AN EMISSION INVENTORY
FOR
JEFFERSON COUNTY (BIRMINGHAM), ALABAMA

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service

Office of Air Programs Publication No. APTD-0893

AN EMISSION INVENTORY FOR JEFFERSON COUNTY (BIRMINGHAM), ALABAMA

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U. S. Department of Health, Education, and Welfare
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration
Abatement Program
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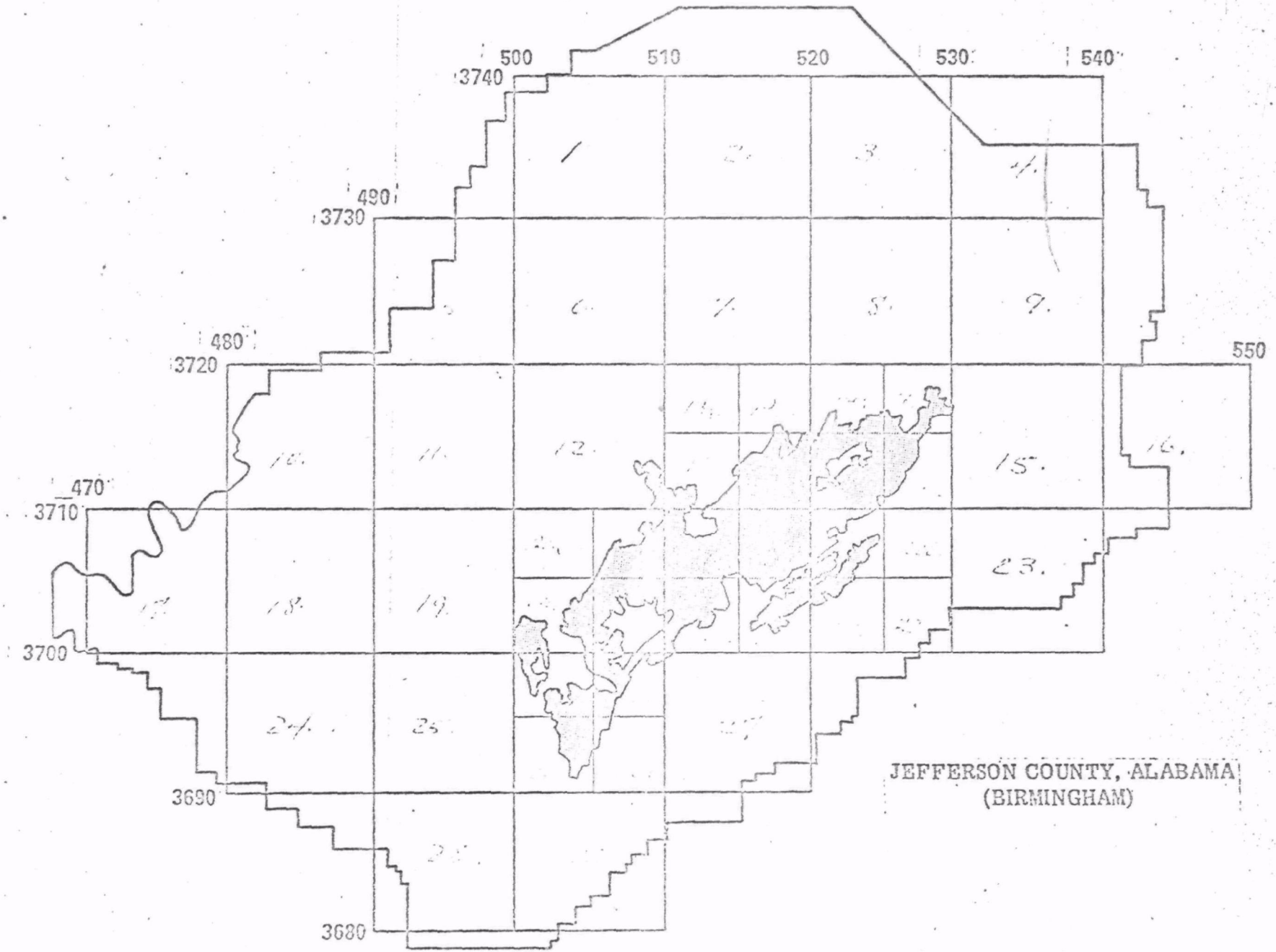
AN EMISSION INVENTORY FOR JEFFERSON COUNTY (BIRMINGHAM), ALABAMA

This emission inventory is based on a report prepared by the Jefferson County Air Pollution Control Program with assistance from the Public Health Service, and published in June, 1967. A copy of this report is attached. The industrial questionnaires and the area source tabulations were provided by Mr. Charles B. Robison, Engineer, Jefferson County Department of Health, who also supplied land use data and helped to locate the point sources.

Although the Birmingham Standard Metropolitan Statistical Area includes Jefferson, Shelby and Walker Counties, the original report dealt with Jefferson County alone. However, this county has approximately 90 percent of the total population and dwelling units, and 93 percent of the manufacturing employees in the Birmingham SMSA. Since 93 percent of the particulate and 91 percent of the sulfur oxide emissions in Jefferson County were attributed to point sources, the absence of any large sources in the other two counties, combined with their rural characteristics, indicates that virtually all of the emissions in the SMSA are contributed by Jefferson County. Consequently, no attempt was made to expand the original report and estimate the emissions from Shelby and Walker Counties.

All of the area emissions were originally calculated on a township or neighborhood basis, which simplified the apportionment into the grid zones. Land use maps were employed whenever a township occupied more than one grid. Motor vehicle emissions were distributed by rating each grid for number and type of roads and traffic density. The content of this report is as follows:

1. A map of Jefferson County showing the selected grid zones.
2. A map locating the point sources with an accompanying table listing the emissions at each source.
3. The emission data by grid in the required format.
4. The average day emission density maps for each pollutant.
5. The intermediate calculations for each grid.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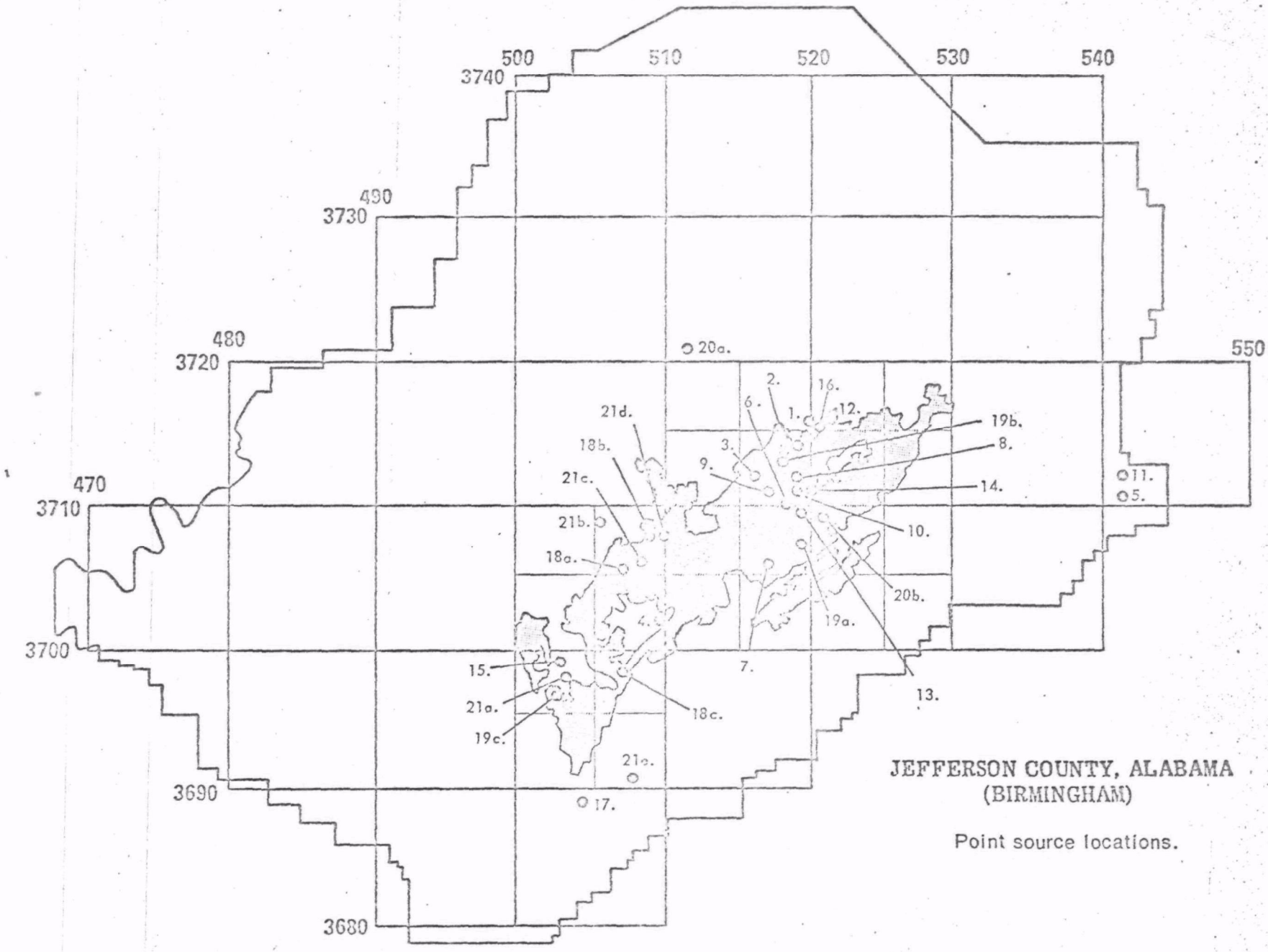
JEFFERSON COUNTY, ALABAMA
(BIRMINGHAM)



JEFFERSON COUNTY, ALABAMA
(BIRMINGHAM)

Point source locations.

JEFFERSON COUNTY INDUSTRIAL POINT SOURCES

Company Name	Emissions - tons/year			
	Grid Coordinates	Part.	SO_2	CO
1. Lehigh Portland	520-3716	25,759	152	12
2. Lone Star	519-3714	25,312	142	12
3. ACIPCO	516-3712	1,973	19	---
4. Alpha Portland	509.5-3702	15,013	34	3
5. Universal Atlas	542-3711	26,825	285	18
6. H. K. Porter (Connors Steel)	518-3710	936	8	---
7. Farmers' Ginners	517-3706	170	---	---
8. U. S. Gypsum	519-3712	384	5	---
9. So. Elec. Steel	517-3711	390	4	---
10. V. C. Chemical	519-3711	---	563	---
11. Rock Wool Mfg.	542-3712.5	129	---	---
12. James B. Clow	522-3716	1,402	4	---
13. Southern Amiesite	519.5-3709.5	200	---	---
14. Stockham	520-3711	191	46	4
15. Woodward Iron	503-3699	16,050	150	1,000
16. Ala. By-Products	520.5-3715.5	689	2,725	38
17. F. S. Royster G	504-3689	1,050	---	---
Multiple Sources				
18. U. S. Steel				
a. Fairfield	507-3705.5	14,011	14,018	129
b. Ensley	509-3708	37,751	1,540	---
c. Wenonah	507-3698	7,563	1,708	---
Total		59,325	17,266	129
19. U. S. Pipe				
a. City Furnaces	519-3707	503	154	18
b. No. Birm. Complex	518-3713	6,285	7,408	44
c. Bess. Pipe Plt.	502.5-3697	804	15	---
Total		7,592	7,577	62

JEFFERSON COUNTY INDUSTRIAL POINT SOURCES (con't.)

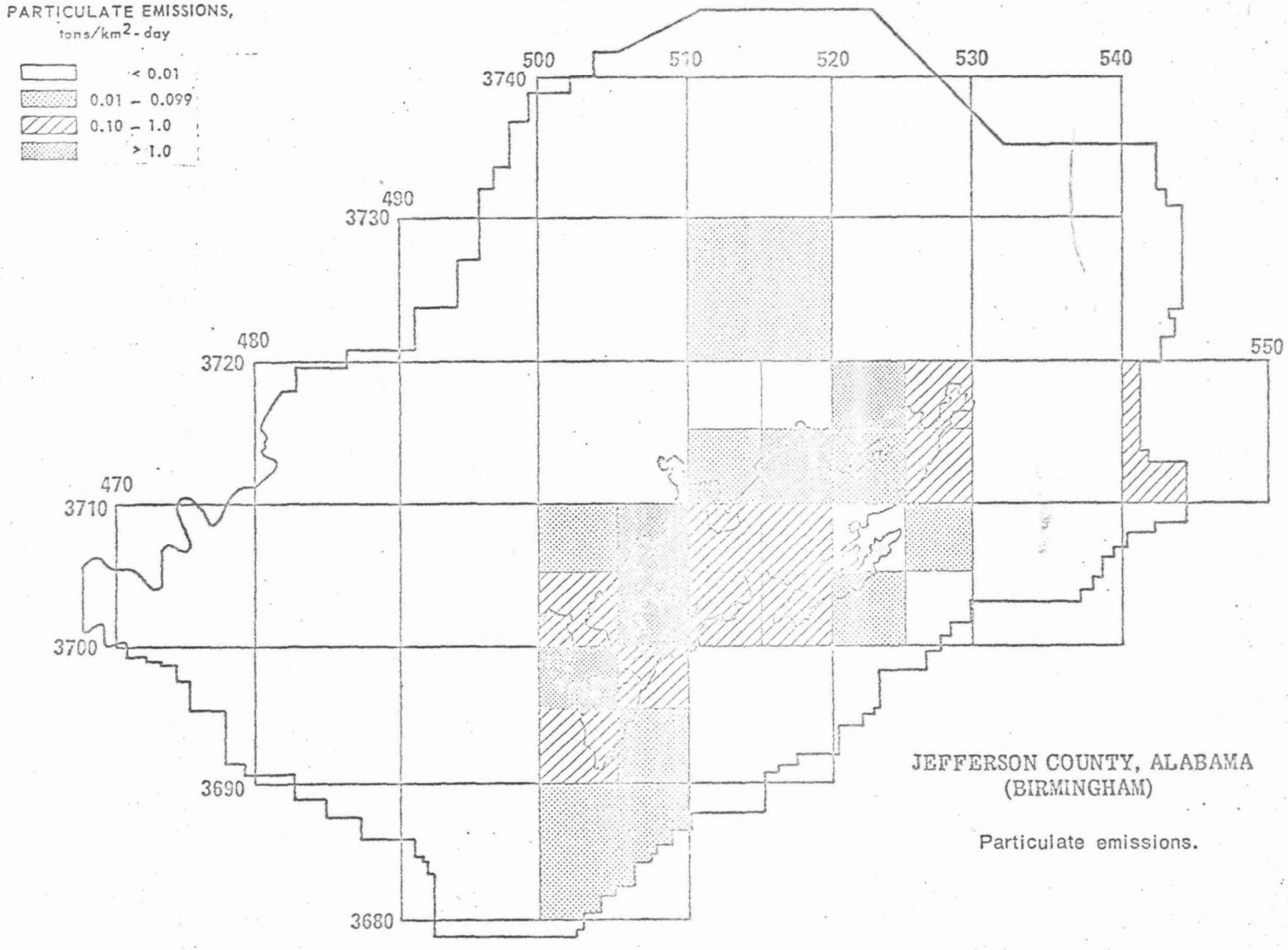
Company Name	Emissions - tons/year			
	Grid Coordinates	Part.	SO_2	CO
20. E. I. DuPont				
a. Explosives	511.5-3721	203	204	15
b. Org. Chem.	520.5-3709	---	602	2
Total		203	806	17
21. Vulcan Material				
a. Woodward	504-3689	644	1	---
b. Edgewater Road	506-3709	700	.1	---
c. Fairfield	508-3706	949	0	---
d. Ensley	510-3708	985	2	---
e. Parkwood	508-3691	215	0	---
Total		3,493	4	---
Grand Totals		187,086	29,790	1,295

TOTAL EMISSIONS FOR THE BIRMINGHAM, ALABAMA SMSA

Tons/year

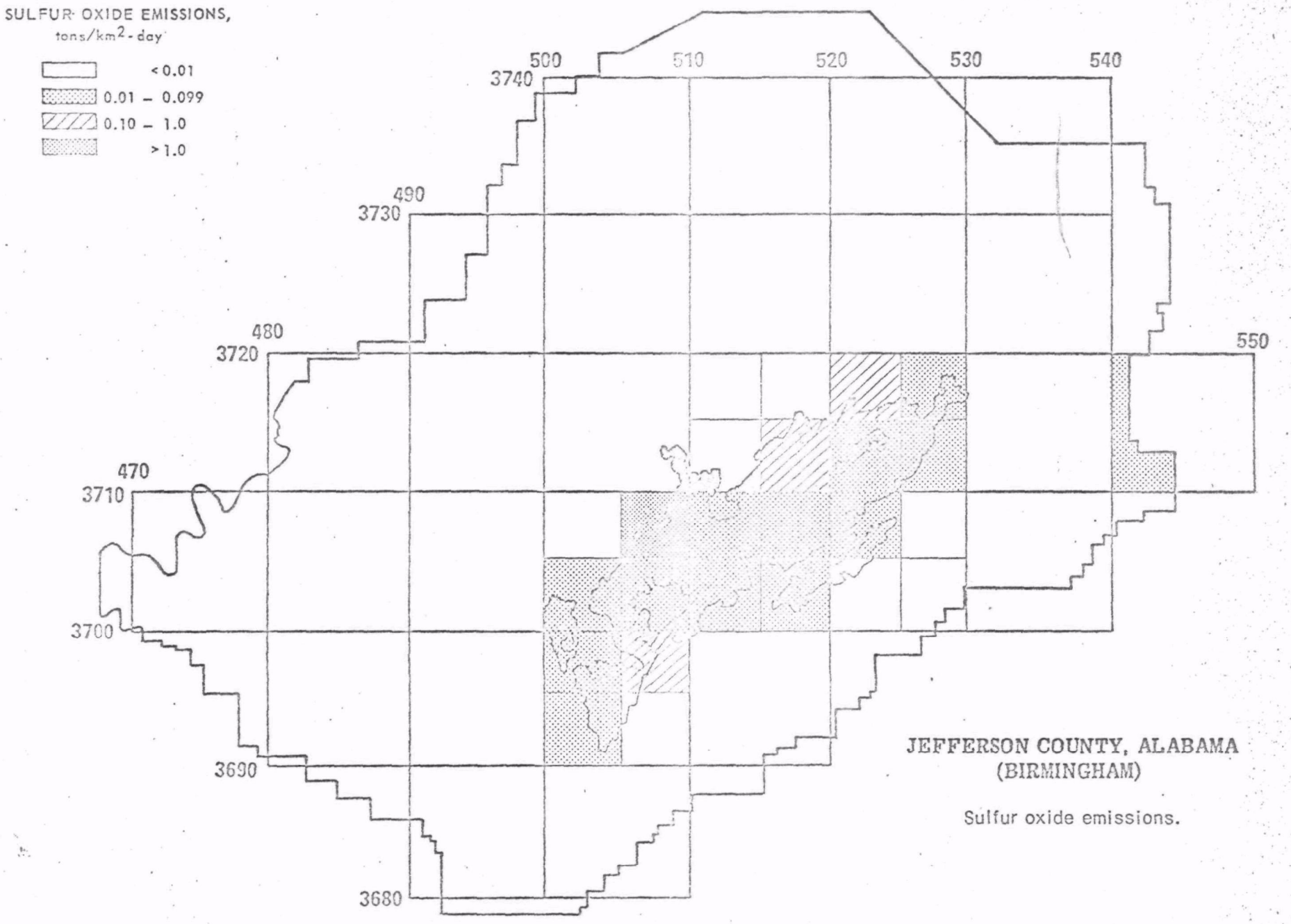
	Part.	SO_2	CO	NO_2	HC
Fuel Combustion - Stationary Sources					
Residential Fuel	1,261	1,047	1,357	801	583
Commercial Fuel	1,796	605	961	210	1,420*
Industrial Fuel	7,130	7,263	191	6,922	411
Totals	10,187	8,915	2,509	7,933	2,414
Industrial Process Emissions					
Point Sources	179,987	22,785	1,000	1,615	3,698
Area Sources	9,433	-	-	1	2,159
Totals	189,420	22,785	1,000	1,616	5,857
Solid Waste Disposal					
Municipal Incineration	156	25	9	27	26
Burning Dumps	664	17	-	8	3,949
On-site Burning - Industrial	143	3	136	2	761
On-site Burning - Commercial	13	-	127	-	72
On-site Burning - Residential	55	4	249	6	134
Totals	1,031	49	521	43	4,942
Transportation					
Gasoline Motor Vehicles	881	721	233,195	9,055	42,311
Diesel Motor Vehicles	2,938	1,068	1,602	5,930	5,636
Aircraft	258	-	13,898	956	2,791
Totals	4,077	1,789	248,695	15,941	50,738
Grand Totals	204,715	33,538	252,725	25,533	63,951

* Includes solvent evaporation - dry cleaning



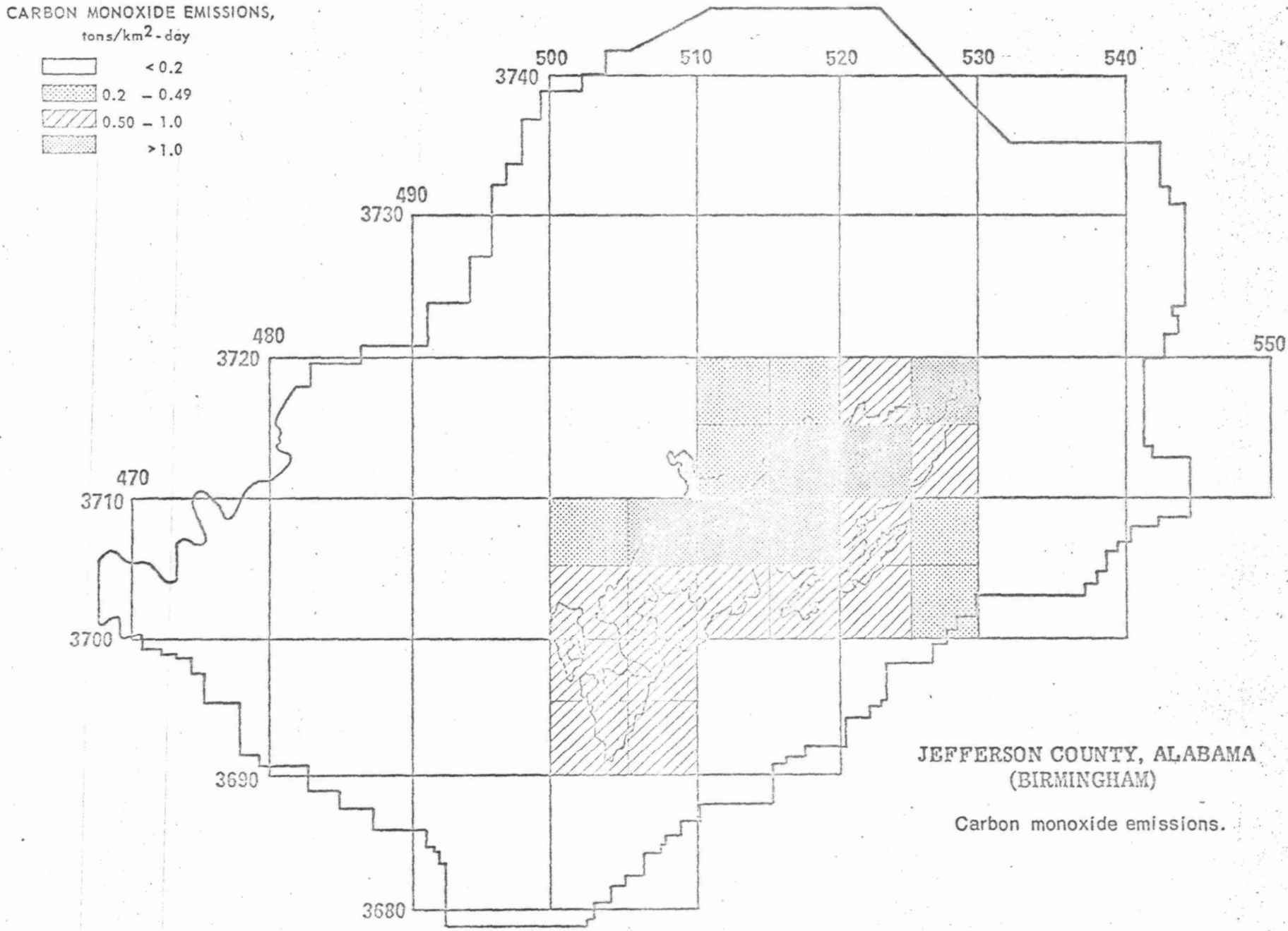
JEFFERSON COUNTY, ALABAMA
(BIRMINGHAM)

Particulate emissions.



JEFFERSON COUNTY, ALABAMA
(BIRMINGHAM)

Sulfur oxide emissions.



JEFFERSON COUNTY, ALABAMA
(BIRMINGHAM)

Carbon monoxide emissions.

JEFFERSON CO. (BIRMINGHAM), ALA. - PARTICULATE EMISSIONS (TONS/YEAR)

GRID NO.	INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL*	COMM'L/GOV. FUEL	RESID. FUEL	REFUSE DISPOSAL	TRANSPORTATION	TOTALS	AVE. TONS/DAY	AVE. TONS/KM²/DAY
1	–	–	–	–	–	–	–	64	64	.175	.00175
2	–	–	–	–	–	–	–	64	64	.175	.00175
3	–	–	–	–	–	–	–	64	64	.175	.00175
4	–	–	–	–	–	–	–	32	32	.088	.00088
5	–	–	–	–	–	–	–	32	32	.088	.00088
6	–	–	–	–	23	93	11	64	181	.490	.0049
7	203	–	–	203	10	20	92	64	389	1.06	.0106
8	–	–	–	–	–	–	1	64	65	.175	.00175
9	–	–	–	–	11	51	72	64	198	.540	.0054
10	–	–	–	–	–	–	–	32	32	.088	.00088
11	–	–	–	–	–	–	–	32	32	.088	.00088
12	–	–	–	–	10	30	–	95	135	.370	.00370
(13)	–	–	–	–	–	–	–	32	32	.088	.0035
13b	–	–	–	–	14	20	–	32	66	.180	.0072
13c	–	–	–	–	11	50	34	64	159	.436	.0174
13d	1144	34,136	–	35,280	10	189	10	159	35,646	97.68	3.907
14a	874	26,975	1	27,850	–	6	56	127	28,139	77.10	3.084
14b	–	1,500	–	1,500	3	11	24	159	1,697	4.65	.1860
14c	163	27	1	191	2	20	20	417*	650	1.78	.0712
14d	149	1,433	25	1,607	3	13	2	127	1,752	4.8	.1920
15	–	–	–	–	–	2	62	95	199	.545	.00545
16	826	26,128	–	26,954	4	40	90	95	27,135	74.38	.7438
17	–	–	–	–	–	–	–	32	32	.088	.00088
18	–	–	–	–	–	–	–	32	32	.088	.00088
19	–	–	–	–	–	–	–	64	64	.175	.00175
20a	3340	49,995	76	53,411	23	18	35	32	138	.378	.0151
20b	–	1,000	–	1,000	–	27	2	159	53591	146.86	5.874
20c	13	15,000	–	15,013	13	56	4	127	1,198	3.28	.1313
20d	2	1,483	–	1,485	11	9	4	127	15,164	41.55	1.6619
21a	414	919	40	1,373	15	126	5	159	1,809	5.12	.2048
21b	–	1,000	–	1,000	43	59	3	159	1,638	4.49	.1795
21c	–	1,000	–	1,000	1537	165	15	127	2,882	7.90	.3159
21d	–	1,500	–	1,500	10	24	2	95	1,131	3.10	.1240
22a	–	–	–	–	–	5	1	127	1,633	4.47	.1790
22b	–	–	–	–	9	25	4	64	102	.279	.0112
22c	–	–	–	–	4	2	3	95	100	.274	.0109
22d	–	–	–	–	–	–	–	32	32	.088	.0035
23	–	–	–	–	–	–	–	32	32	.088	.00088
24	–	–	–	–	–	–	–	32	32	.088	.00088
25	–	–	–	–	3	30	2	95	17,628	48.30	1.932
26a	2	17,496	–	17,496	17	44	1	127	7,752	21.20	.8496
26b	–	7,563	–	7,563	3	80	–	95	1,178	3.23	.1291
26c	–	1,000	–	1,000	–	20	–	95	330	.904	.0362
26d	–	215	–	215	11	36	1	64	158	.433	.00433
27	–	–	–	–	–	–	–	32	32	.088	.00088
28	–	–	–	–	–	–	–	64	1,114	3.05	.0305
29	–	1,650	–	1,650	–	–	–				
TOTALS	7130	189,420	143	196,693	1796	1261	488	4077	204,715	560.86	

* NUMBERED GRIDS = 100 km²; SUFFIXED NUMBERS = 25 km²

* INCLUDING AREA SOURCES

* INCLUDES AIRCRAFT

JEFFERSON CO. (BIRMINGHAM), ALA. - SO_2 EMISSIONS (TONS/YEAR)

GRID NO.*		INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL		COMM. & GOV. FUEL	RESID. FUEL		REFUSE DISPOSAL	TRANSPORTATION		TOTALS		AVE. TONS/DAY		AVE. TONS/KM² DAY		
1		–	–	–	–		–	–		–	30		30		.0822		.000822		
2		–	–	–	–		–	–		–	30		30		.0822		.000822		
3		–	–	–	–		–	–		–	30		30		.0821		.000822		
4		–	–	–	–		–	–		–	15		15		.0411		.000411		
5		–	–	–	–		–	–		–	15		15		.0411		.000411		
6		–	–	–	–		20	80		4	30		130		.3562		.003562		
7		204	–	–	204		10	16		–	30		264		.7234		.007234		
8		–	–	–	–		–	–		–	30		30		.0822		.000822		
9		–	–	–	–		9	41		2	30		82		.2247		.002247		
10		–	–	–	–		–	–		–	15		15		.0411		.000411		
11		–	–	–	–		–	–		–	15		15		.0411		.000411		
12		–	–	–	–		–	22		–	45		67		.1836		.001836		
13		–	–	–	–		–	–		–	15		15		.0411		.001644		
14		–	–	–	–		12	16		–	15		43		.1178		.004712		
15		–	–	–	–		18	43		1	30		89		.2438		.009756		
16		–	–	–	–		23	153		–	73		8,398		23.0105		.922420		
17		1001	7118	–	8,149		–	4		4	60		2,469		6.1350		.3254		
18		631	4,250	6	2,881		–	12		2	73		127		.4028		.016112		
19		66	–	–	66		1	20		–	73		140		.3836		.015344		
20		46	–	–	46		4	9		–	60		123		.3370		.01348		
21		50	–	–	50		–	5		3	45		50		.1534		.001534		
22		–	–	–	–		9	30		–	45		369		1.0110		.011110		
23		285	–	–	285		–	–		–	15		15		.0411		.000411		
24		–	–	–	–		–	–		–	15		15		.0411		.000411		
25		–	–	–	–		–	–		–	30		30		.0822		.000822		
26a		–	–	–	–		–	–		–	15		50		.1370		.00548		
26b		–	–	–	–		20	13		2	73		15,653		42.8692		1.715568		
26c		4016	10,942	1	15,539		–	21		–	60		161		.4411		.017644		
26d		50	–	–	50		11	46		–	60		106		.2959		.011836		
27		34	–	–	34		6	6		3	73		202		.5535		.02214		
28		2	–	–	2		15	109		–	74		310		.8494		.033976		
29		153	–	1	154		38	44		2	60		589		1.6139		.064556		
21b		25	–	–	25		363	139		–	45		98		.2685		.01074		
21c		25	–	–	25		9	19		–	60		715		1.9591		.078364		
21d		50	602	–	652		–	3		–	30		51		.1397		.005588		
22a		–	–	–	–		2	19		–	45		45		.1233		.004932		
22b		–	–	–	–		–	–		–	15		15		.0411		.001644		
22c		–	–	–	–		–	–		–	15		15		.0411		.000411		
22d		–	–	–	–		–	–		–	15		15		.0411		.000411		
23		–	–	–	–		–	–		–	15		15		.0411		.000411		
24		–	–	–	–		–	–		–	45		242		.6630		.02652		
25		1	165	–	166		3	28		–	60		1,849		5.0663		.20265		
26a		–	1,108	–	1,108		13	68		–	45		102		.2795		.01118		
26b		–	–	–	–		7	50		–	45		55		.1507		.006028		
26c		–	–	–	–		–	16		–	30		71		.1945		.001945		
26d		–	–	–	–		10	30		–	15		15		.0411		.000411		
27		–	–	–	–		–	–		–	30		30		.0822		.000822		
28		–	–	–	–		–	–		–									
29		–	–	–	–						1789		33,538		91.5934				
TOTALS		7263	22,785	2	30,050		605	1047											

* NUMBERED GRIDS = 100 km²; SUFFIXED NUMBERS = 25 km²

JEFFERSON CO. (BIRMINGHAM), ALA. - CO EMISSIONS (TONS/YEAR)

GRID NO.*	INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL	COMM./GOV. FUEL	RESID. FUEL	REFUSE DISPOSAL	TRANSPORTATION	TOTALS	AVE. TONS/DAY	AVE. DENSITY TONS/DAY-KM²
1	-	-	-	-	-	-	-	3,913	3,913	10.72	.1072
2	-	-	-	-	-	-	-	3,913	3,913	10.72	.1072
3	-	-	-	-	-	-	-	3,913	3,913	10.72	.1072
4	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
5	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
6	-	-	-	-	26	93	10	3,913	4,048	11.09	.1109
7	15	-	-	15	10	21	13	3,913	3,972	10.88	.1088
8	-	-	-	-	-	-	3	3,913	3,916	10.73	.1073
9	-	-	-	-	12	54	19	3,913	3,998	10.95	.1095
10	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
11	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
12	-	-	-	-	-	32	-	5,870	5,902	16.17	.1617
13a	-	-	-	-	-	-	-	1,957	1,957	5.36	.2144
13b	-	-	-	-	18	21	-	1,957	1,996	5.47	.2188
13c	-	-	-	-	24	50	11	3,913	3,998	10.95	.4380
13d	56	-	-	56	10	206	42	9,783	10,097	27.67	1.107
14a	50	-	-	50	-	6	13	7,826	7,895	21.63	.8652
14b	13	-	19	32	-	11	10	9,783	9,836	26.95	1.078
14c	4	-	-	4	1	36	10	23,681*	23,726	65.00	2.600
14d	-	-	-	-	6	12	7	7,826	7,853	21.52	.8608
15	-	-	-	-	-	5	-	5,870	5,875	16.10	.1610
16	18	-	-	18	12	40	11	5,876	5,951	16.31	.1631
17	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
18	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
19	-	-	-	-	-	-	-	3,913	3,913	10.72	.1072
20a	-	-	-	-	26	17	17	1,957	2,017	5.53	.2212
20b	14	-	115	129	-	28	8	9,784	9,949	27.26	1.090
20c	-	-	-	-	13	56	13	7,826	7,892	21.65	.8661
20d	3	-	-	3	10	7	24	7,826	7,870	21.56	.8624
21a	-	-	-	-	16	132	34	9,784	9,966	27.30	1.092
21b	18	-	-	18	48	58	20	9,784	9,928	27.20	1.088
21c	-	-	-	-	670	183	24	7,826	8,703	23.85	.9540
21d	-	-	-	-	12	25	11	5,870	5,918	16.22	.6488
22a	-	-	2	2	-	3	4	7,826	7,835	21.47	.8588
22b	-	-	-	-	3	26	19	3,913	3,960	10.85	.4340
22c	-	-	-	-	-	-	13	5,870	5,883	16.12	.6448
22d	-	-	-	-	-	-	-	1,957	1,957	5.36	.2144
23	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
24	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
25	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
26a	-	1000	-	1000	5	58	15	5,870	6,948	19.04	.7616
26b	-	-	-	-	17	80	9	7,826	7,932	21.73	.8692
26c	-	-	-	-	9	66	-	5,870	5,939	16.27	.6508
26d	-	-	-	-	-	10	-	5,870	5,880	16.10	.6440
27	-	-	-	-	15	40	17	3,913	3,985	10.91	.1091
28	-	-	-	-	-	-	-	1,957	1,957	5.36	.0536
29	-	-	-	-	-	-	-	3,913	3,913	10.72	.1072
TOTALS	191	1000	136	1327	961	1357	385	245,695	252,725	692.40	

* NUMBERED GRIDS = 100 km²; SUFFIXED NUMBERS = 25 km²

* INCLUDES AIRCRAFT

AVERAGE SUMMER DAY - PARTICULATES - TONS/DAY

GRID NO.	INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL	COMM'L/GOV. FUEL	RESID. FUEL	REFUSE DISPOSAL	TRANSPORTATION	AREA TOTALS	GRAND TOTALS
1	-	-	-	-	-	-	-	.1911	.1911	.1911
2	-	-	-	-	-	-	-	.1911	.1911	.1911
3	-	-	-	-	-	-	-	.1911	.1911	.1911
4	-	-	-	-	-	-	-	.0959	.0959	.0959
5	-	-	-	-	-	-	-	.0959	.0959	.0959
6	-	-	-	-	-	.0341	[illegible]	.1911	.2553	.2553
7	.4450	-	-	.4450	-	.0082	[illegible]	.1911	.4514	.8964
8	-	-	-	-	-	-	[illegible]	.1911	.1936	.1936
9	-	-	-	-	-	.0210	1973	.1911	.4094	.4094
10	-	-	-	-	-	-	-	.0959	.0959	.0959
11	-	-	-	-	-	-	-	.0959	.0959	.0959
12	-	-	-	-	-	.0123	-	.2837	.2960	.2960
13	-	-	-	-	-	-	-	.0959	.0959	.0959
14	-	-	-	-	-	.0082	-	.0959	.1041	.1041
15	-	-	-	-	-	.0206	532	.1911	.3049	.3049
16	2.5216	93.5326	-	96.0402	-	.0777	274	.4746	.5799	96.6201
17	1.9158	13.9115	.0027	15.8300	-	.0025	[illegible]	.5792	.8091	16.6391
18	-	4.1100	-	4.1100	-	.0045	[illegible]	.4746	.6451	4.6551
19	.3573	.0140	.0027	.4340	-	.0012	[illegible]	1.2452	1.3062	1.7422
20	.8266	3.9264	.0685	4.8215	-	.0053	555	.5792	.5910	4.7115	
21	-	-	-	-	-	.0006	735	.2837	.5640	.5640
22	1.6106	71.5967	-	73.4013	-	.0164	162	.2837	.5467	73.9480
23	-	-	-	-	-	-	-	.0959	.0959	.0959
24	-	-	-	-	-	-	-	.0959	.0959	.0959
25	-	-	-	-	-	-	-	.1911	.1911	.1911
26	-	-	-	-	-	.0074	721	.0959	.2814	.2814
27	7.5213	136.9263	.2082	144.5558	-	.0111	555	.4746	.4914	145.0072
28	-	2.7400	-	2.7400	-	.0230	055	.3792	.4077	3.1477
29	.0285	41.1000	-	41.1285	-	.0037	110	.3792	.3139	41.5224
30	.0049	4.0634	-	4.0678	-	.0570	322	.4746	.7568	4.8246
31	.9075	2.5160	.1096	3.5331	-	.0242	110	.4746	.5100	4.0451
32	-	2.7400	-	2.7400	-	.0672	552	.3792	.5922	3.3322
33	-	2.7400	-	2.7400	-	.0099	055	.2837	.2991	32391
34	-	4.1100	-	4.1100	-	.0021	627	.3792	.3840	4.4940
35	-	-	-	-	-	.0103	110	.1911	.2124	.2124
36	-	-	-	-	-	.0008	062	.2837	.2927	.2927
37	-	-	-	-	-	-	-	.0959	.0959	.0959
38	-	-	-	-	-	-	-	.0959	.0959	.0959
39	-	-	-	-	-	-	-	.0959	.0959	.0959
40	-	-	-	-	-	-	-	.0959	.0959	.0959
41	.0044	47.9390	-	47.9434	-	.0123	055	.2837	.3015	48.2449
42	-	20.1226	-	20.1226	-	.0181	27	.3792	.4006	21.1226
43	-	2.7400	-	2.7400	-	.0329	-	.2837	.3166	3.0566
44	-	.5691	-	.5691	-	.0082	-	.2837	.2919	.8610
45	-	-	-	-	-	.0148	88	.1911	.3347	.3347
46	-	-	-	-	-	-	-	.0959	.0959	.0959
47	-	2.8710	-	2.8710	-	-	-	.1911	.1911	3.0681
TOTALS	15.6290	519.0106	.5917	535.0313	-	.5182	533	12.1790	15.1305	550.1618

AVERAGE SUMMER DAY - SULFUR OXIDE EMISSIONS - TONS/DAY

GRID NO.	INDUSTRIAL FUEL	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL	COMM./GOV FUEL	RESID. FUEL	REFUSE DISPOSAL	TRANSPORTATION	AREA TOTALS	GRAND TOTALS
1	-	-	-	-	-	-	-	.0896	.0896	.0896
2	-	-	-	-	-	-	-	.0896	.0896	.0896
3	-	-	-	-	-	-	-	.0896	.0896	.0896
4	-	-	-	-	-	-	-	.0448	.0448	.0448
5	-	-	-	-	-	.0329	-	.0448	.0448	.0448
6	-	-	-	-	-	.0066	.0109	.0896	.1225	.1225
7	.4472	-	-	.4472	-	-	-	.0896	.1071	.5543
8	-	-	-	-	-	.0169	.0055	.0896	.0896	.0896
9	-	-	-	-	-	-	-	.0896	.1120	.1120
10	-	-	-	-	-	-	-	.0448	.0448	.0448
11	-	-	-	-	-	.0040	-	.0448	.0448	.0448
12	-	-	-	-	-	-	-	.1344	.1434	.1434
13a	-	-	-	-	-	.0066	-	.0448	.0448	.0448
13b	-	-	-	-	-	.0164	.0027	.0448	.0514	.0514
13c	-	-	-	-	-	.0629	-	.0896	.1067	.1067
13d	2.2600	19.5033	-	21.7633	-	.0016	.0658	.2180	.2809	22.0442
14a	1.3632	6.1850	-	7.5482	-	.0049	.0055	.1792	.2466	7.7948
14b	.1315	-	-	.1315	-	.0082	-	.2180	.2284	.3599
14c	.1006	-	-	.1006	-	.0031	-	.2180	.2262	.3270
14d	.1096	-	-	.1096	-	.0021	.0164	.1792	.1829	.2925
15	-	-	-	-	-	.0123	-	.1344	.1523	.1523
16	.6247	-	-	.6247	-	-	-	.1344	.1467	.7714
17	-	-	-	-	-	-	-	.0448	.0448	.0448
18	-	-	-	-	-	-	-	.0448	.0448	.0448
19	-	-	-	-	-	-	-	.0896	.0896	.0896
20a	-	-	-	-	-	.0053	.0055	.0448	.0556	.0556
20b	10.1183	29.9211 ~~1.0745~~	.0027	~~41.7765~~	40.1021	.0056	-	.2180	.2286	11.9971
20c	.1096	-	-	.1096	-	.0104	-	.1792	.1956	.3052
20d	.0745	-	-	.0745	-	.0025	-	.1792	.1817	.2562
21a	.0044	-	-	.0044	-	.0446	.0082	.2180	.2710	.2754
21b	.3354	-	.0027	.3381	-	.0181	-	.2180	.2361	.5742
21c	.0548	-	-	.0548	-	.0571	.0055	.1792	.2418	.2966
21d	.0548	1.6495	-	.0548	-	.0078	-	.1344	.1422	.1970
22a	.1096	~~41.7671~~	-	~~30.6401~~	1.1591	.0012	-	.1792	.1804	30.2711
22b	-	-	-	-	-	.0076	-	.0896	.0974	.0974
22c	-	-	-	-	-	-	-	.1344	.1344	.1344
22d	-	-	-	-	-	-	-	.0448	.0448	.0448
23	-	-	-	-	-	-	-	.0448	.0448	.0448
24	-	-	-	-	-	-	-	.0448	.0448	.0448
25	-	-	-	-	-	-	-	.0448	.0448	.0448
26a	.0022	.4521	-	.4543	-	.0015	-	.1344	.1459	.6002
26b	-	4.6799	-	4.6799	-	.0279	-	.1792	.2071	4.8870
26c	-	-	-	-	-	.0206	-	.1344	.1550	.1550
26d	-	-	-	-	-	.0041	-	.1344	.1385	.1385
27	-	-	-	-	-	.0123	.27	.0896	.1046	.1046
28	-	-	-	-	-	-	-	.0448	.0448	.0448
29	-	-	-	-	-	-	-	.0896	.0896	.0896
TOTALS	15.9206	62.4309	.0054	78.3569	-	.4301	.47	5.3400	5.8988	84.2557

AVERAGE SUMMER DAY - CO EMISSIONS - TONS/DAY

GRID NO.	INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL	COMM.& GOV. FUEL	RESID. FUEL	REFUS DISPOS	TRANSPOR-TATION	AREA TOTAL	GRAND TOTALS
1	-	-	-	-	-	-	-	11.5825	11.5825	11.5825
2	-	-	-	-	-	-	-	11.5825	11.5825	11.5825
3	-	-	-	-	-	-	-	11.5825	11.5825	11.5825
4	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
5	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
6	-	-	-	-	-	.0382	.0438	11.5825	11.6645	11.6645
7	.0329	-	-	.0329	-	.0086	.035	11.5825	11.6267	11.6596
8	-	-	-	-	-	-	.0082	11.5825	11.5907	11.5907
9	-	-	-	-	-	.0222	.0521	11.5825	11.6568	11.6568
10	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
11	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
12	-	-	-	-	-	.0132	-	17.3752	17.3884	17.3884
13a	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
13b	-	-	-	-	-	.0086	-	5.7927	5.8013	5.8013
13c	-	-	-	-	-	.0205	.0501	11.5825	11.6331	11.6331
13d	.1226	-	-	.1226	-	.0847	.1751	28.9577	29.1575	29.2801
14a	.1095	-	-	.1095	-	.0025	.0356	23.1650	23.2031	23.3126
14b	.0285	-	.0521	.0806	-	.0045	.0274	28.9577	28.9896	29.0702
14c	.0088	-	-	.0088	-	.0123	.0274	70.0955	70.1355	70.1443
14d	-	-	-	-	-	.6049	.0247	23.1650	23.1946	23.1946
15	-	-	-	-	-	.0021	-	17.3752	17.3773	17.3773
16	.0394	-	-	.0394	-	.0164	.0301	17.3752	17.4211	17.4211
17	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
18	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
19	-	-	-	-	-	-	-	11.5825	11.5825	11.5825
20a	-	-	-	-	-	.0070	.0466	5.7927	5.8463	5.8463
20b	.0307	-	.3151	.3456	-	.0115	.0219	28.9577	28.9911	29.3369
20c	-	-	-	-	-	.0205	.0558	23.1650	23.2211	23.2211
21a	.0066	-	-	.0066	-	.0029	.0658	23.1650	23.2337	23.2403
21c	-	-	-	-	-	.0543	.0932	28.9577	29.1052	29.1052
21b	.0394	-	-	.0394	-	.0238	.0548	28.9577	29.0357	29.0357
21c	-	-	-	-	-	.0752	.0658	23.1650	23.3060	23.3060
21d	-	-	-	-	-	.0103	.0301	17.3752	17.4156	17.4156
22a	-	-	.0055	.0055	-	.0012	.0109	23.1650	23.1771	23.1826
22b	-	-	-	-	-	.0103	.0521	11.5825	11.6449	11.6449
22c	-	-	-	-	-	-	.0350	17.3752	17.4108	17.4108
22d	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
23	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
24	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
25	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
26a	-	2.7400	-	2.7400	-	.0238	.0311	17.3752	17.4401	20.1801
26b	-	-	-	-	-	.0329	.0247	23.1650	23.2226	23.2226
26c	-	-	-	-	-	.0247	.0041	17.3752	17.3999	17.3999
26d	-	-	-	-	-	.0041	.0164	17.3752	17.3793	17.3793
27	-	-	-	-	-	.0164	.0166	11.5825	11.6455	11.6455
28	-	-	-	-	-	-	-	5.7927	5.7927	5.7927
29	-	-	-	-	-	-	-	11.5825	11.5825	11.5825
TOTALS	.4184	2.7400	.3727	3.5311	-	.5576	.7749	756.1287	757.7412	741.2723

AVERAGE WINTER DAY - PARTICULATE EMISSIONS - TONS/DAY

GRID NO.	INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL	COMM. & OIL FUEL	RESID. FUEL	REFUSE DISPOSAL	TRANSPORTATION	AREA TOTALS	GRAND TOTALS
1	-	-	-	-	-	-	-	.1613	.1613	.1613
2	-	-	-	-	-	-	-	.1613	.1613	.1613
3	-	-	-	-	-	-	-	.1613	.1613	.1613
4	-	-	-	-	-	-	-	.0806	.0806	.0806
5	-	-	-	-	-	-	-	.0806	.0806	.0806
6	.4456	-	-	-	.1840	.0341+.5644	.0301	.1613	.9739	.9739
7	.3243	-	-	.7698	.0800	.0824+.1660	.3500	.1613	.6376	1.4074
8	-	-	-	-	-	-	.0027	.1613	.1640	.1640
9	-	-	-	-	.0880	.0210+.3486	.1973	.1613	.6144	.6144
10	-	-	-	-	-	-	-	.0806	.0806	.0806
11	-	-	-	-	-	-	-	.0806	.0806	.0806
12	-	-	-	-	.0800	.0125+.2240	-	.2394	.5357	.5357
13	-	-	-	-	-	-	-	.0806	.0806	.6806
13A	-	-	-	-	.1120	.0524+.1580	-	.0806	.3368	.3368
13B	-	-	-	-	.0880	.1206+.3400	.0952	.1613	.7651	.7651
13	2.0674	93.6326	-	97.8706	.0800	.0777+1.2252	.0271	.4067	1.8716	94.7416
14	1.5944	73.9115	.0027	77.2284	-	.0125+.6418	.4274	.3190	.7967	78.0191
14A	1.3324	-	-	4.1100	.0240	.0485+.0745	.0652	.1007	.5092	4.6192
14B	.6974	.0740	.0027	.6948	.0160	.0524+.1560	.0548	1.0508	1.2652	1.9600
15	.2008	5.9264	.0225	6.5597	.0240	.0283+.0634	.0456	.3206	.4432	5.0081
15A	.1324	-	-	-	-	.0245+.0788	.2735	.2394	.5335	.5335
16	1.8156	71.5967	-	74.7224	.0320	.0114+.2120	.2462	.2394	.8064	75.5288
17	-	-	-	-	-	-	-	.0806	.0806	.0806
18	-	-	-	-	-	-	-	.0806	.0806	.0806
19	-	-	-	-	-	-	-	.1613	.1613	.1613
20a	-	-	-	-	.1840	.0074+.1224	.1781	.0806	.5725	.5725
20b	3.3213	136.9863	.2282	149.8598	-	.0111+.1836	.0955	.4067	.6009	156.4607
20c	-	2.7400	-	2.7400	.1040	.0280+.3288	.1955	.3200	.8633	3.5733
20d	.0285	41.1400	-	41.1493	.0320	.0251+.0812	.0710	.3200	.4840	41.6333
21a	.0043	4.0634	-	4.0716	.1200	.0516+.2568	.2302	.4067	1.6515	5.7515
21b	.0224	2.5180	.1496	4.1975	.3240	.0234+.4112	.0910	.4067	1.1811	5.3782
21c	-	2.7400	-	2.7400	12.2760	.0078+.1220	.1452	.3209	13.9510	16.6910
21d	-	2.7400	-	2.7400	.0800	.0094+.1032	.0955	.3394	.4990	3.2390
22a	-	4.1100	-	4.1100	-	.0021+.0240	.0127	.3200	.3588	4.4688
22b	-	-	-	-	.0720	.0154+.1760	.0910	.1613	.4244	.4244
22c	-	-	-	-	-	.0222+.0136	.0252	.2394	.2620	.2620
22d	-	-	-	-	-	-	-	.0806	.0806	.0806
23	-	-	-	-	-	-	-	.0806	.0806	.0806
24	-	-	-	-	-	-	-	.0806	.0806	.0806
25	-	-	-	-	-	-	-	.0806	.0806	.0806
26a	.0044	47.9390	-	47.9466	.0240	.0123+.2240	.0955	.2394	.4852	48.4318
26b	.0032	20.7226	-	20.7226	.1360	.0181+.2442	.0827	.3200	.7760	21.4986
26c	-	2.7400	-	2.7400	.0240	.0329+.5440	.2203	.1394	.9403	3.5803
26d	-	.5891	-	.5891	-	.0221+.1360	.1581	.2394	.5836	.9727
27	-	-	-	-	.0880	.0148+.2448	.1298	.1013	.6377	.6377
28	-	-	-	-	-	-	-	.0806	.0806	.0806
29	-	2.8710	-	2.8710	-	-	-	.1613	.1613	3.0383
TOTALS	27.0370	519.0106	.3917	546.4393	14.3680	23.4611	2.2435	10.2935	36.1079	582.6012

AVERAGE WINTER DAY - SO_x EMISSIONS - TONS/DAY

GRID NO.	INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL		COMM. & GOV FUEL	RESID FUEL	REFUSE DISPOSAL	TRANSPORTATION	AREA TOTAL	GRAND TOTALS
.								-	.0756	.0756	.0756
1	-	-	-	-		-	-	-	.0756	.0756	.0756
2	-	-	-	-		-	-	-	.0756	.0756	.0756
3	-	-	-	-		-	-	-	.0378	.0378	.0378
4	-	-	-	-		-	-	-	.0378	.0378	.0378
5	-	-	-	-		-	-	-	.0756	.8125	.8125
6	-	-	-	-		.1000	.0329+.5440	.0109	.0756	.2219	1.0555
7	.4472 .3264	-	-	.7736		.2800	.0088+.1088	-	.0756	.0756	.0756
8	-	-	-	-		-	-	.0155	.0756	.4488	.4488
9	-	-	-	-		.0720	.0109+.2780	-	.0378	.0378	.0378
10	-	-	-	-		-	-	-	.0378	.0378	.0378
11	-	-	-	-		-	-	-	.1134	.2720	.2720
12	-	-	-	-		-	.0090+.1496	-	.0378	.0378	.0378
13a	-	-	-	-		-	-	-	.0378	.2492	.2492
13b	-	-	-	-		.0900	.0000+.1000	.0027	.0756	.5107	.5107
13c	-	-	-	-		.1140	.0104+.2320	-	.1840	1.4713	24.8842
13d	[illegible]	19.5033	-	23.4129		.1840	[illegible]	.0058	.1512	.2458	8.8656
14a	[illegible]	0.1050	-	8.5578		-	.0010+.0272	.0059	.1840	.2700	.5235
14b	[illegible]	-	-	.2275		-	.0039+.0818	-	.1840	.3362	.5166
14c	[illegible]	-	-	.1744		.0080	.0082+.1300	-	.1512	.2481	.4377
14d	[illegible]	-	-	.1896		.0320	.0047+.0612	.0064	.1134	.1659	.1659
15	-	-	-	-		-	.0021+.2370	-	.1134	.4017	1.4824
16	.0137 .4500	-	-	1.0807		.0720	.0123+.2040		.0378	.0378	.0378
17	-	-	-	-		-	-	-	.0378	.0378	.0378
18	-	-	-	-		-	-	-	.0756	.0756	.0756
19	-	-	-	-		-	-	.0055	.0378	.2970	.2970
20a	-	-	-	-		.1600	.0053+.0084	-	.1840	.3354	19.4915
20b	[illegible]	29.9611 ~~[illegible]~~	.0027	~~17.1561~~	47.4877	-	.0080+.1428	-	.1512	.5276	.7172
20c	[illegible]	-	-	.1896		.0880	.0164+.2720	-	.1512	.2535	.3874
20d	[illegible]	-	-	.1289		.0640	.0035+.0400	.0082	.1840	1.0962	1.1658
21a	[illegible]	-	-	.0076		.1200	.0049+.7412	-	.1840	.7890	.8719
21b	[illegible]	-	.0027	.5829		.3840	.0181+.2992	.0055	.1512	4.0633	4.1581
21c	[illegible]	-	-	.0748		2.9640	.0571+.9352	-	.1134	.3224	.4172
21d	[illegible]	-	-	.6948		.0720	.0018+.1292	-	.1512	.1728	30.5435
22a	[illegible]	1.6495 ~~22.7811~~	-	~~56.1707~~	1.8391	-	.0012+.0224	-	.0756	.1226	.2286
22b	-	-	-	-		.0120	.0018+.1192	-	.1134	.1134	.1134
22c	-	-	-	-		-	-	-	.0378	.0378	.0378
22d	-	-	-	-		-	-	-	.0378	.0378	.0378
23	-	-	-	-		-	-	-	.0378	.0378	.0378
24	-	-	-	-		-	-	-	.0378	.0378	.0378
25	-	-	-	-		-	-	-	.1134	.3245	.7852
26a	.0022 .0016	.4521	-	.4559		.0240	.0015+.1904	-	.1512	.7455	5.4254
26b	-	4.6799	-	4.6799		.1040	.0179+.4624	-	.1134	.5300	.5300
26c	-	-	-	-		.0560	.0226+.3400	-	.1134	.1655	.1655
26d	-	-	-	-		-	.0041+.0880	.0027	.0756	.3746	.3746
27	-	-	-	-		.0800	.0123+.2640	-	.0378	.0378	.0378
28	-	-	-	-		-	-	-	.0756	.0756	.0756
29	-	-	-	-		-	-				
TOTALS	27.5414	62.4309	.0054	89.9777		4.8400	7.5237	[illegible]	4.5600	16.9984	166.9761

AVERAGE WINTER DAY - CO EMISSIONS - TONS/DAY

GRID NO.	INDUSTRIAL FUEL USE	INDUSTRIAL PROCESS	INDUSTRIAL REFUSE DISPOSAL	TOTAL INDUSTRIAL	COMM. & GOV. FUEL	RESID. FUEL	REFUSE DISPOSAL	TRANSPORTATION	AREA TOTALS	GRAND TOTALS
1	-	-	-	-	-	-	-	9.8608	9.8608	9.8608
2	-	-	-	-	-	-	-	9.8608	9.8608	9.8608
3	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
4	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
5	-	-	-	-	.2680	.0352+.6324	.0456	9.8608	10.7832	10.7832
6	.0329	-	-	.0569	.0000	.0000+.1428	.0356	9.8605	10.1270	10.1847
7	.0240	-	-		-	-	.0052	9.8608	9.8690	9.8690
8	-	-	-	-	.0960	.0222+.3672	.0521	9.8605	10.3985	10.3985
9	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
10	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
11	-	-	-	-	-	.0132+.2176	-	14.7924	15.0232	15.0232
12	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
13a	-	-	-	-	.1440	.0240+.1428	-	4.9316	5.2270	5.2270
13b	-	-	-	-	.1926	.0215+.3400	.0361	9.8608	10.4434	10.4434
13c	.1226	-	-	.2122	.0800	.0241+.2408	.1151	24.6532	26.3836	26.5486
13d	.0096	-	-							
14a	.1013	-	-	.1895	-	.0035+.0405	.0846	19.7215	19.9594	19.9594
14b	.0800	-	.0521	.1614	-	.0035+.0778	.0194	24.6532	24.8615	24.9627
14c	.0482	-	-	.0152	.0080	.0123+.2040	.1292	59.6761	59.9278	59.9456
14d	.0070	-								
14e	.0064	-	-		.0480	.0049+.0216	.0247	19.7215	19.8007	19.8007
14f	-	-	-	-	-	.0021-.0360	-	14.7924	14.7564	14.8285
15	-	-	-	-	.0960	.0124+.2920	.0361	14.7924	15.2169	15.2351
16	.0004	-	-	.0182						
17	.0220	-	-		-	-	-	4.9316	4.9316	4.9316
18	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
19	-	-	-	-	-	-	-	9.8608	9.8606	9.8608
20a	-	-	-	-	.2880	.0070+.1152	.0411	4.9316	5.3038	5.3038
20b	.0357	-	.3151	.3682	-	.0015+.1904	.0219	24.6532	24.8670	25.2352
20c	.0224	-	-		.1040	.0205+.3400	.0556	19.7215	20.2216	20.2216
20d	-	-	-	-	.0800	.0024+.0476	.0852	19.7215	19.9118	19.9232
21a	.0016	-	-	.0114	.1280	.0431+.8576	.1752	24.6532	25.8213	25.8213
21b	.0098	-	-		.3840	.0252+.3844	.0545	24.6532	25.5102	25.5154
21c	-	-	-	-	5.3600	.0752+1.2444	.0658	19.7215	26.4669	26.4669
21d	.0304	-	-	.0682	.0960	.0134+.1700	.0301	14.7924	15.0988	15.0988
22a	.0260	-	-		-	.0012+.0244	.0109	19.7215	19.7540	19.7595
22b	-	-	.0055	.0055	.0240	.0134+.1700	.0521	9.8608	10.1172	10.1172
22c	-	-	-	-	-	-	.0358	14.7924	14.8280	14.8280
22d	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
23	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
24	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
25	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
26a	-	2.7400	-	2.7400	.0400	.0238+.3944	.0411	14.7924	15.2477	18.0317
26b	-	-	-	-	.1360	.0329+.5440	.0427	19.7215	20.4771	20.4771
26c	-	-	-	-	.0720	.0247+.4080	-	14.7924	15.2971	15.2971
26d	-	-	-	-	-	.0021+.0360	-	14.7924	14.8645	14.8645
27	-	-	-	-	.1040	.0164+.2720	.0411	9.8608	10.2948	10.2948
28	-	-	-	-	-	-	-	4.9316	4.9316	4.9316
29	-	-	-	-	-	-	-	9.8608	9.8608	9.8608
TOTALS	.7240	2.7400	.3727	5.8367	7.6880	9.8946	.0549	622.7035	645.3413	649.1780

POINT SOURCES

Grid Number	Coordinates		Area (km^2)	Emissions (Tons/Day)								
				SO_x			Particulate			CO		
	Horizontal	Vertical		Summer	Winter	Average	Summer	Winter	Average	Summer	Winter	Average
22a*	522.5	3707.5	25	.11	.19	.14	4.11	4.11	4.11	-	-	-
22a	520.5	3709	"	1.65	1.65	1.65	-	-	-	.01	.01	.01
26a	503	3699	"	.41	.41	.41	43.98	43.98	43.98	2.74	2.74	2.74
"	502.5	3697	"	.04	.05	.04	2.20	2.21	2.20	-	-	-
"	504	3689	"	-	-	-	1.76	1.76	1.76	-	-	-
26b	507	3698	"	4.68	4.68	4.68	20.72	20.72	20.72	-	-	-
26c*	502.5	3692.5	"	-	-	-	2.74	2.74	2.74	-	-	-
26d	508	3691	"	-	-	-	.59	.59	.59	-	-	-
29	504	3689	100	-	-	-	2.88	2.88	2.88	-	-	-

* Area total treated as point source

POINT SOURCES

Grid Number	Coordinates		Area (km^2)	Emissions (Tons/Day)								
				SO_x			Particulate			CO		
	Horizontal	Vertical		Summer	Winter	Average	Summer	Winter	Average	Summer	Winter	Average
16	542	3711	100	.62	1.08	.78	73.05	74.37	73.50	.04	.07	.05
"	542	3712.5	"	-	-	-	.35	.35	.35	-	-	-
20b	507	3707.5	25	35.88	43.27	38.41	35.56	40.90	37.37	.34	.37	.35
"	509	3708	"	4.22	4.22	4.22	103.44	103.44	103.44	-	-	-
"	506	3709	"	-	-	-	1.92	1.92	1.92	-	-	-
"	503	3706	"	-	-	-	3.60	3.60	3.60	-	-	-
20c*	502.5	3702.5	"	.11	.19	.14	2.74	2.74	2.74	-	-	-
20d	509.5	3702	"	.07	.13	.09	41.13	41.15	41.13	.01	.01	.01
21a*	512.5	3707.5	"	-	-	-	1.37	1.37	1.37	-	-	-
21a	510	3708	"	-	.01	.01	2.70	2.70	2.70	-	-	-
21b*	517.5	3707.5	"	-	-	-	1.37	1.37	1.37	-	-	-
21b	517	3706	"	-	-	-	.47	.47	.47	-	-	-
"	519.5	3709.5	"	-	-	-	.55	.55	.55	-	-	-
"	519	3707	"	.34	.58	.42	1.15	1.81	1.37	.04	.07	.05
21c*	512.5	3702.5	"	.05	.09	.07	2.74	2.74	2.74	-	-	-
21d*	517.5	3702.5	"	.05	.09	.07	2.74	2.74	2.74	-	-	-

* Area total treated as point source

POINT SOURCES

Grid Number	Coordinates		Area (km^2)	Emissions (Tons/Day)								
				SO_x			Particulate			CO		
	Horizontal	Vertical		Summer	Winter	Average	Summer	Winter	Average	Summer	Winter	Average
7	511.5	3721	100	.45	.77	.56	.45	.77	.56	.03	.06	.04
13d	519	3714	25	.31	.54	.46	69.29	69.41	69.31	.03	.04	.04
"	516	3712	25	.04	.07	.06	5.41	5.41	5.41	-	-	-
"	518	3710	"	.02	.03	.03	2.56	2.56	2.56	-	-	-
"	519	3712	"	.01	.02	.02	1.05	1.05	1.05	-	-	-
"	517	3711	"	.01	.02	.01	1.07	1.07	1.07	-	-	-
"	519	3711	"	1.23	1.23	1.23	-	-	-	-	-	-
"	520	3711	"	.10	.19	.14	.08	.08	.08	.01	.02	.01
"	518	3713	"	20.04	21.31	20.38	16.58	18.29	17.18	.08	.15	.10
14a	520	3716	"	.33	.58	.51	70.27	71.17	70.44	.03	.04	.04
"	522	3716	"	.01	.02	.01	3.84	3.84	3.84	.01	.01	.01
"	520.5	3715.5	"	7.21	7.96	7.37	1.72	2.22	2.02	.07	.14	.09
14b*	527.5	3717.5	"	.13	.23	.16	4.11	4.11	4.11	.08	.10	.09
14c*	522.5	3712.5	"	.10	.17	.13	.43	.69	.52	.01	.02	.01
14d*	527.5	3712.5	"	.11	.19	.14	4.32	4.56	4.40	-	-	-

* Area total treated as point source

AREA SOURCES

Grid Number	Coordinates		Area (km^2)	Emissions (Tons/Day)								
				SO_x			Particulate			CO		
	Horizontal	Vertical		Summer	Winter	Average	Summer	Winter	Average	Summer	Winter	Average
21d	517.5	3702.5	25	.14	.32	.20	.30	.50	.36	17.42	15.10	16.22
22a	522.5	3707.5	"	.18	.17	.17	.38	.36	.36	23.18	19.75	21.46
22b	527.5	3707.5	"	.10	.23	.14	.21	.42	.28	11.64	10.12	10.85
22c	522.5	3702.5	"	.13	.11	.12	.29	.26	.27	17.41	14.83	16.12
22d	527.5	3702.5	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
23	535	3705	100	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
24	485	3695	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
25	495	3695	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
26a	502.5	3697.5	25	.15	.33	.21	.30	.49	.36	17.44	15.29	16.30
26b	507.5	3697.5	"	.21	.75	.39	.40	.78	.48	23.22	20.48	21.75
26c	502.5	3692.5	"	.16	.53	.28	.32	.84	.49	17.40	15.30	16.27
26d	507.5	3692.5	"	.14	.19	.15	.29	.38	.32	17.38	14.86	16.10
27	515	3695	100	.10	.37	.19	.33	.64	.43	11.65	10.30	10.91
28	495	3685	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
29	505	3685	"	.09	.08	.08	.19	.16	.17	11.58	9.86	10.72

AREA SOURCES

Grid Number	Coordinates		Area (km^2)	Emissions (Tons/Day)								
				SO_x			Particulate			CO		
	Horizontal	Vertical		Summer	Winter	Average	Summer	Winter	Average	Summer	Winter	Average
1	505	3735	100	.09	.08	.08	.19	.16	.18	11.58	9.86	10.72
2	515	3735	"	.09	.08	.08	.19	.16	.18	11.58	9.86	10.72
3	525	3735	"	.09	.08	.08	.19	.16	.18	11.58	9.86	10.72
4	535	3735	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
5	495	3725	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
6	505	3725	"	.12	.81	.36	.26	.97	.49	11.66	10.78	11.09
7	515	3725	"	.11	.28	.16	.48	.64	.50	11.63	10.13	10.84
8	525	3725	"	.09	.08	.08	.19	.16	.18	11.59	9.87	[illegible]
9	535	3725	"	.11	.45	.22	.41	.81	.54	11.66	10.40	[illegible]
10	485	3715	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
11	495	3715	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
12	505	3715	"	.14	.27	.18	.30	.54	.37	17.39	15.02	16.17
13a	512.5	3717.5	25	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
13b	517.5	3717.5	"	.05	.25	.12	.10	.34	.18	5.80	5.23	5.47
13c	512.5	3712.5	"	.11	.51	.24	.30	.70	.44	11.63	10.44	10.95
13d	517.5	3712.5	"	.28	1.47	.68	.58	1.87	1.02	29.16	26.33	27.52

AREA SOURCES

Grid Number	Coordinates		Area (km^2)	Emissions (Tons/Day)								
				SO_x			Particulate			CO		
	Horizontal	Vertical		Summer	Winter	Average	Summer	Winter	Average	Summer	Winter	Average
14a	522.5	3717.5	.25	.25	.25	.24	.81	.79	.80	23.20	19.80	21.49
14b	527.5	3717.5	"	.23	.28	.24	.55	.57	.54	28.99	24.86	26.86
14c	522.5	3712.5	"	.23	.34	.26	1.31	1.27	1.26	70.14	59.93	64.99
14d	527.5	3712.5	"	.18	.25	.20	.39	.44	.40	23.19	19.88	21.52
15	535	3715	100	.15	.17	.15	.56	.53	.55	17.38	14.83	16.10
16	545	3715	"	.15	.40	.23	.55	.81	.63	17.42	15.21	16.26
17	475	3705	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
18	485	3705	"	.04	.04	.04	.10	.08	.09	5.79	4.93	5.36
19	495	3705	"	.09	.08	.08	.19	.16	.18	11.58	9.86	10.72
20a	502.5	3707.5	25	.06	.30	.14	.28	.57	.38	5.85	5.31	5.53
20b	507.5	3707.5	"	.23	.34	.26	.49	.60	.53	28.99	24.87	26.91
20c	502.5	3702.5	"	.20	.53	.30	.41	.83	.54	23.22	20.22	21.65
20d	507.5	3702.5	"	.18	.26	.20	.39	.48	.42	23.23	19.92	21.55
21a	512.5	3707.5	"	.27	1.10	.55	.76	1.66	1.05	29.11	25.83	27.30
21b	517.5	3707.5	"	.24	.80	.43	.51	1.18	.73	29.04	25.51	27.15
21c	512.5	3702.5	"	.24	4.06	1.55	.59	13.95	5.16	23.31	26.47	23.85

DEFINING THE PROBLEM OF AIR POLLUTION

IN

METROPOLITAN BIRMINGHAM, ALABAMA

Charles B. Robison, Engineer

J. Carroll Chambers, Health Officer

Joseph W. Bates, Inspector

Jefferson County Air Pollution Control Program

Jefferson County Department of Health

Birmingham, Alabama

June, 1967

PREFACE

Air pollution, like most other problems, must be studied in order to define its nature and extent, to establish the basic knowledge of the problem which is a prerequisite to its solution. Once this knowledge has been acquired, it is then time to take appropriate action toward solving the problem.

For the past ten years the Jefferson County air pollution problem has been studied extensively. These studies have provided this basic knowledge and have clearly established these facts: (1) That there is a significant air pollution problem in Jefferson County, (2) that industrial activities are a major contributor to this problem, and (3) that this problem can and should be brought under control. Although there may be some gaps in our knowledge of this air pollution problem, there is sufficient evidence to warrant a concerted effort to bring the major portions of the problem under control. Most of the major sources of air pollution in Jefferson County and can be controlled through application of existing techniques and equipment.

Air pollution is a problem of many dimensions. There is ample evidence that it adversely affects the economy, materials, vegetation and animals, and that it poses a direct threat to the public health and welfare. Each of these reasons, and especially the last one, should be motive enough to control air pollution to the best of our ability.

A visit to Birmingham at almost any time of the year certainly provides ample evidence of a significant air pollution problem. The heavy pall of smoke, dust, and particulate material that usually hangs over the city clearly establishes the magnitude of the problem.

In my opinion, this report provides a clear definition of the air pollution problem in Jefferson County including its nature, extent, characteristics, and major sources. Additional studies could add very little to this basic definition and they should not be considered an appropriate step at this time.

The proper solution to the Jefferson County air pollution problem is appropriate action to control it and the time for action is now.

Gene B. Welsh
Regional Program Director
Air Pollution
U. S. Public Health Service

ABSTRACT

This paper presents in five sections, the air pollution problem as it exists today in Metropolitan Birmingham, Alabama (Jefferson County).

An attempt has been made to bring together the results and recommendations of previous and current studies of air pollution in Jefferson County. These include air quality measurements, climatological studies, an emission inventory, and the results of a public opinion survey. Possible methods of air pollution control are also discussed.

PREVIOUS STUDIES IN THE GREATER BIRMINGHAM AREA

Jefferson County's atmosphere has been studied extensively during the past ten years. The results of these studies have provided identical conclusions; namely, that Jefferson County has an air pollution problem, that it should be controlled, and that industrial activities are probably the major source of this pollution.

During the 1956 steel strike, a special air sampling study was conducted during July and August for the purpose of investigating the effect of this industry on suspended particulate levels.[1] Sampling was done both during and after the strike at three locations in the Birmingham area. The sampling sites were located in central Birmingham, Bessemer, and at the Western Health Center. The average levels of suspended particulates increased significantly when the steel industry resumed activity. In addition to the increase in the average levels, the variability of suspended particulate levels increased greatly with maximum values after the strike being almost three times as great as the corresponding maximum values during the strike.

In 1957, at the request of local officials, a survey of the air pollution situation in Birmingham and Jefferson County was made by the Community Air Pollution Program of the Public Health Service.[2] This survey was limited to the collection and review of existing data, interviews, and personal observations of the investigators.

The report of this survey indicated that meteorological conditions in Jones Valley are often favorable to the accumulation of pollution emissions that result from the use of fuel, industrial activity, and the incineration of wastes. It was also determined that there had been

a rapid decrease in the use of coal for domestic purposes but an increase in the amount used for steel manufacturing. The following is quoted from the report:

> "The Birmingham area is a manufacturing center and has many sources of industrial emissions. The heavy metals industry, particularly the steel industry, is undoubtedly the major source of industrial pollution. Air pollution in Birmingham has a significant effect on visibility which can be observed on those days when the atmosphere is unable to disperse the pollutants effectively. Difficulty in growing certain plants and damage to foliage were reported by local nurserymen who believed that air pollution was responsible. The damaging effects of atmospheric pollutants on clothing, surface coatings, and construction materials were not measured specifically in this study, but on the basis of present knowledge and of the conditions noted, it is reasonable to assume that they exist in the Birmingham area."

In 1961, the City of Birmingham and Jefferson County, Alabama, in the interest of gathering more facts about air pollution, conducted a short-term two-season air quality study.[3] This study was carried out with the assistance of the Public Health Service in two parts of three weeks each, June 15 - July 4 and November 20 - December 19, 1961.

The results of the sampling during this study indicated that in general, concentrations of gaseous pollutants were low. However, particulate pollutants, notably dustfall, smoke, and total suspended particulates, were found to be very high, particularly during the fall. However, all pollutant concentrations might have been higher except for ideal dispersion conditions which existed during the study period.

Some of the recommendations that were made by the agencies conducting the three previous studies were:

1) A county-wide program of study, surveillance, prevention, and control of air pollution should be developed and should include:

   (a) An inventory of air pollution sources and emissions.

   (b) An air pollution meteorological study.

(c) Sampling of the ambient air for particulate and gaseous pollutants to determine trends and control needs.

(d) Laboratory services for sample analyses and investigative activities.

(e) Abatement of the causes of justified public complaints.

2) Institution of an effective air pollution control program aimed at minimizing emissions of particulate matter into the atmosphere.

3) Establish limits for stack emissions of particulate matter.

4) Conduct an informational program to acquaint citizens with the causes, effects, and methods of control of air pollution.

In 1962, the Alabama Air Pollution and Respiratory Disease Study was initiated by the Public Health Service.[4] Sampling in the Birmingham area was resumed on a limited basis until the fall of 1963 when a 21-station sampling network was set up with seven stations located within Birmingham proper and 14 stations located in seven principal municipalities surrounding Birmingham. Intensive sampling was carried on during this study from November, 1963, through February, 1965, for atmospheric particulate matter and gaseous pollutants. The most significant specific pollutants were found to be dustfall, suspended particulate matter, and nitrogen dioxide.

After the conclusion of this study, the Jefferson County Health Department began its own Air Pollution Study and continued atmospheric sampling at ten (10) of the original station locations and nine (9) semi-mobile stations. Since the initiation of the Jefferson County

Air Pollution Program in 1965, all of the previously mentioned recommendations have been carried out, with the exception of those pertaining to control. At present, no agency of the State of Alabama, or Jefferson County, has the legal authority to initiate any emission control program. The most logical solution to the control problem appears to be through state enabling legislation, which would authorize the existence of an air pollution control agency or agencies and give them sufficient authority to clean the air.

AIR QUALITY AND CLIMATOLOGY

In 1962, the Alabama Air Pollution and Respiratory Disease Study was initiated by the U. S. Public Health Service. Sampling in the Birmingham area was conducted on a limited basis until the fall of 1963 when a 21-station sampling network was set up with seven stations located within Birmingham proper and 14 stations located in seven principal municipalities surrounding Birmingham. Intensive sampling was carried on during this study from November, 1963, through February, 1965, for atmospheric particulate matter and the gaseous pollutants, SO_2, NO_2, and aldehydes.[5]

At the conclusion of this study, the Jefferson County Health Department began its own Air Pollution Study and continued atmospheric sampling at ten of the original USPHS stations and several mobile stations. Samples are still being collected and analyzed at the time of this report. In all, this has resulted in three and one half years of continuous air monitoring in Jefferson County.

In these three and one half years a total of 6,628 suspended particulate samples, 5,191 sulfur dioxide samples, 6,884 nitrogen dioxide samples, 5,445 aldehyde samples, 433 dustfall samples, 405 sulfation samples, and over 2,400 pollen and spore samples have been collected and analyzed by either the Public Health Service or the Jefferson County Health Department personnel. In addition, more than 40,000 two-hour soiling samples have been collected and partially analyzed and continuous monitoring of oxidants, oxides of nitrogen, and numerous other special samples have been collected. Meteorological data from the weather bureau was evaluated with regards to air pollution levels and these results as well as those from the air sampling are presented in the

following paragraphs.

Suspended Particulate

Results of suspended particulate matter samples are reported in micrograms of particulates per cubic meter of air ($\mu g/m^3$). These are the accepted units and give an indication of the weight of dirt suspended in a given quantity of air.

The range of annual averages in the 10 station sampling network varied from 72 to 281 $\mu g/m^3$ with a combined area wide average of 151 $\mu g/m^3$. In addition, results show that 20% of the time (equivalent of two months each year) suspended particulate matter in Jefferson County exceeds 265 $\mu g/m^3$ which is about ten times the background or natural levels found in less polluted areas of Alabama.[6]

In addition, there are specific problem areas in Jefferson County where levels of suspended particulates are always found to be above 200 $\mu g/m^3$ of air with levels exceeding 500 $\mu g/m^3$ of air not being uncommon.

Since 1957, the U. S. Public Health Service has operated the National Sampling Network in numerous cities throughout the country. Their findings indicate a national urban average of only 104 $\mu g/m^3$. While this is not a legitimate number to compare our findings with, it is legitimate to say that Jefferson County's average level of suspended particulates (151 $\mu g/m^3$) is higher than 70% of all 14,494 samples collected by the National Air Sampling Network in the years 1957 - 1961[6] and this same average of 151 $\mu g/m^3$ is higher than 80% of all 12,607 samples collected by this agency in 1964 and 1965.[7]

North and Central Birmingham and the Tarrant City areas consistently reported the highest levels of suspended particulates with the southside

and Bessemer areas also having relatively high levels. Complete annual averages and peak levels are presented in Table I.

Seasonal variations of suspended particulate matter were small, indicating year-round sources of pollution in Jefferson County.

Dustfall

Dustfall sample results are reported in the recommended units[8] of tons of dustfall per square mile per month, and give an indication of the amount of dirt or particulate matter one can expect to settle out of the air in a month's time in a square mile area.

The annual averages for dustfall range from 9.5 tons/mi^2/mo in Mountain Brook to 87.8 tons/mi^2/mo in North Birmingham. The stations reporting the highest levels of dustfall are the same as those having the highest levels of suspended particulate matter. However, there are not as many stations with extremely high levels of dustfall as there are those with excessive suspended particulates. This would indicate that there is more fine solid matter (inhalable) than there is heavier particulate in the atmosphere.

Annual averages and peak levels of dustfall are presented in Table I.

Gaseous Pollutants

The sulfation rate (commonly known as lead candle) is a monthly measurement of sulfur compounds in the air. The results are presented in milligrams of sulfur trioxide per 100 square centimeters per day. Table I gives a brief summary of the results of these samples.

Sulfation levels are generally rather low in Jefferson County but they do follow a definite seasonal trend with winter levels being about twice as high as any other season. The Fairfield, north, central, and Southside Birmingham stations usually report the highest levels of sulfation.

Three gaseous pollutants, sulfur dioxide, nitrogen dioxide, and aldehydes, are measured every 24 hours at all 10 stations in the sampling network.

Sulfur dioxide levels, consistent with sulfation, are generally low year round with the winter season having the highest concentrations. Ninety percent of all the sulfur dioxide samples were below 1.0 parts per hundred million.

Nitrogen dioxide was the only gaseous pollutant found in any significant quantities with the range of daily levels being 0.7 to 62.7 parts per hundred million. Nitrogen dioxide levels were found to be highest in areas of industrial activity where dustfall and suspended particulates were also at the maximum.

Daily aldehyde levels ranged from 0 to 4.0 parts per hundred million. No geographical or source relationship to aldehydes is obvious as in the case of suspended particulates, dustfall, and nitrogen dioxide. Detailed results are presented in Table I.

Special Sampling Results

1. Mobile suspended particulate samples

Results from sampling for suspended particulates at nine locations (other than the ten fixed stations) was conducted during the fall and spring seasons. Location of these stations is shown in Figure 1. The monthly means for these 9 stations ranged from 48 to 180 $\mu g/m^3$ with highest levels being in the southwest section of the area. The city of Homewood had four of the 9 samplers located within its limits and with one exception showed very little variation in suspended particulate levels. In general, the levels of suspended particulates found at these 9 mobile stations was somewhat lower than those found at the majority of the 10 fixed stations.

2. Continuous oxidants and oxides of nitrogen

Continuous sampling, with special instrumentation, was begun for oxidants and total oxides of nitrogen in mid-August, 1966. Since then, the highest levels of oxidants recorded has been about 4 parts per hundred million, while the background levels appear to be approximately 1.5 parts per hundred million. For total oxides of nitrogen, the peak value to date was 17 parts per hundred million, with a background of approximately 6 parts per hundred million. The rather low levels of oxidants indicates an absence of photochemical smog which is a result of heavy automobile pollution.

3. Metal analysis

Since the beginning of the study a limited number of samples have been analyzed for their metal content. Metals found in the particulate matter of the atmosphere are usually indicative of a nearby source. Results of these samples indicate a high metal content, especially iron. This is as expected, since Birmingham is the metal industry center of the South. Some of the other metals found in relatively high concentrations are manganese, lead, and zinc.

Climatology and Air Pollution

The topography of the Birmingham area is irregular, consisting of ridges with intervening valleys. The city proper is in a valley between a series of low ridges extending from northeast to west, and Red Mountain extending from east to southwest which approaches a height of 600 feet above valley level.

The main climatic effect of the topography is that during winter months it produces extreme temperature inversions and rather low minimum temperatures. Associated with this is a marked reduction in visibility during early morning and late afternoon due to air borne particulate

matter and to some extent fog.

Visibility restrictions less than six miles and frequently less than one mile due largely to air pollution occur throughout the year but are most numerous and intense during winter and fall months.

Pollution sources include industrial areas lying from four to eight miles to the southwest of the city, but, the most heavily concentrated groups of known industrial sources extend from central to north and northeast Birmingham.

In general, the greatest pollution (at all stations for all measured pollutants) occurs on calm days with little or no wind movement.

On days when there is significant wind movement, the highest levels of pollution generally occurs at stations downwind from the industrialized North Birmingham, Tarrant area. This is true for all pollutants except gaseous aldehydes which show no consistent pattern in relation to wind directions.

During 1964, days classified as calm by the weather bureau occurred, on the average, 16.7% of the time, visibility was reduced below 6 miles 22.0% of the time and significant quantities of smoke and/or haze existed at the airport 15.1% of the time.

Summary

Results of sampling have shown conclusively that there is a serious air pollution problem in Jefferson County, especially in Jones Valley where meteorological conditions quite often favor accumulation of pollutants. Of major significance is particulate matter or general aerial filth. In fact, Birmingham has just recently been rated by the Public Health Service as one of the dirtiest cities in the country with regards

to particulates, including organic matter and metals in the atmosphere.[9]

Results of our studies show that particulate levels are high year-round with little seasonal variation indicating a constant source of pollution.

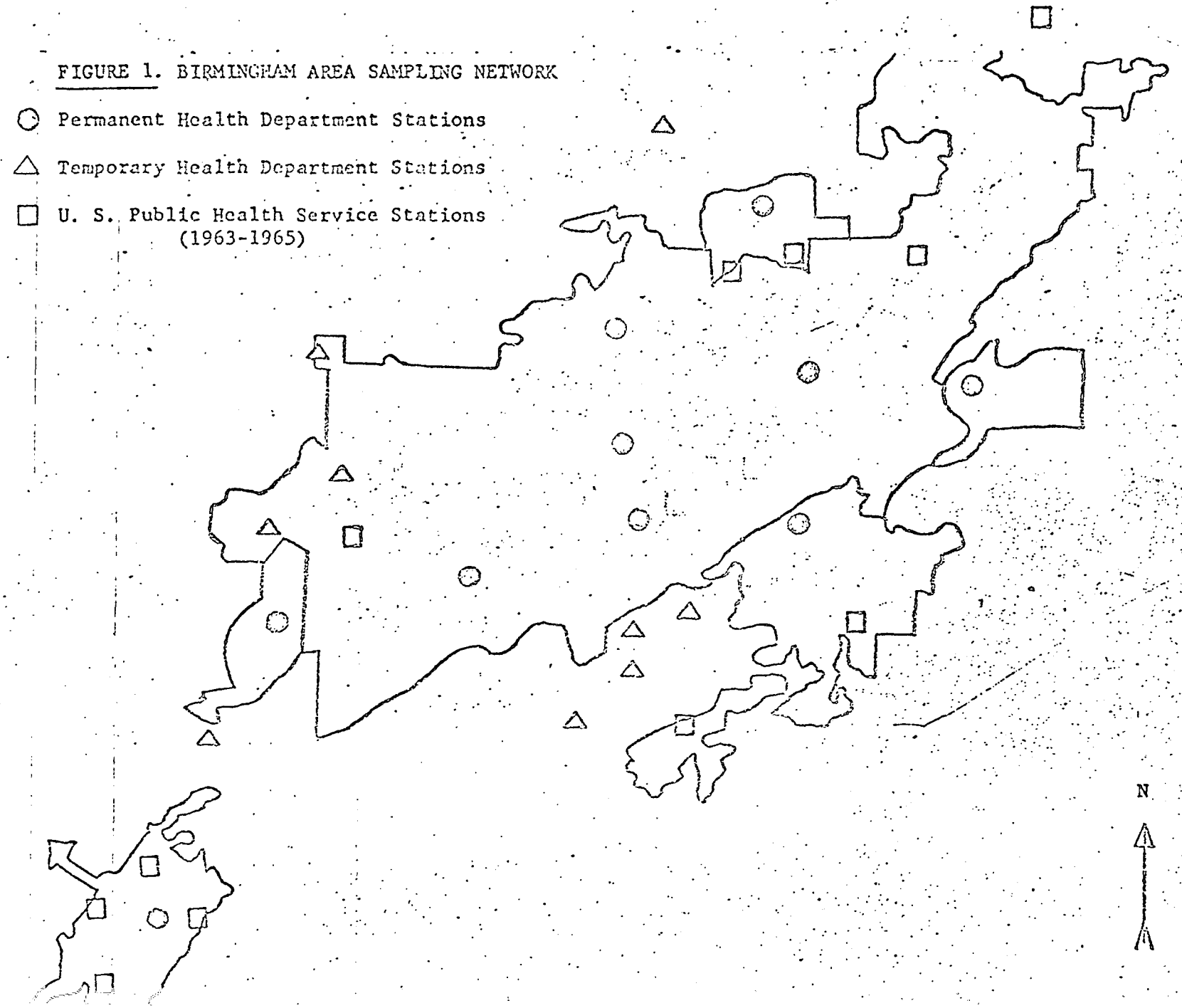
Table I ANNUAL POLLUTION LEVELS IN JEFFERSON COUNTY ALABAMA*

Location	Suspended[1] Particulate ug/m^3		Dustfall[1] Tons/m^2/mo		Sulfation[2] mgSO$_3$/100cm^2/day		Sulfur Dioxide[2] pphm		Nitrogen Dioxide[2] pphm		Aldehyde[2] pphm	
	Mean	20%[3]	Mean	20%	Mean	20%	Mean	20%	Mean	20%	Mean	20%
Bessemer	176	270	20	25	0.20	0.30	0.2	0.4	8.3	12.0	1.4	2.2
Fairfield	126	205	20	23	0.31	0.47	0.3	0.8	7.4	12.0	1.4	2.6
West End	124	200	21	27	0.14	0.19	0.2	0.4	7.9	12.0	1.3	2.2
No. B'ham	281	440	88	124	0.55	1.00	0.4	1.3	10.3	15.0	1.4	2.1
Central B'ham	197	300	22	26	0.32	0.50	0.4	1.3	9.7	13.5	1.5	2.2
Southside	179	276	20	25	0.33	0.52	0.3	0.9	8.6	12.8	1.8	2.7
Woodlawn	139	220	24	30	0.07	0.18	0.1	0.3	8.3	12.0	1.4	2.2
Tarrant	219	362	53	70	0.13	0.22	0.2	0.4	7.9	10.5	1.3	2.0
Irondale	115	180	15	18	0.12	0.18	0.2	0.6	7.2	10.6	1.5	2.3
Mt. Brook	72	115	10	13	0.08	0.19	0.2	0.4	7.1	10.8	1.3	2.0
All Stations	151	265	29	38	.23	0.38	0.3	0.7	8.3	12.1	1.4	2.3

1. Jefferson County Air Pollution Program Data
2. U. S. Public Health Service Data Reference 5
3. Indicates Levels That Occur 20% Of The Time Or Slightly More Than 2 Months Per Year

* Geometric means or averages are used throughout this paper for all pollutants.

FIGURE 1. BIRMINGHAM AREA SAMPLING NETWORK



EMISSION INVENTORY

In 1965, a year long effort was begun by the Jefferson County Department of Health to obtain a comprehensive and complete inventory of the air pollutants emitted into Jefferson County's atmosphere. One thing that was learned as a result of this emission inventory was that of all the air pollution in Jefferson County, about 50% comes from within the city limits of Birmingham with the remaining 50% coming from the many communities surrounding Birmingham.

In general, this air pollution comes from four main sources. These sources and the method used to estimate their individual contribution to the air pollution problem in Jefferson County are:

(1) Domestic sources; information on fuel, trash, and leaf burning was obtained via a random survey of 7,200 households in Jefferson County. The results were then extrapolated to include all 188,000 households in the county.

(2) Transportation sources; information was obtained from tax records which is directly related to fuel consumed in combustion engines. Airplane and diesel powered vehicles were included in this study as well as buses, trucks, and automobiles.

(3) Commercial sources; information was obtained via "fuel use" questionnaires which were sent out to 498 laundries, dry cleaners, hospitals, rest homes, hotels, motels, schools, and shopping centers. Approximately 90% of the questionnaires were returned and it is estimated that 75% of all "commercial" establishments were sent questionnaires. Therefore, the commercial emissions are based on approximately 68% of all the commercial establishments in Jefferson County.

(4) Industrial sources; information was obtained via a "fuel use"

and "process" questionnaire. Questionnaires were sent out to the 815 industrial establishments as listed in the 1964 Industrial Directory of the Birmingham Area Chamber of Commerce. Of these only 368 were returned with usable information. Therefore, the industrial emissions are based on approximately 46% of the industries in Jefferson County. Most of the major industries, however, were included in this 46%.

Emissions from Stationary Sources

Stationary sources include the domestic, commercial and industrial contributors to air pollution. The emissions from the transportation industry will be presented separately.

In most communities one of the biggest sources of air pollution is the emissions given off from the burning of fuel for heating requirements. In a large industrial area such as Jefferson County, however, it would seem logical that the largest amount of fuel is consumed by industry for process heat, making the over-all emissions relatively constant year round. This assumption is validated by the seasonal air pollution levels presented in a separate section which show very little seasonal variation in particulate matter.

Figure 2 is a map illustrating quantity ranges of particulate emissions and showing some of the known major industrial and commercial sources of air pollution. Figures 3 and 4 show the emission breakdown for stationary sources in Jefferson County.

From Table II it can be seen that industrial sources account for approximately 98% of the particulate emissions, 88% of the gaseous emissions and 53% of the hydrocarbon emissions from stationary sources. In addition, the map indicates that emissions are greatest in areas of concentrated industrial activities. The fairly large percentage of

commercial hydrocarbon emissions comes mainly from burning dumps and dry cleaning establishments.

The small amount of emissions from domestic sources can be attributed primarily to the decline over the past 20 years of coal as a source of space heating and cooking fuel.

The five largest sources of particulate emissions in Jefferson County from stationary sources are listed below in decreasing order of importance:

Source	Particulate Emissions Llbs. per year
Industrial processes	378,840,000
Industrial fuel use	14,260,000
Commercial fuel use	3,592,000
Domestic fuel use	2,522,000
Burning dumps	1,328,000

Industrial activities clearly account for the vast majority of particulate emissions in Jefferson County. However, the remaining sources should not be completely overlooked as they are often large enough to cause severe localized nuisance and/or health problems.

Transportation Emissions

The estimated emissions from the transportation industry include those associated with automobiles, diesel vehicles, and aircraft. The calculations are based on fuel use data and airport flight information. Figure 5 shows the various types of pollutants emitted and their relative percentages.

In comparison with stationary sources it can be seen that transportation contributes only slightly to the particulate matter in Jefferson County's air. Carbon monoxide emissions are primarily from

the transportation industry and a signigicant portion of the hydrocarbon emissions also are associated with transportation sources.

In the area of transportation, however, it must be noted that the federal government has already passed legislation relating to the control of motor vehicle emissions. All new vehicles now have crankcase blow-by devices which control up to 30% of the total emissions of motor vehicles. This factor was not considered when calculating the estimated emissions. In addition, beginning with 1968 model vehicles, exhaust control devices will be standard equipment. This equipment will reduce the emissions from new automobiles approximately 70 percent.

Summary

Estimated air pollution emissions in Jefferson County have been tabulated and summarized in Table II, and Figures 3, 4, 5, 6, and 7.

From this data several things become evident:

(1) That the greatest source of particulate emissions is from stationary sources, and in particular from industrial sources.

(2) That the problem of hydrocarbons is associated with both stationary and transportation sources.

(3) That carbon monoxide is primarily from transportation sources.

(4) That federal law will substantially reduce the amount of air pollution emitted from motor vehicles in the near future.

(5) That stationary sources, particularly industrial, is the area in which air pollution control efforts should be directed, and that transportation source emissions are a secondary problem.

Legitimate comparisons of emissions between various communities are difficult to make due to the inherent incompleteness of any such survey. However, some comparisons might give more insight into the extent of

Jefferson County's air pollution problem.

In Nashville, Tennessee,[10] total particulate emissions (including transportation) were estimated at 42,000,000 lbs. per year which is only one-tenth of those in Jefferson County. Gaseous emissions, including hydrocarbons, were estimated to be 172,348,000 lbs. per year while Jefferson County's total gaseous emissions are approximately 753,000,000 lbs. per year.

In Chattanooga, Tennessee,[11] total particulate emissions were estimated to be 204,612,000 lbs. per year which is approximately one-half the amount found in Jefferson County.

TABLE II ESTIMATED EMISSIONS FOR JEFFERSON COUNTY, ALABAMA, (1965 DATA)

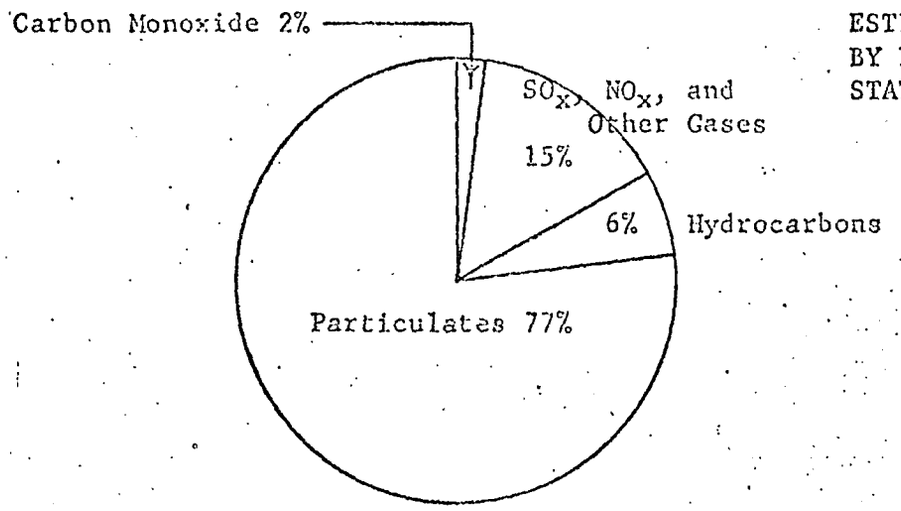
Pollutant / Source	Particulate Tons/Yr	Carbon Monoxide Tons/Yr	Hydrocarbon Organic Acids Tons/Yr	Sulfur Oxides Tons/Yr	Nitrogen Oxides Tons/Yr	Aldehydes Tons/Yr	Ammonia Tons/Yr
Indust. fuel use	7,130	191	411	7,263	6,922	41	N.A.
Commer. fuel use	1,796	961	1,420 [1]	605	210	Neg.	N.A.
Residential fuel use	1,261	1,357	583	1,047	801	Neg.	N.A.
Indust. Processes	189,420	1,000	5,857	22,785	1,616	N.A.	N.A.
Mun. Incinerator	156	9	26	25	27	14	4
Mun. Dumps	664	N.A.	3,949	17	8	57	33
Indust. Refuse	143	136	761	3	2	33	5
Commer. Refuse	13	127	72	Neg.	Neg.	21	Neg.
Residential Refuse	55	249	134	4	6	14	Neg.
Gasoline (Auto & Trucks)	881	233,195	42,311	721	9,055	320	160
Diesel (Auto & Trucks)	2,938	1,602	5,636	1,068	5,930	106	N.A.
Airplanes	258	13,898	2,791	Neg.	956	54	N.A.
TOTALS	204,715	252,725	63,951	33,538	25,533	660	202

1 - Includes 1,200 Tons/Yr from Dry Cleaners

N.A. - Not Available

Neg. - Negligible Amount

Figure 2. ESTIMATED PARTICULATE EMISSIONS BY NEIGHBORHOOD AREAS SHOWING MAJOR INDUSTRIAL & COMMERCIAL SOURCES



ESTIMATED % CONTRIBUTIONS BY POLLUTANT FROM STATIONARY SOURCES

Figure 3

ESTIMATED % CONTRIBUTION OF EACH STATIONARY SOURCE

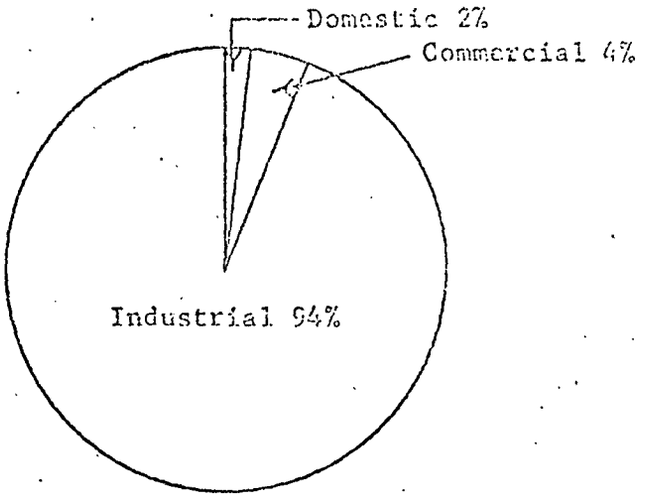
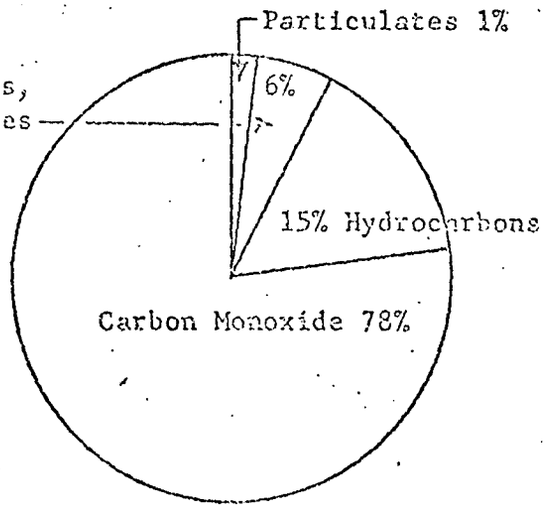


Figure 4



ESTIMATED % CONTRIBUTION BY POLLUTANT FROM TRANSPORTATION SOURCES

Figure 5

ESTIMATED % CONTRIBUTION
OF ALL EMISSIONS
FROM ALL SOURCES

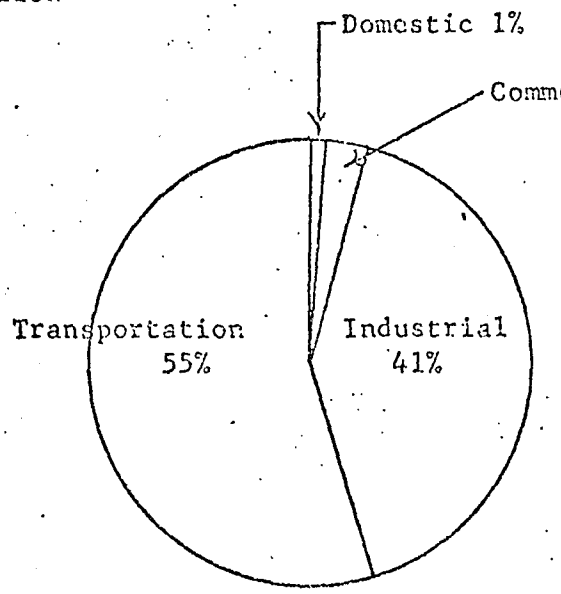


Figure 6

ESTIMATED EMISSIONS AS
PERCENT OF TOTAL FROM
ALL SOURCES BY POLLUTANT

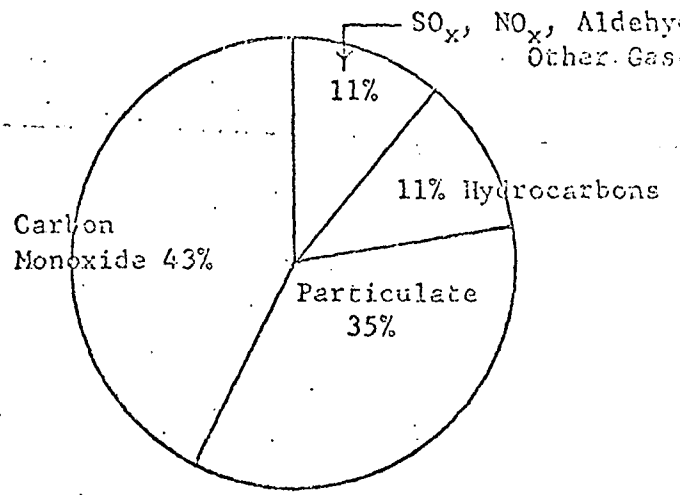


Figure 7

Total Estimated Emissions = 581,324 Tons/Year

PUBLIC OPINION

Over 300 complaints regarding air pollution have been received and investigated by the Jefferson County Health Department since its air pollution program began in 1965. In addition, during the summer of 1965 approximately 7,200 households were interviewed by Health Department personnel in an extensive public opinion survey. Results of these activities conclusively show that the public is vitally concerned about and annoyed by the air pollution that exists in Jefferson County.

The household public opinion survey was conducted at random and instructions were issued to the interviewers as to how to select houses randomly. Only adult members of the households were interviewed. On the average one home in 26 was interviewed in this survey. The survey showed that 54% of the people within the City of Birmingham and an average of 42% of the people outside the city limits were annoyed or affected adversely in some way by air pollution. The actual percent of people affected in the various communities ranged from 22% to 87% (Table III). Some of the statistical conclusions which were made as a result of this survey were:[12]

(1) That 33% of the people are adversely affected when suspended particulate levels exceed 150 micrograms per cubic foot of air.

(2) That 33% of the people are adversely affected when dustfall levels exceed 30 tons per square mile per month.

These are levels of pollution that are quite often greatly exceeded in Jefferson County and one-third of the people is a significant number.

The relation between public opinion in the communities and the measured gaseous pollutants were not significant in most of the cases

studied. However, it should be noted that gaseous concentrations were in most instances very low.

The number of complaints received regarding air pollution over the past two years obviously reflects only a small percentage of the total population of Jefferson County. However, since to make a complaint one has to first place a phone call and then identify himself, it is apparent that these complaints most likely represent severe and specific problems resulting from localized sources of pollution. This theory is supported by the fact that 2/3 of all complaints received have been regarding "health effects" or "property damage", which is in contrast to the public opinion survey where most of the complaints were classified as a general nuisance.

A look at Table IV also indicates that 2/3 of the complaints are about particulate matter (dust, smoke, and flyash), and 2/3 of the sources of this pollution are said to be industrial.

In the absence of specific regulations and control legislation, investigation of the complaints are made to ascertain if the complaint is justified, to make a visible inspection of the source, and where possible to make appropriate recommendations for voluntary control.

Since the beginning of the program, it has been possible to investigate about 75% of the complaints received. However, the amount of voluntary compliance in abating these complaints is less than 5% of all the complaints; and in most cases, these were very small air pollution sources, e.g., leaf burning, trash burning, etc. It is not felt that the voluntary compliance has reduced the air pollution levels by any appreciable amount.

Table III

EFFECTS OF AIR POLLUTION ON POPULATION
PUBLIC OPINION SURVEY

CITY	Percent of Household Adversely Affected				
	Total % Household Affected	General Nuisance Response	Health Effects Response	Material Damage Response	Odor Response
Birmingham	54	33	18	19	23
Bessemer	35	17	11	8	20
Fairfield	66	60	3	--	19
Tarrant	87	74	53	9	68
Center Point	36	16	7	--	7
Irondale	23	12	9	2	4
Mountain Brook	22	12	16	--	2
Vestavia	24	15	24	--	3

Table IV SUMMARY OF AIR POLLUTION COMPLAINTS

Source of Complaint	Total
Industrial	209
Domestic	33
Commercial	51
Transportation	9
Total	302

Types of Effects	Total*
Property Damage	120
Health Effect	178
Odor	107
Visibility	28
General Nuisance	133
Total	566

Type of Pollutant		Total*
Dust	Particulate	112
Smoke		127
Flyash		45
Gas		13
Odor		99
Total		396

* Since more than one effect or type of pollutant can occur simultaneously, these totals are naturally larger than the number of complaints received.

CONTROL OF AIR POLLUTION

There are many avenues of approach to the problem of air pollution control. The first and perhaps the most obvious solution is to zone or segregate industry away and downwind from residential areas. This approach usually fails due to the rapid expansion of cities and the refusal of the winds to always blow in the same direction.

In some cases, it is possible to avoid polluting the air by more efficient combustion or by changing fuels or by simple modifications of the processes in use. These solutions are generally more applicable to domestic and commercial space heating and waste incineration than to large industrial processes. The control of automobile exhaust is a good example of control by modifications resulting in more efficient combustion. Federal law requires that all new automobiles (1968 models on) be modified or have factory installed devices to reduce the amount of carbon monoxide and hydrocarbons that are emitted.[13] These reductions will average 60% to 80% depending on the vehicle and the conditions under which it is being driven. These regulations will undoubtably be tightened in 1970 and will probably include buses and diesel powered vehicles.

Another widely used technique, especially in the power industry, is the erection of extremely high stacks (500 feet or higher). These stacks carry their load of pollutants higher into the atmosphere where they are more easily dispersed. This method of control is often satisfactory but offers no safeguard against downdrafts or prolonged stagnation periods. Here in Jefferson County with the many mountains and valleys this method would most likely be unsatisfactory.

In addition to the above methods, there are for most industries and processes methods and equipment to remove the bulk of the pollutants from the stack gases before they are discharged into the atmosphere. These methods or devices are generally placed in four broad categories.

The first method is mechanical, the most common form being the cyclone collector. In this method the gas is forced into a swift spiral and the centrifugal force created causes the solid particles to be thrown out of the gas stream and into a hopper. The cleaned gas then passes out into the atmosphere.

The second group of collectors are generally classified as wet collectors. In this method the polluted gases are forced into intimate contact with finely divided liquid (usually water) droplets. This wetting causes many of the solid and gaseous pollutants to be trapped in the water where it can later be recovered for disposal or reuse.

The third class of collectors work on a principal similar to that of a vacuum cleaner. The dust laden gases are passed through a large filter bag where the solid matter is trapped in the fabric of the filter. This type of collector is somewhat limited due to clogging of the filters and to the high temperatures of some of the exhaust gases encountered in industrial processes.

The fourth type of air pollution control equipment is the electrostatic precipitator. In this collector the dust is given an electric charge while passing through tubes or between plates which have a charge opposite to that of the particles. These opposite charges cause the particles to be attracted electrically to the walls of the tube where they can then be mechanically removed.

All of the above methods of control are technically feasible and are presently being used either by themselves or in combinations by industry throughout the country. Table V shows some examples of air pollution sources, types of pollutants emitted, common control methods, and average amounts of pollutants emitted both before and after control equipment is installed. These are average figures and do not necessarily reflect the performance of any individual industry, process, or source. This table does, however, give some insight into the amount of pollutants that can be kept from the atmosphere with reasonable amount of control.

The cost of air pollution control is high, but so is the cost of not controlling this pollution. Just recently it was reported that the cost of air pollution (not including health effects) in Canada is $25.00 per person per year.[14] This same figure for U. S. citizens has been estimated in excess of $65.00 per year.[15]

Here in Jefferson County numerous instances have been reported where roofs have had to be replaced in as little as three years due to air pollution and houses needing repainting after turning black almost overnight. These factors along with many others including increased public and private housekeeping expenses, plant damage, and health effects, cost our community untold millions of dollars annually. The cost of cleaning our skies will vary from a few dollars per source to as high as one million dollars for one stack, but the time has come when we can no longer afford not to clean our air. Air pollution is a liability to every citizen and to our fine community. Air pollution costs us much more in economic and health loss than it will cost to control.

Table V ESTIMATED UNCONTROLLED AND CONTROLLED PARTICULATE EMISSIONS FROM SELECTED SOURCES*

Specific Process or Operation	Major Pollutant Emitted	Type of Control Equipment	Collector Efficiency (%)	Estimated Emissions Uncontrolled	Estimated Emissions with Controls
Blast Furnace	Iron Ore & Coke Dust	Wet Scrubber	90	200 #/ton of product	6 #/ton of product
Open Hearth	Iron Oxide Fume	Electrostatic and/or Wet Scrubber	85-98	9 #/ton of product	0.8 #/ton of product
Cement Kilns	Cement Dust	Electrostatic	85-99	4 #/1000 $Ft.^3$ of exhaust	0.2 #/1000 $Ft.^3$
Gray Iron Cupolas	Iron Oxide Dust and Fume	Filter Bags	98	17 #/ton of material	0.3 #/ton of material
Asphalt Batching	Sand and Gravel Dust	Cyclone	85	5 #/ton of product	0.8 #/ton of product
Coffee Roasting	Dust, Chaffe	Cyclone	75	3 #/1000 $Ft.^3$ of exhaust	0.7 #/1000 $Ft.^3$ of exhaust
Industrial and Commercial Incinerators	Particulates			23 #/ton of refuse (single chamber)	4 #/ton of refuse (multiple chamber)

* Obtained from: "Inventory of Air Contaminant Emissions," New York State Air Pollution Control Board, and "A Compilation of Emission Factors for Combustion Processes, Gasoline Evaporation, and Selected Industrial Processes," Martin Mayer, Technical Assistance Branch, Division of Air Pollution, U. S. Public Health Service, Cincinnati, Ohio.

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