School Air Toxics Project – An Overview and Lessons Learned

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ABSTRACT

On March 31, 2009, the Environmental Protection Agency (EPA) released a list of priority schools for air quality monitoring as part of an initiative to understand whether outdoor toxic air pollution poses health concerns to school children. Schools were selected using a number of factors, including results from the National- Scale Air Toxics Assessment (NATA)computer modeling analysis using the 2002 National Emission Inventory (NEI), results from a recent newspaper series on air toxics at schools (modeling analysis using the 2005 Toxics Release Inventory (TRI)), and in consultation with state and local air agencies.[1] Information from these sources was used to prioritize pollutants and possible emission sources, and identify schools for further investigation.

Early in the process of selecting schools and after the selection, it became clear that facility information provided in the various inventories was often incorrect as facilities had often over reported, miss-reported or under reported. This presentation will focus on an overview of the project to date, analysis of the results, and lessons learned.

INTRODUCTION

On March 31, 2009, EPA released a list of 63 schools in 22 states and 2 tribal schools for air quality monitoring as part of an initiative to understand whether outdoor toxic air pollution poses health concerns to school children. Schools were selected based on background information, including results from the 2002 National-Scale Air Toxics Assessment (NATA)[2] computer modeling analysis using the 2002 National Emission Inventory (NEI)[3], results from a recent USA Today newspaper series on air toxics at schools[4] (modeling analysis using the 2005 Toxics Release Inventory (TRI)[5]), and in consultation with state and local air agencies. The analysis by USA Today involved use of EPA's Risk Screening Environmental Indicators tools and TRI for 2005. Modeling information and information supplied by state, local and tribal agencies raised questions about air quality near these schools which EPA determined required investigation. In many cases, the information suggested annual average concentrations of some air toxics to be greater than long-term risk-based concentrations associated with an additional cancer risk greater than 1-in-10,000 or a hazard index on the order of or above 10.

Key pollutants designated for each monitored schools were based on what background information indicated regarding pollutant emissions, potential air concentrations and risk in each area. The monitoring data and other information collected for each school during this initiative will allow us to evaluate the key pollutants occurring at these sites including the potential for contributions from nearby sources. In addition, several of the schools being monitored were selected due to their location near interstates or transportation facilities such as airports.

The ambient air monitoring data collected at each site (along with source specific information such as emissions, current production information) will be used to determine follow-up actions near

each school. That evaluation is considering several analyses and factor which include site-specific ambient air measurements along with source specific information, typical ambient levels in urban areas and nationally, and long-term health risk-related exposure concentrations for monitored pollutants. Follow-up activities may include: no additional monitoring, additional monitoring to better characterize a source and its impact on a community, or evaluation of potential emission reduction activities from a source.

METHODOLOGY

Project Design

Once schools were selected for the project, EPA purchased ambient monitors, and working with state and local agencies to place monitors. In some cases, state or local agencies were unable to assist EPA with monitoring, and EPA used contractors to locate and collect samples. In all cases, EPA, state or local agencies contacted the administrators at the schools selected to ensure the schools would allow monitoring. In a very few instances, some schools were not willing to allow monitoring and alternate school locations representative of the rationale for selection were used. Monitors were placed at each school for a minimum of 60 days, taking samples on a 1 in 6 day schedule for a minimum of 10 valid samples all of which were sent to EPA contract laboratories. Scheduled sampling dates were not publicly available, as there was a concern from some of the public that sources may not operate on sampling dates if they knew in advance and could minimize operation.

Air toxics monitored included metals, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), carbonyls, diisocyanates, and in some instances specific pollutants such as 4,4-methylenedianiline and hexavalent chromium (Cr^{6+}). EPA used two different types of methods to sample for metals in the air around schools. The first method "PM10" captures only smaller particles that can be inhaled and enter the lungs (those that are 10 micrometers in diameter or smaller). The other method collects total suspended particles (TSP). At the majority of schools where we were not measuring for lead we used PM_{10} samples. At schools where we were interested in levels of lead in the air, we used TSP samples. At some schools we collected both PM_{10} and TSP samples. All samples were analyzed for the key pollutants and other pollutants measured at the same time as identified for each school. For additional information on the monitoring plan and quality assurance project plan see *School Air Toxics Ambient Air Monitoring Plan* and *Quality Assurance Project Plan For the EPA School Air Toxics Monitoring Program.*[6,7]

In addition, we collected meteorological data, minimally for wind speed and direction during the sampling period and up to six months if possible at each school. We also identified the nearest National Weather Service (NWS) station at which a longer meteorological record was available.

Evaluating Potential Risk

The primary objective of this initiative is to investigate through monitoring air concentrations of key air toxics at each school over a 2-3 month period whether levels measured are a short- or long-term exposure concern, and what actions are appropriate based on monitored results. To evaluate the monitoring results, we developed health risk-based air concentrations for the monitored air toxics using established EPA methodology and practices for health risk assessment, and in the case of cancer risk, consistent with the implied level of risk considered in identifying schools for monitoring (*Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*).[8] Health risk-based air monitoring concentrations were developed for both short term (e.g. several weeks) and long term exposure (over a life time). These levels are based upon health effects information, exposure concentrations and risk estimates developed and assessed by EPA,[9] the U.S. Agency for Toxic Substances and Disease Registry,[10] and the California EPA.[11] These agencies recognize the need to

account for potential differences in sensitivity or susceptibility of different groups (e.g., asthmatics) or lifestages/ages (e.g., young children or the elderly) to a particular pollutant's effects so that the resulting comparison levels are relevant for these potentially sensitive groups as well as the broader population.

As sample results were received from the analytical laboratory, EPA reviewed the data to identify any situations where additional attention might be appropriate to confirm sample results and to assess the potential for short term health concerns. Monitoring results were compared with individual sample screening levels. Any sample results higher than the sample screening levels were further considered based on chemical-specific information on health effects, along with information about collection, sample analysis and potential sources of the pollutants.

Consistent with the long term or chronic focus of the initiative, we derived a 95 percent confidence interval for the estimate of the longer-term average concentration of each pollutant. All numerical values measured are reported as actual numerical values for pollutant concentrations including any values below method detection limit. Additionally, a value of 0.0 is being used when a measured pollutant had no value detected. The projected range for the longer-term concentration estimate for each pollutant (in particular the upper end of the range) is compared to the long-term comparison levels. These long-term comparison levels presume continuous (all-day, all-year) exposure over a lifetime. In addition, the analysis also considers the potential for cumulative multiple pollutant impacts.

Evaluating Key Emission Sources

In reviewing the meteorological data at each school, we are considering if these data indicate that the general pattern of winds on our sampling dates are significantly different from those occurring across the full sampling period or from those expected over the longer term. We identified an approximate range of wind directions to use in considering the potential influence of the source on air concentrations at the school which we refer to as the zone of source influence (ZOI). Based on the ZOI, we are noting whether wind conditions on some portion of the sampling dates appear to capture contributions from the nearby source. In a few cases the ZOI is 360 degrees if the school is surrounded by interstate highways. Also, in some cases there is more than one ZOI, as more than one nearby source of interest was identified.

As part of this evaluation, EPA used data from the National Air Toxics Trends Sites (NATTS)[12] which indicate that levels of some pollutants are commonly higher in urban areas than elsewhere. Sample concentrations from each key pollutant is compared to the 75th percentile of samples collected in the NATTS from 2004-2008. Because the NATTS sites are generally sited so as to not be influenced by specific nearby sources, EPA is using the 75th percentile point of concentrations at these sites as a benchmark of indicating potential influence from a source nearby a school. While in some locations several pollutants (e.g. benzene and 1,3-butadiene) may be associated with specific industrial sources, they are also associated with mobile source emissions and are commonly occurring at sites near urban areas or near large roadways and other transportation facilities.[13] EPA is considering the proximity of schools to nearby roadways or transportation facilities as part of the evaluation for these pollutants.

In addition, EPA considered information about the key source(s) identified in the background information. Information about production rates during monitoring was provided by state and local agencies. In many cases, sources had significant emissions reductions from 2002-2008 as emissions were reported. In a few cases during the process of determining operation status at some facilities, the facilities themselves realized they had over reported emissions to TRI and requested changes as a result of this initiative (at least 12 sources have been identified). Additionally, in some instances, facilities had temporarily been shut down or reduced production due to economic reasons during the monitoring

initiative. EPA will conduct additional sampling at these schools when the facilities return to more typical operations.

RESULTS

After looking at all of the above information, EPA is developing for each school a final technical recommendation report for what additional actions will take place at each school including:

- Not to extend monitoring,
- Additional monitoring to better characterize a source or better characterize the potential exposure to the community,
- Evaluating potential emission reduction actions from a source.

Issues Identified – Finalizing Schools List

During the initial school selection process several issues were identified. The first issue was trying to determine the status and location of schools for children 1-12 grades. EPA started with an ESRI (Environmental Research Systems Institute) school list that was supplied with the newest version of ArcGIS 9.3. After evaluating the data we determined that a lot of the schools were closed and the data was out of date. We then switched to a school database from the Department of Education for the 2006-2007 schools years and imported that data into the NATA model.

We found the nearest census block centroid to each school location in the database, then joined the census block NATA data to the school. Schools were sorted based on cancer risk, noncancer respiratory hazard index (HI), and noncancer neurological HI from point sources. This list was then vetted by EPA staff familiar with large industrial sources and the inventory. We determined that some information for sources was inaccurate. We also asked the EPA regions, state and local agencies to review the list. During this process, we determined more schools were closed, had changed names or in some cases location. A few schools that were still open were slated for demolition or to be closed in the future.

State and locals were familiar with some facilities and knew that these facilities were closed or that the emission estimates were inaccurate. There was at least one large source which was identified by a state which had not reported its emissions to the inventory. States and local agencies made some suggestions for schools to add to the list. This information was evaluated using NATA (information generated about cancer risk, noncancer respiratory HI and noncancer neurological HI), and more recent inventory information. Based on this review, EPA developed a final list of schools to be investigated under the initiative.

Issues Identified – Potential Contamination

Once the school list was finalized, the next step was to initiate monitoring, and as with a lot of field work there were problems getting equipment situated and anemometors sited correctly. Once monitoring was initiated, several locations were reporting exceptionally high values for some VOC pollutants (e.g., acrylonitrile and dichloromethane) which normally had very low values or were not detected. After looking at the equipment it was determined that some samples were contaminated when a timer on the VOC monitors leaked, allowing chemical produced by the timer's box to enter the sampling canister.

Once EPA learned the timer on the VOC sampler was leaking and causing samples to be contaminated, EPA notified its monitoring partners to 1) either remove the timer and manually open and shut the VOC sample collection valve; or 2) replace the timer with a timer box EPA's laboratory had retrofitted to prevent the leak. This situation did not occur in all the timers. EPA then analyzed the

results and determined that by comparing two of the "signature" pollutants, acrylonitrile and dichloromethane, with the typical levels found at other national monitoring sites, samples within a certain value range would be valid.

EPA reviewed their results with the National Association of Clean Air Agencies' (NACAA) Monitoring Steering Committee (MSC). The MSC recommended a conservative approach by which all data which had been collected prior to the timer being changed out or manually opened would be invalidated at an individual school if the levels of either acrylonitrile or dichloromethane were above the typical levels found. The VOC samples collected at more than half of the schools were invalidated. These schools then needed to collect additional VOC samples until they had the 10 valid samples required for the study. For more information refer to *EPA's Investigation and Resolution of Contamination Problems in the Collection of Volatile Organic Compounds*.[14]

Issues Identified – Acrolein Samples

As the SAT project progressed, some of EPA's state and local partners noticed that different monitors located at the same schools were showing different results for the pollutant acrolein. The discrepancies in the results were big enough that EPA agreed to examine them further. EPA worked with several states and local air quality agencies to conduct a short-term laboratory study on acrolein to examine whether monitoring results were affected by the type of canister used to collect the air quality sample or how that canister is cleaned in preparation for sample collection. Based on results from initial tests, EPA had to question the consistency and reliability of monitoring results for acrolein not only in this study but also for state and local agencies. As a result, EPA determined it was best to not use the acrolein data in evaluating potential health concerns from exposure to air toxics in outdoor air as part of the SAT project.[15] EPA is pursuing improving the method to measure acrolein, but an official change to the method will take several years.

Issues Identified – Anemometer Data

As noted above, we located anemometers at all of the monitoring stations and requested that they remain until we had collected at least six months of data. The meteorological data is being used to evaluate several items:

1) Did the wind blow from the direction of the key source on part or some of the sampling days?
2) How do the wind patterns compare on sampling days with the wind pattern over the entire period?
3) How do the wind patterns at the school compare with the wind patterns at the nearest national weather service station?

Unfortunately, several issues occurred with some of the anemometers including: improper siting; some instruments were affected by storms in the area and would report exceptionally high winds which were not reported elsewhere; other instruments would for some reason get stuck and would not report data for periods of time; and some anemometers failed completely and this was not known until data might be downloaded several months later. When these failures occurred, we tried to find data from another nearby meteorological station and use that information or substitute data from the nearest NWS. As a preliminary estimate, approximately 10% of all the wind data collected were not used due to equipment failure. Additionally, 41 of the 59 schools experienced some sort of equipment failure.

LESSONS LEARNED

Improving Emissions Inventories

One of the most immediate lessons learned, was better emission inventory information is needed. This became obvious with our initial evaluation of source information. Under the Clean Air Act, we can not require states to collect air toxics information; however, state data is critical to making the inventory better. As maximum achievable control technology standards (MACT) are being reviewed and updated,[16] EPA is requiring industry to report their emissions, and conduct some emissions monitoring. This is a good step towards improved inventories, but it does not cover the spectrum of facilities which emit air toxics including smaller sources. Improvements can also be made in TRI data, including informing industry that the data may be used for other purposed than community-right-to-know actions. Information incorporated into the inventory is used for modeling risk as in NATA and other efforts by states and EPA. As TRI is a self-reporting database, many companies do not always understand or appreciate that the data they enter may be used for different efforts. However, errors in emission rates, facility status, and/or locational coordinates were updated into EPA's most recent version of the 2005 NEI.

Improving Models

One of the primary tools that EPA, state, and local agencies use to try to determine risk or exposure is models. Modeling the most current inventories will produce more realistic results. In this initiative, EPA used the 2002 NATA as part of the school selection process. Because the inventory used was from 2002, this led to model outputs indicating higher risks in some areas than more recent information would have yielded. Over 60 percent of the sources that were labeled as "key" in determining which schools were monitored had significant reductions since 2002. On the other hand, 24-36% of the sources had increases in some or part of their emissions which was also not reflected by the modeling. In addition, based on this initiative at least 12 facilities requested changes in the data they had reported to the TRI for 2002 and 2005, and revised their most current estimates in the TRI.

Increasing Knowledge of Air Toxics Monitoring

We also learned several things about our monitoring methods for air toxics. In particular, this initiative highlighted the problems with measuring acrolein, not only for the initiative but at labs across the country. EPA is working on an approach to improve the method over the long term. We also evaluated some of the monitoring equipment and meteorological equipment through the initiative and made recommendations to some manufacturers on improvements that might be made. As mentioned above, meteorological equipment is important to the results in a study and should be carefully considered including siting location, and length of time data is collected.

EPA has been providing funding for community-scale monitoring for air toxics through several different areas including the Community-Scale Air Toxics Ambient Monitoring (CSATAM) projects,[17] local EPA regional grants, and Community Action for Renewed Environment (CARE)[18] cooperative agreements. The approach in most of these projects has been to monitor in several locations within a community to better determine the ambient air quality in the community. Monitoring at only one location, such as school provides limited information about the health of a community as a whole. EPA is now promoting a return to the community-scale monitoring approach as a preferred approach to evaluating sources and ambient air quality within a community.

Appreciating Stakeholders

This project would not have been possible with out the assistance of our state and local partners, who provided man power, equipment and advice over the length of the project. These partners continue to assist in reviewing reports and providing information about facility production during sampling collection. Unfortunately, the speed with which this project was implemented did not always allow for the time that would have been helpful to get the best "buy-in" from all partners. Many state and local agencies are already short staffed, and the SAT initiative was additional work with out incentives other than providing additional monitoring equipment. EPA paid for all analytical costs and equipment used in the initiative. All equipment provided will be transferred to the state, local and tribal agencies for their use when the initiative is completed.

Communicating Results

As with many projects, it would have been nice to pilot a few projects in order to work out issues before proceeding to a large monitoring project. We did have the advantage of two areas in Tennessee being ready to monitor almost immediately as equipment was available from EPA Region 4. This helped us to work out some of our issues regarding use of meteorological data and development of what would be included in the reports and on the web pages. Of course, nothing is ever simple or smooth when it comes to monitoring, and this project has been no exception; however, there are areas which EPA will be improving because of the project.

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KEY WORDS
Air toxics
Schools
Volatile organic compounds
Metals
Carbonyls
Acrolein
Diisocyanates
Chromium VI