Air Toxics Emission Inventory

for the

Southeast Chicago Area

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Increasing national attention has focussed on the health risks from "toxic" (non-criteria) air pollutants that arise in urban areas where a concentrated level of industrial activity coexists with high population density. Within Region V, perhaps the most serious combination of concentrated industrial activity with high population density is in Southeast Chicago. In particular, the area is one of the foremost locations for integrated steel production and chemical production of the coatings used in Chicago's substantial manufacturing economy. This area also has one of the nation's five permitted PCB incinerators and has a variety of other facilities for treating, storing and disposing of hazardous waste. Therefore, Region V, with assistance from the Illinois Environmental Protection Agency (IEPA) and the Indiana Department of Environmental Management (IDEM), has compiled a comprehensive inventory of "air toxics" emissions in the Southeast Chicago area.

The inventory described in this report represents the first component of a three part project. The next component of this project is a modeling analysis, which will serve to estimate the exposure of Southeast Chicago residents to the emitted pollutants. The third component will then estimate the health risks that would be expected from the estimated exposure.

In any inventory of this type, resource considerations require a choice between developing a screening inventory covering multiple source types using only readily available information versus developing a more focussed inventory investigating only a few source types or pollutants. This inventory may be considered a screening inventory, intended to provide an overview of air carcinogen emissions in the covered area.

This inventory has been designed to be comprehensive in several respects. First, this study has attempted to include all source types that emit air toxics. Second, although the focus of this study is an exposure in a moderate sized area (approximately 65 square miles), a much broader area was inventoried to include all sources with potentially significant impacts in the selected receptor area. Third, this study inventoried for a comprehensive list of potential carcinogens. Specifically, the inventory included all potential carcinogens for which a dose-response relationship has been estimated even including some compounds with minimal evidence of carcinogenicity. This inventory also included three compounds which are not suspected of being carcinogens but have been measured at relatively high concentrations in the area. Unfortunately, apart from these three compounds, the inclusion of compounds of the basis of noncarcinogenic health effects was judged to be beyond to scope of this study, due to the relative sparsity of data on dose-response relationship for such health effects, the uncertainties about presence and magnitude of threshold concentrations, the uncertainties about the relative importance of short term peak versus long term average concentrations, and the analytical difficulties of considering these various parameters. Also, a fourth substance, mercury, is also not a suspected carcinogen but was included because a National Emission Standard for Hazardous Air Pollutants has been promulgated for this pollutant.
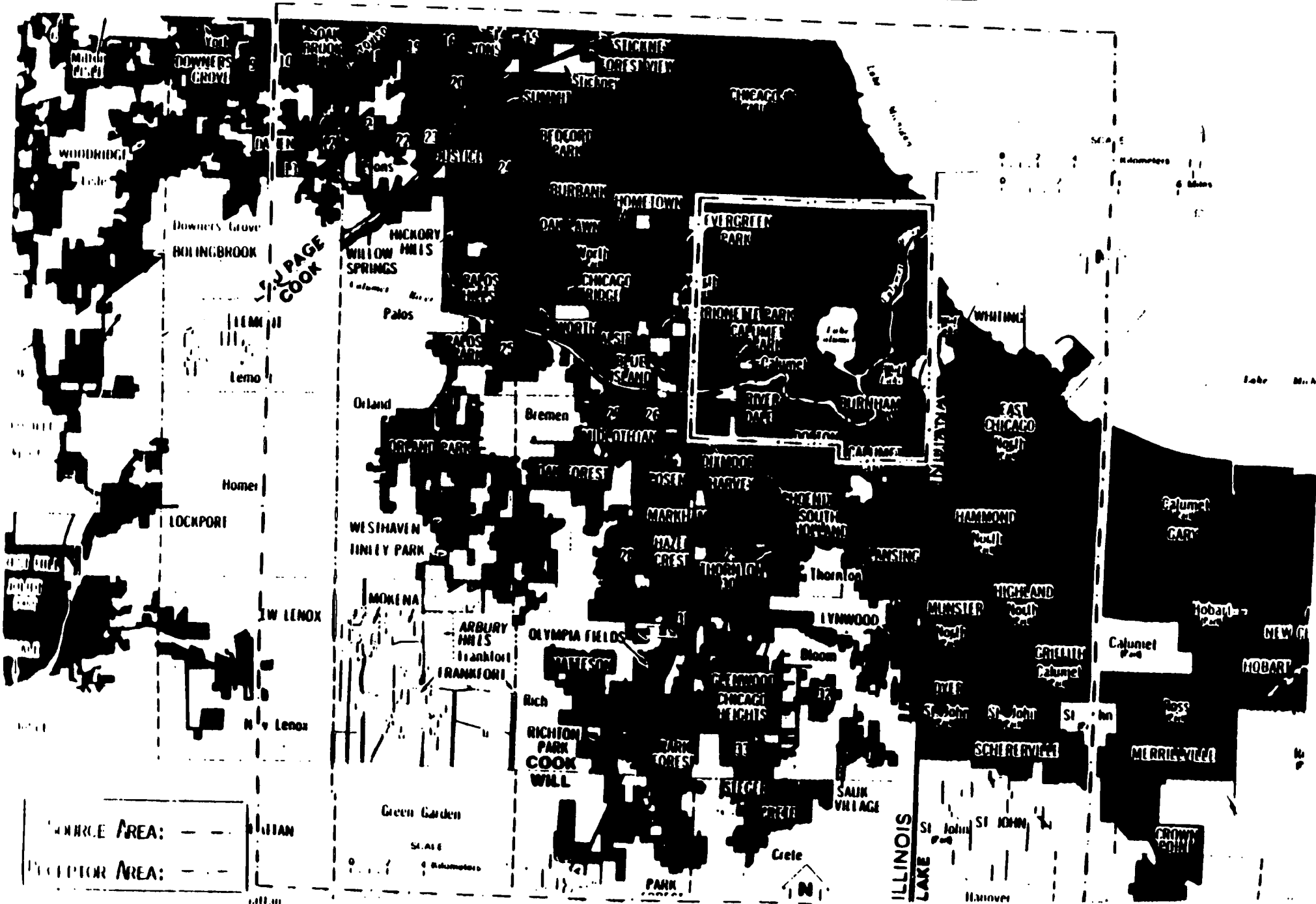
With respect to source types, this study included all source types for which air toxics emissions could be estimated. The inventory included point sources, area sources, and mobile sources, and further included volatilization from wastewater treatment plants. Emissions estimates for hazardous waste treatment, storage and disposal facilities (TSDF's) have been difficult to derive but are expected to become available in the next few months. It must be noted that there may be source categories which are not included because data for estimating the emissions are not available. On the other hand, it is a reasonable hope that data are available for the most significant categories.

With respect to spatial coverage, Figure 1 is a map showing both the target "receptor area" for the exposure analysis and the broader source area included in the inventory. The target area of the exposure analysis component of this study is an area approximately 13 kilometers square (8 miles square) for a total of 167 square kilometers (65 square miles). The specific boundaries of this receptor area are: north-87th; south-Sibley Blvd/Pulaski St.; west-Western Ave.; and east-Indiana/Illinois border. In order to include all significant sources, a substantially larger source area was inventoried. The source area covers a 46 kilometer (about 29 miles) square area. Since the prevailing winds in the area are from the southwest quadrant, the source area is skewed toward the south and west of the receptor area. The specific boundaries of the source area are, in terms of UTM coordinates from 4584 to 4620 kilometers northing and from 420 to 466 kilometers easting in zone 16. This source area extends approximately 30 kilometers south and west and 16 kilometers north and east of the center of the receptor area. The inventory further includes a few additional point sources which are outside this source area but were judged to be potentially significant sources.

With respect to pollutants covered, the inventory includes 47 compounds for which quantitative estimates of carcinogenicity (unit risk factors) have been made. The list of compounds is given in Table 1 and includes 22 nonhalogenated organics compounds, 17 halogenated organic compounds (including 16 chlorinated and one brominated organics), and 8 inorganic species (especially metals). It is important to note that the carcinogenicity of some of these compounds is quite speculative. Nevertheless, these compounds were included so that any error would be on the side of being comprehensive. As noted above, the compound list also included four compounds which are not suspected of being carcinogenic, but otherwise did not include any compounds on the basis of noncarcinogenic health effects. It might also be noted that several of the compounds on the inventory are relatively esoteric. As will be discussed below, the inventory for Southeast Chicago found emissions for 39 of the 51 compounds.

Some of the pollutants in this study warrant special discussion. First, form-aldehyde is not only emitted into the atmosphere but it is also photochemically formed during atmospheric reactions of other organics. Current evidence indicates that substantially more formaldehyde results from photochemical formation than from direct emissions. Thus, the ultimate total exposure estimate is likely to rely more heavily on monitoring data, with the inventorybased exposure estimate serving only to help characterize the relative importance of emissions versus photochemical formation. Somewhat similar considerations apply for a second pollutant, carbon tetrachloride. This compound has an atmospheric half-life of many years, and so exposure may be more a function of historic emissions than of current emissions. Thus, monitoring data may again

Southeast Chicago
Source Area & Receptor Area

Table 1. Substances included in inventory

NON-CHLORINATED VOC (22)	CHLORINATED VOC (17)	INORGANIC (8)
Acrylamide	Allyl Chloride	Arsenic
Acrylonitrile	Benzyl Chloride	Asbestos
Benzene	Carbon Tetrachloride	Beryllium
Butadiene	Chloroform	Cadmium
Coke Oven Emissions	Dioxin	Chromium
Diethanolamine	Epichlorohydrin	Nickel
Dimethylnitrosamine	Ethylene Dibromide*	Titanium Dioxide
Dioctylphthalate	Ethylene Dichloride	Radionuclides
Ethyl Acrylate	Methyl Chloride	
Ethylene	Methylene Chloride	NON-CARCINOGENS (4)
Ethylene Oxide	Pentachlorophenol	
Formaldehyde	Perchloroethylene	Acetone
Gasoline Vapors	PCB's	Mercury
Isopropylidene Diphenol	Propylene Dichloride	Toluene
Melamine	Trichloroethylene	Xylene
Nitrobenzene	Vinyl Chloride	
Nitrosomorpholine	Vinylidene Chloride	
Polycyclic Organic Matter		
Propylene Oxide		
Styrene		
Terephthalic Acid		

*Although ethylene dibromide is not, strictly speaking, chlorinated, it is halogenated
   and is included among chlorinated compounds due to chemical similarity.

may be a more reliable basis for assessing exposure. A third "pollutant", identified here as polycyclic organic matter, is actually a class of aromatic compounds. Three of the lightest such compounds, namely napthalene (a two ring structure), anthracene (a three ring structure), and phenanthrene (also a three ring structure), are both among the most highly emitted and among the least toxic of this class of compounds. In order to focus on the more significantly toxic compounds, this inventory includes not only an estimate of total polycyclic organic matter but also an estimate of "heavy" polycyclic organic matter that excludes these three compounds. A fourth pollutant, chromium, also in a sense represents a class of pollutants. In this case the different forms are different valence states, including Cr^{+6} (such as found in chromic acid), Cr^{+3}, and neutral (metallic) chromium. It is known that Cr^{+6} is the most toxic form, but it is usually not clear what mix of valence states is present in any set of emissions. Generally, this inventory conservatively assumed that all chromium in the most toxic valence.

Methods used in Inventorying Point Sources

The first component of the inventory was for discrete industrial facilities within (or in a few cases, just outside) the source area. For 29 of the 88 facilities in the source area, questionnaires were sent to the facility by the appropriate State agency (Illinois EPA for Illinois sources, Indiana DEM for Indiana sources). The selection of facilities was intended to include the sources suspected of having the greatest air toxics impact on the receptor area. The first step in the selection procedure was to develop rankings of criteria pollutant impacts on the receptor area. Two rankings were developed, including one for VOC and the other for total suspended particulate matter (TSP), based on indices defined as the respective pollutant emissions divided by distance from source to the center of the receptor area. For the top 25 sources in each ranking, the second step of the selection procedure was a subjective screening of sources for the probability of emitting compounds of interest. This second step of the procedure effectively took into account the fact that VOC and TSP emissions totals are not necessarily indicative of air toxics emissions. This process led to the selection of 13 facilities. In addition, all other chemical manufacturing facilities were included, representing an additional 16 facilities (above and beyond 2 chemical manufacturing facilities selected on the basis of the ranking procedure).

A copy of a sample questionnaire is included as Appendix A. This questionnaire asked the companies to make their own estimates of emissions of each of the substances on the inventory list, and asked for a few other pieces of information needed for modeling. Comments regarding the challenges confronted during the process of companies answering and U.S. EPA processing these questionnaires are given in a concluding section of this report. It may be noted here that substantial followup was often necessary to obtain responses, and in many cases the companies asked U.S.EPA to supply appropriate species fractions or even to estimate emissions (e.g. from storage tank data). Also, in U.S.EPA's review of questionnaire responses, companies were asked in a few cases to clarify or to confirm their responses.

For the other 59 facilities in the source area, a method labeled the "species fraction method" was used. The first step of this method is to obtain emission estimates for total volatile organic compounds and total suspended particulate

matter for each operation of each facility. The second step of the method is to obtain species fractions representing the fractions of the total VOC or the TSP that are emitted as the various individual species. For example, in this study, the fugitive emissions from purging operations at refineries were estimated to be 2.4% benzene. These fractions are then multiplied times the VOC or TSP emissions estimate to obtain estimates of emissions of individual species.

The two main sources of species fraction information were the Volatile Organic Compound (VOC) Species Data Manual and the Receptor Model Source Composition Library. The index indicating which species profiles in the VOC Species Data Manual (i.e., which sets of species fractions) should be applied to which SCC's was developed by the GCA Corporation for another project (the National Acid Precipitation Assessment Program) being undertaken by U.S. EPA. Both the profiles and the index are shown in reference P.2. The authors developed the index indicating which sets of metal species fractions from the Receptor Model Source Composition Library should be applied to which SCCs. This index is shown as Table 2. For this study, estimates of total VOC and TSP emissions were taken from the National Emissions Data System (NEDS), which provided emissions data and identified the Standard Classification Code (SCC) for each operation at each facility.

One subtle point concerning the use of species fractions with VOC totals concerns compounds that are negligibly photochemically reactive, such as methane and methylene chloride. In some cases, the VOC emissions may be derived in a way that excludes these compounds. To the extent this is true, it would be desirable to apply species-fractions derived on the same basis, i.e., species emissions as fractions of just the reactive VOC. Unfortunately, it is not clear what VOC emission estimates exclude the negligibly reactive species. Therefore, all species fractions were derived and applied on a fraction-of-total VOC basis. In any case, the negligibly reactive portion of VOC tends to be small, so that any error here is likely also to be small.

The estimation of emissions by the species fraction method was performed for all facilities, including facilities that were sent questionnaires. This provided the opportunity for quality assurance test of comparing the results of these two methods.

Limited additional information was obtained from a variety of other sources. Coke oven emissions were based on TSP emissions estimates provided as part of Indiana and Illinois TSP SIP submittals. Based on information in reference P.6, emissions of the pollutant identified as "Coke oven emissions" (including organics soluble in benzene) were estimated as 1.1 times the TSP emissions for relevant emission points (coke oven charging and leak emissions). Estimates of benzene emissions from coke by-product recovery plants were obtained directly from reference P.7, (except for Acme, for which an Illinois EPA estimate was used). Toluene and xylene emissions estimates were derived from benzene emissions estimates based on information in reference P.7 suggesting that the coke oven gases are 60-85% benzene, 6-17% toluene, and 1-7% xylene.

Species fraction information for formaldehyde from utility fuel combustion and from industrial coal combustion was derived from the formaldehyde "locator document" (Locating and Estimating Air Emissions from Sources of Formaldehyde, ref. P.4e). This document provided emissions factors in units of grams per Joule of heat input, which was multiplied times the heat content of typical locally used fuels and compared against the standard VOC emission factor to derive the formaldehyde species fraction.

Area Source Inventorying Methods

As with point sources, the most commonly used method for developing area source emissions estimates was the species fraction method. The categories inventoried by this method, the species fractions, and other relevant information are shown in Table 3. In general, the first piece of necessary information was a county-by-county estimate of emissions from each category being assessed. This information was generally derived by the State from the 1982 Chicago ozone State Implementation Plan (SIP). The SIP included VOC emissions estimates based for example on appropriate emission factors times gasoline sales or numbers of houses. Heating TSP emissions were also estimated from fuel use data in the SIP times an appropriate TSP emission factor. The SIP provided county VPOC emissions estimates in kilograms per day for 1980 and 1987. Illinois EPA staff converted these estimates to annual emissions (tons/year) and interpolated to 1984 emissions for Illinois counties, and the authors performed similar calculations for Lake County, Indiana.

The second piece of information was then a set of species fractions, which could be multiplied times the county VOC or TSP emissions to obtain county total species emissions. At this point a third step of spatial disaggregation was performed. This step was necessary to support the modeling analysis of population exposure, since the exposure in the receptor area to emissions is a function of the spatial distribution of emissions. For each source category, a surrogate parameter (e.g. population) was selected which could be assumed to have a similar spatial distribution. For each source category, then, each 2 kilometer grid square was assigned a fraction of the county emissions equal to the grid square's fraction of the total surrogate parameter in the county. For example, if a grid had 1% of Cook County's arterial traffic, the grid would be assigned 1% of Cook County's gas marketing emissions. Note that although most of the surrogate data were 1985 projections made in 1976, the use of these data for performing spatial allocations should not introduce any significant errors.

A second method used for inventorying areas sources was an emission factor approach. The catefories inventoried by this method, the emissions factors, and other relevant information are shown in Table 4. This method was used in different forms for different categories. For heating, the available emission factors for formaldehyde and polycyclic organic matter (POM) for various types of fuel use were multiplied times county level estimates of the quantities of the respective fuels used. These emissions were then spatially disaggregated to estimate emissions in each of the above grids. For per capita emissions, (e.g. the emissions from various consumer products), emissions in each grid square were estimated by multiplying the per capita emissions factor times the number of people in the grid square.

Table 2. Particulate Matter Species Fractions
(Taken from Reference P.3. All data in percent)

Source Category	Arsenic	Cadmium	Species Fraction* Chromium	Mercury	Nickel	Applicable SCCs
Coal combustion	.058%	.006%	.054%		.040%	1-01-002-01,-02,-03,-23 1-02-002-01,-02,-04
Oil combustion	.015	.001	.089		1.622	1-01-004-01, 1-02-004-01,-04 1-02-005-01,-04 3-06-001-03***
Steel making: Sinter plants	.550**	.550**	3.000			3-03-008-01,-02,-08,-09 -11,-12,-13,-14,-21 -22,-24,-25,-99
Open hearth, basic oxygen furnaces	.050**	.050**	.20			3-03-009-04,-10,-11,-12,-13 -14,-15,-31,-32,-33,-99 3-04-007-01,-05,-06,-07 -15,-99
Gray iron foundries	.012	.006	.038		.067	3-04-003-01,-20,-31,-40 -50,-51
Asphalt roofing			.550**			3-05-001-01,-02,-03,-04,-05
Glass manufacturing	.023	.003	.218		.004	3-05-015-01,-02,-06,-08,-10
Gypsum manufacturing	.050**	.050**	.550**		.550**	3-05-015-01,-02,-03,-04
Lime and cement manufacturing****			.011		.00012	3-05-006-06 3-05-016-01,-02,-04,-07,-08 -09,-10,-14,-15,-99
Refinery heater (gas-fired)			.550**		.550**	3-06-001-04
Refinery cat. cracker		.010		.003	.43	3-06-002-01
Municipal incinerator	.020	.115	.036	5.330	.014	5-01-001-02

* Although reference P.3. shows data for beryllium, beryllium does not show up for any source
   types in Southeast Chicago.
** Where this table (and reference P.3) shows species fraction of .550% and .050%, the original
   study reported values of "trace" (0.1 to 1.0%) and "below detection limits" (<0.1%).
*** SCC 3-06-001-03 is for oil-fired process heaters at refineries.
**** These species fractions are not taken from reference P.3 but are derived from the
   "locator documents" references P.4.f and P.4.g.

For decreasing, county level emissions estimates were derived from a national study that estimated total usage of each of the compounds, divided the total by the total number of employees in the Standard Industrial Classification (SICs) relevant to the respective compound, and multiplied the resultant emission factor times the number of employees in these classifications employed in the counties in the Southeast Chicago area. County emissions were then distributed according to total manufacturing employment, since spatial distribution data were not avaiable for the specific industrial categories. Similarly for dry cleaning, national emissions data were distributed to county level estimate using employment data for relevant SICs, which were in turn distributed to grids in the study area using commercial employment data. For comfort cooling towers, the draft background information document for a possible NESHAP (reference A.13) provided per capita emission factors reflecting the per capita number of buildings in six building size ranges and emissions factors for each size range adjusted to reflect the probability of having a comfort cooling tower and the probability that chromium is used as a corrosion retardant. These emission factors were provided on a state-by-state basis to reflect the cooling load in each state. Reference A.13 provided upper and lower bound estimates reflecting disparate emissions testing results. This study used the more conservative, upper bound value; the lower bound value is about 28 times lower. The ratio of Cook County population versus "other" (nonmanufacturing, non-commerical) employment (3.4 people/"other" employee) was used to adjust the per capita emission factor to a per "other" employee emission factor, which was used with gridded "other" employment data to estimate grid-by-grid emissions.

An important subcategory within heating is residential wood combustion. This category includes woodburning in wood stoves, wood furnaces, fireplace inserts, and fireplaces. The principal data sources for estimating wood usage were a contractor study for the Department of Energy and the Department of Energy's Residential Energy Consumption Survey (RECS) data (References A.7 and A.8). The contractor study estimated state by state wood usage based on the heating degree days for the state, the probable proportions of households using wood as a primary or secondary heat source, and various surveys indicating the relationship between these factors and wood usage for each kind of wood user. This survey indicated a 1981 statewide Illinois usage of 1830,000 dry tons of wood per year (about 2,150,000 actual tons/year or 1,510.000 cords/year). This translates to about 0.43 dry tons of wood (about 0.50 actual tons or 0.35 cords) per year per Illinois household. However, the Chicago area is likely to have a lower percentage of wood burners and a lower rate of wood consumption that the estimated Illinois average. Therefore, RECS data on the wood usage in central cities in the North Central region of the United States versus the regional average wood usage were used to adjust the Illinois usage estimates. These data indicated that in central cities in the North Central U.S., 0.8 million cords were used per year, which divided by approximately 5.8 million households represents 0.14 cords/household. By comparison, in the full North Central region, 10.9 million cords divided by 22.75 million households represents 0.48 cords per household. (For reference, these data suggest that the central city usage of 0.14 cords/year represents 16% of the households burning 0.9 cords/year, and the regional usage of 0.48 cords represents 21% of the households burning 2.3 cords/year.) Thus, the urban usage may be estimated at 0.14/0.48 or 29% of the regional usage. On this basis, Chicago area wood usage was estimated to be 29% of 0.43 dry tons per year, equalling 0.12 dry tons (0.10 cords or 0.14 actual tons or 288 pounds) per year per household.

Table 3. Species Fractions used in Area Source Inventory
(except as noted, units are % of VOC emissions)

Category	Pollutants	Fractions	Spatial dbn Parameter	Reference
Gasoline Marketing	Benzene	.63%	Arterial VMT	A.3
	Toluene	.64%		
	Xylene	.18%		
Ship and Barge Transfer	Benzene	.63%	Distributed within port areas	A.3
	Toluene	.64		
	Xylene	.18%		
Architectural Surface Coating	Benzene	.18%	Dwelling units	A.3
	Methyl Chloride	.27%		
	Methylene Chloride	3.37%		
	Toluene	7.60%		
	Xylene	1.36%		
Heating (oil-fired)	Chromium	.047%*	**	P.4
	Nickel	5.36%*		

* Heating fractions are fractions of total suspended particulate emissions.

** Spatial distribution parameter for industrial distillate oil use was manufacturing employment. Parameter for all commercial/institutional and residential fuel oil usage was population. Emissions for industrial residual oil and coal usage and for all utility fuel usage were considered in the point source inventory.

Table 4. Emissions Factors used in Area Source Inventory

Source Category	Pollutant	Emission Factor	Spatial dbn.	Ref.
Heating				
Resid. oil: Comm/Inst*	Formaldehyde	.069 ng/J (10.8 mg/gal)	Population	P.4e
Dist. oil: Industrial	"	.10 ng/J (14.5 mg/gal)	Mfg. emp.	"
Comm/Inst	"	" "	Population	"
Residential	"	" "	Population	"
Gas: Industrial	"	.038 ng/J (41 g/mmcf)	mfg. emp.	"
Comm/Inst	"	.095 ng/J (103 g/mmcf)	Population	"
Residential	"	.43 ng/J (464 g/mmcf)	Population	"
Wood stoves, Fireplaces	POM	.078 g/kg wood***	dwell. units	P.4
Dist. Oil (all users)	"	8.7 pg/J (1.4 mg/gal)***	population	"
Gas (all users)	"	11.2 pg/J (12 g/mmcf)***	population	"
Per Capita Emissions				
Aerosol Cans	Methylene Chloride	.50 #/capita-yr	population	A.10
Paint Stripping	Methylene Chloride	.59 "	"	A.10
Misc. Products	Formaldehyde	.048 "	"	P.4e
Chlorinated Drinking Water	Chloroform	.029 "	"	P.4c
Miscellaneous				
Hospital sterilizing	Ethylene oxide	2.8#/year/bed (> 200 beds) .2#/year/bed (< 200 beds)	***	Author's survey
Chrome platers	Chromium	82.5#/year per known facility	***	A.14
Comfort cooling towers	Chromium	2.5#/year/1000 "other" employees****	"other" emp.	A.13
Degreasing	Methylene Chloride	*****	mfg. emp.	A.10
	Perchloroethylene			A.11
	Trichloroethylene			A.12
Dry cleaning	Perchloroethylene	*****	comm. emp.	A.11

*Some of the abbreviations used on this page: Comm/Inst - commercial and institutional:
Resid. - Residual: Dist. - distillate: ng - nanograms (10^{-9} grams):
POM - polycyclic organic matter: mfg. - manufacturing: emp. - employment.

**Excludes naphthalene, anthracene, and phenanthrene (see text). Emission
factor for woodstoves and fireplaces is 60% of total POM, for distillate oil
is 90% of total POM. and for gas is 100% of total POM.

***Distributed at actual location.

****"Other" employees are nonmanufacturing, nonretail employees.

*****Degreasing and dry cleaning emission estimates are derived from national
emissions totals disaggregate to county totals based on employment within
specified Standard Industrial Classification (SIC) Codes. Codes used for
degreasing were 25, 34, 36, 37, and 39, and for dry cleaning were 7216, 7217
and 7218.

The emission factor is derived from data given in a draft POM "locator document", entitled "Locating and Estimating Air Emissions From Sources of Polycyclic Organic Matter (POM)". The emission factor of 78.0 mg POM per kg wood reflects first an exclusion of three lighter-weight POM (napthalene, anthracene, and phenanthrene) and then a numerical averaging over all uncontrolled wood stoves and fireplaces (not including three fireplace measurements which did not reliably measure gaseous emissions.) Note that this emission factor is 60% of the emission factor that would have been obtained had the three lighter weight compounds not been excluded.

A third method used might be called the special survey method. The results of these surveys are also shown on Table 4. One of the special surveys was conducted for chrome plating, which emits chromium. The chrome plating survey was based on the "yellow pages" of the telephone directory. This survey indicated 17 facilities within the Southeast Chicago source area. Information was then obtained from U.S. EPA's Office of Air Quality Planning and Standards (OAQPS), indicating that based on the data obtained in development of a potential NESHAP for chrome plating, one could assume a national average plant emissions of 33 pounds chromium per year. Unfortunately, the listing of platers in the yellow pages presumably does not include "captive platers" which perform chrome plating as one step in manufacturing their own product (e.g., chrome plating as part of an auto assembly plant): this listing presumably only includes "job shops" who specialized in plating work for other customers. Data from OAQPS suggest that "job shops" represent about 40% of total plating, so the emissions estimate here was adjusted accordingly. Note that the result should be quite conservative, both because in reality "job shops" tend to be disproportionately high emitters and because the survey assumed that all platers performed chrome plating.

A second special survey was for hospital use of ethylene oxide for purposes of sterilizing. The first step of this survey was to contact the State Department of Health, which provided an inventory of hospitals in the State. This inventory showed four hospitals in this study's "receptor area" and a total of 24 hospitals in the overall source area. The second step was to contact the purchasing departments of the four "receptor area" hospitals to request information on annual ethylene oxide usage. The third step was to use this information to assess an emission factor. The emission factor was developed on a per bed basis, since the number of beds is an easily obtained piece of information which is considered indicative of the patient load and thus the amount of sterilization taking place at a hospital. (The number of beds does not include "long term care" beds such as found at nursing homes, since such beds are expected not be associated with significant ethylene oxide use.) The fourth step was to multiply the per bed emission factor times the number of beds in each of the hospitals in the source area.

The results of the four hospital survey were as follows: one hospital (427 beds) used 2430 pounds per year: a second hospital (418 beds) used steam, not ethylene oxide, for sterilization: a third hospital (176 beds) also used steam, not ethylene oxide: and a fourth hospital (168 beds) used 80 pounds per year (only a small part of the hospital's sterilization used ethylene oxide). Four hospitals is of course a small sample, and so the emissions factors derived are

very approximate. Nevetheless, the survey suggested that small hospitals are less likely to use ethylene oxide sterilizers then large hospitals, so separate emission factors were derived. (The cutpoint between "large" and "small" was arbitrarily set at 200 beds.) Also, obviously not all hospitals use ethylene oxide for sterilizing. Thus, a large hospital emission factor was estimated by averaging the per bed usage for hospital 1 (2.8 pounds/bed) and hospital 2 (0), and a separate, small hospital emission factor reflected an average for hospital 3 (0) and hospital 4 (.24 pounds/bed).

The data used in this survey reflected only Illinois hospitals. Rather than obtain an inventory of hospitals in Indiana, a per capita approach was used to estimate hospital usage of ethylene oxide in Northwest Indiana. The per capita emissions factor used was 0.010 pounds per year, derived from the Illinois results indicating 22,172 pounds emissions by hospitals serving 2,160,180 people.

Mobile Source Inventorying Methods

As with most of the area source categories, highway vehicle emissions were inventoried using the species fraction method. For both Illinois and Indiana, the analysis differentiated between emission on freeways and arterial emissions (i.e., emissions on arterial roadways and local streets). In Illinois, total county level VOC emissions were first derived, adjusted, and divided into freeway and arterial emissions. A variety of species fractions were derived and used to obtain county level emissions of individual compounds. Finally, the spatial distribution of these emissions data was estimated according to gridded data on freeway and arterial vehicle miles traveled (VMT). In Indiana, gridded emissions data were already available, from the 1982 ozone SIP, so it was only necessary to make adjustments and apply species fractions to obtain the desired inventory. The following discussion documents these calculations and the basis of the underlying data in more detail.

The Illinois county level VOC emissions data were derived by the Illinois EPA based on data in the 1982 ozone SIP. These data were logarithmically inter-polated between 1980 and 1987 to a 1984 base year and converted by Illinois EPA from units of kilograms per day to units of tons per year. The next step of the analysis used mobile source emissions models to make a set of adjustments from conditions inherent in the SIP to conditions appropriate here and simultaneously to disaggregate the arterial and freeway exhaust emissions and the evaporative emissions. The first run, designed to correspond to the SIP emissions estimate, used MOBILE 2, used a summer temperature of 75°F, the Federal Test Procedure (FTP) average speed of 19.6 miles per hour (mph), vehicle mileage and registration data given in the SIP, and areawide averages for VMT mix and hot start/cold start percentages. Then, two runs of MOBILE3 were made to estimate updated, more annual average emissions factors for the Southeast Chicago area. Both of these runs used an annual average temperature of 50°F, and the same mileage and registration data as in the SIP. The run for arterials used a speed of 19.6 mph and hot start/cold start percentages given in the SIP for the southern Chicago area arterials, and the run for freeways used a speed of 45 mph and zero percent hot starts and cold starts. The ratio of these MOBILE3 results to the MOBILE2 results was multiplied times the SIP-derived county emissions totals to derive adjusted county emissions totals for arterial exhaust emissions and freeway exhaust emissions.

A similar procedure was used to estimate adjusted county total evaporative emissions. However, one additional step in this procedure was to assign all evaporative emissions to arterials, i.e., to reassign emissions to arterials that otherwise would have been assigned to freeways. Since most of these emissions may be assumed to occur at trip ends, this reassignment was intended to provide a more reliable assignment of these emissions to where they actually occur. The results of multiplying the MOBILE3 evaporative emissions estimates times the respective traffic volumes indicates that freeway evaporative emissions in the area are 43% of arterial evaporative emissions. Therefore, the reassignment of evaporative emissions was accomplished by zeroing out the freeway evaporative emissions and increasing the arterial evaporative emissions by 43%.

Two further adjustments were made that are not reflected in MOBILE3. The first adjustment only affects evaporative emissions. Based on a paper prepared by U.S. EPA Office of Mobile Source staff, it appears that whereas MOBILE3 uses a single miles per day figure and a single trip per day figure for all vehicle ages in converting from emissions per day to emissions per mile, the use of model year by model year conversion factors yields a higher gram per mile emission factor. Based on information derived from the Office of Mobile Source paper, all evaporative emissions estimates were increased by 28%. The second adjustment only affects exhaust emissions. Limited work by John Sigsby et al. at U.S. EPA's Mobile Source Characterization Branch found that exhaust emission measurements made with the usual, unheated sampling train measured only 77% as much VOC as a parallel heated sampling train. Therefore, all exhaust emissions estimates here were divided by 0.77%, i.e., increased by 30%. It must be noted that these adjustments do not reflect U.S. EPA policy, and especially the exhaust emissions adjustments is based on a sparse and possibly unrepresentative data base. Nevertheless, given the uncertainties that exist throughout this inventory, these adjustments were considered appropriate for use in this study.

The results of the above adjustments may most easily be described in terms of emissions factors. The unadjusted, MOBILE2 based emission estimate translates to .833 tons per year per 1000 daily vehicle miles traveled (tpy/1000 miles). (This is approximately 2.35 g/mile). The various conversions using MOBILE3 and adjustments yielded an arterial exhaust emission factor of 1.122 tpy/1000 miles, an arterial evaporative emission factor of .878 tpy/1000 miles, and a freeway (exhaust only) emission factor of .432 tpy/1000 miles.

The second area of emphasis in the mobile source inventory is species fractions. The species fractions derived in this study are summarized in Table 4. The source of the greatest number of species fractions were taken from a paper by Roy Zweidinger, et al. of U.S. EPA's Mobile Source Characterization Branch reporting concentration measurements of numerous compounds and of total VOC near a limited access roadway near Raleigh, North Carolina (reference M.1). This paper provided the data for the species fractions for formaldehyde, ethylene, toluene, xylene and acetone. Since the gas chromatographic method could not distinguish butadiene from butane, a butadiene species fraction was also derived from this paper using the butane data in conjunction with an assumption (suggested by John Sigsby, reference M.6) that 10% of the material reported to be butane is in fact butadiene. Species fractions for benzene for exhaust emissions and for evaporative emissions were based on empirical formulae derived by Office of Mobile Source staff from existing testing data. The input to the calculation

of fractions used here include national average gasoline benzene content (1.34%) and aromatic content (32.5%) and an approximate North Central annual average reid vapor pressure (12.6).

Ethylene dibromide fractions were calculated from results reported by John Sigsby et al. in a separate paper focussing on ethylene dibromide. For exhaust emissions, the average ratio of EDB emissions to total exhaust hydrocarbon (HC) emissions is 117.4 ug EDC/g HC. However, because gasoline EDB content is proportional to lead content and lead content has declined, this figure must be adjusted. The lead content of Sigsby's fuel was 1.98 g/gallon. The actual 1984 lead content data are derived from a Motor Vehicle Manufacturers Association survey, indicating that the average lead content of 1984 leaded gasoline was 1.07 g/gallon and indicating that leaded gasoline was 42.6% of total sales. Assuming that emissions are proportional to gasoline sales (i.e., more polluting cars also consume more gasoline), these data indicate a 1984 EDB species fraction of 27.1 ug EDB per gram of gasoline vehicle exhaust HC emissions. The local percentages of gasoline vehicles exhaust to total vehicles exhaust for arterials and freeways was then used to derive the species fractions shown on Table 5.

For evaporative emissions, Sigsby et al reported a best fit equation that EDB evaporative emissions in ug/mile = 42 + (48 x HC emission g/mil). This equation reflects FTP operation, so an emission factor for Chicago vehicles operated as in the FTP was input into this equation. The result was adjusted for lead content the same way the exhaust species fraction was. The result was 17.1 ug EDB per gram evaporative HC emissions. Since diesel fuel results in minimal evaporative emissions, no adjustment from gasoline evaporation to total evaporation was necessary.

Sigsby et al. also measured for but did not find any ethylene dichloride in either their exhaust or their evaporative emissions. Therefore, zero species fractions were used for this pollutant.

The final step in deriving Illinois emissions estimates was to determine the spatial distribution. The most recent and applicable data available for this purpose are 1985 VMT projections made in 1977. However, despite how long ago these projections were made, these data should be reasonably accurate for indicating the spatial distribution of emissions.

In Indiana, the 1982 ozone SIP provided direct estimates of emissions by traffic zones. Nevertheless, most of the same adjustments made in the Illinois inventory were also necessary in the Indiana inventory. The SIP provided summer and and winter emissions estimates for 1980 and 1987, so SIP data on monthly traffic volumes was used to estimate annual emissions totals. A county total 1984 emissions estimate was derived by logarithmic interpolation between 1980 and 1987 totals, and the ratio of the 1984 to the 1980 county totals was calculated for use in converting 1980 emissions data to 1984 estimates. For arterials, Northwest Indiana vehicle operating characteristics were assumed to be similar to those in the southern Chicago area, so the same conversions and disaggregations from MOBILE2 total emissions to MOBILE3 arterial exhaust and evaporative emissions were used. For freeways, where the vehicle mix includes

Table 5. Highway vehicle species fractions

Pollutant	Species Fraction (in %)	
	Exhaust	Evaporative
Benzene	3.14%	1.09%
Butadiene	.0345%	0
Ethylene dibromide	.0025%/.0018%*	.0017%
Formaldehyde	.763%	0
Ethylene	7.15%	0
Toluene	6.59%	6.3--
Xylene	5.84%	3.8
Acetone	.072%	0
Benzo(a)Pyrene	.040%/.061%*	0

* Separate figures are for arterial/freeway exhaust emissions. The differences
result from the differences in vehicle mix.

more trucks, a separate Northwest Indiana conversion factor was calculated with the Indiana vehicle mix, translating to an emission factor of .652 tpy/1000 daily miles. The same adjustments as in Illinois were made to reflect possible undermeasurement of exhaust emissions and undercalculation of evaporative emissions. Finally, all of the same species fractions were used in Indiana as were used in Illinois.

Wastewater Volatilization Inventory Methods

National concern has arisen about volatile organics dissolved in wastewater but then volatilizing into the atmosphere. This volatilization can occur during aeration and during other processing at sewage treatment plants, during transit through the sewer system, and during "pretreatment" of company treatment facilities. Unfortunately, methods for assessing the extent to which volatilization rather than biodegradation or transference into sludge and for assessing losses within the sewers and at industrial pretreatment facilities are highly uncertain. Therefore, no attempt was made here to quantify the effect of these factors.

The basis of the emissions estimates derived in this study are measurements of wastewater concentrations made at the sewage treatment plants. The Southeast Chicago source area includes two major sewage treatment plants, both of which have substantial industrial input: the Calumet plant, and the West-Southwest (Stickney) plant. At both plants, a special set of measurements of a broad set of organics were taken on seven consecutive days at each of these plants. Measurements were simultaneously made of the same organics not just in the incoming wastewater but also in the sludge and the treated effluent. Unfortunately, the mixing and variable retention times inherent in the treatment process mean that a given influent measurement cannot be directly compared to any single effluent measurement. Nevertheless, calculations were made to assess whether the quantities in the sludge and the treated effluent for each compound were a substantial fraction of the quantities in the influent.

To estimate emissions, the conservative assumption was made that all of the volatile contaminants coming into these plants actually volatilize. Thus, emissions were calculated as simply the product of the wastewater concentration for each pollutant times the volume of wastewater treated.

This study only includes emissions at the sewage treatment plant. An employee of the Metropolitan Sanitary District indicated there is little if any industrial pretreatment, and in any case there was no information available to estimate any emissions. A more serious omission is the absence of any estimate of emissions out sewer system openings. These emissions may be close to zero or may be on the same order of magnitude as emissions of material reaching the sewage treatment plant. However, no estimate was attempted here, because any estimate would be highly speculative.

Some wastewater treatment plants use chlorine to disinfect the incoming material. This leads to some formation of chloroform, which may be presumed ultimately to volatilize. However, an employee of the relevant Metropolitan Sanitary District stated that these plants do not perform chlorination, so none of this source of chloroform was assumed. (Note, however, that the area source inventory assumes that the drinking water is chlorinated and therefore releases chloroform.)

Inventory Methods for Hazardous Waste Treatment Storage and Disposal Facilities

Emission estimates for this source category are being developed by a contractor and have not yet been completed. Although the facilities have been identified, the methods to be used have not yet been selected. Emission estimates for this category will be included in the inventory as soon as they are available.

Summary of Results

A summary of the emissions from all categories of emissions is provided in Table 6. This table shows emissions estimates for each of the 40 compounds found in this inventory. One column in this table shows totals of point source emissions estimates, one column shows area source totals, one column shows highway vehicle totals, one column shows total emissions from the two wastewater treatment plants. Estimates of emissions from hazardous waste treatment storage and disposal facilities are not yet available. A final column on this table shows total emissions from all facility types in the Southeast Chicago source area.

Following Table 6 are several tables showing the emissions estimates for the various source types. A summary of area source emissions is shown in Table 7. This table shows the estimates of total emissions of each species for each source category within the full Southeast Chicago source as well as the portions of this total within each county. For reference, this table also shows what population in the Southeast Chicago source area resides within each county, what the percentages of these populations these are of the respective total county populations, and what percentage of the 2,361,474 Southeast Chicago source area residents live in each county. These data illustrate that even though barely a third of Cook County is within the source area, this county still dominates the overall source area. By comparison, the receptor area has 395,969 people. Thus, while the receptor area has about 8% of the area in the source area, it has 16.5% of the total source area's population.

Table 8 shows similar information for highway vehicle emissions as Table 7 shows for area source emissions. Table 9 shows emissions from the two wastewater treatment plants.

Following Table 9 are four tables representing the point source inventory. Table 10 shows emissions estimates for those 29 facilities to whom questionnaires were sent. Table 11 shows coke oven emissions estimates from the four facilities in the area with operating coke oven batteries. These emissions estimates are taken from a draft background information document for a proposed coke oven NESHAP, based on questionnaires sent to these firms as part of the NESHAP development. Table 12 shows emissions estimates for organic species for the other 59 facilities present on the NEDS. Table 13 shows emissions estimates for metals for these other facilities that are estimated to have such emissions.

One special entry in Table 13, next to the entry for Commonwealth Edison's State Line plant, is an estimate of polycyclic organic matter from this facility. Although this table is the most convenient location in this report to place this emission estimate, this estimate was in fact estimated by special methods. Specifically, this emission estimate was derived from reference P.5 on fuel use at this plant multiplied times an emission factor taken from reference P.4.

Table 6. Summary of Emissions from all Source Types

Pollutant	Point	Area	Mobile	STP	Total
Benzene	4860.0	43.9	1113.4	2.0	6019.3
Methylene chloride	7.6	1490.3		23.6	1521.5
Perchloroethylene	171.0	1126.2		16.4	1313.6
Trichloroethylene	10.2	401.4		5.2	416.8
Chloroform	.8	34.2		2.0	37.0
Formaldehyde	29.6	122.4	229.5		381.5
Vinyl chloride	.1				.1
Vinylidene chloride				.03	.03
Ethylene	568.8		2137.7		2706.5
Ethylene dichloride	.2			2.0	2.2
Ethylene dibromide			1.0		1.0
Butadiene	12.2		91.3		103.5
Ethylene oxide	16.1	12.3			28.4
Methyl chloride	.3	12.0		.2	12.5
Benzyl chloride	.05			3.7	3.8
Styrene	4.2			6.6	10.8
Gasoline vapors		5221.8	20396.5		25618.3
Toluene	1972.1	372.6	2977.6	18.9	5341.2
Xylene	836.3	70.1	2343.6	43.3	3293.3
Acetone	522.8		21.4	507.3	1051.5
Arsenic	21.2				21.2
Cadmium	19.8				19.8
Chromium	105.9	1.3			107.2
Mercury	3.8				3.8
Nickel	6.5	16.3			22.8
"Heavy POM"	.01	12.3	12.8		25.3
Total POM	.01	18.6	12.8		31.4
Coke oven emissions	740.9				740.9
Diethanolamine	.07				.07
Epichlorohydrin	.1				.1
Propylene oxide	.6				.6
Acrylonitrile	10.5				10.5
Pentachlorophenol	.003				.003
Acrylamide	.03				.03
Ethyl acrylate	.4				.4
Melamine	.3				.3
Carbon tetrachloride	.8				.8
Nitrobenzene	.4				.4
Titanium dioxide	.3				.3
PCBs	.04				.04
Beryllium	.001				.001

Table 7. Area Source Emissions Totals

Category	Pollutant	emissions (tons/year)				
		Total	Cook	DuPage	Will	Lake, In.
Gasoline	benzene	32.9	30.1	.2	1.4	1.2
Marketing	toluene	33.4	30.5	.2	1.5	1.2
	xylene	9.4	8.6	.05	.4	.3
	gasoline vapors	5221.8	4771.6	30.8	230.0	189.4
Ship & Barge	benzene	3.0	1.4	0	.1	1.5
Transfer	toluene	3.1	1.4	0	.1	1.5
	xylene	.9	.4	0	.04	.4
Degreasing	perchloroethylene	242.2	194.2	1.2	3.1	43.7
	trichloroethylene	401.4	332.4	2.3	4.7	62.1
	methylene chloride	295.4	277.8	2.0	3.3	12.2
Architectural	benzene	8.0	6.7	.04	.2	1.1
sfc. coating	methyl chloride	12.0	10.1	.06	.3	1.6
	methylene chloride	150.2	126.3	.7	3.4	19.8
	toluene	338.8	284.8	1.6	7.7	44.7
	xylene	60.6	51.0	.3	1.4	8.0
Aerosol cans	methylene chloride	590.3	502.2	12.5	15.4	60.2
Paint stripping	methylene chloride	454.4	364.7	9.8	9.4	70.5
Dry cleaning	perchloroethylene	884.0	714.7	21.8	15.1	132.4
Misc. products	formaldehyde	56.7	48.2	1.2	1.5	5.8
Drinking water	chloroform	34.2	29.1	0.7	.9	3.5
Heating	formaldehyde	65.7	54.3	1.0	1.1	9.2
(except wood	nickel	16.3	10.8	.2	.2	5.0
stoves)	chromium	.143	.09	.002	.002	.047
	"Heavy POM"	3.4	2.2	.04	.05	1.1
	Total POM	3.4	2.2	.04	.05	1.1
Wood stoves	"Heavy POM"	9.1	7.8	.1	.2	1.0
	Total POM	15.2	13.0	.2	.3	1.7
Chrome plating	chromium	.7	.7	0	0	0
Hospital sterilizing	ethylene oxide	12.3	10.4	.6	0	1.3
Comfort cooling	chromium	.46	.39	.01	.01	.05

Table 8. Highway Vehicle Emissions Totals (in tons/year)

Pollutant	Arterial Exhaust	Freeway Exhaust	Evaporative	Total
Benzene	823.6	116.7	173.1	1113.4
Butadiene	80.0	11.2	-----	91.3
Gasoline vapors	-----	-----	20396.5	20396.5
Ethylene	1871.7	266.0	-----	2137.7
Formaldehyde	201.2	28.3	-----	229.5
Ethylene dibromide	.7	.07	.3	1.0
Polycyclic organics	10.5	2.3	-----	12.8
Toluene	1731.4	240.2	1006.1	2977.6
Xylene	1520.8	214.5	608.3	2343.6
Acetone	18.7	2.7	-----	21.4

Table 9. Wastewater Treatment Plant Emissions Estimates

Pollutant	Calumet	West-Southwest
Benzene	1.7	.3
Methylene chloride	3.3*	20.3*
Perchloroethylene	1.4	15.0*
Trichloroethylene	.8	4.4*
Chloroform	.7*	1.3*
Vinylidene chloride	.03	--
Ethylene dichloride	.4	1.6
Methyl chloride	.2	--
Styrene	4.6	2.0
Chlorobenzene	.7	3.0*
Toluene	12.0	6.9
Xylene	8.7	34.6
Acetone	301.0	206.3

*Because contaminant quantities in the treated effluent are a significant
 fraction of the quantities in the raw influent (suggesting limited
 volatilization), these amounts represent the difference between influent
 and effluent quantities.

Table 10. Emissions Estimates for Facilities Receiving Questionnaires

Nalco Chemical

Methyl chloride	.0016 tpy
Benzyl chloride	.048
Diethanolamine	.065
Epichlorohydrin	.10
Formaldehyde	.278
Pentachlorophenol	.003

Desoto

Titanium dioxide	.20 tpy
Acrylamide	.025
Ethylacrylate	.375
Melamine	.25
Propylene oxide	.075
Styrene	1.95
Formaldehyde	.080
Toluene	2.7
Xylene	2.1

MORECO (Formerly Motor Oil Refining)

Arsenic	.047 lb/yr.
Beryllium	.0011
Cadmium	.18
Chromium	.32
Nickel	.015
Benzene	2.3
Carbon Tet.	.77
Chloroform	.77
Methylene Chloride	.77
Nitrobenzene	.41
PCB	.039
Trichloroethylene	.77
Toluene	18.

Koppers

Styrene	.83 tpy

Ford Motor

Benzene	.06 tpy
Methylene Chloride	1.
Perchloroethylene	1.
Toluene	70.1
Xylene	165.8
Acetone	1.6

Sherwin Williams

Titanium Dioxide	.06 tpy
Chromium	.001
Toluene	2.31
Xylene	1.347
Acetone	.07

PMC

Formaldehyde	.0015 tpy
Toluene	.91

Stolt Terminals

Perchloroethylene	1.73 tpy
Trichloroethylene	6.55
Methylene Chloride	5.68
Benzene	1.09
Toluene	3.09
Xylene	1.45
Acetone	1.17

Clark Oil

Benzene	15. tpy

McKesson Chemical

Trichloroethylene	2.9 tpy
Perchloroethylene	2.0
Toluene	7.2
Xylene	5.7
Acetone	6.8

Union Oil

Benzene	3.59 tpy

Amoco

Benzene	.39 tpy
Toluene	1.6

Conoco

Benzene	.09 tpy

Marbon Div./Anderson Devel.

Styrene	.19 tpy
Butadiene	8.75

Keil

Ethylene Dichloride	.004 tpy

Shell

Benzene	.88 tpy

Stauffer, IN

Perchloroethylene	.010 tpy
Methylene Chloride	.113

Emissions were estimated to be zero for

Trumbull Asphalt	Iovite
3 M	Diamond Shamrock
Signode	PVS
Dynagel	Unichema (formerly Darling)
Getty	Mobil Chemical
Stauffer	Texaco

Table 11. Emissions from coking operations
(All data in tons per year)

| | Coke Ovens* | Byproduct Plants | | |
	"Coke oven emissions"	Benzene	Toluene	Xylene
Interlake	68.61 tpy	474.4 tpy	75.2 tpy	26.2 tpy
LTV Steel (Chicago)	23.27 .	225.8	35.8	12.5
Inland Steel	406.14	1303.4	206.8	71.9
U.S. Steel	242.83	2666.8	423.0	147.1
Total	740.85 tons/year	4670.4 tpy	740.8 tpy	257.7 tpy

*These are total emissions of "coke oven emissions" (benzene soluble organics) that are emitted from charging and leaks at the coke ovens.

(EMISSIONS IN TONS/YEAR)

CNTY	FLTD	PLANT NAME	ETH	13BUT	HCHO	ACE	CTC	PR.O	ACN	MCL	EDC	PERC	VCL	XYL	BENZ	TOL	STYR
1540	1	AMERICAN METAL DECOR	.0	.0	.0	70.7	.0	.0	.0	.0	.0	.0	.0	17.4	.0	43.0	.0
1540	2	VAN LEER CONTAINERS	11.8	.0	.0	27.3	.0	.0	.0	.0	.0	.0	.0	50.0	.0	123.4	.0
1540	5	H C SMITH PAPER CO	1.8	.0	.2	10.3	.0	.0	.0	.0	.0	9.7	.0	3.9	.0	4.3	.0
1540	6	MILES LABORATORIES -	24.1	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	17.4	.8	.0
1540	8	SHELL OIL COMPANY ,	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	11.4	2.1	8.2	.0
1540	10	CONTINENTAL CAN COMP	5.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1540	11	CORN PRODUCTS-ARGO P	1.4	.0	.3	.2	.0	.0	.0	.0	.0	.0	.0	.8	.0	3.4	.0
1540	12	GATX TERMINALS CORP.	.0	.0	.1	6.9	.0	.0	.0	.0	.0	5.6	.0	.0	1.6	5.8	.0
1540	17	G W ELECTRIC SPECIAL	.0	.0	.0	27.9	.0	.0	.0	.0	.0	27.9	.0	11.2	.0	11.2	.0
1540	18	CHICAGO FINISHED MET	.0	.0	.0	12.6	.0	.0	.0	.0	.0	12.6	.0	5.0	.0	5.0	.0
1540	20	GOLDEN OIL & CHEM CO	.0	.0	.3	7.5	.0	.0	.0	.0	.1	6.1	.0	.0	1.9	6.5	.0
1540	21	CALUMET STEEL COMPAN	9.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	7.0	.3	.0
1540	22	CHICAGO HEIGHTS BAR	.0	.0	.0	10.3	.0	.0	.0	.0	.0	.0	.0	6.6	.0	5.2	.0
1540	24	THRALL CAR MFG CO PL	.0	.0	.0	13.5	.0	.0	.0	.0	.0	13.5	.0	5.4	.0	5.4	.0
1540	32	AMOCO OIL CO - CHICA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	22.9	4.1	16.5	.0
1540	36	WYMAN GORDON CO	.0	.0	2.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.1	.0
1540	37	ALLIED TUBE & CONDUI	.0	.0	.0	40.1	.0	.0	.0	.0	.0	40.1	.0	16.0	.0	16.0	.0
1540	40	GENERAL MOTORS - ELE	3.8	.0	.8	124.9	.0	.0	.0	.0	.0	10.1	.0	111.3	.2	262.4	.0
1540	42	REYNOLDS METALS CO	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1540	54	INTERLAKE, INC. RIVE	.0	.0	.6	3.6	.0	.0	.0	.0	.0	.0	.0	5.1	.2	12.8	.0
1540	55	CARAVELLE WOOD PRODU	2.5	.0	.0	15.6	.0	.0	.0	.0	.0	.0	.0	28.5	.0	70.5	.0
1540	57	METROPOLITAN SANITAR	.0	.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.2	.0
1540	58	STOCKNEY TERMINAL	.0	.0	.1	.3	.0	.0	.0	.0	.0	.0	.0	6.2	1.1	4.5	.0
1540	61	ASHLAND CHEMICAL CO	.2	.0	.1	10.9	.0	.0	.0	.0	.1	8.9	.0	.0	2.6	9.2	.0
1540	69	BARCRAFT CORP. OF AM	79.3	.0	.0	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	21.5	.0
1540	79	U S STEEL - SOUTH WO	.0	.0	4.2	4.8	.0	.0	.0	.0	.0	.0	.0	.0	.9	.5	.0
1540	80	INTERLAKE - CHICAGO	.0	.0	6.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1540	81	LTV STEEL COMPANY IN	.0	.0	.2	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1540	82	CHICAGO ROTOPRINT	.0	.0	.0	21.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	327.6	.0
1540	84	CARGILL INC - COMMOD	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1540	87	AMERICAN CAN CO	5.8	.0	.0	22.8	.0	.0	.0	.0	.0	.0	.0	16.5	.0	15.1	.0
1540	90	ALCO GRAVURE INC	.0	.0	.0	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	29.8	.0
1540	94	NATIONAL CAN CORP	.0	.0	.0	3.0	.0	.0	.0	.0	.0	.0	.0	5.5	.0	4.4	.0
1540	98	RHEEM MFG.CO.	2.1	.0	.0	24.4	.0	.0	.0	.0	.0	.0	.0	22.4	.0	35.4	.0
1540	100	MEAD PACKAGING	.0	.0	.0	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	25.3	.0
1540	117	LAKE-RIVER TERMINALS	.1	.0	.1	.3	.0	.0	.0	.0	.0	.0	.0	1.9	.3	1.5	.0
1540	119	NORRE AMERICAN GRAPH	.0	.0	.0	11.7	.0	.0	.0	.0	.0	11.7	.0	4.7	.0	4.7	.0
1540	121	NATIONAL CAN CORP -	.0	.0	.0	25.4	.0	.0	.0	.0	.0	16.2	.0	12.8	.0	11.5	.0
8320	10	UNION CHEMICALS DIV.	2.8	.0	.2	.0	.6	.2	.4	.1	.0	.0	.1	.2	1.3	.5	.4
8320	21	COM ED - WILL COUNTY	.2	.0	2.6	.0	.0	.0	.0	.0	.0	.0	.0	8.2	.0	5.7	.0
8320	24	AMOCO PIPELINE CO C	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12.7	2.4	9.2	.0

							(EMISSIONS IN TONS/YEAR)									
CNTY FLID	PLANT NAME	ETH	13BUT	HCHO	ACE	ETO	PR.O	ACN	MCL	EDC	PERC	VCL	XYL	BENZ	TOL	STYR
2760 52	THERMARK CORP 650 W	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2760 59	ANR PIPELINE ST JOHN	.3	.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2360 117	NIPSCO DEAN H MITCHE	.0	.0	.7	.0	.0	.0	.0	.0	.0	.0	.0	2.1	.0	1.3	.0
2760 120	U.S.STEEL CORP. GARY	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.3	.2	.0
2760 121	U.S.STEEL CORP. GARY	108.3	.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.4	.5	.7	.0
2760 202	AMERICAN CAN COMPANY	7.8	.0	.0	3.9	.0	.0	.0	.0	.0	3.9	.0	1.6	.0	1.6	.0
2760 207	AMERICAN MAIZE-PRODU	.0	.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0
2360 210	COMMONWEALTH EDISON	.0	.0	1.2	.0	.0	.0	.0	.0	.0	.0	.0	2.3	.0	1.5	.0
2760 229	LEVER BROTHERS COMPA	.0	.0	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0
2760 271	MARATHON OIL COMPANY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	4.7	.8	3.4	.0
2760 305	FLAW KNOX FOUNDRY AN	.0	.0	1.4	.7	.0	.0	.0	.0	.0	.0	.0	.2	.0	.6	.0
2760 209	EAST CHICAGO MUNICIP	39.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	34.6	.0	.0
2760 210	E I DUPONT DE NEMOUR	4.3	.0	.4	.0	.9	.3	.6	.2	.0	.0	.1	.3	2.0	.8	.7
2360 216	INLAND STEEL INDIANA	93.9	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	47.8	2.4	.0
2360 217	INLAND STEEL INDIANA	112.7	1.2	1.8	.0	.0	.0	.0	.0	.0	.0	.0	4.2	34.5	4.5	.0
2360 219	LTV STEEL COMPANY	50.4	.0	2.5	1.4	.0	.0	.0	.0	.0	.0	.0	.0	2.2	.5	.0
2360 320	UNION CARBIDE CORP L	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
2360 372	UNION TANK CAR COMPA	.0	.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0

	ETH	HCHO	ETO	ACN	EDC	VCL	BENZ	STYR
TOTALS (FOR 59 PLANTS)	568.842	29.218	1.610	1.050	.176	.210	167.085	1.190

	13BUT	ACE	PR.O	MCL	PERC	XYL	TOL
	3.480	513.189	.490	.315	166.287	402.238	1125.369

KEY:

ETH – ETHYLENE	13BUT– 1,3-BUTADIENE
HCHO – FORMALDEHYDE	ACE – ACETONE
ETO – ETHYLENE OXIDE	PR.O – PROPYLENE OXIDE
ACN – ACRYLONITRILE	MCL – METHYL CHLORIDE
EDC – ETHYLENE DICHLORIDE	PERC – PERCHLOROETHYLENE
VCL – VINYL CHLORIDE	XYL – XYLENE
BENZ – BENZENE	TOL – TOLUENE
STYR – STYRENE	

			EMISSIONS IN TONS			
CNTY	PLID	PLANT NAME	AS	CD	CR	NI	HG
1540	5	M P SMITH PAPER CO	.001	.000	.004	.081	.000
1540	9	SHELL OIL COMPANY ,	.000	.000	.001	.016	.000
1540	11	CORN PRODUCTS-ARGO P	.019	.002	.017	.012	.000
1540	21	CALUMET STEEL COMPAN	.011	.011	.044	.000	.000
1540	60	GENERAL MOTORS - TLE	.053	.005	.049	.036	.000
1540	44	VULCAN MATLS-LIME PL	.000	.000	.030	.000	.000
1540	54	INTERLAKE, INC. FIVE	.582	.581	2.453	.135	.00
1540	55	STICKNEY TERMINAL	.002	.000	.016	.260	.000
1540	59	MARBLEHEAD LIME CO	.000	.000	.009	.000	.00
1540	72	MARBLEHEAD LIME CO	.000	.000	.028	.000	.000
1540	79	U S STEEL - SOUTH WO	.335	.309	1.488	2.984	.000
1540	80	INTERLAKE - CHICAGO	3.239	3.233	17.646	.135	.000
1540	81	LTV STEEL COMPANY IN	1.962	1.962	10.604	.097	.000
1540	106	CINDERS INC	.929	.929	5.070	.000	.000
1540	108	HECKETT ENGINEERING	.547	.547	2.980	.000	.000
1540	117	LAKE-RIVER TERMINALS	.000	.000	.003	.049	.00
1540	121	NATIONAL CAN CORP -	.000	.000	.002	.032	.000
8220	21	COM ED - WILL COUNTY	.510	.053	.475	.352	.00
2360	117	NIPSCO DEAN H MITCHE	.135	.014	.125	.093	.00
2360	120	U.S.STEEL CORP. GARY	1.175	1.175	6.396	.000	.00
2360	121	U.S.STEEL CORP. GARY	6.999	6.639	35.972	.266	.00
2360	210	COMMONWEALTH EDISON*	.633	.065	.589	.436	.00
2360	229	LEVER BROTHERS COMPA	.012	.001	.069	1.265	.00
2360	305	BLAW KNOX FOUNDRY AN	.004	.004	.018	.000	.00
2360	309	EAST CHICAGO MUNICIP	.014	.083	.026	.010	3.83
2360	316	INLAND STEEL INDIANA	.261	.261	1.166	.000	.00
2360	317	INLAND STEEL INDIANA	1.035	.954	5.228	.066	.00
2360	318	LTV STEEL COMPANY	2.784	2.784	15.059	.093	.00

			EMISSIONS IN TONS			
CNTY	PLID	PLANT NAME	AS	CD	CR	NI	HG
		TOTALS (FOR 28 PLANTS)	21.144	19.612	105.564	6.479	3.831

*COMMONWEALTH EDISON PLANT WAS ALSO ESTIMATED TO EMIT .012 TONS/YEAR PCM

KEY: AS - ARSENIC   CD - CADMIUM
     CR - CHROMIUM   HG - MERCURY
     NI - NICKEL

Discussion of Results

The most important question that can be addressed with the results reported in Tables 6 to 13 is what source types contribute most significantly to emissions of air toxicants in the Southeast Chicago area. The first place to look for this kind of information is Table 6. This table shows the contribution from each general kind of source toward the emissions of each pollutant. Obviously, the relative contribution from each kind of source varies for different pollutants. For example, benzene, ethylene, and toluene are about equally emitted by point and mobile sources. Methylene chloride, perchloroethylene, and trichloroethylene, on the other hand, are emitted predominantly by area sources. Formaldehyde and acetone, much of which come from combustion, are about equally emitted by area and mobile sources. The metal species are predominately emitted by point sources. Butadiene is estimated to be emitted almost entirely by point sources. Sewage treatment plants lead to almost half of the area chloroform emissions, but emit less than three percent of any of the other compounds inventoried.

The other tables show more detailed information about particular sources or source types that contribute to those various pollutant emissions. For benzene, the major fraction of benzene emissions from point sources comes from steel mills (coking operations), and about three quarters of the mobile source benzene emissions come from exhaust emissions on arterials. Methylene chloride is emitted in similar quanties from aerosol can usage and paint stripping. Perchloroethylene emissions mostly arise from dry cleaning but also arise in significant quantity from degreasing. Trichloroethylene emissions are almost exclusively from degreasing. Formaldehyde emissions are mostly from combustion by automobiles and by furnaces used in space heating, though an estimated 10% arises from volatilization out of assorted consumer products. Ethylene is emitted predominantly by steel mills and by automobiles. About half the butadiene is emitted by an oil-fired utility power plant and the other half is emitted by the steel mills. Steel mills are also the dominant source of chromium, arsenic, and cadmium.

Another way of analyzing the point source inventory is shown in Table 14. This table summarizes the point source emissions of each organic pollutant by standard classification code (SCC). Note that this table only includes emissions from facilities to which no questionnaire was sent, since the questionnaire responses did not identify SCC's for each set of pollutant emissions.

Perhaps the best means of judging the relative importance of emissions of different compounds from different source categories is to compare the health risks posed by each set of emissions. This comparison, however, requires a dispersion analysis of the exposure to the area's residents from these emissions and then a risk assessment using dose-response data for each compound to translate exposure into risk. A thorough dispersion analysis is planned but has not been completed, and many of the dose-response relationships are subject to question. Indeed it must be highlighted that many of the compounds may not in fact be carcinogens, notwithstanding the availability of an estimate of carcinogenicity per unit concentration. Thus, a review of the emissions data and available dose-response data provide only a qualitative comparison of the relative importance of different pollutants.

A. ORGANICS

SCC	VOC EM	ETH.	13BUT	FORM	ACETONE	ETO	PRO	ACN	CHCL3	EDC	PERC	VINYLCL	XYL.	BENZENE	TOL	STYR.
10100201	72.000	.0	.0	2.2	.0	.0	.0	.0	.0	.0	.0	.0	6.2	.0	4.0	.0
10100202	23.885	.0	.0	.7	.0	.0	.0	.0	.0	.0	.0	.0	2.1	.0	1.3	.0
10100203	23.000	.0	.0	.7	.0	.0	.0	.0	.0	.0	.0	.0	2.0	.0	1.3	.0
10100223	25.000	.0	.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	2.3	.0	1.5	.0
10100601	10.000	.0	.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.2	.0
10200202	57.072	.0	.0	1.7	.0	.0	.0	.0	.0	.0	.0	.0	4.9	.0	3.2	.0
10200204	30.145	.0	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	2.6	.0	1.7	.0
10200401	30.255	.0	.0	2.6	8.5	.0	.0	.0	.0	.0	.0	.0	.8	.0	.0	.0
10200501	1.000	.0	.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
10200601	31.393	.0	.0	4.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.5	1.2	.0
10200602	6.000	.0	.0	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.4	.2	.0
10200704	101.000	.0	.0	7.7	.0	.0	.0	.0	.0	.0	.0	.0	.8	.0	.0	.0
10200707	1.000	8.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.4	.0	.0
10500106	1.000	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
20200202	25.000	.3	.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.3	.0	.0	.0
30199999	35.000	7.6	.0	.6	.0	1.6	.5	1.0	.3	.0	.0	.2	.5	3.5	1.4	1.2
30299998	4.000	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30300202	146.000	40.4	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	20.6	1.0	.0
30300303	123.000	34.1	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	17.3	.9	.0
30300704	243.000	67.3	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	34.3	1.7	.0
30300306	6.000	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.8	.0	.0
30300708	64.000	17.7	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	9.0	.4	.0
30300813	708.000	195.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30300901	1.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30300931	8.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.4	.0
30300933	8.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.4	.0
30300934	1.000	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0
30501699	1.000	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
30900199	12.000	.0	.0	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.1	.0
30999999	159.000	34.0	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	24.5	1.1	.0
39000499	2.000	.0	.0	.8	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
39000699	4.000	.0	.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.3	.2	.1	.0
39000702	5.000	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0
40200101	970.000	.0	.0	.0	118.3	.0	.0	.0	.0	.0	.0	.0	216.3	.0	534.5	.0
40200301	302.000	.0	.0	.0	116.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40200501	498.000	.0	.0	.0	31.4	.0	.0	.0	.0	.0	.0	.0	19.9	.0	15.9	.0
40200601	1451.000	29.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40200610	389.000	7.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40200901	453.000	.0	.0	.0	45.3	.0	.0	.0	.0	.0	45.3	.0	18.1	.0	18.1	.0
40200902	20.293	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40200924	33.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

40201701	165.000	.0	.0	.0	16.6	.0	.0	.0	.0	.0	16.6	.0	6.5	.0	6.6	.0
40201339	5.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.5	.0
40201772	435.000	.0	.0	.0	30.2	.0	.0	.0	.0	.0	.0	.0	20.9	.0	16.6	.0
40201773	54.000	.0	.0	.0	3.8	.0	.0	.0	.0	.0	.0	.0	2.5	.0	2.1	.0
40201775	17.000	.0	.0	.0	1.2	.0	.0	.0	.0	.0	.0	.0	.8	.0	.7	.0
40201776	201.000	.0	.0	.0	20.1	.0	.0	.0	.0	.0	20.1	.0	8.0	.0	8.0	.0
40201778	57.000	.0	.0	.0	4.0	.0	.0	.0	.0	.0	.0	.0	2.8	.0	2.2	.0
40201779	2.000	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.0
40202501	637.000	.0	.0	.0	63.7	.0	.0	.0	.0	.0	63.7	.0	25.5	.0	25.5	.0
40299999	1.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.0
40201001	20.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	2.7	.5	1.9	.0
40301002	1.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.0
40301097	136.000	.0	.0	.1	9.7	.0	.0	.0	.0	.1	7.9	.0	.0	2.3	8.2	.0
40301099	45.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	6.2	1.1	4.5	.0
40301101	122.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	16.5	2.9	11.8	.0
40301109	92.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	12.4	2.2	8.9	.0
40301111	13.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.2	.2	.3	.0
40301199	1.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.0
40302001	217.000	.0	.0	.1	15.5	.0	.0	.0	.0	.1	12.7	.0	.0	3.6	13.1	.0
40400111	14.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	1.9	.3	1.4	.0
40500101	644.000	83.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40500501	7369.000	.0	.0	.0	26.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	404.2	.0
40500571	145.999	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	19.7	3.5	14.1	.0
40600147	17.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40600177	21.000	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
40699999	72.000	1.7	.0	.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	3.5	.0
50100102	449.000	39.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	34.6	.0	.0

CCC	VOC IM	ETH.	13BUT	FCRM	ACETONE	ETC	PRC	ACN	CHCL3	EDC	PERC	VINVLCL	XYL.	BENZENE	TOL	STYR.
TOTAL EM.	17677.641	568.8	3.5	29.2	513.2	1.6	.5	1.0	.3	.2	166.3	.2	402.2	167.1	1125.4	1.2

KEY:
```
ETH  - ETHYLENE              13BUT- 1,3-BUTADIENE
HCHO - FCRMALDEHYCE          ACE  - ACETONE
ETO  - ETHYLENE CXIDE        PR.O - PROPYLENE OXIDE
ACN  - ACRYLCNITRILE         MCL  - METHYL CHLORIDE
EDC  - ETHYLENE DICHLORIDE   PERC - PERCHLOROETHYLENE
VCL  - VINYL CHLORIDE        XYL  - XYLENE
BENZ - BENZENE               TOL  - TOLUENE
STYR - STYRENE
```

3. METAL SPECIES

SCC	TSP EM	ARSENIC	CADMIUM	CHROMIUM	NICKEL	MERCURY
10100201	922.000	.477	.049	.444	.323	.000
10100202	271.996	.135	.014	.125	.093	.000
10100203	68.000	.034	.003	.031	.023	.000
10100222	1051.000	.533	.065	.589	.435	.000
10200202	197.936	.103	.011	.102	.075	.000
10200204	591.031	.343	.035	.319	.235	.000
10200601	315.950	.047	.003	.281	5.125	.000
10200604	5.000	.001	.000	.004	.081	.000
10200501	1.000	.000	.000	.001	.016	.000
30300801	401.000	2.205	2.205	12.030	.000	.000
30300802	533.000	2.931	2.931	15.990	.000	.000
30300808	68.000	.374	.374	2.040	.000	.000
30300809	122.000	.671	.671	3.660	.000	.000
30300811	11.000	.060	.060	.330	.000	.000
30300812	90.000	.495	.495	2.700	.000	.000
30300813	1528.704	8.463	8.463	46.161	.000	.000
30300814	95.556	.551	.551	3.005	.000	.000
30300821	195.000	1.072	1.072	5.850	.000	.000
30300822	2.000	.011	.011	.060	.000	.000
30300824	70.000	.385	.385	2.100	.000	.000
30300825	122.000	.671	.671	3.660	.000	.000
30300899	18.000	.099	.099	.540	.000	.000
30300904	176.000	.088	.088	.352	.000	.000
30300910	2.000	.001	.001	.004	.000	.000
30300911	29.000	.014	.014	.058	.000	.000
30300912	71.000	.035	.035	.142	.000	.000
30300913	943.000	.471	.471	1.886	.000	.000
30300914	1045.000	.522	.522	2.090	.000	.000
30300915	5.000	.003	.003	.010	.000	.000
30300931	25.000	.012	.012	.050	.000	.000
30300932	43.000	.021	.021	.086	.000	.000
30300933	27.000	.013	.013	.054	.000	.000
30300999	284.000	.142	.142	.568	.000	.000
30400231	30.000	.010	.005	.030	.054	.000
30400701	15.000	.009	.009	.030	.000	.000
30400706	1.000	.000	.000	.002	.000	.000
30400715	29.000	.014	.014	.058	.000	.000
30400799	10.000	.005	.005	.020	.000	.000
30501602	1.000	.000	.000	.000	.000	.000
30501604	569.168	.000	.000	.063	.001	.000
30501607	14.000	.000	.000	.002	.000	.000
30501609	10.000	.000	.000	.001	.000	.000
30501610	68.000	.000	.000	.008	.000	.000
30501614	5.000	.000	.000	.001	.000	.000
30501615	2.000	.000	.000	.000	.000	.000
30501699	15.000	.000	.000	.002	.000	.000
50100102	72.000	.014	.063	.026	.010	3.838

SCC	TSP EM	ARSENIC	CADMIUM	CHROMIUM	NICKEL	MERCURY
TOTAL EM. 10116.759		31.144	19.612	105.564	6.479	3.838

One finding from a review of emissions and dose-response data is ironically and unfortunately that the compounds that appear most significant are associated with sme of the greatest uncertainties. Polycyclic organic matter may be the largest contributor to area risk, but is clearly one of the most uncertain estimates in the inventory. This "pollutant" is actually a class of compounds with widely varying toxicities, and measurement of emission factors for this spectrum of compounds is difficult and has been done only a small number of times for any given source category. Emissions of polycyclic organic matter, which emanate mostly as products of incomplete combustion, are estimated to be emitted in similar quantities from residential wood combustion (including wood stoves and fireplaces) and from highway vehicles, with a smaller contribution from other home heating and only a minor contribution from point sources.

A second compound that may contribute significantly to the total risk is chromium. An important uncertainty here relates to the different valence states of chromium, each of which has different level of toxicity. Unfortunately, while for the two major area sources all emissions are the most toxic form (Cr^{+6}), for the largest source of chromium (steel furnaces) there is little basis for estimating the distribution among valence states. For this inventory, these emissions were conservatively estimated to be all the most toxic form.

Other pollutants that may make significant contributions to the total risk include coke oven emissions, arsenic, formaldehyde, benzene, and butadiene. Note that photochemical formation of formaldehyde, which may contribute an order of magnitude more than direct emissions, was not included in this study. There is also significant uncertainty on the most appropriate estimate of the human carcinogencity of formaldehyde.

As implied by the above discussion, area and mobile sources may contribute most of the risk, but point sources also contribute significantly to the total risk. Wastewater treatment plants appear to contribute only a very small fraction of the total risk. Note that emissions estimates are not yet available for hazardous waste treatment storage and disposal facilities, and so no estimate can yet be made of their contrbution to the total risk. Once again, however, a more quantitative evaluation of the relative risks caused by various source types and various pollutants must await the full dispersion and risk assessment that is planned.

As mentioned previously, for point sources that were sent questionnaires, emission estimates were also made using the species fraction approach. This may be viewed as providing quality assurance for the methods used here. The questionnaire results were shown in Table 10. The results of the species fraction approach for organics is shown on Table 15 and for particulate species is shown in Table 16. The sum of questionnaire emission estimates for each compound from the relevant companies is also shown on Table 15 and 16 to facilitate comparison of the results. Note that only 15 of the facilities to whom questionnaires show up on Tables 15 and 16, since these tables are based on updated NEDS data in which many of the smaller facilities (including several chemical plants) have been discarded.

Table 15. Organic Species Fraction-Based Estimates For Facilities Receiving Questionaires

(EMISSIONS IN TONS/YEAR)

CNTY	PLID	PLANT NAME	ETH	13BUT	HCHO	ACE	ETO	PR.O	ACN	MCL	EDC	PERC	VCL	XYL	BENZ	TOL	STYR
1540	1	TRUMBULL ASPHALT CO.	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.8	.3	.8	.0
1540	7	NALCO CHEMICAL CO.-	24.6	.0	2.1	.1	5.2	1.6	3.4	1.0	.0	.0	.7	1.5	11.3	5.5	3.8
1540	9	3M COMPANY - INDUSTR	351.8	.0	.0	54.0	.0	.0	.0	.0	.0	53.7	.0	21.5	.0	25.8	.0
1540	10	SIGNODE CORP	4.3	.0	.0	84.9	.0	.0	.0	.0	.0	.0	.0	.0	28.1	13.3	.0
1540	27	STAUFFER CHEMICAL CO	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.3	.0	5.2	.0
1540	42	MOTOR OIL REFINING C	.0	.0	.1	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
1540	56	KOPPERS COMPANY INC.	11.4	.0	1.3	14.2	2.4	.7	1.6	.5	.0	.9	.3	.7	5.5	3.5	1.8
1540	58	FORD MOTOR COMPANY	2.1	.0	.0	595.5	.1	.0	.1	.0	.0	2.9	.0	84.8	150.1	126.3	.1
1540	75	SHERWIN-WILLIAMS CO	3.2	.0	.3	.8	.7	.2	.4	.1	.0	.0	.1	.2	1.5	.6	.5
1540	115	FORD MOTOR COMPANY C	.0	.0	.0	22.9	.0	.0	.0	.0	.0	.0	.0	41.9	.0	103.6	.0
1540	123	CLARK OILREFINING	.0	.0	96.1	.0	.0	.0	.0	.0	.0	.0	.0	6.6	5.7	7.0	.0
9000	1	MOBIL CHEMICAL CO-PL	105.4	.0	7.4	1.6	20.1	6.1	13.1	3.9	.0	.0	2.6	5.7	43.6	41.3	14.8
9000	2	UNION OIL CO. - CHIC	.0	.0	22.9	.0	.0	.0	.0	.0	.0	.0	.0	3.0	7.9	7.6	.0
9220	20	TEXACO REFINING AND	.0	.0	11.1	2.8	.0	.0	.0	.0	.0	.0	.0	237.7	54.8	196.9	.0
2260	3	AMER OIL CO 2931 IND	.2	.0	27.1	3.9	.0	.0	.0	.0	.0	.0	.0	30.0	23.4	29.6	.0

	ETH	HCHO	ETO	ACN	EDC	VCL	BENZ	STYR
TOTALS (FOR 15 PLANTS)	503.021	158.589	28.428	19.540	.008	3.708	332.169	21.012

	13BUT	ACE	PR.O	MCL	PERC	XYL	TOL
	.012	780.875	8.652	5.562	57.533	434.630	561.974

TABLE 16.   PARTICULATE MATTER SPECIES FRACTION-BASED ESTIMATES
              FOR FACILITIES RECEIVING QUESTIONNAIRES

CNTY	PLID	PLANT NAME	EMISSIONS IN TONS				
			ARSENIC	CADMIUM	CHROMIUM	NICKEL	MERCURY
1540	3	TRUMBULL ASPHALT CO.	.000	.000	.055	.000	.000
1540	20	STAUFFER CHEMICAL CO	.006	.001	.035	.004	.000
1540	42	MOTOR OIL REFINING C	.001	.000	.006	.114	.000
1540	56	KOPPERS COMPANY INC.	.005	.000	.031	.568	.000
1540	127	CLARK OILGREFINING	.000	.007	1.672	1.982	.002
8720	3	UNION OIL CO. - CHIC	.000	.027	.874	2.448	.011
8720	20	TEXACO REFINING AND	.006	.011	.278	1.367	.003
2360	3	AMOCO OIL CO 2831 INC	.125	.033	.893	14.783	.008

CNTY	PLID	PLANT NAME	EMISSIONS IN TONS				
			ARSENIC	CADMIUM	CHROMIUM	NICKEL	MERCURY
		TOTALS	.144	.089	3.806	21.265	.02.
		(FOR 8 PLANTS)					
		(QUESTIONNAIRE TOTALS:)	(.047)	(.19)	(.32)	(.015)	(0)
		(ALSO, BERYLLIUM - .0011 TPY)					

The results in Tables 15 and 16 indicate that total emissions according to questionnaire responses in general were found to be substantially lower than total emissions estimates using the species fraction approach. In some cases, the difference was dramatic: species fractions were higher than questionnaire totals for benzene by a factor of 16, for styrene by a factor of 25, and for formaldehyde by a factor of 566. Also, the species fraction approach estimated some emissions of several compounds which were not found in the questionnaires, including ethylene oxide, propylene oxide, acrylonitrile, and vinyl chloride. In other cases, the species fraction totals were only moderately higher than questionnaire totals, such as for toluene (a factor of 6) and xylene (a factor of 2.6), or even lower (for cadmium the species fraction total was 2 times lower than questionnaire totals). In yet other cases, however, some relatively common chemicals, specifically methylene chloride and trichloroethylene were not estimated to occur using the species fraction approach but were found in the questionnaire responses. Further, it is not surprising that relatively esoteric compounds such as diethanolamine and epichlorohydrin were found with questionnaires and were not found with species fraction approach.

In order to make an overall comparison among the multiple compounds, it is useful to make a qualitative review that considers dose-response relationships as well as emissions. This review suggests that overall the species fraction approach leads to a substantially higher estimate of risk than questionnaire responses.

The results as just discussed by the questions of why the differences arise and what kinds of sources have the greatest differences. In general, differences between the two sets of results may arise either from differences in total emissions estimates (i.e., total VOC or TSP) or from differences in species fractions. Unfortunately, the questionnaire did not ask for total emissions estimates, so it is difficult to distinguish these two origins of discrepancies. Nevertheless, some enlightenment comes from looking in detail at three types of sources: chemical plants, refineries, and miscellaneous manufacturing operations.

Chemical plants exhibited the most dramatic between species fraction results and questionnaire results. For these facilities, the species fraction approach appears to rely on a national mix of chemical production. The result, not surprisingly, bears little resemblence to the chemicals produced and emitted in the Southeast Chicago area. It is these facilities which were estimated to but have been affirmed not to emit ethylene oxide, propylene oxide, acrylonitrile, and vinyl chloride. On the other hand, these facilities did emit non-zero quantities of butadiene, diethanolamine, epichlorohydrin, for which the species fraction approach estimated little or no emissions.

The second source type, refineries, generally requested U.S. EPA assistance particularly in estimating species fractions. Thus, regardless of the actual accuracy of the species fraction used, any discrepancy between species fraction results and "questionnaire results" is caused by a discrepancy in total VOC estimates. For example, for the Texaco refinery, the species fraction approach estimated substantial emissions whereas the questionnaire response indicated that the facility had largely shut down. It is interesting to note further that the species fraction approach predicted substantial refinery emissions of chromium, from combustion of chromium-containing oil for heating. This is illustrative of the possibility in some cases that the species fraction approach may find substantial emissions which are not suspected by the sources themselves.

The third source type, miscellaneous manufacturing operations, sometimes shows surprisingly good correspondence between species fraction results and questionnaire results and sometimes shows firms estimating zero emissions where species fractions indicate substantial emissions. It is possible in some of these latter cases that the firms use solvents for example that are mixtures which, unknown to the firms, contain the compounds of interest.

In summary, the species fraction approach often given reasonable screening estimates of emissions, but the results sometimes differ substantially from the emissions estimates made by the firms themselves. Particularly for chemical plants, the use of national default species fraction cannot be expected to predict what chemicals are used at local facilities. For other facilities, however, the species fraction are generally at least comparable to source estimates, and in fact the species fraction may in some cases be more accurate than the source's own estimation of its emissions mix. In some cases, inaccuracies were a result of inaccurate VOC/TSP emissions data in NEDS. In general, though, in the context that this inventory is intended as a screeening inventory, the species fraction approach appears to give reasonably reliable emissions estimates for this purpose.

General Observations

Substantial interest has arisen in the urban air toxics problem. The inventory described in this report is part of a unique project to assess one urban air toxics "hotspot". It is anticipated that this inventory will facilitate the development of other, similar urban area inventories. Therefore, it is appropriate to discuss the process of inventory development and make other comments that might be useful to other groups developing similar inventories for other areas.

Given the goal of compiling a comprehensive inventory, this inventory necessarily relied heavily on information available in the literature. Even for the point source portion of the inventory, resource constaints led to sending direct questionnaires to only 29 out of 88 facilities. For the other 59 sources, emissions estimates for VOC and TSP were available as part of NEDS. By necessity, literature information, particularly information from the VOC Species Data Manual and the Receptor Model Source Composition Library, were used to assess the toxic compound components of these VOC and TSP emissions estimates.

Fortunately, the above two references provide relatively complete information on point source species fractions. Unfortunately, species fractions for area source categories were much more difficult to obtain. For the point source inventory, the inventory appears to be relatively complete, and the principal question is the accuracy of the available estimates. For area sources, there is more of a question as to the completeness of the inventory. That is, it is more evident in the area source inventory than in the point source inventory that the ability to inventory emissions is limited by the availability of information with which to make estimates.

For mobile sources, substantial literature review was necessary as part of this project, but the result appears to be a fairly complete and seemingly relatively reliable inventory. For wastewater volatilization, the inventory appears relatively complete (with the notable exception that emissions out of sewers are not estimated), though the assumption of 100% volatilization and the reliance on a handful of influent samples leads to questions about reliability. For treatment, storage and disposal facilities, the estimates here, despite being the best available estimates, must be considered highly uncertain, due to uncertainties in waste composition, waste quantities, propensities to volatilize, and the insurmountable difficulties of addressing "special waste" landfills and unauthorized landfills.

Part of the process of developing the inventory was developing a plan for compiling the inventory. This was a useful endeavor, since it helped in defining the source area and the compounds to inventory, and helped in organizing what source types warranted investigation. At the same time, it must be noted that much of the character of the inventory development process was a function of what information was available in the literature. Thus, for example, the inventory includes methylene chloride emissions from its use in aerosol cans and does not include butadiene from oil-fired home heating, simply because emissions factor data were available for the one category and not for the other. As a result, a major portion of the work in compiling this inventory was performing literature review, exploratory work which could not be anticipated in the work plan.

Regarding the literature which was found useful, this report includes a complete bibliography of literature used in this study. The VOC Species Data Manual and the Receptor Model Source Composition Library have already been identified as key data sources for addressing point sources. Most of the literature used in the mobile source inventory was obtained from U.S. EPA's Mobile Source Characterization Branch of the Atmospheric Sciences Research Library in Research Triangle Park, North Carolina, based on considerable work they have performed on the subject. The literature for area source categories was more diverse, including literature focussing on per capita emissions (based on national consumer VOC usage), literature focussing on particular categories such as wood stove emissions, as well as literature from a few broad-based inventory efforts. The wastewater volatilization estimates did not rely on any literature data.

One other series of documents which were reviewed was the documents known as "locator documents" (e.g., "Locating and Estimating Air Emissions from Sources of Formaldehyde"). However, these documents did not lead to very many of the emissions estimates used in this study. This is partly because most of the facility types described in these documents are not present in the Southeast Chicago source area. This is also partly because many of the emission factors provided in these documents rely on information that is not readily available. For example, the chromium locator document provides an estimate of the quantity of chromium emissions per quantity of chrome-containing refractory brick, but the available information on the brick production does not differentiate the various kinds of brick refractories. Thus, the locator documents, while providing some information useful in this study, more often seems oriented toward focussed investigations of individual sources or source types than toward general inventories.

One surprising aspect of the process of completing this inventory was the effort associated with the questionnaires. Numerous companies misplaced the questionnaire. For some companies, plant personnel were unable to process the questionnaire, and we had to send another copy of the questionnaire to company headquarters. We attached to each questionnaire the NEDS information on the company, thinking this would simplify their response, since the companies could just confirm the accuracy of NEDS. This was a mistake: companies felt obliged to have accurate information on every detail on NEDS, and often needed information to decipher which point of their facility corresponded to which point on NEDS. Finally, substantial follow-up work was necessary, particularly where responses appeared incomplete or where companies did not know the composition of the materials they processed.

This report would not be complete without discussion of needs for further investigation. The goal of this project was to obtain a comprehensive inventory of air toxics emissions, so almost by definition any element of the inventory could be improved through further investigation. Nevertheless, it is possible to identify specific elements of the inventory for which further investigation would particularly improve the overall inventory. Perhaps the most important need identified in this study is the need for improvement of point source species fractions. Part of an investigation of this issue would be a more detailed investigation of the cause of the discrepancy found here between species fraction-based emission estimates and questionnaire responses, which would presumably help identified means of improving the reliability of the species fractions. Even apart from this investigation, it is clear that significant improvement to the inventory could be obtained by performing a broader set of species fraction measurements and doing the collateral work of assessing which operations (e.g., by SCC) can be characterized with which sets of species fractions. A second important need is the development of more area source emission fractors (e.g., metals from electroplating and butadiene from home heating) and improvement of existing area source factors (e.g., benzene fractions for various portions of the petroleum/gasoline marketing chain and the composition of coatings used in house painting and auto refinishing).

A third important need is to improve emissions estimates for polycyclic organic matter, as emitted by highway vehicles, by wood stove use, and by other heating uses. Relatively few measurements have been made of the relevant emission factors. Also, for wood stoves, there are significant uncertainties in wood usage in the urban setting of Southeast Chicago area, and there are significant undertainties about the impact of differences between actual and laboratory stove operating characteristics on emissions. In addition, since this is not a single compound but rather a complex mixture of compounds, any assessment of the biological toxicity of the emissions would benefit from a more thorough understanding of the composition of the emissions. Fourth, some studies have indicated that formaldehyde formation from photochemical reactions can cause greater exposure than direct formaldehyde emissions and in fact can represent a major component of ambient toxicity. No effort was made to assess photochemical formaldehyde formation in Southeast Chicago. A need exists for a simple method,

using methods such as correlations with monitored ozone or photochemical box modeling, which could approximate photochemical formaldehyde formation without requiring long-term formaldehyde monitoring. Fifth, a number of improvements could be made in the inventory of emissions from treatment, storage, and disposal facilities, both in the estimation of waste quantities of particular compounds and in the estimation of the degree of volatilization. Although the emissions from these source types are relatively small, the public interest in this general category translates to an interest in these improvements.

Other needs for further investigation exist in the other source types. For mobile sources, the adjustments, particularly the adjustment to reflect the possibility that standard measurement techniques may only measure 77% of total exhaust, warrant further investigation. For wastewater volatilization, further investigation could address volatilization from sewers, collection of a more robust set of influent samples, and refinement of the fraction of influent that volatilizes.

Another set of further investigations represent a broadening of the emission investigation. One such broadening is to include emissions of compounds with non-cancer health impacts. Note that the impacts of such compounds are often a function of short-term average concentrations, and so such an emissions inventory would probably have to address peak short-term average emission rates. A second such broadening would be to assess the impact of potential emissions controls, such as the ozone control program, the total suspended particulate program, or such strategies as a focussed permit review program.

This report describes the completion of a project to estimate emissions of a broad list of potential air toxicants in the Southeast Chicago area. At the same time, this report signals the beginning of a modeling assessment of population exposure to these pollutants. It is also hoped that this report will facilitate the beginning of other projects in other urban areas to assess emissions of potential air toxicants.

Bibliography

Information on Illinois and Indiana emissions/activity levels

I.1. National Emissions Data System (NEDS) - a computer data base maintained by U.S. EPA containing data on point sources (including operating character- istics and emissions of criteria pollutants as obtained by State Agencies).

I.2. 1982 Ozone SIP Revisions by Illinois and Indiana for the Chicago/Northwest Indiana Area - a collective term for numerous submittals most relevantly including a VOC emissions inventory. These submittals were the primary basis for area and mobile source county emissions totals and for various characteristics affecting mobile source emissions. Three specific references included in the SIP are:

I.3. F.M. Sellars, A.M. Kiddie, L.A. Baci, R.J. Rosy, R.D. Green, Development of the Area Source Emissions Inventory for the 1982 Ozone State Implementation Plan for the Chicago Metropolitan Region of Illinois and Indiana, GCA Corp., December 1981.

I.4. "1982 State Implementation Plan Submittal for Northeastern Illinois," Chicago Area Transportation Study, June 24, 1982. (This is the highway vehicle emissions inventory in Illinois' 1982 ozone plan for Chicago.)

I.5. "Mobile Source Emissions Inventory for Lake and Porter Counties, Indiana," Bernardin, Lochmueller & Associates, September 1982.

I.6. Gridded Illinois socio-economic data - a computer file containing gridded socioeconomic data (e.g., arterial and freeway VMT and manufacturing employment) for use in spatially distributing area and mobile source emissions.

I.7. 1980 Census of Population - Illinois (PC(1)-A15) and Indiana (PC(1)-A16) - contains maps of the urbanized area and population data.

I.8. Census data - computerized population and dwelling unit data at the block group level were taken from Bureau of Census data stored on the Graphical Exposure Modeling Systems (GEMS).

I.9. Wastewater Concentration data - data were obtained from the Greater Chicago Metropolitan Sanitary District, in letters (Frank Dalton to Charles Sutfin) dated December 17, 1986, and April 7, 1987.

I.10. Hazardous waste handling data - extensive state data on the quantities of each waste code generated, treated, stored or disposed by each facility were obtained from IEPA and IDEM. (This report does not document final emission estimates for this category, however.)

I.11. "Estimates of U.S. Wood Energy Consumption from 1979 to 1981" (DOE/EIA 0341), Energy Information Administration, Department of Energy - provided state by state estimates of wood usage per household. (The authors used these data as cited in separate references.

I.12. "Inventory of Health Care Facilities and Need Determination by Planning Area", Illinois Department of Public Health - provided data on local hospitals.

Point Source References

P.1. Volatile Organic Compound (VOC) Species Data Manual, Office of Air Quality
      Planning and Standards, USEPA. EPA Report # EPA-450/4-80-015, July 1980 -
      contains 174 profiles and 134 organic species, including 19 species from
      this study.

P.2. Compiling Air Toxics Emissions Inventories, Office of Air Quality Planning
      and Standards. EPA Report #450/4-86-006, June 1986 - contains an index
      of which species profiles to use for which standard Classification Code
      (SCC), and contains a variety of other useful types of information.

P.3. Receptor Model Source Composition Library, Office of Air Quality Planning
      and Standards, EPA Report # EPA-450/4-85-002, November 1984 - covers
      roughly 80 SCC's and 30 metals, including 6 metals in this study (arsenic,
      beryllium, cadmium, chromium, mercury and nickel).

P.4. "Locator documents" e.g., Locating and Estimating Air Emissions From Sources
      of Formaldehyde, EPA Report # EPA-450/4-84-007e, March 1984 - a series of
      documents providing emission factor data and, for source types with a modest
      number of facilities, source location. Such documents are available for:
          a. Acrylonitrile   (EPA-450/4-84-007a)
          b. Carbon Tetrachloride   ("   -007b)
          c. Chloroform   ("   -007c)
          d. Ethylene Dichloride   ("   -007d)
          e. Formaldehyde   ("   -007e)
          f. Nickel   ("   -007f)
          g. Chromium   ("   -007g)
          h. Manganese   ("   -007h)
          i. Phosgene   ("   -007i)
          j. Epichlorohydrin   ("   -007j)
          k. Vinylidene chloride   ("   -007k)

      At time of report preparation, draft "locator documents" were also avail-
      able for chlorobenzenes, ethylene oxide, polychlorinated biphenyls, and
      polycyclic organic matter. For a great majority of these pollutants,
      these reports indicated a probable absence of major point sources. How-
      ever, the Southeast Chicago area does contain sources for which species
      fractions and emission fractions could be derived based on the locator
      documents for chromium, nickel, formaldehyde, and polycyclic organic
      matter.

P.5. Steam Electric Plant Factors, 1982, National Coal Association - provided
      heat content data for various fuels, e.g., BTU/1000 gallons oil. (This
      study used Commonwealth Edison fuel data). These data were used to convert
      emissions factors from units of emissions/heat content (e.g., g/Joule) to
      units of emissions/quantity fuel (e.g., g/1000 gallons oil).

P.6. Coke Oven Emissions from Wet-Coal Charged By-Product Coke Oven Batteries--
      Background Information for Proposed Standards, Draft EIS, OAQPS, August 1986.

P.7. Benzene Emissions from Coke By-Product Recovery Plants -- Background
      Information for Proposed Standards, Draft EIS, OAQPS, EPA Report #450/3-83-016a.

Area Source References

A.1. W.H. Lamason, "Technical Discussion of Per Capita Emission Estimates for Several Area Sources of Volatile Organic Compounds", paper presented at Air Pollution Control Association meeting, June 21-26, 1981 - this is the fundamental source for most of the per capita emission factors.

A.2. End Use of Solvents Containing Volatile Organic Compounds, The Research Corporation of New England (for OAQPS, USEPA), EPA Report # EPA-450/3-79-032, May 1979 - provides additional information for calculating per capita emission factors.

A.3 Improvement of the Emissions Inventory for Reactive Organic Gases and Oxides of Nitrogen in the South Coast Air Basin, Systems Applications, Inc., and Radian Corporation (for California Air Resources Board), May 1985 - provided species profiles for gasoline marketing, architectural surface coating (see especially the main text chapter on "species profile development" and Appendix E).

A.4. "Locator documents" - see reference data and description under point source references. Specific documents from which area source emissions factors were used included the formaldehyde, chloroform, chromium, nickel and draft polycyclic organic matter locator documents.

A.5. Hazardous Air Pollutants: Air Exposure and Preliminary Risk Appraisal for 35 U.S. Counties, Appendix E, "Area Source Emission Factor Documentation," Versar, Inc. and American Management Systems, September 1984 - although the documentation is scant and the reliability of the data are uncertain, this report provides useful species profiles for degreasing: other profiles here were superseded by other references.

A.6. Steam Electric Plant Factors - see reference data under point source references. Again, fuel heat content were used to convert from emissions per Joule to emissions/quantity fuel burned.

A.7. Estimates of U.S. Wood Energy Consumption, 1949-1981, by Applied Management Sciences for Dept. of Energy - supplied Illinois wood usage estimates.

A.8. Residential Energy Consumption Survey: Consumption and Expenditures April 1982 through March 1983, Energy Information Agency (Dept. of Energy) - supplied regional wood usage information used to adjust from statewide to urban wood usage.

A.9. R.L. Gay, W.T. Greene, J.J. Smith, "A National Assessment of Residential Wood Combustion Air Pollution Impacts," Nero and Associates, March 15, 1985 - showed U.S. Dept. of Agriculture wood usage estimates.

A.10. Survey of Methylene Chloride Emission Sources, USEPA Report #450/3-85-015, June 1985 - References A.10, A.11, and A.12 document national emission estimates and procedures underlying county estimates for degreasing emissions of these compounds.

A.11. <u>Survey of Perchloroethylene Emission Sources</u>, U.S. EPA Report #450/3-85-017, June 1985 - see note under A.10. Also supplied similar information for dry cleaning.

A.12. <u>Survey of Trichloroethylene Emission Sources</u>, U.S. EPA Report #450/3-85-021, June 1985 - see note on A.10.

A.13. <u>Chromium Emissions from Comfort Cooling Towers - Background Information for Proposed Standards (Draft EIS)</u>, Office of Air Quality Planning and Standards, March 1987 - provided per capita emission factors used to derive a per "other" (nonmanufacturing; nonretail) employee emission factor.

A.14. Phone conversation with OAQPS staff (Al Vervaert), October 30, 1986 - provided data for crude emissions estimates for chrome plating.

Mobile Source References

M.1. R.B. Zweidinger, J.E. Sigsby, Jr., S.B. Tejada, F.D. Stump, D.L. Dropkin, W.D. Ray, and J. W. Duncan, "Detailed Hydrocarbon and Aldehyde Mobile Source Emissions from Roadway Studies," Environmental Sciences Research Laboratory - provided the majority of exhaust emission fractions.

M.2. J.E. Sigsby, Jr., S.B. Tejada, W.D. Ray, J.M. Lang, and J.M. Duncan, "Volatile Organic Compound Emissions from 46 In-use Passenger Cars," Environmental Sciences Research Laboratory - provided evaporative emission fractions, and documented the possibility of unheated sampling trains under-measuring exhaust emissions.

M.3. J.E. Sigsby, Jr., D.L. Dropkin, R.L. Bradow, J.M. Lang, "Automotive Emissions of Ethylene Dibromide," Environmental Sciences Research Laboratory, presented at Passenger Car Meeting, Troy, Michigan, June 7-10, 1982 - provided exhaust and evaporative emissions data for ethylene dibromide, and documented absence of ethylene dichloride.

M.4. Conversations with staff of Office of Mobile Sources staff - provided data for estimating exhaust and evaporative emissions fractions for benezene.

M.5. <u>User's Guide to MOBILE3 (Mobile Source Emissions Model)</u> - MOBILE3 provided data on total highway vehicle emissions factors and the components of the total from each vehicle type.

M.6. Personal communication from John Sigsby to author (comments on draft report) dated January 30, 1987 -- reports that butadiene has been found to be between 5 and 20% of n-butane.

Wastewater Volatilization References

Apart from local wastewater concentration data, no references were used, since simplying assumption of 100% volatilization was used.

⬤ Illinois Environmental Protection Agency · 2200 Churchill Road, Springfield, IL 62706

217/782-1830

August 14, 1985

Monarch Laundry Co.
140 West 111th Street
Chicago, Illinois

Gentlemen:

The Illinois EPA and USEPA are engaged in a cooperative effort to compile an
inventory of air emissions of selected substances in your area. As authorized
by the Illinois Environmental Protection Act and the federal Clean Air Act, we
are compiling this inventory so that we can assess associated health impacts
on the residents of the Southeast Chicago area. Four types of sources are
being included in this information gathering effort: individual
manufacturing/processing facilities, "area sources" (such as gasoline stations
and dry cleaners), "mobile sources" (traffic) and specific categories such as
landfills and wastewater treatment plants.

After we have collected the necessary emissions data for point, area, mobile,
and special sources, an assessment of the atmospheric dispersion and
population exposure to the emitted material and of the possible adverse health
efforts that exposure could cause will be performed. Results of this analysis
will provide a more enlightened basis for subsequent discussions on the nature
and magnitude of adverse health effects from these air pollutants in Southeast
Chicago.

Although a popular impression exists that commercial facilities are the major
source of environmental health risks, a recent USEPA study has indicated that
area and mobile sources may be major contributors to these risks. We are
seeking your cooperation to obtain the most reliable and most credible basis
for evaluating the relative contribution and overall magnitude of any possible
health risk in the area which might result from the emissions of the selected
substances.

We have included several attachments to this letter to help you provide the
information needed. The first attachment is a list of substances being
inventoried. Most of these substances are organic compounds. A few of the
substances are metals. For the metals, we are interested in the weight of the
metal emitted, regardless of the chemical form in which the metal exists.

Attachment 2 is a printout of information presently on our files. The
parameters which are important to this project have been circled. Please
1) confirm the information is correct by marking "O.K." next to the correct
line of data, 2) substitute corrected data if that presented is incorrect, and
3) supply any data which are missing.

Page 2-

Attachment 3 is a questionnaire which identifies other information needed. I general, this questionnaire seeks emissions estimates for each operation in your facility for each of the listed compounds which you may emit, and some additional information helpful in assessing the possibility of atmospheric releases. Please fill out a questionnaire for each operation or production line in your facility as identified (or as should be identified) in Attachment 2.

Attachment 4 requests additional information on secondary air emissions resulting from plant operations involving wastewater, liquid wastes, and soil wastes.

Please note that in the absence of the requested information, emissions from your facility will be estimated based on the VOC and TSP emissions data shown in Attachment 2, and on estimates of the fractions of these emissions expect to be represented by each of the listed compounds for your "type of operation". This estimation method could significantly misrepresent your contribution to the emissions of these compounds. Therefore, we are seeking your cooperation in providing more accurate and reliable information.

If you wish that some or all of the information you provide should be kept confidential, please provide justification and identify the information you wish kept confidential at the time you submit it. Illinois EPA will follow the procedures given in the State of Illinois Rules and Regulations, Title 3 Chapter II: Part 161 for handling requests for confidentiality, and USEPA wi follow the procedures given in 40 CFR Section 2.100 et seq. Failure to asse a claim of confidentiality makes the information available to the public without further notice.

Please submit the requested information by September 30, 1985. Please addre the USEPA's copy to Harriet Croke (5AR-26), USEPA, 230 S. Dearborn, Chicago, IL 60604. If you would like additional information regarding the questionnaire or the project in general, please call John Shrock of my staff (217/782-1840) or John Summerhays (312/886-6067) or Dr. Harriet Croke (312/353-4009) of the USEPA Region V office. We would also be happy to shar with you, on request, a description of the plan for estimating emissions of other sources and source types in the area. We are looking forward to your cooperation in this effort.

Sincerely,

Michael J. Hayes
Assistant Division Manager
Division of Air Pollution Control

MJH:JS:bjh/sp/1726E/1,2

ATTACHMENT 1
Substances
To Be Inventoried

Acetone
Acrylamide
Acrylonitrile
Allyl chloride
Arsenic
Asbestos
Benzene
Benzyl chloride
Beryllium
1,3 Butadiene
Cadmium
Carbon tetrachloride
Chloroform
Chromium
Coke Oven Emissions
Diethanolamine
Dimethylnitrosamine
Dioctyl phthalate
Dioxin
Epichlorohydrin
Ethyl acrylate
Ethylene
Ethylene dibromide
Ethylene dichloride
Ethylene oxide
Formaldehyde
4,4 Isopropopylidene diphenol
Melamine
Mercury
Methyl chloride
Methylene chloride
4,4 Methylene dianiline
Nickel
Nitrobenzene
Nitrosomorpholine
Pentachlorophenol
Perchloroethylene
PCBs
Polycyclic organic matter
Propylene dichloride
Propylene oxide
Styrene
Terephthalic acid
Titanium dioxide
Trichloroethylene
Toluene
Vinyl Chloride
Vinylidene chloride
Xylene

MJM:JS:bjh/sp/1726E/3

attachment 2

STATE(14): ILLINOIS   AQCR(067): METROPOLITAN CHICAGO   CITY(1220): CHICAGO
COUNTY(1543): COOK CO   PLANT ID: 0223   POINT ID: 01

NAME-ADDRESS: MONARCH LAUNDRY CO 160 W 111ST STREET   SICC   ): MISSING
PERSONAL CONTACT: VAN DEEK   SCC(1-02-006-02): EXTCOMB BOILER   -INDUSTRIAL   -NATURAL GAS   -10-100MMBTU/HR

```
! GENERAL INFORMATION  ! UTM GRID COORDINATES        ! HAND CALCULATED POINT EMISSIONS       ! ALLOWABLE EMISSIONS FOR POINT  !
! .................... ! ..................        B ! ..................................... ! .............................. !
! DATE OF              !        UTM ZONE: 16         ! PARTICULATE:        0 TONS/YR         !   PARTICULATE:          TONS/YR !
! LAST UPDATE: 1981    !                            !          SOX:       0 TONS/YR         !          SOX:           TONS/YR !
!                      !   HORIZONTAL:   447.5 KM   !          NOX:       2 TONS/YR         !          NOX:           TONS/YR !
! OWNERSHIP: INVALID   !   VERTICAL: 4,615.5 KM     !          VOC:       0 TONS/YR         !          VOC:           TONS/YR !
!                      ! ------------------------   !          CO:        0 TONS/YR         !          CO:            TONS/YR !
! IPP PROCESS:         ! STACK PARAMETERS           ! ------------------------------------- ! ------------------------------ !
!                      ! ....................       ! EMISSION ESTIMATION METHODS           ! COMPUTER CALCD SCC EMISSIONS   !
! SOURCE: INVALID      ! STACK HEIGHT:      125 FT  ! .................................     ! ............................   !
!                      ! STACK DIAMETER:    5.9 FT  ! PART: EMISSION FACTOR(NEDS SCC FILE)  !    PART:       <1    TONS/YR   !
!                      ! GAS TEMPERATURE:   350 F   ! SOX: EMISSION FACTOR(NEDS SCC FILE)   !                               !
! NORMAL OPERATIONS    ! GAS FLOW RATE:  11,250 ACFM! NOX: SPECIAL STATE EMISSION FACTOR    !    SOX:        <1    TONS/YR   !
! ................     ! PLUME HT(NO STACK):     FT ! VOC: EMISSION FACTOR(NEDS SCC FILE)   !                               !
!    HOURS/DAY: 10     ! SAME STACK VENTS POINTS 19-02! CO: EMISSION FACTOR(NEDS SCC FILE)  !    NOX:         2    TONS/YR   !
!    DAYS/WEEK: 5      ! ------------------------------------------------------------------ !                               !
!    WEEKS/YEAR: 52    ! CONTROL DEVICE/METHOD IDENTIFICATION              ! CONTROL         !    VOC:        <1    TONS/YR   !
!                      ! .......................................           ! EFFICIENCIES    !                               !
! % ANNUAL THROUGHPUT  ! PRIMARY PART: CENTRIFUGAL COLLECTOR - MEDIUM EFFICIENCY ! ......... !    CO:         <1    TONS/YR   !
! ...................  ! SECOND. PART: UNKNOWN, NOT SPECIFIED              ! PART: 70.2 %    !                               !
!    DEC-FEB: 20 %     !                                                  !                 !                               !
!    MAR-MAY: 30 %     ! PRIMARY SOX: UNKNOWN, NOT SPECIFIED              !                 !                               !
!    JUNE-AUG: 30 %    ! SECOND. SOX: UNKNOWN, NOT SPECIFIED              ! SOX:       %    !                               !
!    SEPT-NOV: 30 %    !                                                  !                 !                               !
!                      ! PRIMARY NOX: UNKNOWN, NOT SPECIFIED              !                 !                               !
! % SPACE HEAT:    %   ! SECOND. NOX: UNKNOWN, NOT SPECIFIED              ! NOX:       %    !                               !
!                      !                                                  !                 !                               !
! COMPLIANCE INFO      ! PRIMARY VOC: UNKNOWN, NOT SPECIFIED              !                 !                               !
! ..............       ! SECOND. VOC: UNKNOWN, NOT SPECIFIED              ! VOC:       %    !                               !
! NOT SPECIFIED        !                                                  !                 !                               !
!                      ! PRIMARY CO: UNKNOWN, NOT SPECIFIED               !                 !                               !
! SCHEDULED            ! SECOND. CO: UNKNOWN, NOT SPECIFIED               ! CO:        %    !                               !
! COMPLNCE DATE:   /   ! --------------------------------------------------------------------                                !
!                      ! FUEL CHARACTERISTICS          ! OPERATING RATES                    ! ------------------------------ !
! COMPLIANCE STATUS    ! .................             ! ...............                    !                                !
! UPDATE:      / /     !                               !   ANNUAL OPERATING RATE:      52 MILLION CUBIC FEET BURNED          !
!                      !                               !                                                                    !
! EMERGENCY CONTROL    ! FUEL SULFUR CONTENT: 0.05 %   !   HOURLY MAXM DESIGN RATE:    .250 MILLION CUBIC FEET BURNED        !
! ACTION PLAN          !                               !                                                                    !
! ...............      !    FUEL ASH CONTENT:      %   !   BOILER DESIGN CAPACITY:     37 MILLION BTU/HR                     !
! NOT REQUIRED         ! --------------------------------------------------------------------------                         !
!                      ! FUEL HEAT CONTENT: 1,000 MILLION BTU/MILLION CUBIC FEET BURNED     COMMENTS:                        !
--------------------------------------------------------------------------------------------------------------------------
! PLANT COMMENT :                                                                                                          !
! POINT COMMENT :                                                                                                          !
! SCC   COMMENT :                                                                                                          !
--------------------------------------------------------------------------------------------------------------------------
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ATTACHMENT 3

A. Identify any chemical listed on Attachment A which is used or created by your process/storage/disposal operations.

B. For each emission stream (stack, process, fugitive, storage tank, end of pipe) please provide the following information on the point of emission for the 1984 calendar year.

latitude_____
longitude_____
height from ground_____
diameter of emission point_____
velocity_____
emission temperature_____
operation time   hrs/da_____ days/wk_____ wks/yr_____

For each chemical substance identified in part A which is in this stream give

Chemical Name   Uncontrolled Emission Rate
                                                          Tons/Yr

_____   _____

_____   _____

_____   _____

What air pollution control are in place for this emission stream

Control   Chemical   Removal efficiency
                                 (Attachment 1)

_____   _____   _____

_____   _____   _____

_____   _____   _____

_____   _____   _____

ATTACHMENT 3 (continued)

During the 1984 calendar year did you have any unscheduled releases resulting in emissions of any of the substances identified in part A?

For each such stream associated with an unscheduled release list for the total calendar year

compound
(identified in attachment 1)

quantity emitted to air
directly/indirectly

_____   _____

_____   _____

_____   _____

AJH:JS:bjh/sp/1726E/4,5

ATTACHMENT 4

C. SECONDARY EMISSIONS OF POTENTIALLY TOXIC SUBSTANCES

Secondary emissions are those air emissions resulting from the treatment or disposal of wastewater, liquid wastes, or solid wastes. For each process waste stream which contains one or more toxic substances, provide information by filling in the table below. If sampling data are not available, provide a best estimate for each waste stream.

Process feeding waste stream:

Treatment or disposal method (if portions of the stream are treated/disposed of differently describe methods separately for each toxic component.)

Total volume of solid waste_____lb/hr.

Total volume of liquid waste_____gal/min.

Total volume of effluent discharged to sewer system_____gal per day.

Substance Name	Substance Concentration (gm/m³)	Total Substance (kg/day)	% of Substance Discharged to Sewer System	Other Treatment/ Disposal of Substance
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

MJH:JS:bjh/sp/1726E/6