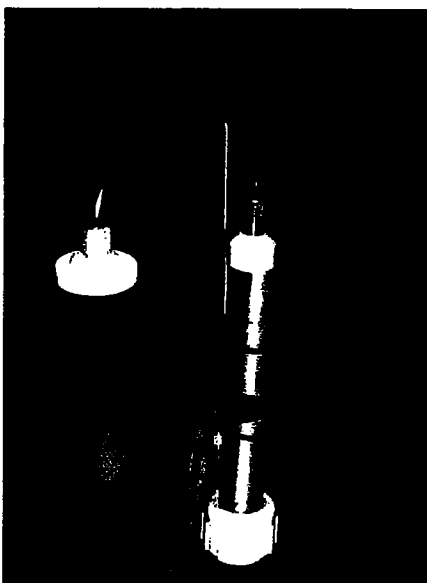


Figure 11 – Sampling Intakes on Roof of Vehicle

