Community Scale Air Dispersion Modeling in Denver: Airing on the Side of Caution

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Abstract

The City and County of Denver Department of Environmental Health (DDEH) has conducted community scale air toxics modeling throughout Denver. The cumulative modeling assessment builds on the National Air Toxics Assessment (NATA) using detailed local data. However, due to the limited air toxics monitoring data set in the urban core, predicted "hot-spot" areas cannot be verified. Carbon monoxide "hot-spot" data has compared very well with the community scale dispersion model.

This project will combine conventional air sampling methods with innovative real-time measurements to assess the spatial and temporal distribution of specific air toxics across Denver. The need for both real-time and conventional 24-hour average sampling has been revealed in both short and long-term air toxics sampling campaigns in and around Denver. Though the size of these datasets is limited, the resulting data analyses have revealed several interesting and surprising results.

DDEH and its partners propose to monitor C_6-C_{12} VOCs and carbonyls using conventional 24-hour average, 1-in-6 day sampling at six sites. Conventional samples will often be sited near stations with existing criteria pollutant and meteorological monitors (to support modeling). In addition, real-time (1-hour average) VOC data will be collected using an automatic gas chromatograph along with carbon monoxide and ozone concentrations. The real-time monitors will be mounted in a trailer that will act as a roving or special purpose air toxics monitor. The roving monitor will also collect six co-located 4-hour average conventional samples for the VOCs and carbonyls on the 1-in-6 day cycle. An aethalometer will be used to measure real-time black carbon (BC). BC has been shown to be a reliable surrogate for diesel PM exhaust (as reported in the 1996-97 Northern Front Range Air Quality Study conducted locally).

I. OBJECTIVES

This proposal is intended to provide targeted ambient air toxics monitoring to improve our understanding of spatial and temporal variations of air toxics identified during previous monitoring campaigns, as well as to evaluate a community scale air dispersion model that predicts high resolution air toxics concentrations (see section III). Model-to-monitor validations with existing data show excellent agreement, but targeted monitoring is necessary to better critique the model performance and to instill greater confidence in the results.

A. SPECIFIC OBJECTIVES

1. Use the spatial and temporal air toxics monitoring data to evaluate an already established community scale air dispersion model, as well as the National Air Toxics Assessment (NATA) results for Denver.
2. Combine conventional air toxics monitoring methods with collocated innovative real-time technologies to better assess both the spatial and temporal distribution of air toxics concentrations throughout Denver.
3. Use the spatial and temporal distributions of air toxics concentrations to educate the community on the effects that personal habits such as driving and wood burning have on ambient air quality.
4. Conduct statistical analyses of the data to determine if certain relationships exist (correlations, cluster analysis, and factor analysis) and whether or not different source categories can be reliably identified from the data (following similar analyses by Battelle on the Urban Air Toxics Pilot Program data).
5. Establish a baseline frame of reference for planned emission reduction strategies, such as reduced gasoline RVP, Tier II gasoline and heavy-duty diesel vehicle standards, and oil and gas flash emission controls.

B. PROJECT AREA

The project will be conducted at six sites throughout Denver County, a portion of the Denver-Boulder-Greeley, Colorado Metropolitan area. The project applicant, the City and County of Denver Department of Environmental Health (DDEH), is the environmental health agency for Denver County. DDEH is responsible for enforcing environmental ordinances.

Metro Denver is home to approximately 2,500,000 residents, with approximately 560,000 residents living in Denver County. Denver County is the smallest county in Colorado and occupies less than 4 percent of the total area in the seven county region (154 mi^2 out of 4527 mi^2), making Denver a densely populated urban center.

C. COMMUNITY NEEDS

Prior to the year 2000, no long-term air toxics monitoring data was collected as part of the Urban Air Toxics Monitoring Program in Denver. Since then two non-contiguous years of sampling have been conducted and have provided some interesting results, both in comparison to other metropolitan areas as well as identifying significant spatial variations within the region. Additional monitoring is needed to build upon the results already established.

Denver County has many mixed-use zoning communities. Several communities are intermixed with heavy industrial and commercial businesses including power plants, refineries, and furniture manufacturing. Some of the same communities have major interstates located immediately adjacent to residences. Some of these thoroughfares carry over 240,000 vehicles per day. The cumulative impacts in many communities in Denver create significant perceived impacts on large numbers of people.

II. PREVIOUS AIR TOXICS MONITORING RESULTS

The following sections summarize results from previous air toxics monitoring conducted in Metro Denver. Results from previous monitoring campaigns should be analyzed to guide future efforts and efficiently utilize available resources.

A. 2000-2001 AIR TOXICS MONITORING DATA HIGHLIGHTS

Air toxics monitoring as part of USEPA's Urban Air Toxics Monitoring Program (UATMP) was conducted at one site in downtown Denver from October 2000 through September 2001. Prior to this, the only long-term air toxics monitoring near Denver was associated with CERCLA cleanup activities and represented mainly suburban characteristics.

One of the more interesting findings from this campaign was how air toxics concentrations in Denver relate to other cities like Houston, TX. Data during the summer of 2000 were compared with data from the Texas Air Quality (TexAQS 2000) study for the same time period. Houston has heavy port traffic and much more heavy industry than Denver. The three Houston sites were sited near suburban, traffic impacted, and industrial areas. Speciated Non-Methane Organic Compounds (SNMOC) data in Denver show that for almost all compounds, concentrations equal or exceed those observed in Houston. This was a surprising result considering the differences between the two areas. Table 1 lists differences between the two cities for select compounds.

Table 1. Summer 2000 24-hour average concentrations in Denver and Houston (ppbC).

Compound	Avg ppbC Denver Summer 2000	Avg ppbC Houston Summer 2000
Ethylene	8.2	4
Acetylene	5.6	2
Ethane	17.2	14-16
Propylene	4.1	2-4
Propane	13.3	13-15
n-Butane	12.8	7-16
Isopentane	24.0	4.5-13
n-Pentane	16.7	2.5 - 6
2-Methylpentane	9.3	1.7 - 3.9
3-Methylpentane	5.1	1.2 - 2.3
Benzene	5.3	2.0 - 3.0
Toluene	11.3	3 - 6.5
m-Xylene/p-Xylene	5.7	1.5 - 4
o-Xylene	2.2	0.6 - 1.4

Both SNMOC and VOC (EPA Method TO-15) were analyzed during this campaign. It should be noted that the SNMOC analyses provided much more information than the TO-15 samples. In fact, of the 58 compounds analyzed using method TO-15, 33 of them (57 percent) registered less than 10 percent completeness (> 90 percent non-detects) whereas 64 of the 77 SNMOC (83 percent) data met the 75 percent completeness criteria.

B. 2002-2003 AIR TOXICS MONITORING DATA HIGHLIGHTS

VOC TO-15 data were collected at three sites along an approximate eight-mile line extending SSW-NNE from downtown Denver to Adams County. Of particular interest were results for acetonitrile. The traffic impacted site registered an average concentration of 0.6 ppbv, with 80 percent non-detects. However, the commercial and industrial sites, located 3.5 and 8 miles away from the traffic site recorded average concentrations of 85 and 132 ppbv, respectively, with only 1 non-detected sample (out of 32). The ambient concentrations at the two sites exceed the non-cancer health benchmark of 36 ppbv. This compound is likely being emitted in large quantities by stationary or area sources not identified in the emission databases.

C. 1996 AND 2003 SHORT –TERM AIR TOXICS MONITORING

PAMS-type 3-hour average SNMOC samples were collected to determine 6-9 a.m. average ambient concentrations. The 2003 sampling campaign was in response to the highest ozone concentrations experienced in Metro Denver in over 15 years.

At the traffic impacted site in Denver, concentrations for most pollutants decreased substantially. However, benzene showed a 13 percent increase. At the Adams County (industrial) site, benzene registered a 170 percent increase. This is a surprising result considering that many mobile source air toxic pollutants have decreased 30-40 percent over that time.

The 2003 summer concentrations in Denver were also compared to 2001 PAMS 6-9 am average concentrations in Fort Worth, TX and at several sites immediately downwind of Los Angeles, CA. For most of the pollutants, including benzene, concentrations in Denver exceeded those in the other two metropolitan areas. This was a surprising result considering Denver's smaller size and population as compared to the other metropolitan areas.

Recent work conducted by CDPHE shows that oil and gas flash emissions are a previously unknown large source of VOC emissions that may be contributing to increased ozone levels in Denver over the past few years; the 2003 monitoring data appear to confirm large quantities of flash gas VOC emissions. Monitoring conducted under this grant would take place during a time when VOC controls are being installed as part of the ozone Early Action Compact recently sent to the Colorado Legislature. It may be possible to observe reductions associated with this control strategy.

D. MONITORING DATA SUMMARY

The data presented in the preceding sections highlight that Metro Denver has unique characteristics that affect spatial variations in air toxics concentrations. Also, meteorological and altitudinal differences appear to enhance air toxics concentrations in Denver when compared to larger cities in the U.S. However, with only two non-contiguous years of air toxics data in the urban core, conclusions cannot be drawn from these limited data sets. This highlights the need for additional and targeted air toxics monitoring in Metro Denver.

Additional air toxics monitoring data collected in Denver and the resulting analyses of the data would provide a wealth of information to add to the national database. More importantly, it would help the local parties better understand the spatial differences in air toxics concentrations and to identify where resources could best be spent in trying to reduce risks associated with air toxics.

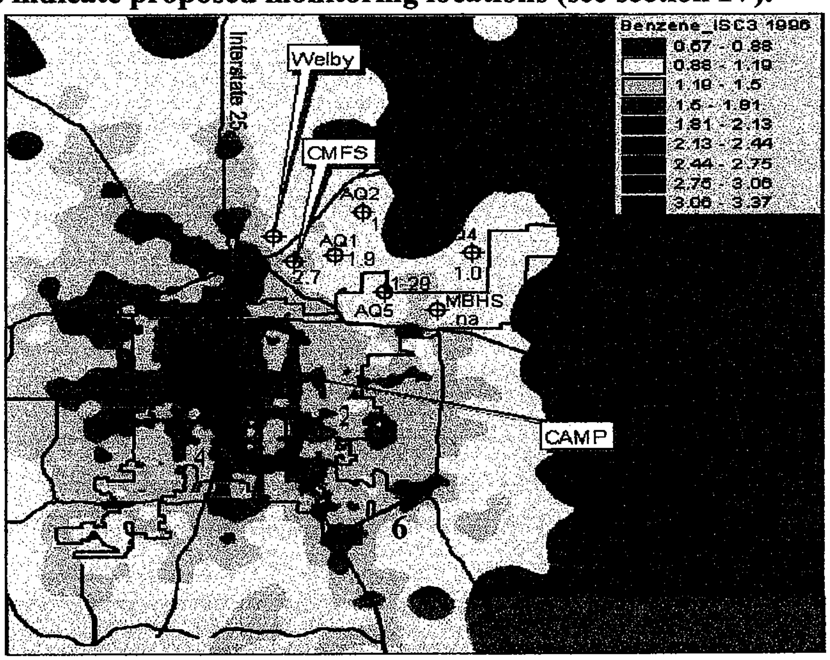
III. COMMUNITY SCALE AIR TOXICS MODELING

DDEH recently conducted a cumulative air toxics assessment that combined high-resolution community scale air toxics modeling with monitoring. DDEH used two EPA approved dispersion models: the Industrial Source Complex Short-Term model (ISCST3) and AERMOD. The baseline emissions year was 1996. The model will be updated every three years to coincide with the NATA and the NEI. A final report detailing the baseline modeling effort is to be released in summer 2004.

Mobile, area, and point source emissions were spatially and temporally allocated using a geographic information system (GIS) and detailed local data sets developed and maintained by various regional entities.

Figure 1 shows predicted benzene concentrations along with monitored concentrations collected under remedial activities at the Rocky Mountain Arsenal CERCLA site. The model predicts within a factor of 1-2 at all sites; this is considered excellent performance for an air dispersion model. More importantly, the dispersion model approximates the spatial pattern of the monitored concentrations, an indication that the appropriate spatial surrogates were utilized.
Long-term monitored benzene concentrations were not collected in the areas where the highest concentrations are predicted. This leaves some uncertainty with how the model may be performing in the urban core. Monitoring needed to further validate the model is addressed in this proposal.

Figure 1. Predicted and observed benzene concentrations for 1996 (micrograms per cubic meter). Color plot reflects Denver DEH community scale modeling results. Camp and Welby sites only had short-term monitoring during the summer. Blue triangles indicate proposed monitoring locations (see section IV).



In 2003 DDEH received a grant from the Federal Highway Administration to perform more detailed on-road mobile source modeling. The grant will confine mobile source emissions on interstates and major arterials to the roadway polygons only. No funds for air toxics monitoring were available through the FHWA grant.

IV. PROPOSED AIR TOXICS MONITORING PLAN

A. OVERALL OBJECTIVES AND SAMPLING LOCATIONS

The parties propose to collect conventional 24-hour average samples at six sites once every six days. In addition, a mobile or roving air toxics monitor will be equipped with real-time instruments such as an automated gas chromatograph, aethalometer, and carbon monoxide and ozone monitors.

such as an automated gas chromatograph, aethalometer, and carbon monoxide and ozone monitors. The roving monitor will also collect six 4-hour average conventional samples for VOCs and carbonyl compounds on the once every six day cycle to provide improved temporal resolution and for collocated comparison with the real-time monitors. The roving monitor will usually be placed at the same site where conventional 24-hour average samples are being collected. The location of the roving monitor will rotate between sites where 24-hour average samples are collected.

In all, 420 24-hour average conventional samples will be collected across the six sites. It is proposed that 360 24-hour average samples will be collected using sorbent tubes and analyzed via Method TO-17. The remaining 60 24-hour average samples will be collected using SUMMA canisters and analyzed via Method TO-15; the canister samples will be collocated with the sorbent tube samples. The main advantage to collecting samples via sorbent tubes and Method TO-17 is that a much faster turnaround time is achievable because the analyses will be performed at the university laboratory. An EPA-approved laboratory will be contracted to analyze the TO-15 canister analyses. In addition, 360 24-hour average samples will be collected across the six sites for carbonyl compounds. These will be analyzed via Method TO-11A by the same university laboratory. Special emphasis will be place on accurately quantifying the two core air toxics carbonyl compounds, formaldehyde and acrolein.

In addition, the roving monitor platform will collect real-time and time-resolved data at each of the six sites for approximately ten weeks each throughout the year. The roving monitor will enable the parties to examine the temporal distribution of air toxics concentrations as well as to further investigate the relationships between several air toxics and criteria pollutants identified during previous sampling campaigns. Such relationships may allow for a better estimation of impacts from different source categories at the various sites. This data will also be very important in understanding the temporal variability of these pollutants.

Proposed monitoring sites are identified in Figure 1 (blue triangles). A brief description of each site follows; these could be changed in consultation with Region VIII EPA.

1) Globeville/Elyria-Swansea neighborhoods – Demographics: ~80 percent Latino, 10 percent African American, persons in poverty 30-40 percent, adjacent to Interstates 25 and 70, rail lines, and heavy industrial areas. Interstate traffic counts in this area exceed 200,000 vehicles per day. Environmental justice issues are typically raised in this community. Moderate to high concentrations are expected.
2) Lowry Campus - former U.S. Air Force base that has seen significant residential redevelopment over the past few years which will continue through 2008. 56 percent non-Latino White. Low to moderate concentrations are expected, reflective of urban background.
3) Auraria Campus - where University of Colorado at Denver is located. Moderate to high concentrations are expected due to close proximity to Interstate 25 and downtown thoroughfares. With over 30,000 students and many nearby tourist attractions, Auraria represents an area in Denver where large numbers of people are exposed each day. Moderate to high concentrations are expected.
4) Athmar Park - Demographics: 65 percent Latino, persons in poverty 15 percent, near busy main arterial roadways and interstates, major rail lines, and numerous small to medium sized commercial and industrial businesses. Moderate to high concentrations are expected.
5) Villa Park - Demographics: 80 percent Latino, mainly residential area bordering major roadways and interstates. Moderate concentrations are expected.

6) Kennedy – Demographics: 65 percent non-Latino White. Residential with nearby commercial businesses and major thoroughfares nearby. Moderate concentrations are expected.

B. AIR TOXICS SAMPLING TECHNIQUES

1. Conventional VOC Sampling

U.S. Environmental Protection Agency[1] compendium methods will be used as the basis for the conventional sampling and analyses of the ambient VOCs. The conventional approach to VOC sampling to be used in this project includes the use of EPA Method TO-17 sorbent tube sampling for selected VOCs, followed by GC-MS analysis of the samples. SUMMA canister sampling followed by EPA Method TO-15 analyses for VOCs will also be done for intercomparison with the TO-17 method and with previous studies that have been conducted in the Denver metropolitan area.

Carbonyl compounds will be collected and analyzed using EPA Method TO-11A. EPA Methods TO-11A and TO-17 will be used for the bulk of the conventional VOC sampling and analysis, because the partnering research group at the University of Colorado at Denver has considerable experience with the implementation of these sampling and analysis procedures.[2,3]

TO-17 Analysis. The method TO-17 analysis will use a mixed bed sorbent to collect a wider range of VOCs. We will use a Carbotrap 300 mixed bed sorbent (Carbotrap C, Carbotrap B and Carbosieve S-III) so that we can collect VOCs in the range from C_2 through C_{12}. Analyses will be performed using a GC-MS system with a Perkin-Elmer ATD-400 automated thermal desorber. We will collect and analyze six 24-hour average samples every sixth day at six different fixed sampling sites used to provide spatial resolution in the data. In addition, we will collect six 4-hour average samples every sixth day at the site where the roving monitor is located. This will allow us to compare the average of the six 4-hour average samples with the 24-hour average sample at the site. It will also provide much better time resolution information at one site every sixth day.

TO-15 Analysis. To provide a basis for comparison with previous studies conducted in the Denver metropolitan area, we will collect one 24-hour average sample on each sampling day using a SUMMA canister that is collocated with a TO-17 sample. These samples will be analyzed by an EPA-approved laboratory. In addition, this will provide a collocated comparison between the results of TO-17 sampling and TO-15 sampling.

TO-11A Analysis. Method TO-11A will be used to collect carbonyl samples on the same schedule and locations as the TO-17 sampling. We will collect six 24-hour average samples every sixth day at each of the fixed sampling sites, and six 4-hour average samples every sixth day at the roving monitoring location. These carbonyl samples will be analyzed by high performance liquid chromatography with ultraviolet absorption detection.

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[1] U.S. Environmental Protection Agency, 1997. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. 2nd ed.

[2] L. G. Anderson, J. A. Lanning, R. Barrell, J. Miyagishima, R. H. Jones and P. Wolfe, 1996. Sources and Sinks of Formaldehyde and Acetaldehyde: An Analysis of Denver's Ambient Concentration Data, Atmos. Environ., 30, 2113-2123.

[3] L. G. Anderson and P. Wigraisakda, 2003. Ambient Air Sampling for Benzene in Commerce City, Colorado, Final Report for the Rapid Mapping for Clean Air in Commerce City, Tri-County Health Department, Englewood, CO.

2. Continuous Speciated VOC Measurements

Two recent papers by Prevot, et al.[4,5] describe the application of the Airmotec HC1010 gas chromatographs for hydrocarbon concentration speciation. This work reported detection limits for individual compounds between 0.005 and 0.02 ppbv, depending on the compound, and accuracies of better than 25 percent for concentrations above 0.05-0.1 ppbv. Chromatotec Inc. has U.S. based sales and technical field support. For this project, we will purchase an AirmoVOC system from Chromatotec Inc. The system will be setup for continuous sampling and analysis of C_6 through C_{12} VOC compounds.

The system will be set up to collect and analyze one-hour average samples for 32 target VOCs. Samples will be separated by gas chromatography (GC) and measured with flame ionization detection. This system will be setup to operate continuously throughout the one-year sampling period of the proposed project. This instrument will be operated in the sampling trailer with the roving monitoring equipment. Scheduled servicing and maintenance of this instrument will be scheduled to occur during periods between the every sixth day sampling cycles. We intend to maximize the overlap between the continuous GC, the 4-hour average TO-17 sampling, the 24-hour average TO-17 sampling and the 24-hour average TO-15 sampling.

3. Other Continuous Monitoring

In addition to the continuous VOC monitoring, we will operate continuous monitors for carbon monoxide, ozone, and an aethalometer, for the measurement of black carbon. The carbon monoxide data will be a useful indicator of motor vehicle contributions to the VOCs. The aethalometer data is intended to allow us to identify the diesel vehicle contribution of the VOCs. Ozone will be a useful indicator of the impact of photochemical activity on the air that is being sampled. All of these continuous analyzers will be operated in the trailer with the remainder of the roving monitoring equipment.

4. Continuous Formaldehyde Measurements

As a part of on-going research at the University of Colorado at Denver, a continuous technique for the measurement of formaldehyde in air based on the Hantzsch reaction to form a fluorescent derivative of formaldehyde is being developed. This will be done at no additional cost to the project currently being proposed. It will provide a nice means for comparison between method TO-11A and the newly implemented Hantzsch reaction based technique. Continuous formaldehyde monitoring using this technique is being conducted at three of the Urban Air Toxics Pilot Program sites as well.

5. Calibration System

The continuous VOC system to be used in this project will include a permeation based calibration system that will be used for calibration. In addition, we will use a standard gas mixture and a dynamic dilution system for generating zero, span and calibration concentrations of the gases to be measured. This dilution system will be used to calibrate both the continuous VOC system and the sorbent tube sampling system for VOCs. The carbonyl sampling system will also be field calibrated

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[4] Prevot, A. S. H., Dommen, J., Baumle, M., Furger, M., 2000. Diurnal variations of volatile organic compounds and local circulation system in an Alpine valley. *Atmos. Environ.*, **34**, 1413-1423.

[5] Prevot, A. S. H., Dommen, J., Baumle, M., 2000. Influence of road traffic on volatile organic compound concentrations in and above a deep Alpine valley. *Atmos. Environ.*, **34**, 4719-4726.

using a permeation system and a dynamic dilution system for generating known concentrations of carbonyl compounds.

6. VOCs to be Monitored

The VOC data to be collected in this project will be used primarily to assess air toxics exposure and the concentrations of air toxics in various locations and at different times in Denver. The conventional method for making these measurements is by using TO-15 analysis of samples for a suite of 58 compounds. Of the 15 VOCs on the current list of 33 urban air toxics, 14 of these are part of the TO-15 suite, this includes 8 of the list of 18 core HAPS [6]. During the 2002-2003 air toxics monitoring campaign using TO-15 sampling at three different sites in the Denver metropolitan area, only 25 of the 58 TO-15 compounds (43 percent) were detected in more than 10 percent of the 24-hour average samples at any site. This number drops to 20 (33 percent) or fewer if detected in at least 50 percent of the samples.

The Carbotrap 300 sorbent has been tested with the Japanese Hazardous Air Pollutant (JHAP) suite of compounds which include 38 of the 58 TO-15 compounds and 13 of the current U.S. list of HAPs. [7] This test of the Carbotrap 300 sorbent demonstrates its utility for all but seven of the 25 TO-15 compounds detected in the previous Denver studies.

Acetonitrile concentrations in the 2002-2003 monitoring campaign were quite high at two of the three sites. It is not clear how well Carbotrap 300 would work collecting acetonitrile. But we will carefully test the system with acetonitrile, in an attempt to be able to quantify acetonitrile.

The AirmoVOC C_6-C_{12} system is setup to measure 10 compounds that are part of the TO-15 suite. Benzene is the only compound for which the AirmoVOC system is setup that is on the list of 33 HAPs and the core list of 18. Since 11 of the 14 HAPs measured by Method TO-15 are halogenated compounds, the response to these compounds with this instrument is limited.

In addition to measuring air toxics in Denver's air, it would be useful to gain additional information on important VOCs that act as ozone precursors. The TO-15 suite of VOCs does not overlap well with the PAMS target compound list. Only 15 of the 54 PAMS target compounds are measured by Method TO-15. All 32 of the VOCs for which the AirmoVOC system is setup to measure are on the PAMS target list. The TO-17 sampling and analysis should work for all of these C_6 and larger compounds, as well as some smaller compounds, at least the C_5's.

We will be measuring carbonyl compounds using Method TO-11A, which adds two more of the 33 urban air toxics, formaldehyde and acetaldehyde. With modifications to the method discussed in the air toxics technical assistance document [6], method TO-11A can be used to measure acrolein as well. This is also on the list of 33 air toxics, and all three carbonyl compounds are also on the core list of 18 air toxics.

In addition to the list of 33 air toxics, black carbon was added to the list and is to be monitored using an aethalometer. Black carbon was added to the list to determine its viability as a diesel

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[6] Eastern Research Group, Inc., 2003. DRAFT: Technical Assistance Document for the National Ambient Air Toxics Trends and Assessment Program.

[7] Brown, J., Pfannkoch, E., Collins, B. Volatile Organic Compounds in Air. Gerstel TechNote S-44. http://www.getech.com.tw/Upload/1222/%7B89F74829-C799-4D2D-B3C5-98F12F4E5B0F%7D_SEM92003.pdf

surrogate. This is expected to be of greatest importance at the traffic impacted sites. An aethalometer will be used as a part of the proposed experiments.

7. Significance of the Data

Inconsistencies have been observed between the previous monitoring studies where sampling was conducted for different time periods and at different times of day. The sampling plan for this project is intended to allow us to better understand the temporal variability in the VOC concentrations. At the monitoring site where the roving monitoring system is located, we will have a variety of measurements of VOCs every sixth day. We will have a 24-hour average sample collected on a sorbent tube for TO-17 analyses. We will have a 24-hour average sample collected in a SUMMA canister for TO-15 analyses. We will have six 4-hour average samples collected on sorbent tubes for TO-17 analyses. We will also have twenty-four 1-hour average samples collected and analyzed by the continuous VOC chromatographic system. This data will be quite useful in aiding in the interpretation of data collected over different averaging periods. By comparing results collected every day with data collected every sixth day, we can better understand the limitations of every sixth day sampling, and the day-to-day variability of the VOC concentrations. The continuous VOC data will also allow us to better assess the importance of the diurnal variability in the VOC concentrations.

In the proposed project, we have incorporated one technology that is not used extensively in U.S. air toxics monitoring studies. This is the continuous VOC system, which will allow measurement of 1-hour average concentrations of VOCs on a continuous basis. The system can be set up to monitor up to 32 compounds. The detection limits are reported as 0.01 ppb or 0.06 $\mu g/m^3$ for a 15 to 30 minute cycle time. In this project, we will use a 60 minute cycle time which should allow even lower detection limits. Using this system will allow us to assess the reliability of the technique in ambient air quality applications.

8. Monitoring Plan Summary

The parties propose to combine conventional and real-time technologies to improve our understanding of the spatial and temporal variation of air toxics concentrations in Denver. EPA compendium methods will be utilized for conventional sampling. Considerable overlap between 24-hour average, 4-hour-average, and 1-hour average samples will be achieved at each site through the use of a roving monitor. This will allow the parties to evaluate the various sampling methods and averaging periods.

The information gathered as part of this monitoring campaign would be a valuable addition to the national air toxics database. Locally, this data will be used to better assess the community scale air dispersion model developed by DDEH. The air dispersion model can easily be expanded to include the entire Metro Denver region, but additional validation is necessary before doing so.