Addressing Community Health Concerns Around SeaTac Airport

Response to the question, "Is it possible to monitor jet engine exhaust emissions or to model their path using data on prevailing winds and takeoff patterns?"

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http://www.doh.wa.gov/EHSPHL/Epidemiology/NICE/default.htm

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List of Abbreviations

ASIL	Acceptable Source Impact Level
CMB	Chemical Mass Balance
CO	Carbon monoxide
CPF	Cancer Potency Factor
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HAP	Hazardous Air Pollutant
NAAQS	National Ambient Air Quality Standards
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
O_3	ozone
PAH	polycyclic aromatic hydrocarbon
PHSKC	Public Health—Seattle & King County
$PM_{2.5}$	particulate matter < = 2.5 microns in diameter
RFC	Reference Concentration
SO_2	Sulfur dioxide
TEOM	Tapered Element Oscillating Microbalance
TO	toxic organic
VOC	volatile organic compound
WDOH	Washington State Department of Health

EXECUTIVE SUMMARY

PREFACE

This document attempts to answer a question posed by the residents of the community surrounding SeaTac Airport about the possibility of monitoring jet engine exhaust emissions or modeling their path using data on prevailing winds and takeoff patterns. It outlines an approach to monitoring and modeling that the authors believe is consistent with the community's goals. However, air monitoring and modeling are extremely complex activities and other approaches may be possible or desirable.

BACKGROUND

This document is part of a larger project in which the Washington State Department of Health (WDOH) and Public Health – Seattle & King County (PHSKC) responded to concerns from residents of the SeaTac Airport area at the request of Senator Julia Patterson. The concerns were about whether operations at SeaTac Airport affected the health of nearby residents. Two previous reports focusing primarily on health data are available through WDOH or they can be viewed at http://www.metrokc.gov/health/.

This document summarizes the work of the Advisory Committee convened by WDOH to address the question, "Is it possible to monitor jet engine exhaust emissions or to model their path using data on prevailing winds and takeoff patterns?" The Committee includes representatives from the SeaTac Airport community and experts from state and local agencies and institutions, including WDOH, PHSKC, Washington State Department of Ecology, Puget Sound Clean Air Agency, and the University of Washington. The committee has consulted with the US Environmental Protection Agency (EPA) and Washington State University.

This report reflects the findings and recommendations of the majority of the committee members. Attachment 10 was prepared by the community representatives. It describes their viewpoint on issues which they thought needed more emphasis and issues on which we did not reach consensus.

CONCLUSIONS BASED ON PREVIOUS AIR QUALITY STUDIES

The Committee reviewed previously collected information related to air quality at or near SeaTac International Airport. Based on these studies, the committee concluded:

- Monitored levels of carbon monoxide and nitrogen dioxide do not exceed the National Ambient Air Quality Standards (NAAQS).
- There is not a compelling reason to monitor for sulfur dioxide (SO_2) in the vicinity of the airport. Airports are not significant sources of SO_2 and SO_2 levels in the Puget Sound area are generally well below the NAAQS.
- Due to the chemistry of ozone (O_3) and the finding that in the Puget Sound region, the highest levels of O_3 are found well south and east of the major urban areas, the committee concluded that there is not a compelling reason to monitor for O_3 in the vicinity of the airport.

- There has not been adequate monitoring for volatile organic compounds (VOCs), such as benzene and 1,3 butadiene; carbonyl compounds, such as formaldehyde and acrolein; polycyclic aromatic hydrocarbons (PAHs); particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$) or specific particulates. EPA has identified these classes of compounds as major combustion and evaporation products associated with jet fuels. These compounds also originate from other sources, such as automobiles, wood stoves and industry.

The Committee also noted that

- Winds are predominantly northerly or southerly, and airport operations and motor vehicle traffic patterns primarily affect the air quality north, south and east of the airport.
- The airport sits at a relatively high elevation with respect to the surrounding area and therefore, pollutants are usually not trapped around SeaTac Airport and do not accumulate.
- Pollutants attributable to airport activity are expected to be highest on the edge of the airport property closest to their source.
- Regional air pollution levels (including airport levels) are relatively low when wind speeds are high.

RECOMMENDATIONS AND GOALS

The Committee recommends an air quality study around SeaTac Airport for the following reasons:

- There is a lack of information on toxic air pollutants around major airports, in general, and around SeaTac Airport, in particular. Specifically, major emission and evaporation products of jet fuels, including VOCs, carbonyl compounds, PAHs, $PM_{2.5}$ and specific particulates have not been assessed in the vicinity of the airport.
- The airport and airport-related activities are potentially major sources of air pollution and environmental justice requires that one group of people not benefit at the cost of environmental degradation affecting the quality of life of another group.
- Because of the lack of information on specific air pollutants, we cannot rule out the possibility that air pollution around SeaTac Airport affects the health of the residents.

For an air quality study to be useful, it needs to answer the following questions:

- Are total amounts of specific VOCs, carbonyl compounds, PAHs, $PM_{2.5}$ and selected particulates present at levels high enough to potentially cause adverse health affects?
- What portion of the air toxics of concern can be attributed to airplane emissions and airport operations?

METHODS AND DATA ANALYSIS

Air monitoring (i.e., collection of samples for analysis) is necessary to obtain information on what compounds are in the air adjacent to SeaTac Airport and on the amounts of these compounds. We recommend following standard protocols for collecting information on air pollutants that EPA has identified as major emission products of jet engines, as well as some additional chemicals that are markers for other sources of pollution. For some of the compounds, we recommend comparing levels around SeaTac Airport to levels in other Seattle urban areas not subsubstantially affected by airport operations to get an understanding of the impact of the airport. We recommend placing monitoring stations immediately north and south of the airport. These monitoring stations will allow an evaluation the overall impact of airport operations and facilitate the modeling exercises necessary for determining the sources of air pollution and for understanding any potential health impacts.

ESTIMATED COST

The current budget estimated budget is approximately four million dollars over a five year period. However, we have not included all costs and it is not unreasonable to estimate that the project as outlined could cost up to five million dollars.

PREFACE

This document attempts to answer a question posed by the residents of the community surrounding SeaTac Airport about the possibility of monitoring jet engine exhaust emissions or modeling their path using data on prevailing winds and takeoff patterns. It outlines an approach to monitoring and modeling that the authors believe is consistent with the community's goals. However, air monitoring and modeling are extremely complex activities and other approaches may be possible or desirable. We hope this document provides the basis for further discussion on the desirability and technical feasibility of the recommendations described below. If there is a consensus that these activities are both desirable and feasible, the next step involves securing funding for the project.

BACKGROUND

In response to community concerns, the Washington State Department of Health (WDOH) and Public Health – Seattle & King County (PHSKC) met with people living in the vicinity of SeaTac Airport in several meetings arranged by Senator Julia Patterson. As a result of these meetings, WDOH, PHSKC, and community representatives developed a workplan to answer the community's questions. The majority of the questions focused on issues related to health and air pollution. WDOH, PHSKC and community representatives issued reports in February and December 1999 in response to nine of the first 10 questions. (WDOH et al., 1999) These reports are available through WDOH or they can be viewed at http://www.metrokc.gov/health/. This report responds to Question 9 which asked, "Is it possible to monitor jet engine exhaust emissions or to model their path using data on prevailing winds and takeoff patterns?"

To answer this question, WDOH convened an Advisory Committee to assist in reviewing studies on air quality around SeaTac Airport; determine whether there are gaps in the previously collected air quality data; and recommend methods and procedures for possible future air monitoring and modeling. The committee includes representatives from the SeaTac Airport community and experts from state and local agencies and institutions, including WDOH, PHSKC, Washington State Department of Ecology (Ecology), Puget Sound Clean Air Agency, and the University of Washington. The committee has also consulted with Dr. Joellen Lewtas from the US Environmental Protection Agency (EPA) and Dr. Hal Westberg from Washington State University. Attachment 1 lists committee members and consultants.

The committee has not been able to reach a consensus in all areas. This report reflects the findings and recommendations of the majority of the committee members. Attachment 10 was prepared by the community representatives. It describes their viewpoint on issues which they thought needed more emphasis and issues on which we did not reach consensus.

CONCLUSIONS BASED ON PREVIOUS AIR QUALITY STUDIES
Attachment 2 provides a summary of the studies related to air quality at or near SeaTac International Airport. Based on these studies, the committee concluded the following.

- Previous monitoring for carbon monoxide (CO) (Ecology, 1997; Port of Seattle et al., 1997; Radian Corp, 1994) nitrogen dioxide (NO_2) (Urry and Larson, 1999; Port of Seattle et al., 1997), and particulate matter 10 microns in diameter (Port of Seattle et al., 1997) in the vicinity of the airport does not suggest the need for additional monitoring for these parameters. Monitored levels of these pollutants did not exceed the National Ambient Air Quality Standards (NAAQS).

- There is not a compelling reason to monitor for sulfur dioxide (SO_2) in the vicinity of the airport. Although the monitoring data are extremely limited [one 8-hour $S0_2$ sample (McCulley et al., 1995) and routine monitoring in the Duwamish Valley five miles north of the airport (as cited in Port of Seattle et al., 1997)], airports are not significant sources of SO_2 and SO_2 levels in the Puget Sound area are generally well below the NAAQS. Data on SO_2 measurement in the Puget Sound area are available through Puget Sound Clean Air Agency's annual Air Quality Data Summary. To request a copy, contact Mary Hoffman at (206) 689-4006 or download from the Agency's website at www.pscleanair.org/ds97/index.htm.

- There has not been monitoring for ozone (O_3) in the vicinity of the airport. O_3 is formed in the atmosphere from a set of reactions involving nitrogen oxides (NO_x) and hydrocarbons. The reaction is driven by ultraviolet radiation from the sun. The formation of O_3 from NO_x and hydrocarbons takes time. Thus, in the Puget Sound region, the highest levels of O_3 are found well south and east (downwind) of the major urban areas (personal communication, Dr. Tim Larson, University of Washington, August 1999). Where large amounts of nitrogen oxide are present, such as in urban areas with high traffic, O_3 is rapidly converted to NO_2 and oxygen. This being the case, we conclude that there is not a compelling reason to monitor for O_3 in the vicinity of the airport.

- There has not been adequate monitoring for VOCs, such as benzene and 1,3 butadiene; carbonyl compounds, such as formaldehyde and acrolein; polycyclic aromatic hydrocarbons (PAHs); particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$) or specific particulates. The small amount of testing performed in 1994 indicated ASIL levels[1] were exceeded for several carcinogens including dichloromethane, carbon tetrachloride, benzene, and trichloroethylene (McCulley et al., 1995) McCulley et al. cite EPA data showing that the levels of these compounds are similar to those found in other urban environments. EPA has identified these classes of compounds as major combustion and evaporation products associated with jet fuels (personal communication, Joellen Lewtas, US EPA, August 1999). These

[1] See page 12 for a discussion of Acceptable Source Impact Levels (ASILs). The exceedence of an ASIL does not necessarily have a health impact.

compounds also originate from other sources including cars, trucks, wood stoves, and industry.

The group also noted that:

- Winds are predominantly northerly or southerly, and airport operations and motor vehicle traffic patterns primarily affect the air quality north, south and east of the airport.
- The airport sits at a relatively high elevation with respect to the surrounding area and therefore, pollutants are usually not trapped around SeaTac Airport and do not accumulate.
- Pollutants attributable to airport activity are expected to be highest on the edge of the airport property closest to their source.
- Regional air pollution levels (including airport levels) are relatively low when wind speeds are high.

RATIONALE FOR FURTHER STUDY

Health Issues

Previous reports have identified health issues of concern to the community (WDOH et al., February and December 1999). Scientific studies in other locations have associated exposure to air pollution with some of the same conditions that are high among residents in the SeaTac Airport area. Specifically, in the SeaTac Airport area, there are statistically significantly higher rates of the following:

- lung cancer cases within one mile of the airport compared to the rest of King County and to Washington State;
- oral and pharyngeal cancer cases within one mile of the airport compared to Washington State;
- deaths from lung cancer and chronic obstructive pulmonary disease in an area approximately three miles to the west and north and one mile to the east and south of the airport (defined by census tracts) compared to King County; and
- hospital admission for asthma and pneumonia/influenza in an area approximately three miles to the west, north and east and one half mile to the south of the airport (defined by zip codes) compared to King County.

In addition to associations with air pollution, most of these health concerns have been associated with tobacco smoking. The data on the prevalence of smoking in the SeaTac area are conflicting. Between 1993 and 1997, 17.6% of women giving birth who resided in the vicinity of SeaTac Airport reported smoking during pregnancy. This is statistically significantly higher than the 11.8% for King County as a whole (WDOH et al., February 1999). In contrast, a 1998 survey on adult smoking does not show an increased rate of smoking for residents in South West County compared to King County as a whole. (21.5% in South West County compared to 19.3% overall) (personal communication, David Solet, PHSKC, February 2000). South West County includes but is not limited to the SeaTac Airport area.

Hospital admissions for asthma may be influenced by a mix of risk factors, including asthma prevalence and severity of asthma episodes, the presence of environmental triggers such as a variety of indoor and outdoor air problems, smoking, poor housing and poverty, inappropriate case management, and lack of access to high quality medical care. There are indications that there may be poorer access to and utilization of medical care in the SeaTac Airport area compared to King County as a whole, but the data are limited either to a subset of the population (e.g, data on late prenatal care are limited to mothers giving birth) or to a population not specific to the SeaTac Airport area (i.e., all of South County for data on insurance coverage and unmet need) (WDOH et al., February 1999). With the data available to us, we can only speculate on which of the risk factors for increased asthma hospitalizations predominate.

Although the conditions listed above are associated with air pollution, as well as other risk factors, we have not been able to establish a probable causal relationship between the health of the residents living near SeaTac Airport and air pollution. However, available data do not allow us to rule out air pollution as a contributing factor. Additionally, the health studies are limited by lack of information on several health outcomes of concern to residents (such as adverse birth outcomes) and a lack of information on what pollutants are in the area that may be associated with specific health conditions.

Environmental Justice

In addition to considerations based on health, we can consider people's rights not to be directly impacted by pollution from commercial operations. For example, it is against the law to apply most pesticides in such a way that the pesticide drifts onto land owned by other people.[2] People do not have to prove that exposure to the pesticide is causing health problems in order to require that the applicator change procedures so that the pesticide does not cross a specific boundary. In a similar fashion, the committee questions whether the people living around SeaTac Airport need to prove they are sick to get an understanding of what is in the air surrounding this large enterprise that directly and indirectly (through airport-related traffic) emits significant amounts of pollutants into the air.

Fundamental to the concept of environmental equity is the value that one group of people not incur environmental exposures from commercial activities from which another group benefits. Those who use SeaTac Airport often derive great financial and other benefits from worldwide travel. The extent to which these benefits come at the expense of environmental degradation affecting the people who live around the airport is unknown, since a comprehensive air quality study has not been performed at SeaTac Airport to determine the impacts attributable to airplane emissions and airport-related traffic. Additionally, we have not been able to locate recent comprehensive air quality studies around any major airport and so we cannot try to draw conclusions based on other studies.

[2] Most pesticides have labels that read, "Do not apply this product in a manner that would allow contact either directly or through drift." The label is a federal requirement, enforceable by the state.

RECOMMENDATIONS

The committee recommends an air quality study around SeaTac Airport for the following reasons:

- There is a lack of information on air pollutants around major airports, in general, and around SeaTac Airport, in particular. Specifically, major emission and evaporation products of jet fuels, including VOCs, carbonyl compounds, PAHs, $PM_{2.5}$ and specific particulates have not been assessed in the vicinity of the airport.
- The airport and airport-related activities are potentially major sources of air pollution and environmental justice requires that one group of people not benefit at the cost of environmental degradation affecting the quality of life of another group.
- Because of the lack of information on specific air pollutants, we cannot rule out the possibility that air pollution around SeaTac Airport affects the health of the residents.

Goals of an air quality study

For an air quality study to be useful, it needs to answer the following questions:

- Are total amounts of specific VOCs, carbonyls compounds, PAHs, $PM_{2.5}$ and selected particulates present at levels high enough to potentially cause adverse health affects?
- What portion of the air toxics of concern can be attributed to airplane emissions and airport operations?

General recommendations for an air quality study

Conceptually, the activities necessary for an air quality study can be divided into air monitoring and modeling. Monitoring involves collection of samples for measuring what is in the air. Modeling is used to predict what is in the air away from the monitored sites and to determine the sources of air pollution. The group does not recommend modeling as a substitute for monitoring. Although air pollution modeling can be used to estimate pollutant levels under different meteorological conditions, without actual measurements, the accuracy of the model is always open to question. Factors that confound the accuracy of modeling results include the accuracy of the emission and meteorological data that comprise the major input into the model and the complexity of the terrain in the area modeled. The most commonly used models were developed for use in flat terrain. Additionally, determination of the sources of different pollutants requires knowledge about specific chemicals that cannot be derived without actual measurements.

The goal of the monitoring is to obtain information on what compounds are in the air adjacent to SeaTac Airport at what levels. We recommend getting an understanding of the impact of the airport by comparing levels around SeaTac Airport to levels in other Seattle urban areas not substantially affected by airport operations and by looking at differences in pollutant concentrations upwind and downwind of the airport. We also recommend determining whether levels of compounds at the monitoring sites have potential human health impacts. If high levels of some substances are found at the monitoring sites, we recommend additional study to determine the contribution from different sources more precisely and to determine potential health effects in areas where people live.

METHODS

We recommend focusing on air pollutants that EPA has identified as major emission products of jet engines, as well as some additional chemicals that are markers for other sources of pollution. Many of these chemicals have also been identified as having significant potential health impacts. These chemicals can be grouped into several general categories that include VOCs, carbonyls, PAHs and particulate matter. Attachment 3 provides a complete list of chemicals with an indication of the importance of including each chemical or class of chemicals. It also provides a method for measuring each pollutant where we have been able to identify a method.

Attachments 4 – 7 present the EPA methods for each class of compounds, as well as the list of individual compounds included in each method. Two methods are provided for VOCs and the committee has not determined which specific method to recommend. It is important to note that the methods do not provide for all of the compounds specified in Attachment 3 and so additional or alternative methods must be explored or some of the compounds listed in Attachment 3 must be dropped.

We recommend obtaining information on amounts of specific compounds over a 24-hour period, as well as shorter time intervals. We recommend placing monitors

- close enough to the airport that the airport will have a significant contribution to measured levels of pollutants;
- in an area where pollutant levels are high enough to use in subsequent modeling; and
- away from significant local sources of pollution, such as body shops or other local industry.

Based on previous work (Urry and Larson, 1999; McCulley et al., 1995), we recommend placement of one monitor south of the airport, just outside the fence line. The monitor needs to be aligned such that it will capture maximum pollution from the airport with minimal pollution from highway 99 or other sources of air pollution. Alignment with the midpoint of the long runway (16L) or just to the east of the midpoint may provide a suitable location. We also recommend placement of a monitor north of the airport at a site to be determined. Placement of this monitor may be more problematic than at the south end because of the proximity of major highways. Monitors north and south of the airport will allow us to measure upwind and downwind to help determine if and how much the airport is contributing to the overall air pollution in the area. We recommend that the monitors be sited following EPA siting criteria contained in Title 40 of the Code of Federal Regulations Part 58 (40CFR58) Appendices D and E.

The committee recognizes the importance of consensus in siting the monitors to obtain scientifically sound data that will be accepted as valid by all interested parties.

Manual Methods

We recommend using established methods promulgated through EPA to obtain 24-hour average concentrations of the toxic air pollutants. In addition to the chemicals listed in

Attachment 3, these methods will capture information on many of the 33 Hazardous Air Pollutants (HAPs) identified in the draft Integrated Urban Air Toxics Strategy, which are thought to have the greatest impact on the public and the environment in urban areas. This subset is commonly referred to as the "Urban Air Toxics List".

For consistency with EPA protocols and to provide for statistically significant annual average values, we recommend sampling every six days. Since conditions for any given year may not be representative, we recommend sampling for three years. Additionally, since sampling occurs only every six days and since the climate in the area around SeaTac Airport is generally unstable, in any given year, it is possible to miss the most highly polluted days. This is less likely to happen with monitoring over a three-year period. Monitoring every six days for three years will provide solid information by which to understand annual averages. Additionally, to determine the contribution from different sources, it may be necessary for daily monitoring of some compounds for several 30 - 60-day periods.

Automated Methods

We also recommend using EPA reference or equivalent methods to obtain continuous measurement of meteorological conditions (wind speed, wind direction and temperature), nitrogen oxides (nitrogen oxide, NO_2, NOx), CO and $PM_{2.5}$. The results from these methods will assist with subsequent data analysis and modeling. The automated, continuous methods will also allow us to gauge whether we are missing major air pollution events and permit us to evaluate diurnal fluctuations. Since the information from these methods is used in conjunction with the data from the manual methods, we recommend that these measurements also be collected for a three-year period.

In addition, since 24-hour averages may miss peak VOC concentrations, we recommend augmenting the 24-hour average speciated VOC values with sampling for targeted VOC's using portable gas chromatographs to provide shorter time resolved concentrations (e.g., 15-minute averages). We recommend using results from targeted hourly canister sampling to determine which VOCs to sample with the gas chromatographs. In conjunction with the other automated, continuous measurements, the shorter time resolved VOC sampling from both ends of the airport provides data that may be used to estimate the contribution of the airport's emissions.

Quality Assurance Procedures

To assure consistent data of high quality, it is important to use scientifically sound monitoring protocols. The methods need to consider the threshold concentrations at which effects have been documented and be sufficiently sensitive to provide an adequate limit of detection. Additionally, the monitoring protocols need to provide for adequate quality assurance and data management. We recommend using the procedures in EPA's air toxic quality assurance plan for the manual methods. For the automated, continuous methods, we recommend the sampling and quality assurance protocols in Ecology's "Air Monitoring Quality Assurance Plan & Produces" document #95-201 to ensure that consistently high quality data are generated for these parameters. We estimate that quality control and quality assurance procedures will add approximately 10% to the budget.

DATA ANALYSIS AND INTERPRETATION

We recommend that initial data analysis focus on determining

- whether the levels of pollutants at the monitoring sites are at levels high enough to be a health concern;
- differences between pollutant levels at the two monitoring sites in relation to wind direction to get a preliminary estimate of the effect of airport operations and
- the differences in pollutant levels between the sites near the airport and comparison sites.

Depending on the findings related to the three analyses described above and technical feasibility, we recommend additional analysis to determine

- potential health effects in areas where people live and
- the potential contribution of airplanes, cars and diesel-powered vehicles.

Initial Data Analysis

Health Concerns. We recommend beginning an analysis of potential health impacts upon receipt of air monitoring data that have undergone quality assurance and quality control. As a first step, we propose comparing the measured values at the monitors with benchmark levels such as Ecology's Acceptable Source Impact Levels (ASILs) for chemicals that are on Ecology's air toxics list. The ASIL is a number used by Ecology and the Puget Sound Clean Air Agency for permitting purposes. It is based on

- Reference Concentrations (RFCs) developed by EPA for non-carcinogenic air pollutants;
- Cancer Potency Factors (CPFs) for carcinogens; or
- in the absence of either RFCs or CPFs, Threshold Limit Values divided by 300. The division by 300 extends the occupational 8-hour value to a 24-hour duration.

The ASIL is a number that is defined as low or no risk, based on its derivation. Exceeding the ASIL does not mean that a health impact is expected. For permitting purposes, exceeding the ASIL by a permit applicant requires the applicant conduct further analysis to determine whether a health impact exists.

Because the ASIL is used as a number that is of no or low risk, it is assumed that any exposure less than that represented by an ASIL will have no impact on health. Comparing monitored concentrations of air pollutants to ASILs allows the screening out of pollutants that are present at concentrations too low to have a health impact.

There may be some compounds monitored in this study for which neither ASILs, nor RFCs, nor CPFs have been determined. The reason for the lack of screening values may be that the chemical has little exposure potential, and therefore, no reference value has been calculated. Compounds may also be of very low toxicity and have low enough ambient exposure potential that expenditure of resources to determine screening values was not warranted. Alternatively, no health or toxicological data may exist from which health criteria can be determined. This means that some compounds may be detected during monitoring for which health analyses cannot be performed.

We recommended compounds for monitoring not only for the purpose of determining health impacts, but also to determine the sources of air pollution. Therefore, health analyses may not be possible or recommended for all compounds.

Upwind and downwind levels of pollutants. We recommend sampling locations at both ends of the runway to provide for some basic analysis of the airport's contribution to overall air quality in the area. When the wind is from the north, there are several reasons why we expect that the north monitoring site is not impacted by the airport as much as the south site. When the wind is from the north, the planes queue up and prepare to takeoff toward the north (into the wind). Emissions are highest during takeoff, taxiing and idling, and the north wind blows their emissions to the south. While airplanes flying over the monitoring station to the north may have some impact on the north monitoring station, it will be relatively much lower than the impact at the downwind site. This is due to the dispersion of the emissions with distance from the source and diffusion due to wind currents. The scenario is reversed when the wind is from the south.

Comparison to other urban areas. The Committee recommends Beacon Hill as an excellent urban site to use as a comparison for a SeaTac Airport air toxics study. It is a regionally representative site located in a densely populated area that is centered within the Seattle metropolitan air mass. It captures low to medium levels of pollutants due to its relatively high elevation. Source apportionment studies show that it is impacted by sources in a fairly regionally representative fashion. It is most highly impacted by mobile sources followed by indoor and outdoor burning and finally, to a small extent (less than 7%), by industrial sources (Chow and Watson, 1998). The Chow and Watson study also showed that the annual and peak concentrations at Beacon Hill were well below the annual and peak concentrations measured at other Puget Sound Clean Air Agency $PM_{2.5}$ monitoring sites. Although measurements at Beacon Hill reflect relatively high concentrations of NOx, the values are about half the National Ambient Air Quality Standards.

Due to local topography and meteorology, it is highly unlikely that emissions from either SeaTac or King County Airport have a significant impact on the Beacon Hill site. Planes landing and taking off from SeaTac Airport do not pass close enough to Beacon Hill to impact the site substantially. By far the majority of emissions from operations at King County Airport take place well below or above the Beacon Hill site.

Local topography coupled with inversion/stagnation conditions will further segregate emissions from King County Airport and the Beacon Hill site. The highest $PM_{2.5}$ concentrations occur concurrently with wintertime inversion/stagnation conditions. A comparison between the $PM_{2.5}$ values from Beacon Hill and the Puget Sound Clean Air Agency's monitoring site in the Duwamish valley was included in a recent study (Maykut, Knowle, and Larson, 1998). The comparison clearly showed that during wintertime stagnation/inversion conditions the $PM_{2.5}$ concentrations at Beacon Hill were much lower than $PM_{2.5}$ concentrations measured in the Duwamish valley. This is the result of the inhibited mixing in the inversion layer, which prevents emissions from sources located in the valley from reaching the Beacon Hill site. Therefore, comparing measurements made at Beacon Hill with those taken at or near SeaTac Airport should be a valid comparison of urban data from similar neighborhoods with and without significant impacts from airport operations.

As with siting of the monitors, the choice of a comparison site is important in assuring valid interpretation of the data and acceptability of the conclusions by all interested parties. In this regard, it is important to note while the majority of the committee agreed in the suitability of Beacon Hill as a comparison site, there was not unanimity on this point.

Additional Data Analysis

Health Concerns. For air pollutants that are monitored at or above ASIL values at the monitoring sites, we recommend additional work to determine the potential health impact on nearby residents. To understand the potential health impact, we need to determine the level of pollutants in areas where people live. There are several approaches to determining ambient concentrations (that is, the concentration that people are likely to breathe). The committee considered three approaches. Except for dispersion analysis, the committee has not assessed specific methodologies for implementing these approaches and, therefore, has not reached a consensus on feasibility, utility and estimated costs. While the committee considered dispersion analysis in more detail than the other approaches, there was not a consensus on the technical feasibility of developing the emission inventory that is crucial to the ability of the model to accurately predict levels of pollutants at locations away from the monitors.

- Dispersion analysis can be used to model the levels of pollutants in locations where people live. Dispersion analysis requires an emissions inventory for sources that emit the compounds of concern and emissions factors for those sources. Emissions from these sources are modeled using emissions inventories and actual meteorological data from the monitoring stations. Using a computer model, concentrations of the selected chemicals of concern are estimated at the monitoring site locations and compared with actual monitoring results, accounting for background concentrations coming from regional sources. If necessary, the modeling parameters are adjusted to match actual measured concentrations at the monitoring locations. Once agreement between modeling results and measured concentrations is achieved, the model can be used to predict concentrations of the selected chemicals of concern at locations away from the monitoring sites.
- Levels of pollutants can be measured at selected locations where people live, using canister sampling for specific pollutants.

- Depending on the specific pollutants of concern, it may be possible to use personal monitoring badges to determine exposures.

If the modeled or monitored concentration is at or greater than the ASIL, then we recommend conducting a health analysis. The data on which ASILs are based are not of the same extent or quality for all compounds. For this reason, chemicals that are at or above ASIL levels must be examined further to determine the nature and quality of the information on which they are based. Dose-response and other data found in the health and scientific literature can then be applied to determine whether the modeled or measured concentration for the chemical under analysis could have an impact on health. If it is determined that a risk for health impact exists, the magnitude of that risk to various susceptible members of the population can be determined. Recommendations for reduction of exposure can then be provided to the public and to regulatory agencies.

Source Apportionment. The goal of source apportionment is to understand the airport's relative contribution to air quality in the area. We recommend utilizing several approaches described below, since all models have associated uncertainties and receptor modeling (that is, modeling based on pollutant concentrations at the monitor) is relatively inexpensive compared to the cost of collecting the data. A technical discussion of receptor modeling follows.

Receptor models based solely upon air monitoring data. These models rely upon the variations in the ambient concentrations of pollutants over time at a given location. There are currently two different models that have been evaluated by EPA: "Positive Matrix Factorization" and "UNMIX." The strength of these types of receptor models is their ability to identify source fingerprints without prior knowledge of the source emission composition.

These models can be used to estimate the number of independent sources that are influencing the site; estimate the relative concentration attributable to each source for each sample taken at the site; and predict the source fingerprints for each source. The actual source fingerprints or source profiles from the airport are not well known. Therefore, these types of receptor models are useful in this context. The predictions of these models can also be combined with wind direction analysis to further confirm the presence of unique airport fingerprints.

In order to implement these models successfully, a sufficient number of samples to capture the influence of each of the important sources that impact the monitoring site is needed. This usually requires at least a year's worth of data with at least a one in three day sampling frequency or the equivalent number of samples (e.g., two years of a one in six sampling frequency).

Receptor models based upon source emission measurements as well as air monitoring data. These models rely upon prior knowledge of source fingerprints as well as air measurements at a given site. The standard EPA model is named "Effective Variance

Weighted Chemical Mass Balance" (CMB). This is the traditional receptor model. It requires that one measure a tracer or tracers that are unique to a given source. Measurement of that tracer or tracers at the site of interest indicates the impact of that source on that site. Obviously, the more unique the tracer, the better the method will work for a given source.

The CMB model consists of a least-squares solution to a set of linear equations that expresses each receptor concentration of a chemical species as a linear sum of products of source profile species and source contributions. The source profile species (the fractional amount of the species in the emissions from each source type) and the receptor concentrations, each with realistic uncertainty estimates, serve as input data to the CMB model. The output consists of the contributions for each source type to the total ambient aerosol mass as well as to individual chemical species concentrations. The CMB calculates values for contributions for each source and the uncertainties of those values. Input data uncertainties are used both to weight the relative importance of the input data to the model solution and to estimate uncertainties of the source contributions.

The CMB modeling procedure requires 1) identification of the contributing source types; 2) selection of chemical species to be included; 3) estimation of the fractions of each chemical species contained in each source type (i.e., the source profiles); 4) estimation of the uncertainties in both ambient concentrations and source compositions; and 5) solution of the CMB equations.

The difficulty in apportioning the airport emissions is the identification of unique tracers. Therefore, the success of the chemical mass balance approach alone is questionable in this case. A combined approach including both types of receptor models has the best chance for success.

TIMEFRAME

The committee anticipates that it would take approximately eight to 10 months to purchase and install equipment for collecting data. We recommend data collection for three years. Subsequent to data collection, we anticipate up to another 12 months for data analysis. Thus, we anticipate that it would require approximately five years to implement the recommendations in this report.

ESTIMATED COSTS AS OF MARCH 2000

A summary of estimated costs follows. Costs for sample collection and laboratory work include the majority the compounds listed in Attachment 3, but not all (for example, there may be additional costs for measuring naphthalene; we have not identified a method for measuring benzo(a)anthracene; it is not clear whether the methods recommended for VOCs are appropriate for all of the VOCs of interest). Personnel requirements and costs are based on state agency hiring practices and include salaries, benefits, overhead, and anticipated increases over the next five years. We have not estimated costs for contracting these portions of the work plan. Details of costs for sample collection and laboratory work are provided in Attachment 9.

	Cost per year	Number of years	TOTAL per item	Subtotal and Total
SAMPLE COLLECTION and LABORATORY WORK				
One-time capital costs for 2 monitoring stations	$560,000	NA	$ 560,000	
On-going supplies and laboratory costs for 2 stations	$418,000	3	$1,254,000	
Personnel for operating 2 sites: 2 FTE at $80,000	$160,000	3	$ 480,000	
Personnel for equipment purchase, testing, maintenance; training and technical assistance (.5 FTE)	$ 40,000	4	$ 160,000	**$2,454,000**
QUALITY ASSURANCE				
Non-personnel costs: 10% of non-capital and non-personnel data collection costs	$ 41,800		$ 125,400	
Personnel for protocol development, field auditing and data validation: .5 FTE	$ 40,000	4	$ 160,000	**$ 285,400**
DATA MANAGEMENT, ANALYSIS and INTERPRETATION				
Data management: .5 FTE	$ 40,000	4	$ 160,000	
Health impacts: 1 full time toxicologist	$ 100,000	1	$ 100,000	
Dispersion analysis	$ 200,000		$ 200,000	
Beacon Hill/Upwind-downwind comparison	$ 50,000	1	$ 50,000	**$**
Source apportionment	$ 75,000	2	$ 150,000	**$ 660,000**
PROJECT MANAGEMENT				
General management: 1 FTE	100,000	Five years	$ 500,000	
Field work management: .5 FTE	40,000	Four years	$ 160,000	**$ 660,000**
TOTAL				**$4,032,400**

While the current total estimated cost is approximately four million dollars, additional resources may be needed to measure all of the recommended pollutants. Additionally, we have not estimated costs for alternatives to dispersion modeling to determine levels of pollutants to which people are exposed. We believe that it is reasonable to estimate that the costs could be as high as five million dollars for the project as outlined above.

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ATTACHMENT 2: Summary of recent studies examining air quality in the vicinity of SeaTac International Airport

We are aware of two studies from the 1970s (Air Pollution by Jet Aircraft at SeaTac Airport. Department of Commerce 1970 and ESL Incorporated SeaTac Air Quality – Final report ESL-ET59, June 28, 1973). The group did not review these studies, since these studies most likely do not reflect current conditions.

- SeaTac Airport Spatial Nitrogen Dioxide Study. Doug Urry and Tim Larson, 1999 (Unpublished)
  This study assessed whether concentrations measured in areas near SeaTac exceed the National Ambient Air Quality Standards (NAAQS) for nitrogen dioxide (NO_2); whether there are NO_2 concentration gradients in the SeaTac area; and whether aircraft operations impact local NO_2 concentrations. The researchers measured NO_2 using passive badge samplers. They sampled at 16 locations with the majority of the samplers placed north and south of the airport. They sampled continuously for an entire year. During the time period of the study, the average annual NO_2 level did not exceed the NAAQS; there were only small NO_2 concentration gradients (concentration levels generally decreased with distance from the airport and from heavily trafficked areas, and from east to west); and NO_2 levels near the airport were highly affected by regional levels (i.e., NO_2 from many sources contributing to levels in a wider area) and did not differ greatly from concentrations measured in a separate study in other Seattle urban areas.[3] Overall, the data did not support the hypothesis that operations at SeaTac Airport significantly impact local NO_2 concentrations.

- EIS – Master Plan Update Final and Final Supplemental Environmental Impact Statement. Port of Seattle/Department of Transportation/Federal Aviation Agency, 1997.
  The purpose of this study was to determine the impact of increased air traffic at SeaTac Airport on ambient air pollution. The study focused on three areas:
    the development of an emissions inventory by using modeling to determine the sources and relative contribution of emissions from aircraft, road traffic and parking lot activities;
    an area dispersion analysis to model the effect of pollutants related to airport activities on the area immediately around the airport; and
    a roadway intersection dispersion analysis that modeled air pollution related to changes in traffic patterns and volumes over time.

  The emissions inventory modeling indicated that all aircraft emissions are expected to increase with increased air traffic. However, the modeling predicted that emissions increases related to additional air traffic would not exceed the levels allowed in the 1995 state implementation plan. The state implementation plan provides for

[3] Norris G and Larson T. Spatial and temporal measurements of NO_2 in an urban area using continuous mobile monitoring and passive samplers. *Journal of Exposure Analysis and Environmental Epidemiology* 9(6): 1-8, 1999.

implementation, maintenance, and enforcement of the NAAQS. The report states that the addition of a runway was expected to reduce emissions by 2005 and 2010 since an additional runway would lessen time currently spent queued up waiting to take off.

The area dispersion analysis included pollutants from a broader range of airport activities than the emission inventory analysis. The area dispersion analysis concluded that increased activity at the airport would not create violations of the NAAQS.

The roadway intersection modeling concluded that in a worst case scenario, four intersections near the airport would exceed the 8-hour carbon monoxide (CO) NAAQS. However, current measured levels of CO were below those predicted by the model.

This study looked only at criteria pollutants (i.e., those covered by the NAAQS) and did not model levels of volatile organic compounds (VOCs). Additionally, modeling is only accurate to the extent that the underlying assumptions are accurate. Since we do not have the resources to verify all of the assumptions, it is difficult for us to assess the accuracy of the predictions. We have not relied on this study as a primary source in drawing conclusions, except where the study included actual measurements of pollutants.

- 1996-1997 Carbon Monoxide Saturation Study Sea-Tac International Airport Area. Washington State Department of Ecology,1997.
  This study evaluated the impacts of increasing population and traffic congestion on CO levels in the Puget Sound area. The Department of Ecology sampled at 27 locations for 60 days during the winter of 1996-1997. They located portable bag samplers near major roadways and near intersections with high traffic density and poor atmospheric ventilation. Air was blown through the samplers for 8-hours at a time. The 8-hour level of CO in the SeaTac area did not exceed the NAAQS. The highest CO concentration was 7.2 parts per million (ppm). The 8-hour NAAQS is 9 ppm.

- Air Quality Survey Sea-Tac International Airport. McCulley, Frick & Gillman, Inc., 1995.
  This study looked at airborne toxic compounds and CO in the vicinity of SeaTac International Airport. Samples were collected during four late fall to early winter days in 1993 at locations within the airport operations area and outside the airport including upwind of the airport, downwind of the airport, near International Boulevard, and at a residential location in Normandy Park. The sampling periods were selected to evaluate different meteorological conditions, which result in different modes of airport operations. CO levels were below the 8-hour NAAQS. VOC monitoring showed:

    Mean concentrations of several VOCs were higher than acceptable source impact levels (acetaldehyde, formaldehyde, acrolein, benzene, carbon tetrachloride, 1,2-

dichloroethane and dichloromethane). Acceptable source impact levels (ASILs) are screening levels that Department of Ecology, Puget Sound Clean Air Agency and other clean air agencies use in permitting new equipment, such as boilers and spray-painting equipment. They are based on criteria intended to protect health. Because of the protective assumptions used to develop most ASILs, exceeding an ASIL does not necessarily indicate a health concern. However, ASIL analysis is chemical and facility specific and does not take into account the total exposure of individuals in the area impacted by specific emissions.

Benzene was found in every sample collected. The highest levels were collected at Gate B3 and next to International Boulevard. The lowest levels. were observed at the residential location.

Monitoring could not discern significant differences in upwind versus downwind levels of VOCs. However, we do not know whether this would be true if more extensive sampling had been performed.

Levels of VOCs were within a range exhibited in other similarly sized urban areas. We would need to do additional research to interpret this finding. For example, we would need to understand how and where the measurements in the other urban areas were obtained.

Chemicals or ratios of several key VOCs were indicative of automobile exhaust and did not resemble the VOC profiles associated with aircraft emissions. We are currently trying to determine how the authors arrived at this conclusion, since published studies indicate that there are no pollutants unique to aircraft emissions.

This study also collected one 8-hour $S0_2$ sample. This sample showed an SO_2 concentration of 0.017 ppm. Currently, there is no 8-hour standard for SO_2. The 3- and 24-hour average standards for SO_2 are 0.50 and 0.140 ppm, respectively.

Because this study only collected samples on four days, we have not relied on this study as a primary source of information in drawing conclusions.

- Mobile Source Hazardous Air Pollutant Emissions in the Sea-Tac Urban Area. Radian Corp., 1994.
  This study was contracted by the US Environmental Protection Agency and Puget Sound Clean Air Agency to develop a hazardous air pollutant (HAP) emissions inventory (mainly VOCs) for mobile polluters in the Seattle-Tacoma area. A HAP emissions inventory shows which hazardous pollutants and how much of each pollutant comes from each mobile source of pollution. Mobile polluters include on-road vehicles, aircraft and other non-road vehicles and equipment. The study concluded that on-road vehicles are a primary source of HAP emissions in the Seattle-Tacoma area. Results for aircraft indicate that they are not a significant area-wide source of HAP. However, airport facilities may be more significant contributors to overall HAP emissions in areas near these facilities. The study suggested the need for additional information on VOC emissions from aircraft.

ATTACHMENT 3: DRAFT List of Recommended Pollutants for Air Monitoring

Nitrogen oxides (NO, NO_2, NO_X) and c**arbon monoxide**: major emission product of burned fuel; for comparison to other urban areas; EPA reference or equivalent method.

Volatile Organic Compounds: Although EPA methods TO-14A and TO-15 measure VOCs, of the compounds listed below, only 1,3 butadiene and benzene are included in Attachments 6 and 7. We need to determine whether these methods cover the other VOCs listed below.

- alkanes: major product of unburned fuel; slightly different signatures from evaporation of diesel, gasoline and jet fuel
  - methane
  - methylpentanes
- alkenes: major product of unburned fuel
  - ethene
  - propene
  - acetylene
  - 1,3 butadiene:*unstable, will react with NO_x to form nitroalkenes;
- aromatic compounds: major emission product of unburned fuel
  - benzene:*

Carbonyls: EPA method TO-11A.

- aldehydes:* major product of unburned fuel
  - formaldehyde*
  - acetaldehyde

Polycyclic Aromatic Hydrocarbons: major emission products of burned fuel; EPA method TO-13A measures PAHs, but we need to determine whether it can be used for the PAHs listed below.

- naphthalene
- methylated naphthalenes (1-methyl and 2-methyl)
- dimethyl naphthalenes

Particulate Matter

- Speciated $PM_{2.5}$: for source apportionment
  - mass: TEOM and EPA reference method
  - organic and elemental carbon: elemental carbon is a marker for diesel exhaust; NIOSH method 5040
  - trace elements: for source tracers (for example, potassium is a good marker of wood smoke; mercury is a good indicator of industrial emissions); EPA method IO-3.3
- Organic Aromatic including Polycyclic Aromatic Hydrocarbons:* emission product of burned fuel, potential markers of specific combustion sources; EPA method TO-13A.
  - phenanthrene
  - anthracene
  - fluoranthene
  - pyrene
  - benzo(a)anthracene*
  - chrysene*
  - benzo(a)pyrene*
  - benzo(ghi)pyrelene (marker for gasoline)

* Chemical classes or specific chemicals which are carcinogenic, mutagenic or cause reproductive effects.

ATTACHMENT 4

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, **Compendium Method TO-11A: Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC)** [Active Sampling Methodology]
Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268
January 1999

Acetaldehyde[1,2]
Acetone
Benzaldehyde
Butyraldehyde
Crotonaldehyde
2,5-Dimethylbenzaldehyde
Formaldehyde[1,2]
Hexanaldehyde
Isovaleraldehyde
Methyl ethyl ketone
Propionaldehyde
m-Tolualdehyde
o-Tolualdehyde
p-Tolualdehyde
Valeraldehyde

1. Major emission products of unburned fuel, see Attachment 3.
2. Identified in the Integrated Urban Air Toxics Strategy as having a potentially large impact on the public and the environment in urban areas.

ATTACHMENT 5

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, **Compendium Method TO-13A: Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography/Mass Spectrometry (GC/MS)**

Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268
January 1999

Acenaphthene (low collection efficiency; see Section 6.1.3)
Acenaphthylene (low collection efficiency; see Section 6.1.3)
Anthracene[1,2]
Benz(a)anthracene[3]
Benzo(a)pyrene[1,2,3]
Benzo(b)fluoranthene[3]
Benzo(e)pyrene
Benzo(g,h,i)perylene[1,2]
Benzo(k)fluoranthene[3]
Chrysene[1,2,3]
Coronene
Dibenz(a,h)anthracene[3]
Fluoranthene[1,2]
Fluorene
Indeno(1,2,3-cd)pyrene[3]
Naphthalene (low collection efficiency; see Section 6.1.3) [1]
Perylene
Phenanthrene[1,2]
Pyrene[1,2]

1. Emission product of burned fuel, see Attachment 3.
2. Potential marker for combustion source, see Attachment 3.
3. This method covers one urban hazardous air pollutant (HAP) identified in the Integrated Urban Air Toxics Strategy, polycyclic organic matter (POM). With this method, this HAP is being represented by 19 PAHs. The seven that are most toxic are footnoted.

NOTE: Attachment 3 includes benzo(a)anthracene, methylated naphthalenes and dimethyl naphthalenes. These compounds do not appear on this list. Also, while naphthalene is on this list, this method does not appear to provide high quality data on naphthalene.

ATTACHMENT 6

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, **Compendium Method TO-14A: Determination Of Volatile Organic Compounds (VOCs) In Ambient Air Using Specially Prepared Canisters With Subsequent Analysis By Gas Chromatography**

Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268
January 1999

COMPOUND (SYNONYM)
Freon 12 (Dichlorodifluoromethane)
Methyl chloride (Chloromethane)
Freon 114 (1,2-Dichloro-1,1,2,2- tetrafluoroethane)
Vinyl chloride (Chloroethylene)[2]
Methyl bromide (Bromomethane)
Ethyl chloride (Chloroethane)
Freon 11 (Trichlorofluoromethane)
Vinylidene chloride (1,1-Dichloroethene)
Dichloromethane (Methylene chloride)[2]
Freon 113 (1,1,2-Trichloro-1,2,2- trifluoroethane)
1,1-Dichloroethane (Ethylidene chloride)
cis-1,2-Dichloroethylene
Chloroform (Trichloromethane)[2]
1,2-Dichloroethane (Ethylene dichloride)[2]
Methyl chloroform (1,1,1-Trichloroethane)
Benzene (Cyclohexatriene)[1,2]
Carbon tetrachloride (Tetrachloromethane)[2]
1,2-Dichloropropane (Propylene dichloride) [2]
Trichloroethylene (Trichloroethene)[2]
cis-1,3-Dichloropropene (cis-1,3-dichloropropylene)[2]
trans-1,3-Dichloropropene (trans-1,3-Dichloropropylene)
1,1,2-Trichloroethane (Vinyl trichloride)
Toluene (Methyl benzene)
1,2-Dibromoethane (Ethylene dibromide)[2]
Tetrachloroethylene (Perchloroethylene)[2]
Chlorobenzene (Phenyl chloride)

1. Major emission product of unburned fuel, see Attachment 3.
2. This method covers 13 of the 16 VOC urban hazardous air pollutants (HAP) identified in the Integrated Urban Air Toxics Strategy.
3. Requested by the community.

NOTE: The compounds on this list do not correspond well to those listed in Attachment 3. We need to determine whether this represents a complete list of compounds available through this method before determining whether it can be used.

Attachment 6 continued

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, **Compendium Method TO-14A: Determination Of Volatile Organic Compounds (VOCs) In Ambient Air Using Specially Prepared Canisters With Subsequent Analysis By Gas Chromatography**

Ethylbenzene
m-Xylene (1,3-Dimethylbenzene)
p-Xylene (,14-Dimethylxylene)
Styrene (Vinyl benzene)
1,1,2,2-Tetrachloroethane[2]
o-Xylene (1,2-Dimethylbenzene)
1,3,5-Trimethylbenzene (Mesitylene)
1,2,4-Trimethylbenzene (Pseudocumene)
m-Dichlorobenzene (1,3-Dichlorobenzene)
Benzyl chloride (alpha-Chlorotoluene)
o-Dichlorobenzene (1,2-dichlorobenzene)
p-Dichlorobenzene (1,4-dichlorobenzene)
1,2,4-Trichlorobenzene
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)[1,2]

1. Major emission product of unburned fuel, see Attachment 3.
2. This method covers 13 of the 16 VOC urban hazardous air pollutants (HAP) identified in the Integrated Urban Air Toxics Strategy.
3. Requested by the community.

NOTE: The compounds on this list do not correspond well to those listed in Attachment 3. We need to determine whether this represents a complete list of compounds available through this method before determining whether it can be used.

ATTACHMENT 7

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, **Compendium Method TO-15: Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)**

Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268
January 1999

Methyl chloride (chloromethane)[3]
Carbonyl sulfide
Vinyl chloride (chloroethene) [2, 3]
Diazomethane
Formaldehyde[1]
1,3-Butadiene[1,2]
Methyl bromide (bromomethane)
Phosgene
Vinyl bromide (bromoethene)
Ethylene oxide[2]
Ethyl chloride (chloroethane)
Acetaldehyde (ethanal)
Vinylidene chloride (1,1- dichloroethylene)
Propylene oxide
Methyl iodide (iodomethane)
Methylene chloride[2]
Methyl isocyanate
Allyl chloride (3- chloropropene)
Carbon disulfide
Methyl tert- butyl ether
Propionaldehyde
Ethylidene dichloride (1,1- dichloroethane)
Chloroprene (2- chloro- 1,3- butadiene)
Chloromethyl methyl ether
Acrolein (2- propenal)[3]
1,2- Epoxybutane (1,2- butylene oxide)
Chloroform[2]
Ethyleneimine (aziridine)
1,1- Dimethylhydrazine
Hexane
1,2- Propyleneimine (2- methylaziridine)
Acrylonitrile (2- propenenitrile)
Methyl chloroform (1,1,1- trichloroethane)
Methanol

1. Major emission product of unburned fuel, see Attachment 3.
2. This method covers 15 of the 16 VOC urban hazardous air pollutants identified in the Integrated Urban Air Toxics Strategy.
3. Requested by the community.

Attachment 7 continued

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, **Compendium Method TO-15: Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)**

Carbon tetrachloride[2]
Vinyl acetate
Methyl ethyl ketone (2- butanone)
Benzene[1,2]
Acetonitrile (cyanomethane)
Ethylene dichloride (1,2- dichloroethane) [2]
Triethylamine
Methylhydrazine
Propylene dichloride (1,2- dichloropropane)
2,2,4- Trimethyl pentane
1,4- Dioxane (1,4- Diethylene oxide)
Bis(chloromethyl) ether
Ethyl acrylate
Methyl methacrylate
Methyl methacrylate
1,3- Dichloropropene[2]
Toluene
Trichloroethylene[2]
1,1,2- Trichloroethane
Tetrachloroethylene[2]
Epichlorohydrin (1- chloro- 2,3- epoxy propane)
Ethylene dibromide (1,2- dibromoethane) [2]
N- Nitroso- N- methylurea
2- Nitropropane
Chlorobenzene
Ethylbenzene
Xylenes (isomer & mixtures)
Styrene
p- Xylene
m- Xylene
Methyl isobutyl ketone (hexone)
Bromoform (tribromomethane)
l, l, 2,2- Tetrachloroethane[2]
o- Xylene
Dimethylcarbamyl chloride
N- Nitrosodimethylamine
Beta- Propiolactone
Cumene (isopropylbenzene)
Acrylic acid
N, N- Dimethylformamide
1,3- Propane sultone
Acetophenone
Dimethyl sulfate

1. Major emission product of unburned fuel, see Attachment 3.
2. This method covers 15 of the 16 VOC urban hazardous air pollutants identified in the Integrated Urban Air Toxics Strategy.
3. Requested by the community.

Attachment 7 continued

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, **Compendium Method TO-15: Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters And Analyzed By Gas Chromatography/Mass Spectrometry (GC/MS)**

Benzyl chloride (a- chlorotoluene)
1,2- Dibromo- 3- chloropropane
Bis(2- Chloroethyl) ether
Chloroacetic acid
Aniline (aminobenzene)
1,4- Dichlorobenzene (p-)
Ethyl carbamate (urethane)
Acrylamide
N, N- Dimethylaniline
Hexachloroethane
Hexachlorobutadiene[2]
Isophorone
N- Nitrosomorpholine
Styrene oxide
Diethyl sulfate
Cresylic acid (cresol isomer mixture)
o- Cresol
Catechol (o- hydroxyphenol)
Phenol
1,2,4- Trichlorobenzene
nitrobenzene

1. Major emission product of unburned fuel, see Attachment 3.
2. This method covers 15 of the 16 VOC urban hazardous air pollutants identified in the Integrated Urban Air Toxics Strategy.
3. Requested by the community.

ATTACHMENT 8

Compendium of Methods for the Determination of Inorganic Compounds in Ambient Air
Compendium Method IO-3.3: Determination of Metals in Ambient Particulate Matter Using X-Ray Fluorescence (XRF) Spectroscopy

Center for Environmental Research Information
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268
June 1999

Chemical analysis using $PM_{2.5}$ speciation samplers will be used to provide data on 58 elements including all seven (arsenic, cadmium, chromium, lead, manganese, mercury, nickel) of the eight Urban Air Toxics HAP metals. X-ray Fluorescence (XRF) will be used as the analytical method for metals. This is the same method as will be used in the $PM_{2.5}$ chemical speciation program. These chemicals will be collected with the same speciated particulate matter samplers but would be analyzed with more specific analytical techniques (neutron activation).

ATTACHMENT 9: Estimated Costs

One time capital costs

Compounds	**Method**	**Cost**	**Subtotal &Total**
NO, NO_2, NO_X	EPA reference or equivalent	$ 36,000	
CO	EPA reference or equivalent	$ 20,000	
VOCs	EPA TO-14A or 15	$ 32,000	
Carbonyls	EPA TO-11a	$ 18,000	
PAHs	EPA TO-13a	$ 16,000	
Speciated $PM_{2.5}$ Trace elements (metals) Organic and elemental carbon	 EPA IO-3.3 NIOSH 5040	$ 20,000	
$PM_{2.5}$ (mass)	EPA reference or equivalent	$ 20,000	
Automated $PM_{2.5}$ (mass)	TEOM	$ 26,000	
SUBTOTAL			**$188,000**
Meteorological		$ 10,000	
Site & Shelter		$ 30,000	
Automated Gas Chromatograph – Targeted Continuous VOCs		$ 30,000	
2 Strip chart recorders		$ 10,000	
2 Data loggers		$ 12,000	
SUBTOTAL			**$ 92,000**
TOTAL PER SITE			**$280,000**
TOTAL FOR 2 SITES			**$560,000**

Operation and maintenance (including annual parts, supplies, laboratory analysis)

Compounds	**Method**	**Cost/site/year**	**Subtotal &Total**
NO, NO_2, NO_X	EPA reference or equivalent	$ 12,000	
CO	EPA reference or equivalent	$ 15,000	
VOCs	EPA TO-14A or 15	$ 40,000	
Carbonyls	EPA TO-11a	$ 12,000	
PAHs	EPA TO-13a	$ 60,000	
Speciated $PM_{2.5}$ Trace elements (metals) Organic and elemental carbon	 EPA IO-3.3 NIOSH 5040	$ 32,000	
$PM_{2.5}$ (mass)	EPA reference or equivalent	$ 10,000	
Automated $PM_{2.5}$ (mass)	TEOM	$ 10,000	
SUBTOTAL			**$ 191,000**
Meteorological		$ 2,000	
Site & Shelter		$ 2,000	
Targeted Continuous VOCs		$ 12,000	
2 Strip chart recorders		$ 1,000	
2 Data loggers		$ 1,000	
SUBTOTAL			**$ 18,000**
TOTAL/ SITE/ YEAR		$ 211,000	**$ 209,000**
TOTAL/ 2 SITES/ 3 YEARS			**$1, 254,000**

Attachment 10: Community Representatives Comments

SUMMARY

We, the community representatives, would like to express our appreciation for being invited to participate in the study team's efforts and being given this opportunity to provide additional information. The community is very concerned about the health effects of many toxic emissions caused by airport related activities. We recognize that the technical points of the report should be beyond dispute. However we have some differences and there are other issues that require more emphasis and explanation for clarity.

These are the topics of concern:
1. Comparison of the Sea-Tac community to Beacon Hill
2. Assessment of data underestimates issues
3. Lack of conclusive scientific data makes analysis difficult.

We would also like to provide additional reasons to conduct the study including the close proximity of Federal Detention Center and the additional pollution from the anticipated airport growth.

SELECTION OF BEACON HILL AS BASELINE MONITORING SITE

After careful consideration, we, the community representatives, believe the very best comparison site to the SeaTac communities (Highline area) is Shoreline, or a site similar to the Shoreline area. We understand that financing a study at a site where there are no monitors presently located (as there are presently on Beacon Hill) would be more costly, but we feel we should be compared in the fairest manner.

Site Similar to SeaTac needed such as Shoreline

Shoreline is about equal distance north of the city center of Seattle as Highline is to the south. The community of Shoreline developed at the same time as Highline. Both communities started developing before World War II and then developed at a rapid pace after the war and into the 1950's and the 1960's with moderately priced homes east and west of Highway 99 (which both communities share), to more expensive homes along the slopes to Puget Sound (which both communities share). Both communities became primarily bedroom communities with no large industries.

In contrast, Beacon Hill is in close proximity to the city center of Seattle, Renton and the industrial areas of Harbor Island, the Duwamish, and Georgetown; it is also very close to Interstate Highways I-5 and I-90. We believe we should not be compared with the worst or the best environments in the county, but to one that is comparable.

It was not until the early 1970's that Sea-Tac Airport became an increasingly large problem for the residents of Highline. Since 1972 and the opening of the second runway at Sea-Tac Airport, the socio-economic level of Highline community has progressively deteriorated along with the increase in flights at the airport. The one big difference between the Shoreline and Highline areas is Sea-Tac International Airport.

It should be noted that for purposes of comparisons the City of Burien and the Highline School District use Shoreline because of commonality on a multitude of points. The Legislatively funded Burien study known as the HOK Study (Ref. Hellmuth, Obata and Kassabaum, 1997) also used Shoreline as a comparable.

Beacon Hill Site Inadequate for Comparison

Beacon Hill Site Near Three Airports

If you look at a map, you will see that Beacon Hill is located 4.5 miles north of Sea-Tac Airport, 1.25 miles northeast of King County International Airport - Boeing Field, and 3.5 miles northwest of the Renton Airport. With the elevation of Beacon Hill (336 feet) being lower than Sea-Tac Airport (428 feet), and the fact that it is only 4.5 miles away, it is inundated with landings and take-offs from Sea-Tac (Ref. Hopkins, 2000).

When Governor Gary Locke was a candidate for the office of King County Executive in 1993, he spoke at a meeting of Citizens Against Sea-Tac Expansion (CASE). He told of growing up on Beacon Hill where his parents had a small grocery store. He said he could sympathize with people living around Sea-Tac Airport, and he was not for a third runway because he also wanted to protect people on Beacon Hill from more overflights. He remembered growing up on Beacon Hill and pointing his pretend gun at the noisy jets flying overhead. If it is noisy on Beacon Hill from aircraft, it surely must be polluted as well with its close proximity to three airports.

It is important to note that we know of no comprehensive study that has conclusively defined the amount of Beacon Hill ground pollution that is caused by nearby flights, particularly those still at relatively low altitudes. There is insufficient industry data to support the assumption that no airport related activity associated with the three nearby airports contributes to Beacon Hill pollution.

Beacon Hill: “Downwind of Maximum NOx Emissions”

Beacon Hill is the Washington Department of Ecology regional reference monitor site for NO_2. One of the reasons this site was chosen for the permanent monitor is due to several near ozone violations, and one actual ozone violation, in the previous years. NO_2 is an ozone precursor and high rates of NO_2 are indicative of potential ozone violations. To quote the report that recommended it as the regional site (bolding added for emphasis): "*Based on the results presented in the previous sections, we recommend that a permanent NO_2 monitoring site be located at the Beacon Hill Reservoir. Based upon our mobile monitoring surveys, this site has the* ***highest neighborhood scale NO_2*** *concentrations and therefore meets the requirements of the Category (a) NAM site."…"center of the urban scale NO_2 peak and is therefore also an appropriate Category (b) NAM site as specified by EPA. This location therefore serves a dual purpose for* ***urban*** *NO_2 monitoring". . ."A type 2 sites reflects precursor emissions and is located in an area* ***downwind of maximum NOx emissions****. The site is typically located near the boundary of the central* ***business district****. The Beacon Hill site fits this description."* (Ref. Norris, 1995, pages 24, 25). In other words, Beacon Hill was selected as a regional site in part due to its exposure levels of NOx and VOCs (volatile organic components).

Beacon Hill versus SeaTac Existing Data

In the 1993-1994 time frame when the University of Washington (for a Masters project) in conjunction with Department of Ecology conducted a regional saturation study (Ref. Norris, 1995), NO_2 was highest at Beacon Hill. They used a mobile monitoring van that traveled the southern section of Snohomish County, through King County, but bypassed Sea-Tac Airport, through Renton, Kent-east hill, and on to Enumclaw, then to Pierce County. The **highest** regional rates of NO_2 detected in the five-minute averages using the mobile monitoring were at Beacon Hill. In 1993-94, canister samplers were placed throughout Seattle. The results of these canister samples were compared to the mobile monitoring data and found to be somewhat lower (six week averages usually tend to be lower than five minute averages) but still found Beacon Hill to be the highest site in the greater Seattle area (Ref. Norris, 1993)**.** Neither of these studies took measurements near Sea-Tac Airport.

The fact that no monitoring for NO_2 had been done around the area was an important factor in the Department of Ecology's willingness to begin the 1998/1999 study (Ref. Frost Draft NOx report, 1999). Beacon Hill was used as a comparison site. The results of the Sea-Tac monitoring showed a higher yearly NO_2 average for SeaTac than Beacon Hill. Although the averages are not violating the federal standard, they are still an indicator of potential regional ozone problems. A review of the raw Sea-Tac NOx data supplied to D. Wagner suggests that the high hourly readings are not Highway 518 traffic related. This leads to the hypothesis that the unidentified local NO source mentioned in the Dec. 1999 draft report (Ref. Frost, 1999) is airport related. There is insufficient data to determine how much of the NO is from airport ground equipment, vehicles and aircraft.

The Washington Dept of Ecology 1997 Air Quality Data Summary report for Washington shows Beacon Hill's NO_2 levels to be the highest of all the sites regularly measured for 1995 through 1997. The SeaTac area was not measured.

If the various data sources mentioned above are considered, one might draw the conclusion that SeaTac has the highest annual NO_2 average of any site measured in the area. This leads to the logical question, how much is Sea-Tac Airport's ground and air traffic influencing the regional pollution levels? This question cannot be answered if Beacon Hill is used as the only comparison site.

Obviously, Beacon Hill is a heavily polluted area. It has numerous pollution sources including several nearby significant industrial source polluters and freeways on both sides. In addition, it's potentially influenced by heavy overhead traffic from King County International Airport-Boeing Field and Sea-Tac as well as to a lesser extent, the Renton airport. It is virtually unknown how high the rates of pollutants of concern, primarily air toxics, will be at Beacon Hill. But reason dictates that they may be higher than average for other residential communities located upwind and away from regional pollution sources. Sea-Tac Airport area is a relatively clean area with no other industrial sources besides the airport. It is unfair to compare bad to bad and then conclude that Sea-Tac Airport area is no different than other areas in the region.

Site Selection Summary

We, the community representatives, feel that when considering the difference between $3.2 million for a study using heavily polluted Beacon Hill as the comparison site and $3.7 million for a study using a more representative residential site for comparison, the more meaningful comparison is worth the additional cost. The difference is an additional $500,000 or 13.5% more to have a more scientifically acceptable study.

In addition, we recommend canisters or other testing equipment be placed in nearby neighborhoods to characterize pollutants such as the east-west Normandy Park trough where kerosene smell complaints are common. A schedule could be developed to move the equipment periodically so multiple locations could be assessed seasonally using one set of equipment (omit metrology equipment to save costs).

ASSESSMENT OF DATA UNDERESTIMATES ISSUES

The body of the report intentionally avoided drawing conclusions regarding data that was not statistically significant or did not have a large body of scientific data behind it. We, the Community members, appreciate this opportunity to identify additional areas of concern. Until a much larger database can be gathered, it will be extremely difficult to gather statistically significant data due to small population size at any one airport and the large number of other variables. Some key discussion areas are:

a) Baseline used for comparison already had acknowledged health issues
b) Inherent variability in statistical analysis of small populations
c) Complex demographics
d) Study area definition influences results
e) Lack of conclusive scientific data regarding glioblastoma, de-icers and other pollutants.

Baseline Data used for Comparison has Health Issues

King County is one of 7 counties in the US with 8 Superfund sites. The County is ranked number 1 in the State of Washington for cancer risk associated with mobile and point sources by the Environmental Defense Scorecard database which is passed on EPA data (Ref. Environmental Defense, 1999). This database excludes airport pollution so it underestimates pollution for King County compared to other Washington counties. It is reasonable to assume that pollution related illnesses would be high in King County even if Sea-Tac Airport were not present.

The Department of Public Health data (Georgetown, 1997, SeaTac Health reports Feb. and Dec. 1999) and King County (Ref. Public Health Data Watch Vol. 2, No. 1 and 2, The Health of King County report, 1998) reports shows that Georgetown, South Park and SeaTac area share common health problems. In other words, these recent health studies have uncovered an asthma hot spot in King County including central Seattle, Southeast Seattle, West Seattle, White Center, and the SeaTac area. Where more detailed studies have been performed, studies reveal it is not just asthma but respiratory illnesses in general that are statistically significantly higher than the rest of King County. The other illnesses include, but are not limited to, pneumonia/influenza, and lung cancer. Comparing the SeaTac area, whose only real industry is the Sea-Tac Airport, to the King County baseline data tends to make the health issues appear less significant than when the Washington state rate is used. In particular -

a) Except for the cancer incidence data, which also reports the state rate, the Feb. 1999 SeaTac Health report uses King County as the baseline. The February 1998 Public Health Data Watch states on page 1 that the King County childhood asthma hospitalizations are "significantly higher than elsewhere in Washington State". The central Seattle asthma rates, that are even higher than the SeaTac area, are in the King County baseline.

b) The August 1998 Public Health Data Watch indicates that the King County trend in childhood asthma hospitalizations is increasing, particularly for the age 1 to 4 group. It increased 39% from 1987 to 1996.

c) The health data also sometimes uses Washington as the comparison point. The Washington data is skewed higher because of the large contribution of King County data. King County is the most densely populated county in state and represents over 10% of the state population. The February 1998 Public Health Data Watch also includes a graph that shows that the King County data contributes so much to the Washington State average, that the Washington average for the 1996 childhood hospitalizations is inflated by 25 per 100,000. Note, that when Washington was used as a baseline rather than King County, liver cancer became statistically significant for the SeaTac area.

<u>Inherent variability in Statistical Approach</u>

Using census tract data, for 1993-1997, the average for the ten leading causes of death was higher for SeaTac area than King County except for AIDS, which was 41% lower, and cerebrovascular disease, which was the same as King County (Ref. Table 2 of the Feb. 1999 SeaTac Health report). Of the eight causes of death whose average was higher, only two were "statistically significant", namely, cancer of all sites combined and chronic pulmonary obstructive disease.

A review of the Appendix A statistics in the Feb. 1999 SeaTac Health report indicates that typically the difference between the lower bound and upper bound numbers corresponding to the 95% confidence interval (95% probability additional data will fall between the upper and lower bound numbers, i.e. the error band around the average or the "plus or minus" around the average) is greater for the SeaTac area than King County. The SeaTac error bands are so large that the SeaTac area average can be higher than the King County baseline by 33%, as is the case for deaths due to breast cancer, or 28% higher for suicide, yet it is NOT statistically significant (Ref. Table 3 and 2 respectively, Feb. 1999 SeaTac Health report). One of the reasons for the large error band for the SeaTac area calculations is the smaller population group that is used to generate it as compared to the large population group that generated the King County data. This is an inherent problem with small population statistical analysis.

Small population analysis difficulties are so prevalent that “virtually all of the top tier medical journals now require that the authors have performed a Power Analysis. The Power Analysis is a measure of chance that the authors missed an association that actually was present. In some ways, it is a reverse of a P value and is commonly referred to as the chance of beta error. Not surprisingly, studies with small sample sizes are much more likely to miss an association than studies with large sizes" (Ref. Noller, 2000).

Note, some of the large SeaTac error bands that lead to the conclusion that something is not statistically significant, may also be caused by how the data was generated. If the flight path area had been treated as a single group, the statistics might have been tighter (i.e. smaller plus or minus around the average) assuming the study area is defined in such a way to have about the same population. Health problems may be underestimated by treating as one study group both the less polluted west side with those that have more direct pollution exposure, i.e. those under the flight path or in a direct line with jet exhaust as aircraft await take-off such as Riverton Heights to the northeast.

Complex Demographics

Susceptibility varies by Age and Gender

Nationally cancer data are tracked not only by total numbers but also by sex and age. This is because susceptibility to disease varies both by sex and age (Ref. Highline Community Hospital Admission data and Highline Community Hospital cancer data as reported 1991 through 1999). This may help explain why the Dec. 1999 SeaTac Health report identified esophagus cancer as high, but not statistically significant, while Highline Hospital data indicated it was **about double the National average for women** (Ref. Highline Hospital data 1994, 1995, 1997 and Brown 1999). The Dept of Public Health recently indicated that they had made some internal age and sex adjustments to the cancer incidence data but additional work would be needed to provide the data by sex and age. Since this data was unavailable for review, we were unable to determine if items of the most interest to the community were on the border of being statistically significant.

Transient Population Skews Statistics

In linking tobacco smoking of pregnant women to health risks around the airport, we believe the following explanation to be true: Apartment rental rates near Sea-Tac Airport are the lowest in the Seattle area, for obvious reasons. Many young pregnant women arrive in our community and stay in one of the many apartments for a short period of time and move on after giving birth. These young women and their children are a transient population and consume a large portion of health care dollars in our community; they also skew the statistics for prenatal care. Our community also has a large stable, multi-generational population of homeowners that do not fit the profile that these statistics show.

Study Area Definition Influences Results

Assembled data used three different study area definitions

It is difficult to compare data in the 1999 SeaTac Health reports because the **study boundaries are all different** (see maps in Feb. 1999 report). For the following sets of data, the boundaries are different, **particularly with respect to the southern boundary.**

(1) Table 1 detailed cancer incidence data based on geocoding and reported as 1, 3 and 5-mile concentric circles (Table 1, Feb. 1999, also in Dec. 1999).
(2) Appendix A hospitalizations (all causes) based on zip codes. The area extended almost 5 miles to the northeast but excluded almost the entire southern flight path area (zip code 98198).
(3) Appendix A mortalities (all causes) based on census tracts. The area extended about 3 miles north of the airport but only a little over a mile south of it.

Why is there such a difference in the Feb. 1999 Appendix A mortality census data versus the incidence geocoded data (Feb. 1999, Table 1). For example, Table 1 of the Feb. 1999 SeaTac report, also included as an attachment in the Dec. 1999 SeaTac Health report, indicated that the number of breast cancer cases is lower than expected based on geocode data. This contrasts sharply with the Feb. 1999 SeaTac Health report Appendix A, Table 3 census data; it indicated deaths from breast cancer are 33 % higher for the SeaTac area than King County. Can delayed care or just the typical variation from these types of statistics really be the only reason for this disparity?

Key zip code missing from some data

Zip code 98198, whose northern section is highly impacted by the flight path on the south end of the airport, was **missing** from the hospitalization data in the Feb. 1999 SeaTac Health report. When the south end was analyzed for glioblastoma using geospatial analysis that broke east, west, north and south into quadrants (Figure 1, Dec. 1999), the statistically significant glioblastoma was no longer just limited to year 1992. This raises the question that if the south end zip code had been included in hospitalizations, would the statistically significant 13% higher hospitalizations (all causes) be even higher (Ref. Feb. 1999, Appendix A, Table 4)?

Circular distribution of study group non-representative of Pollution Distribution

In close proximity to the airport the communities most severely impacted should be those under the flight paths. These areas would be represented by a rectangle. However, following traditional methodology, the Feb. 1999 SeaTac Health report used concentric circles to report the incidence of various diseases (i.e.. one, three and five miles around the airport). The issue with these statistics became very obvious when, at the request of one community member, the data on glioblastoma multiformes (GBM) was restated in terms of “North, South, East and West” in the Dec. 1999 SeaTac Health report (see Table 3 glioblastoma data in report). The incidence of GBM was found to be statistically significantly elevated in the south for more than one year. This is the south part of the rectangle representing the flight pathways and the missing zip code (98198).

In addition to the “quadrant” geospatial analysis, a SaTScan geospatial analysis that used the center of census tracks as the starting point, was run. It showed elevated brain cancer in the south, as did the quadrant approach, however, using the SatScan geospatial analysis, the increased GBM was no longer statistically significant. The different results using these different approaches illustrate the importance of selecting the most suitable analytical approach for the situation. In addition to trying to determine valid study groups and analysis tools, the task is further complicated by the difficulty of getting accurate incidence and mortality data. Washington death certificate coding does not even include GBM.

Flight operations and Winds Impact Exposure Levels

Since aircraft fly certain flight paths more often and the wind blows from some directions more frequently than others, different areas are exposed to different combinations of pollutants at different frequencies and concentrations. The analysis conducted during the 1998/1999 nitrogen oxides (NOx refers to NO and NO_2) study by the Washington Dept. of Ecology in conjunction with the University of Washington illustrates the effects of wind. This provides additional justification for grouping health study groups by their exposure level to aircraft pollutants rather than using large concentric circles, zip codes or census tracts.

Terrain Differences Impact Exposure Levels

Terrain differences influence what chemicals, their potency, and the frequency of exposure may help account for the differences in health data, including glioblastomas. Based on the topography map IV19-1 in the Sea-Tac Final Environmental Impact Statement (FEIS) Vol. 1 and touch down altitudes for each runway, it appears that the distance from the flying aircraft to the people, as well as the terrain, may be an important factor in understanding the areas' health and pollution problems including the higher incidence of brain tumors on the south end.

When at the schools affected by the south flight path, including Olympic Elementary School, North Hill Elementary, St. Philomena Elementary, Midway Intermediate, Pacific Middle and Mount Rainier High School, the aircraft are so close that it feels like you could reach up and touch the passenger aircraft (Ref. Brown 1999 provides elevation data). When the heavily loaded cargo planes take-off at the south end, they tend to climb up more slowly. Thus, they remain lower over the community for a longer distance.

The high northeast corner that was identified in the 1998/1999 NOx study to be one of the areas most impacted by NOx, is near the buy-out area whose number of glioblastomas prior to 1992, sparked the communities first concerns regarding glioblastoma. See also the following Glioblastomas section.

It should also be noted that during the 1995 McCully, Frick & Gilman airport study the residential area in Normandy Park, site 7, which was expected to have the lowest pollution, actually had some of the highest values for some pollutants such as methyl chloride and 1,1,1 trichloroethane. This may illustrate the complexity of the flight path, wind and terrain interactions.

Lack of Conclusive Scientific Data

Glioblastomas

Glioblastoma multiforme (GBM) is a very rare primary brain tumor. It is thought to be linked with the petroleum industry. A study in Sweden focused on an oil refinery while another in the US focused on a petroleum research facility (Ref. Gaines, 1997). It should be noted that jet exhaust, including unburned fuel, is a byproduct of petroleum. For those living near the airport, jet exhaust is breathed daily and absorbed through the skin. That there is a large number of glioblastoma in the area south of Sea-Tac Airport is not disputed. That there was a "spike" in 1992 is not disputed.

What is disputed, is what it means. All of the cases were among older people: older in terms of both years and residency. This data, especially the spike, should be a warning that the problem is long term in developing; GBM has a long latency period. That with our aging population the numbers may continue to increase; that with planes flying over areas of this community not directly flown over previously exposing more people to direct contamination with airport pollution we may indeed see an increase in the incidence of GBM. Admittedly we know little about glioblastoma but available information points towards pollutants as a potential cause (Ref. Rock 1999, Lamberton 1998, EPA database - vinyl chloride). It should behoove society to fund more research into the causes of this disease that leads to such a painful death.

We are still concerned about if there is a relationship between pollutants from the airport and people living nearby developing glioblastoma multiforme (GBM). Is it a coincidence that we know of four people who both lived and worked in very close proximity to the airport for over 30 years and died of GBM? Three were women who worked at Riverton Elementary School, a small school located near the northeast corner of the Sea-Tac runways. The school has since been closed. The fourth was a man who delivered jet fuel to the airport, and a husband to one of the three women. All four died in the late 1980's and early 1990's. One of these deaths is included in the SeaTac Health report.

All four lived in a buy-out area - three lived in homes that were bought out by the airport in the early 1990's; one lived in an earlier buy-out area. The Washington State Health Department has attempted two times to reach those from the early 1990's buy-out area with some success. We wonder how many of the residents from the earlier buy-out areas who relocated may have developed GBM as the one case mentioned above.

The expected rate of glioblastoma identified for the south was almost double the expected Washington state rate (17 compared to 8.87 for 1992 through 1997, Ref. Dec. 1999 SeaTac Health report, Table 3) using one type of geospatial analysis. Page 9 of the Dec. 1999 report states (bolding added for emphasis)" *This results in statistically significant elevation . . . between 1992 and 1997…* ***No single year accounts for the elevation****."* This combined with other anecdotal evidence, leads the community members to conclude that there are serious health issues in the area.

<u>De-icers</u>

Although de-icing activity is greatest in the winter, it is required year round for some types of aircraft at Sea-Tac. Just before take-off a plane is sprayed with de-icer. As the planes rise, the de-icer vaporizes and sheets off the wings. This is the same area that exhaust enters the air. Could the de-icer mist mixing with jet exhaust cause a chemical interaction that creates health problems, in addition to those created by jet exhaust or de-icers individually, for those living near the airport? We would like to know what chemicals are used in these de-icers. Do they react with components of air or water? What are their possible effects (known or not yet determined but likely) on human health? These chemicals should be evaluated and their levels assessed.

Considering the recent studies uncovering their toxicity in water, their toxicity as they fall to the ground also becomes an issue. A 1993 report by Hartwell states, "It appears the additives are the major sources of acute toxicity rather than the glycols..." When referring to de-icers in a 1999 newspaper interview, Devon Cancilla, a WWU environmental chemist states, "This is a very toxic stew". He also states, "Moreover, the tolyltriazoles are making the de-icers more hazardous to workers and the environment than propylene glycol or ethylene glycol, the chemicals they are typically mixed with." As a result of Canadian studies, Canada now regulates de-icers.

Impacts from Pollutants

The body of this report mentioned only those illnesses officially linked to air pollutants with extremely well documented health effects. Several carcinogenic chemicals have been measured at SeaTac that exceed acceptable source impact levels (ASILs) (Ref. Adams, et al. 1973, McCulley et al., 1995 and DesMarias, 1995, page 18). The online EPA Integrated Risk Assessment Information System (IRIS) and Unified Toxics databases as well as EPA reports such as EPA420-R-00-013 released in 1999 list numerous possible health effects for pollutants present near airports. In some cases, the data may be based on animal studies or just limited to occupational exposure and, therefore, is not conclusive. The possible health effects include various cancers, respiratory illness and low birth weight, etc. (Ref. Batt, 1999, EPA databases).

Nitro compounds are of particular concern to the community (Ref. CASE Western University, 1986). However, it is our understanding that standard test methods do not exist for these chemicals so their measurement cannot be pursued as part of this study.

ADDITIONAL REASONS FOR THE STUDY

One area of concern is that the jets are allowed to fly without the express permission of the people who are physically affected. There are flight tracks on a map. In reality planes spewing exhaust fly outside those tracks. On the one hand, this is a noise issue. On the other hand, it is an emerging issue of spreading jet exhaust to populations that have formerly been somewhat to the side and perhaps not as directly contaminated. In the interest of environmental justice, the impacts on the residents need to be considered. The question that begs an answer is "Is the jet exhaust creating health risks for a long established, rooted community shortening lifespan, or negatively impacting their quality of life with a number of health impacts? If so, what has happened to their rights? If not, do we know that all available means of protecting the population have been exhausted?

Close Proximity To Federal Detention Center And Environmental Justice

One of the most "captive" of area residents are the inmates of the Federal Detention Center located almost directly under the southern flight path on southern S 200 Street. They have absolutely no means of moving to a healthier location. Due to high aircraft noise exposure the north side of a two-lane road running east and west was purchased by Sea-Tac Airport. The south side of that same road was determined to be a suitable location for what is in reality a prison. The site was never studied from the aspect of possibly unhealthy air quality. Is it right and proper that we house a captive population within a potential health hazard area?

The same arguments of environmental justice can also be applied to those who work for the Federal Detention Center. It is assumed that the work environment is safe and that they are not intentionally placed in an area of risk. Is that not what happened to residents near and employees of several of US nuclear plants, including our own Hanford? What are we, as a society, going to do if these employees learn that their lives have been shortened due the poor air quality of their work environment?

When the existing runway is lengthened, the Federal Detention Center will be just outside the area officially defined as a ‘no build zone” by the FAA. The 600-foot runway extension will increase the pollution exposure of these workers and inmates.

Additional Operations will Increase Exposure

We feel very strongly that an inventory of jet fuel toxic emissions is urgently needed. It is critical that levels of these toxins not be allowed to increase without regard to their effects on surrounding communities. Exposure to these chemicals most likely takes several years to appear in health statistics.

Around Sea-Tac Airport are old, well-established, multigenerational communities. Children born in the area are in the community twenty-four hours daily. They attend local schools, many of which are directly under the flight path. Some attend Highline Community College, which is also under the flight path. Like small town people, they often settle in the same area.

We should be trying to reduce diseases caused by toxins by removing the toxins from the environment. We should be protecting the air and ground water where these toxins are known to ultimately settle. The airport has several "dump sites" where toxic waste from chemicals produced and used by them are left to find their way into ground water. The Port of Seattle wants to increase capacity by doubling the air traffic at this airport.

We, the community representatives, would like to know:

1) What are the levels of these toxic products released into our environment currently?
2) What are they likely to be as the airport growth increases (both the air and ground vehicle pollution)?

The proposed Third runway will be lower, and to the west, of the current two runways. The terrain is such that the departing and arriving aircraft will be closer to people when the Third runway is used than with current aircraft operations**.**

Since it was out of scope to review the underlying modeling assumptions, the Dec. 1999 SeaTac Health report understated the ramifications of the emissions analysis in the Master Plan Project Update Supplementary Environmental Impact Statement

(SEIS) and Final Environmental Impact Statement (FEIS). The Dec 1999 Health report, when referring to the FEIS/SEIS, states *“The report states that the addition of a runway was expected to reduce emissions by 2005 and 2010 since the additional runway would lessen the time currently spent queued up waiting for take-off.”* However, in reality, the analysis calculated pollution for a “Do Nothing” scenario that assumed the airport would operate over theoretical capacity and that no street or parking improvements would be made. By making these false assumptions, it overestimated BOTH the air and ground traffic pollution for the existing configuration. It then compared the unrealistically high “Do Nothing” pollution to the Third runway configuration. The Third runway configuration included a new parking lot and a new road that was already planned in order to reduce ground traffic pollution in, what was then, a non-attainment area. Had the EIS analyzed what the Dec. 1999 report indicated, i.e. compared the Third runway to the existing pollution, instead of concluding there would be less pollution, it would have concluded that there was so much additional pollution that the Clean Air Act de-minimus limit for NOx would be exceeded (Ref. Brown 1999).

Further substantiation for our concerns of increasing health threat posed by the increasing number of operations at the airport can be found in a 1999 report, EPA420-R-00-013, Evaluation of Air Pollutant Emissions from Subsonic Commercial Jet Aircraft”. It discusses the increasing percentage of NOx being contributed by air traffic compared to ground traffic in the U.S. and health impacts associated with even “low” levels of NOx. Its references to childhood asthma are particularly relevant considering the high asthma rates in children discussed earlier herein. Note the 1999 EPA report assumed an air traffic growth factor that appears low with respect to SeaTac, so the report may underestimate the issues at SeaTac.

CONCLUSION

This study would be an excellent baseline for an urban airport study. The absence of major industrial pollution sources nearby will help to isolate the airport pollutants. It could then be used to help interpret other airport pollution data such as O'Hare with more complex situations due to nearby heavy industry (Ref. EPA proposal, 1999). Ground traffic pollutants are present at all busy airports but the SeaTac highway configurations are such that the traffic can be accounted for. The close proximity of schools and homes, as well as the diverse socio-economic backgrounds of the community, would make it suitable for follow-on health studies if the data warrants it. Over 300,000 people live within a five-mile radius of Sea-Tac Airport, hence, the concern that no inventory of pollutants has been performed for this area. Sea-Tac Airport's manager, Gina Marie Lindsey, said in an interview on KIRO-TV, on July 10, 1998, speaking on health research needed around airports, *"new research would be welcome. We would certainly support that and we would even invite that here to Seattle to use us as a test case."*

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