THE NATURE AND QUANTITY OF CONTAMINANTS IN THE CINCINNATI AREA

November 1946 to November 1947

Introduction

Much has been said and written about the possible effects of the contaminants of the atmosphere of great industrial cities upon the health of the people who live in and around these cities. Sinusitis, chronic catarrh, bronchitis, and asthmatic bronchitis have often been said to have been caused or exaggerated by dirty atmospheres. There ~~appear to be~~ are those who ~~feel~~ believe that carcinoma of the bronchus may be on the increase because irritant dusts and fumes in the atmosphere in some way excite the lesion into being. ~~Autopsied~~ The lungs ~~and chest X-rays~~ of the life-long inhabitants of industrial cities do show a different appearance in X-Ray photographs and at necropsy, than is true of ~~comparable material from~~ the rural ~~inhabitants~~ population.

Yet ~~we feel~~ it is fair to say that no one really knows what the nature of the contaminants of the atmosphere of industrial urban areas are, how much of these contaminants can and do get into the upper respiratory tract, how much gets into the lung, and finally, we do not know what effects these contaminants, singly and in groups, have upon the anatomy and physiology of the respiratory apparatus.

Before one can undertake any satisfactory experimental study of the effects of atmospheric contamination on the inhabitants of a polluted area, it is obviously necessary first to obtain basic data concerning the qualitative and quantitative nature of air pollution. It will be well to know its sources, causes and seasonal magnitude and to relate them to the various meteorological phenomena which constitute weather. Having obtained these basic data, it may

then be possible to ~~go into the laboratory and~~ design a series of experiments which will shed light on this problem.

The purpose of this study, therefore, is to obtain certain basic qualitative and quantitative data about atmospheric pollution in Cincinnati with respect to dustiness, ~~metal~~, carbon, ~~soot~~ silica ~~content~~, acid gases, fluorine, ~~CO~~. As a starting point, a number of contaminants have been measured, at monthly intervals, ~~under~~ a variety of ~~conditions~~ with respect to proximity of industrial plants, heavy automotive traffic, business ~~areas, residential areas, etc.~~, in the belief that these initial data will indicate ~~the~~ trends ~~for future work which we estimate may take about five years~~. ~~Obviously the program will have to expand along certain lines and contract along others, but it is hoped that after a five-year period we may obtain a fair picture of the nature of atmospheric contamination in Cincinnati.~~ This preliminary report covers the period from November 1946 to November 1947. No ~~final~~ conclusion can be drawn from the data presented but we believe they are of sufficient general interest to merit presentation at this time.

Procedure

Twelve areas in Cincinnati were carefully selected for ~~study, in order to attempt to measure the variables which effect atmospheric contamination under a variety of circumstances~~. These ~~areas~~ include residential and business areas, areas with light and heavy automotive traffic, areas close to railroads and heavy industry, areas varying in altitude but otherwise similar, and areas in close proximity to selected chemical and metallurgical industries. ~~These areas are~~ controlled by samples taken in a rural area protected from the Cincinnati atmosphere by prevailing winds

and by a number of hills. The sampling areas are geographically arranged to take into consideration the effect of population density, the prevailing winds, and other meteorological and sociological phenomena. At each of the twelve areas, records were kept of the temperature, relative humidity, barometric pressure, wind velocity, the amount of the last rainfall, degree of overcast, and the amount of automotive traffic passing the area during the sampling time. Each area is sampled monthly and at approximately the same time of day each month. Monthly collections consist of electrostatic precipitator samples, gas absorber samples, and street sweepings. The first two samples are taken at breathing level (i.e. five feet above sidewalk). In addition, soot fall samples collected by the city smoke department from certain areas in close proximity to the sampling points mentioned above are submitted for analysis each month.

The atmospheric dust samples are collected by means of a DC electrostatic precipitator. Power is obtained from a 12-volt truck battery through an electronic converter. The dust is washed out of the aluminum cylinders with redistilled ethyl alcohol and the particles, in an aliquot portion, are counted on the screen of a MSA microprojector apparatus. Counts are made at 900 to 1000 magnifications under light field illumination. The remainder of the suspension is taken to dryness in a suitable container and weighed on a micro balance to determine the total weight of the sample. The dried residue is then taken up in acid and analyzed spectrographically for its metal content.

Absorber samples are collected by pulling air through a solution of 0.1 N sodium hydroxide. Suction is provided by a Willson

pump attached to a 12-volt DC motor which is operated directly from the battery. An aliquot of the solution is titrated with 0.1 N hydrochloric acid to determine the acid gases absorbed, using phenolphthalein as an indicator. The increase in acidity above that obtained for the control point is recorded. Fluorine is determined by ~~the standard~~ a method ~~as used at the Kettering Laboratory~~ described in detail elsewhere (reference).

The soot samples are collected in standard soot jars, 12.5 cm. in diameter and 27 cm. high, containing a glycerine-water solution which is provided with a mold inhibitor. The samples are filtered and weighed in Gooch type crucibles provided with a fritted disc. The sample is then ashed at 500°C. to give the percentage of combustible material and ash. A portion of the ash is analyzed for acid soluble material, combined and free silica, while the remainder of the ash is analyzed for trace metals by means of the spectrograph.

The street sweepings are dried at 115°F. and screened through a 60 mesh screen to eliminate rocks, leaves, etc. ~~A one~~ a portion consisting of one gram ~~portion~~ of the dried sample is then digested with nitric acid and the mixture is analyzed for lead. Another portion of one gram portion is fused with 10 per cent sodium hydroxide and analyzed for bromine. ~~to determine the amount of lead due to automotive traffic.~~ A third portion of one gram portion is used to determine the content of combustible material, ~~the~~ of acid soluble material ~~content~~, and ~~the~~ total silica. ~~contents~~

Results

The data suggest that the year in Cincinnati may be divided into three seasons according to ~~the~~ climate, ~~in Cincinnati. The months of~~ November, December, January, and February ~~were~~ combined to represent ~~as~~ the

cold months, while ~~The months of~~ March, April, May, and October were grouped as ~~considered~~ the cool months, while ~~the months of~~ June, July, August, and September were designated as the warm months.

In Table 1 and Chart 1 are given data dealing with the general dustiness of the air.

Tables 2 and 3 list the lead, aluminum, manganese, and copper ~~content of~~ the air at the various locations studied. Chart 2a ~~shows~~ presents the ~~lead~~ data on lead in graphical form while Chart 2b shows the lead content of the air of an industrial area compared with the lead content of the air of a number of residential areas. Charts 3a, 3b, and 3c show the aluminum, manganese, and copper concentrations. Other metals such as tin and silver are not listed or charted because of the insignificant quantities found. ~~Iron~~ The values for iron could not be regarded as sufficiently accurate, as there are not listed, ~~are not accurate due to possible contamination~~ and therefore for the time being ~~this metal has not been listed~~.

Table 4 shows the data obtained from the ~~"sweep up"~~ samples of street dusts. Chart 4 shows graphically the total lead content of the street dust at a number of localities.

Table 5 gives the data obtained for the soot samples. Chart 5 shows the lead content of the soot and the total weight of soot collected at each point.

Table 6 gives the acid gas content and ~~the~~ the separate values for fluorine ~~content of air~~ samples taken at a number of locations.

Table 7 lists other pertinent data such as mean temperature, rainfall, etc., for the period of study.

Discussion

It is apparent that the dustiness of the air in Cincinnati is, in part, at least, a function of cold weather (Table 1, Chart 1).

Of the twelve locations studied, eleven show decided increases for the cold months as compared to the cool and warm months. Except for one location (Western Hills Viaduct) there appears to be little difference between the cool and warm months. Only one location (University of Cincinnati Law School) showed no seasonal variation.

Generally, areas with high automotive traffic showed higher dust counts for all seasons. The preliminary data seem to show that automotive traffic contributes materially to the dustiness of the atmosphere in the immediate vicinity of the traffic. The Cedar-Hamilton and Cedar-Lathrop areas differ from each other only in their automotive ratio, 512:52 per hour, and are only a block apart. It is not yet apparent why these two residential areas in what is considered a "clean" part of town (College Hill) should be so dirty. While there is less soot fall in this area than in many others, the amount of fine particulate matter appears to exceed that in many of the business and industrial areas.

The highest dust count (1.6 PP cu. ft.) is found at the Western Hills Viaduct, which crosses ~~an enormous~~ wide railroad bed in the Mill Creek Valley and is essentially surrounded by hills. Here the automotive traffic is extremely heavy (1270 cars per hour), at the level of the road ~~and it~~ is elevated above the basin of the city only 100 feet. These factors seem to be responsible for the extremely high counts at this point. They are higher than those obtained at the actual level of the railroad yard proper (Gest and McLean). Additional data from more sampling points will probably help to clarify many of these problems.

The amount of lead found in the atmosphere does not necessarily follow the seasonal trend (Table 2, Charts 2a, 2b), but in general is higher in the colder ~~months~~ months than in the warm ~~ones~~. It ~~rises~~ varies with the degree of automotive traffic and the nature of

the area, i.e. industrial vs. residential.

The lead content of the samples collected by the electrostatic precipitator are of particular interest. The area of the city with the highest lead content is in the immediate neighborhood of two lead foundries (average of 0.088 mg. lead per 10 cubic meters). The second highest area is the Western Hills Viaduct, the heaviest traffic and probably the greatest railroad and industrial ~~contamination~~ (0.05 mg. lead per 10 cubic meters) ~~and~~ the third highest is in the neighborhood of a recently closed white and red lead plant (also an area of heavy automotive traffic). There are measurable differences also in the lead content of samples taken in two areas ~~differing only in~~ their automotive traffic, and there is a marked general increase in these areas in cold weather. However, ~~differing from~~ the general dust content the lead content is higher in the cool months in many areas than it is in the warm months. The only significant reversal of this phenomenon appears to ~~be~~ in areas where heavy automotive traffic ~~plays~~ a significant role. Several areas show essentially no seasonal variation. A full explanation of the whole atmospheric ~~lead problem~~ must await additional studies.

The factors which control the content of aluminum in the atmospheric dust appear to differ materially from those affecting lead in some situations and to be similar but of lesser magnitude in others (Table 3, Chart 3a). Manganese (Table 3, Chart 3b) on the other hand appears to have no relationship to the other two and therefore may turn out to be a useful tool in determining ~~casual~~ relationships. Copper (Table 3, Chart 3c) likewise seems to have a pattern quite different from that of lead, manganese, or aluminum (Table 3, Charts 3a, 5).

Reference is made to the control point (Winton and Science Hall Road). In Chart 2 and Table 2 one sees that there is no conspicuous rise in the lead content of the aluminum in cold weather although it is markedly elevated by colder weather in most of the other areas. (The yearly average for lead is 0.006 mg. per 10 cubic meters of air.) The concentration of aluminum (Chart 3a) in the atmosphere at this point is constant throughout the year, a phenomenon not seen at any other point. The pattern of the seasonal variations in manganese (Chart 3b) at the control point differs from that of several areas in the city only in magnitude. The data on copper (Chart 3c) suggest that the control point may be unique. All of these data would seem to indicate that the increased dustiness of the aluminum in the winter months at the control point, as shown in Chart 1, may not be due to contamination from the city, but one cannot be sure. Additional control points will have to be studied.

The lead found in the sweepings from streets (Table 4, Chart 4), taken at five intersections at which there is highly movable automobile traffic, show distinct differences which appear to depend upon density of traffic. Also sweepings in the city proper show more seasonal variation than do those taken at the rural control point, the latter being remarkably constant at the 1% level. The average monthly lead content at Western Hills Viaduct was 0.74 per cent as compared to 0.05 per cent at Winton and Science Hall Road, 0.20 per cent at Cedar and Hamilton Avenues, 0.12 per cent at Cedar and Lathrop Avenues, and 0.15 per cent at Fifth and Vine Streets. A factor other than traffic must account for the extremely high value obtained at Western Hills Viaduct.

Because of the small amount of ash obtained from the samples of soot, free silica determinations were carried out only on samples from Brighton and the downtown area. The average content of free silica determined chemically did not exceed [illegible].

exceeded a monthly average of 7 per cent by chemical methods. This finding may be in error since the chemical method is known to be attended by numerous difficulties which affect the analytical accuracy. It is hoped during the coming year to employ X-ray diffraction methods in order to improve the accuracy.

The data obtained for the absorber samples have not given results which can be used with confidence. It appears that larger samples will have to be taken in order to determine the fluorine content of the air. However, the absorber data show appreciable difference in the acid content of the city air as compared to the air of the rural control point. There is little difference between industrial and other areas.

Conclusions

The dustiness of the atmosphere as measured by the electrostatic precipitator shows marked seasonal variations, being highest in the cold months. The dustiness as measured by this method is not necessarily relatively similar to soot fall data in similar areas.

The analysis of the data shows that there are differences in the lead content of the atmosphere in two areas, which differ only in the magnitude of their automotive traffic, and also that the lead content varies with the nature of the industrial area. The air in the area of a lead foundry contains larger concentrations of lead than is found in the air of other areas.

The mean lead content of the Cincinnati air is approximately 0.032 mg. per 10 cubic meters, compared to 0.006 mg. per 10 cubic meters for the rural control point, while the highest mean value is 0.09- mg. per 10 cubic meters in the area near a

lead foundry. The amounts of other metals, manganese, tin, copper, and silver, are extremely small. The mean aluminum content of the air is slightly higher than that of lead, 0.04 mg. per 10 cubic meters.

~~Soot~~ samples show the following ~~yearly~~ average metal ~~content~~ per cent of ash: lead 0.26, manganese 0.15, aluminum 4.0, copper 0.33, zinc 0.06, ~~and silver and tin nil or negligible~~.

Street sweepings show variations in lead content which correlate with the automotive traffic ~~load~~. A point with much automotive traffic (more than 1200 cars per hour) gave a yearly average of 0.74 per cent lead as compared to 0.05 per cent for the control point (90 cars per hour).

The yearly average ~~titration~~ value for 10 cubic meters of ~~air shows that the city air corresponds~~ to ~~an acidity of~~ 151 ml. of 0.1 N hydrochloric acid (~~equivalent~~ to 0.55 gram of hydrochloric acid per 10 cubic meters) ~~in excess of the control point in a rural area.~~

Future Program

It is planned to continue the study along the same line for the coming year with the following modifications:

1. ~~Include~~ street sweepings at Seventh and Freeman Avenue
2. Change Gest and McLean to Lincoln Parkway and Betts Street and ~~include~~ street sweepings. This point is a more representative area to show contaminations due to railroad yards, since the point is more in line with prevailing wind than is Gest and McLean.
3. Take traffic count at all stations sampled.
4. Include Brighton Corner as a ~~dust~~ sampling point since ~~these~~ soot ~~samples~~ are submitted for this point.

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5. Include ~~dust samples~~ Collect samples of particulate matter at Murray Road

6. Take 2-hour (1200 liters) ~~absorber~~ samples by absorption technique at two ~~points in addition to the present absorber samples.~~ additional locations

7. Study a more distant control point.

8. Attempt to increase the number and variety of areas sampled.

9. Gather data on the content of carbon monoxide in the air at all locations at which samples for lead determinations (particulate matter and gaseous) are taken

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Note

On March 5, 1947, Ordinance 90 was passed by the City of Cincinnati to go into effect April 4, 1947. The law, in effect, is that coal dealers cannot sell low volatile coal to consumers having hand-fired units. However, if the consumers had low volatile coal on hand, they were allowed to use it until June 1, 1947.

Table 1

Average Dust Concentration
(PPFt3)

Cincinnati, Ohio
November 1946 - November 1947

Street Locations	Yearly Avg.	4-Month Avg. November December January February	4-Month Avg. March April May October	4-Month Avg. June July August September	Car Count per hr.	Average Temperature °F. During Sampling			Elevation Above Sea Level Feet *
						Cold Months	Cool Months	Warm Months	
Cedar and Hamilton	0.390	1.050	0.051	0.068	512	38.5	46.7	68.5	891
Cedar and Lathrop	0.263	0.733	0.025	0.038	52	38.8	46.7	62.3	896
Winton and Science Hall	0.196	0.501	0.020	0.042	90	34.7	52.3	78.2	790
Sycamore and Dorchester	0.203	0.450	0.088	0.073	--	55.2	52.0	88.0	801
U. C. Law School	0.094	0.124	0.099	0.070	664	50.0	53.0	85.0	848
Western Hills Viaduct	0.710	1.600	0.475	0.089	1273	40.0	44.5	80.5	553
Vine and E. McMicken	0.162	0.315	0.091	0.081	--	54.2	57.0	92.0	549
Reading Rd. and Broadway	0.118	0.220	0.063	0.073	--	52.0	55.5	90.5	552
Freeman near Seventh	0.358	0.833	0.143	0.091	--	55.3	47.5	83.0	504
Fifth and Vine	0.290	0.595	0.120	0.156	--	49.2	49.0	82.0	550
Kincaid and Harvest	0.104	0.195	0.014	0.053	31	53.6	53.5	85.5	796
Gest and McLean (on or near R.R. tracks)	0.160	0.352	0.053	0.075	--	50.0	51.8	87.0	514
City Average	0.254	0.580	0.104	0.076		47.6	50.9	81.9	

*Ohio River at Cincinnati -- Zero of Gage 429.24, Ohio River Pool Stage 440.58

Table 2

Average Lead Data
(mg./10M3)

Cincinnati, Ohio
November 1946 - November 1947

Street Locations	Yearly Avg.	4-Month Avg. November December January February	4-Month Avg. March April May October	4-Month Avg. June July August September
Cedar and Hamilton	0.023	0.029	0.010	0.030
Cedar and Lathrop	0.016	0.022	0.013	0.017
Winton and Science Hall	0.006	0.009	0.009	Nil
Sycamore and Dorchester	0.028	0.016	0.055	0.014
U. C. Law School	0.020	0.009	0.030	0.023
Western Hills Viaduct	0.049	0.079	0.029	0.040
Vine and E. McMicken	0.014	0.018	0.012	0.012
Reading Rd. and Broadway	0.038	0.060	0.036	0.017
Freeman near Seventh	0.088	0.102	0.091	0.065
Fifth and Vine	0.047	0.031	0.082	0.030
Kincaid and Harvest	0.017	0.014	0.009	0.031
Gest and McLean (on or near R.R. tracks)	0.016	0.015	0.019	0.013
City Average	0.032	0.036	0.035	0.027

CHART 2b

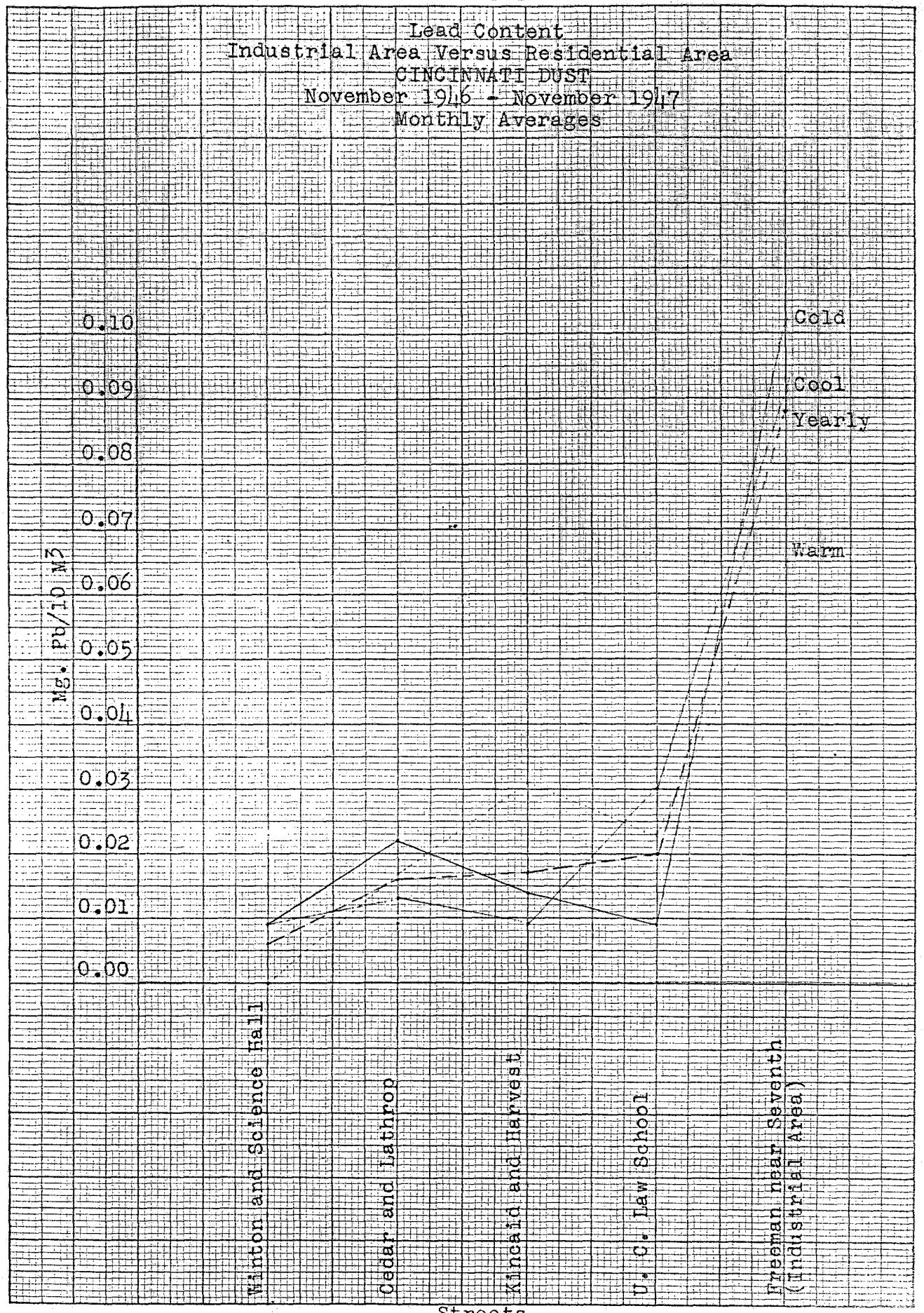

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Table 3

Average Metal Content of Dust
(mg./10M³)

Cincinnati, Ohio
November 1946 - November 1947

Street Locations	Aluminum				Manganese				Copper			
	Yearly Avg.	4-Month Avg.			Yearly Avg.	4-Month Avg.			Yearly Avg.	4-Month Avg.		
		Nov. Dec. Jan. Feb.	Mar. Apr. May Oct.	June July Aug. Sept.		Nov. Dec. Jan. Feb.	Mar. Apr. May Oct.	June July Aug. Sept.		Nov. Dec. Jan. Feb.	Mar. Apr. May Oct.	June July Aug. Sept.
Cedar and Hamilton	0.041	0.027	0.033	0.076	0.005	0.002	0.005	0.008	0.010	0.017	0.003	0.009
Cedar and Lathrop	0.013	0.031	0.001	0.011	0.005	0.001	0.008	0.006	0.007	0.007	0.005	0.008
Minton and Science Hall	0.013	0.013	0.012	0.011	0.005	0.001	0.015	Nil	0.021	0.041	0.008	0.016
Sycamore and Dorchester	0.057	0.064	0.097	0.010	0.003	0.001	0.008	0.001	0.006	0.005	0.007	0.006
U. C. Law School	0.033	0.049	0.017	0.034	0.006	0.001	0.008	0.001	0.008	0.010	0.004	0.009
Western Hills Viaduct	0.048	0.077	0.062	0.017	0.008	0.003	0.011	0.010	0.010	0.009	0.006	0.014
Vine and E. McMicken	0.040	0.068	0.029	0.038	0.006	0.005	0.005	0.007	0.010	0.015	0.004	0.018
Reading and Broadway	0.027	0.055	0.003	0.027	0.005	Nil	0.011	0.004	0.019	0.009	0.027	0.020
Freeman near Seventh	0.050	0.040	0.012	0.095	0.012	0.004	0.015	0.017	0.011	0.013	0.008	0.011
Fifth and Vine	0.083	0.036	0.104	0.108	0.006	0.001	0.003	0.013	0.015	0.019	0.005	0.022
Kincaid and Harvest	0.015	0.018	0.006	0.019	0.011	Nil	0.011	0.023	0.015	0.026	0.005	0.014
West and McLean (on or near R.R. tracks)	0.032	0.008	0.044	0.046	0.007	Nil	0.006	0.015	0.013	0.007	0.008	0.022
City Average	0.040	0.043	0.035	0.044	0.007	0.002	0.008	0.010	0.011	0.012	0.007	0.014

Table 5

Soot Data

Cincinnati, Ohio
November 1946 - November 1947

	Downtown				Brighton				College Hill				Avondale			
	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	Warm Months Avg.	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	Warm Months Avg.	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	Warm Months Avg.	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	
Collected (Grams)	0.4895	0.5606	0.5198	0.3880	0.6362	0.6817	0.6262	0.6007	0.0756	0.0388	0.0775	0.0564	0.1496	0.1159	0.2462	
Collected (tons/mile^2)*	114	130	120	90	147	158	145	139	17.5	9.0	18.0	13.1	34.8	27.0	58.0	
stible	42.07	38.0	36.7	51.5	45.23	47.1	46.1	42.5	41.6	39.7	41.1	43.9	45.2	41.1	57.2	
	57.93	62.0	63.3	48.5	54.77	52.9	53.9	57.5	58.4	60.3	58.9	56.1	54.8	58.9	42.8	
Soluble	19.4	10.2	23.2	22.4	14.56	7.6	16.1	20.0								
ned Si	29.38	35.2	32.5	19.4	30.4	31.8	32.3	30.5								
Si	2.9	2.26	3.04	2.98	5.28	6.94	5.63	4.92								
ue	5.86	14.5	3.14	4.28	4.76	8.31	2.07	3.56								
Ash (Avg. 0.255%)	0.164	0.190	0.144	0.158	0.100	0.092	0.090	0.119	0.570	0.428	0.702	0.450	0.184	0.175	0.178	
Ash (Avg. 0.145%)	0.21	0.068	0.456	0.078	0.110	0.048	0.236	0.044	0.138	0.090	0.248	0.074	0.124	0.073	0.221	
Ash (Avg. 4.04%)	3.31	3.76	4.29	1.82	5.32	5.97	5.50	4.50	2.92	2.50	5.72	1.31	4.62	4.68	5.92	
Ash (Avg. 0.333%)	0.21	0.183	0.116	0.408	0.228	0.173	0.148	0.365	0.640	0.607	0.223	0.974	0.256	0.241	0.136	
Ash	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.04	0.190	0.003	0.019	Nil	Nil	Nil	
Ash (Avg. 0.055%)	0.04	0.052	0.025	0.044	0.043	0.088	0.049	0.032	0.071	0.087	0.056	0.070	0.066	0.052	0.115	
Ash	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	

t was collected in jars with a 14.5 cm. opening with an area of 0.132 square feet. Therefore the ms found in the jars times 232 equal tons per square mile. The jars contained glycerine-water ture plus an insecticide.

CHART 5

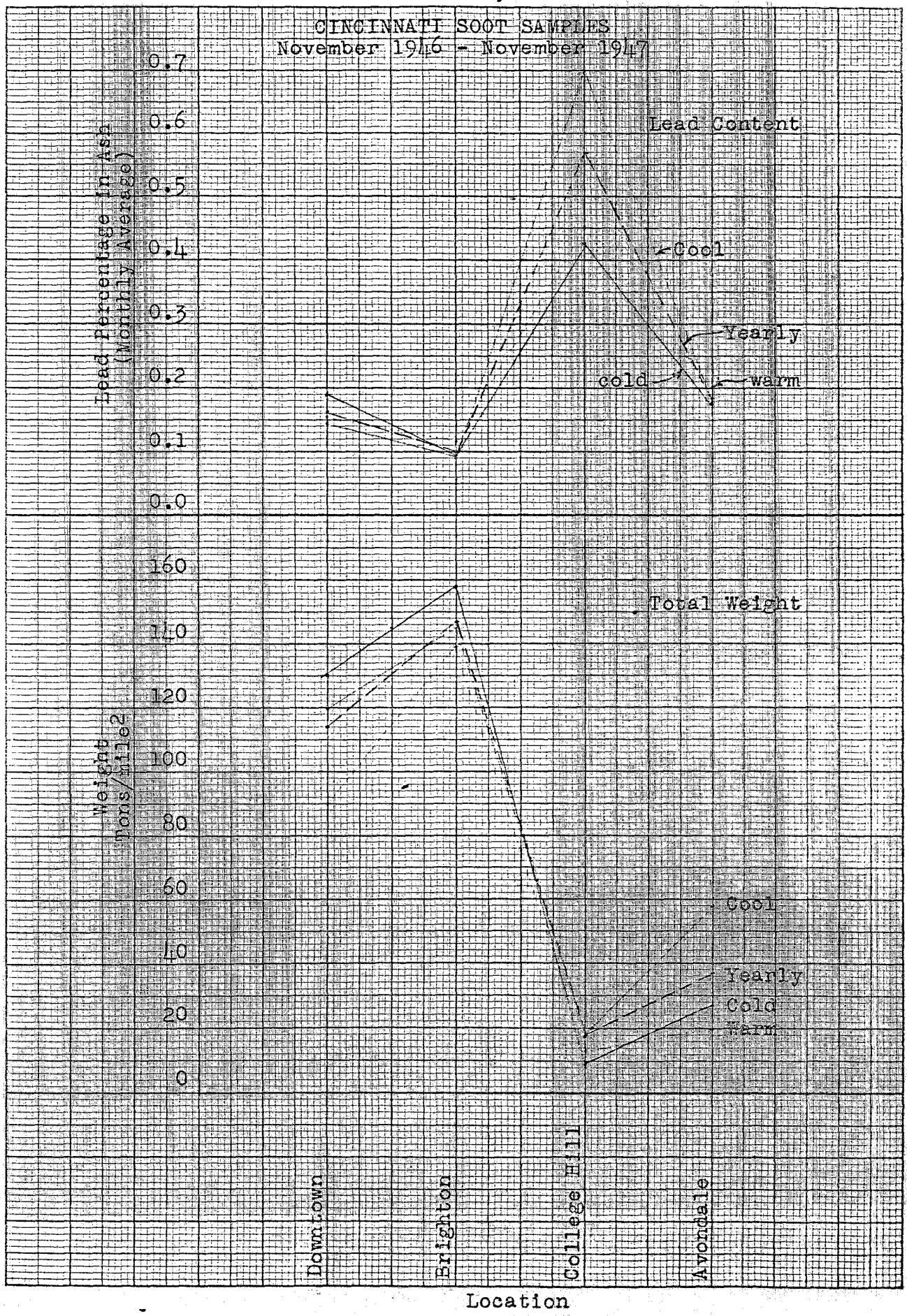


Table 6

Absorber Samples

Cincinnati, Ohio
November 1946 - November 1947

Location	Acid Gases in $10M^3$ as ml. of 0.1N HCl*				Fluorine, mg./10 M^3			
	Yearly Avg.	Cold Months	Cool Months	Warm Months	Yearly Avg.	Cold Months	Cool Months	Warm Months
Spring Grove Avenue (Formica Company)	119	129	159	74	0.017	0.033	0.017	Nil
J. C. Law School	177	217	246	59	0.028	0.044	0.008	0.029
Best and McLean (on or near R.R. tracks)	123	115	91	62	0.017	0.044	Nil	0.014
Murray Road, Big 4 Railroad	190	373	145	99	0.021	0.011	0.017	0.032
Langdon Farm Road (Hilton Davis Company)	142	383	108	54	0.017	0.022	0.012	0.018
Kincaid and Harvest (Pleasant Ridge)	142	250	160	70	0.041	0.100	0.017	0.022
Fifth and Vine	165	218	163	128	0.010	Nil	0.025	0.004
City Average	151	210	153	78	0.022	0.036	0.014	0.017

*Winton and Science Hall Road was used as a control point and all values were calculated on that basis.

Table 7

Cincinnati, Ohio
November 1946 - November 1947

	Yearly Avg.	Cold Months	Cool Months	Warm Months
Average City Temperature, °F.	56.5	39.7	55.5	74.4
Average Recorded Temperature, °F.*	60.1	47.6	50.9	81.9
Total City Rainfall, Inches	42.60	12.97	17.09	12.54
Average Monthly City Rainfall, Inches	3.22	3.24	4.27	3.14
Barometric Pressure, City	29.28	29.55	29.2	29.1
Barometric Pressure, Kettering Laboratory*	29.46	29.42	29.53	29.43
Per Cent Humidity, City	83.00	80.50	83.00	86.00
Per Cent Humidity, Recorded*	54.6	59.0	55.3	54.0

*Figured on the hour and day sample was taken.

CHART 3b

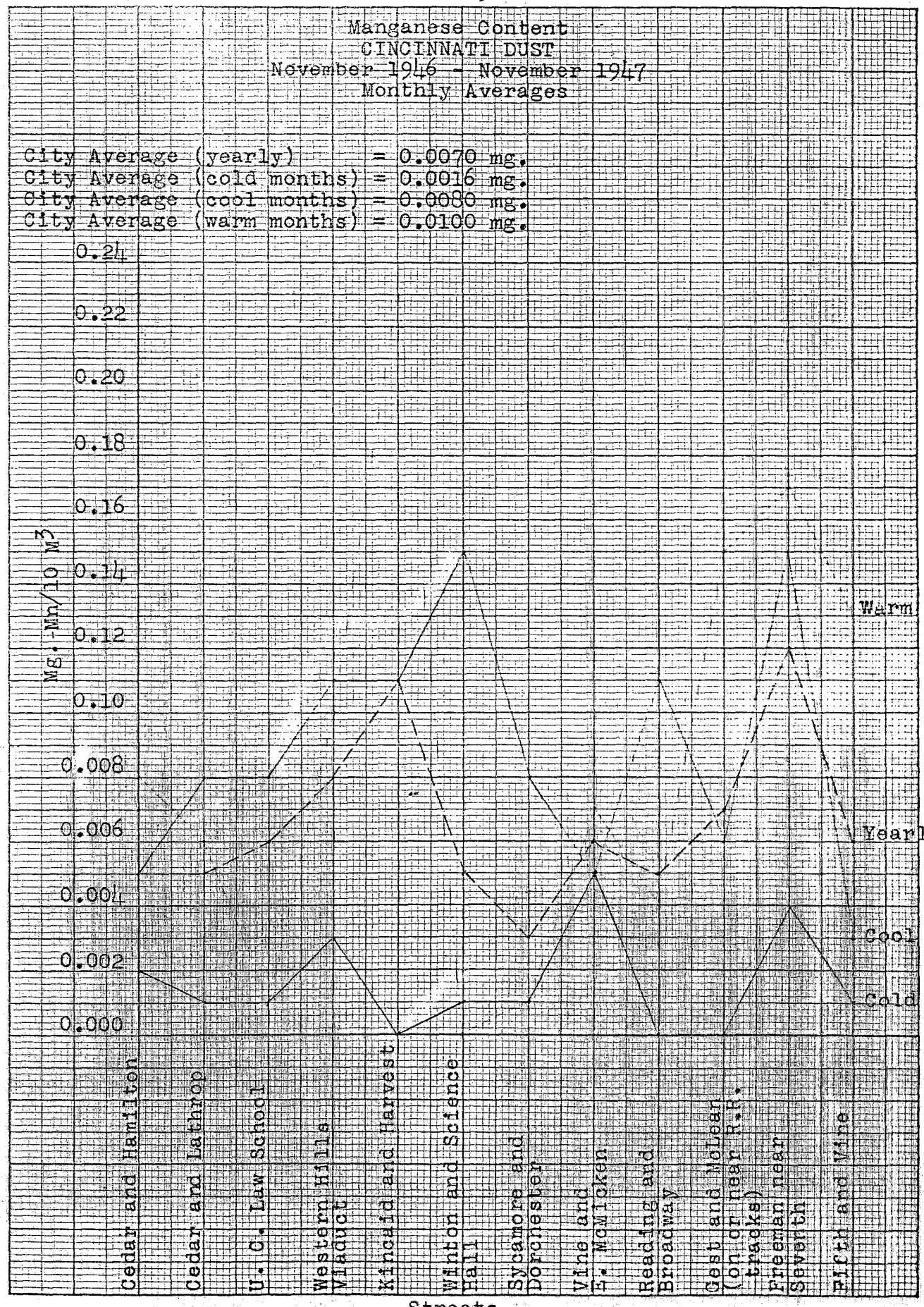


Table 4

Street Sweepings

Cincinnati, Ohio
November 1946 - November 1947

	Cedar and Hamilton Ave.				Cedar and Lathrop Ave.					Wint
	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	Warm Months Avg.	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	Warm Months Avg.	Yearly Avg.	Co Mon Av
Pb (Per Cent)	0.200	0.216	0.148	0.235	0.117	0.107	0.103	0.143	0.050	0.(
Br_2 (Per Cent)	0.004	0.005	0.003	0.004	0.014	0.025	0.014	0.009	0.005	--
le Matter	18.8	25.3	18.6	12.3	14.9	18.9	12.7	13.0	9.2	13.
oluble	30.08	28.43	28.28	33.54	28.34	29.25	33.99	29.01	43.73	35.
Si	37.60	30.47	40.09	42.26	37.96	31.73	37.72	42.90	31.11	34.
e	13.67	15.92	13.22	11.87	15.81	19.91	15.79	12.76	11.05	16.

inton and Science Hall			Fifth and Vine				Western Hills Viaduct			
Cold Months Avg.	Cool Months Avg.	Warm Months Avg.	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	Warm Months Avg.	Yearly Avg.	Cold Months Avg.	Cool Months Avg.	Warm Months Avg.
0.045	0.058	0.050	0.150	0.117	0.152	0.163	0.740	0.363	0.840	0.940
--	0.005	0.008	0.008	0.012	0.008	0.004	0.019	0.045	0.016	0.004
13.2	12.7	6.1	14.7	17.0	17.1	10.6	21.4	20.8	21.9	28.5
35.5	42.97	65.21	32.14	24.71	39.47	28.87	23.6	20.18	21.89	27.7
34.35	36.78	21.39	38.92	34.19	33.45	47.95	38.45	35.79	40.23	38.66
16.95	11.06	5.34	16.54	24.03	12.48	14.98	16.68	23.30	15.85	12.51

CHART 4

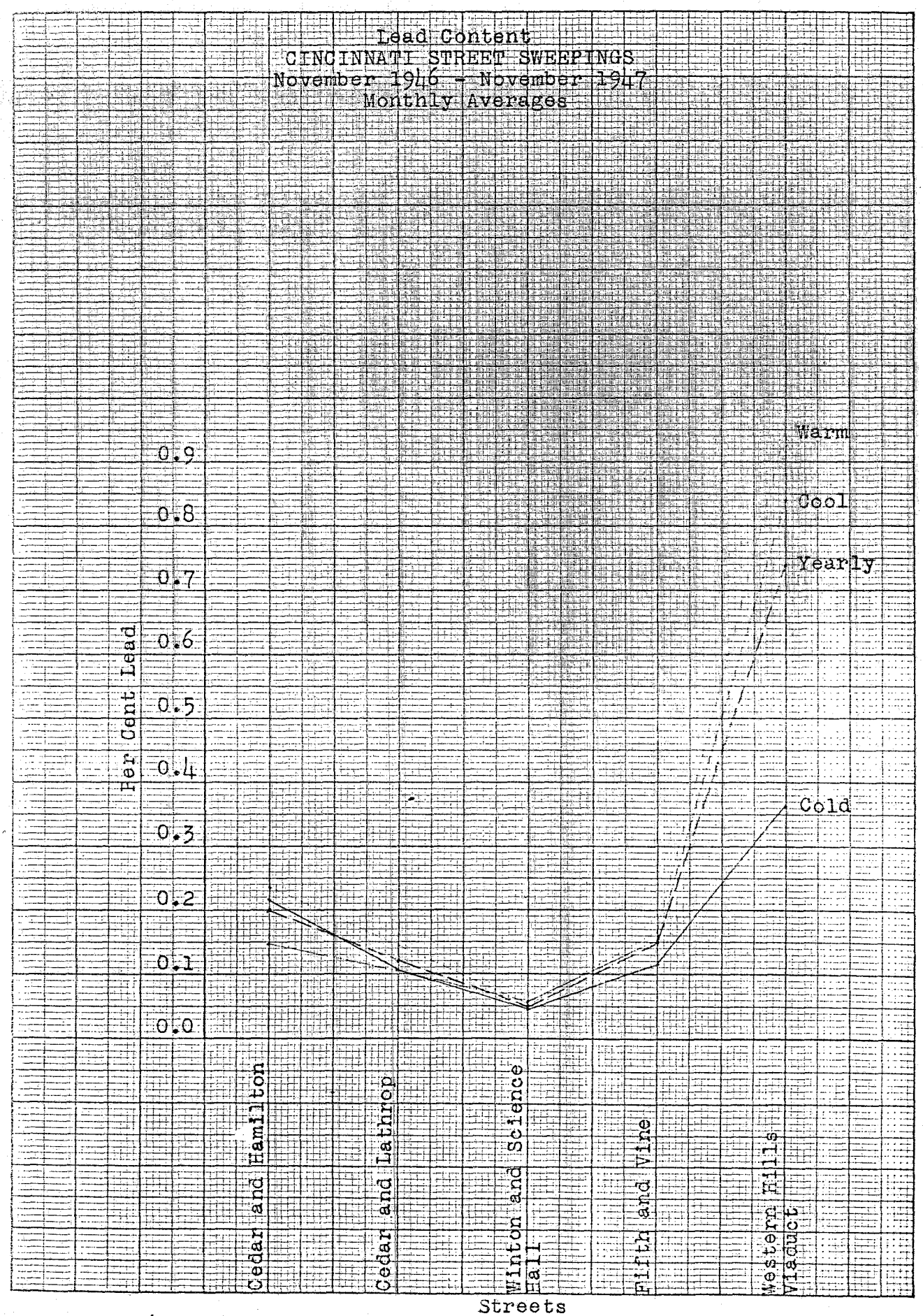


CHART 3a

Aluminum Content
CINCINNATI DUST
November 1946 - November 1947
Monthly Averages

City Average (yearly) = 0.040
City Average (cold months) = 0.043
City Average (cool months) = 0.035
City Average (warm months) = 0.044

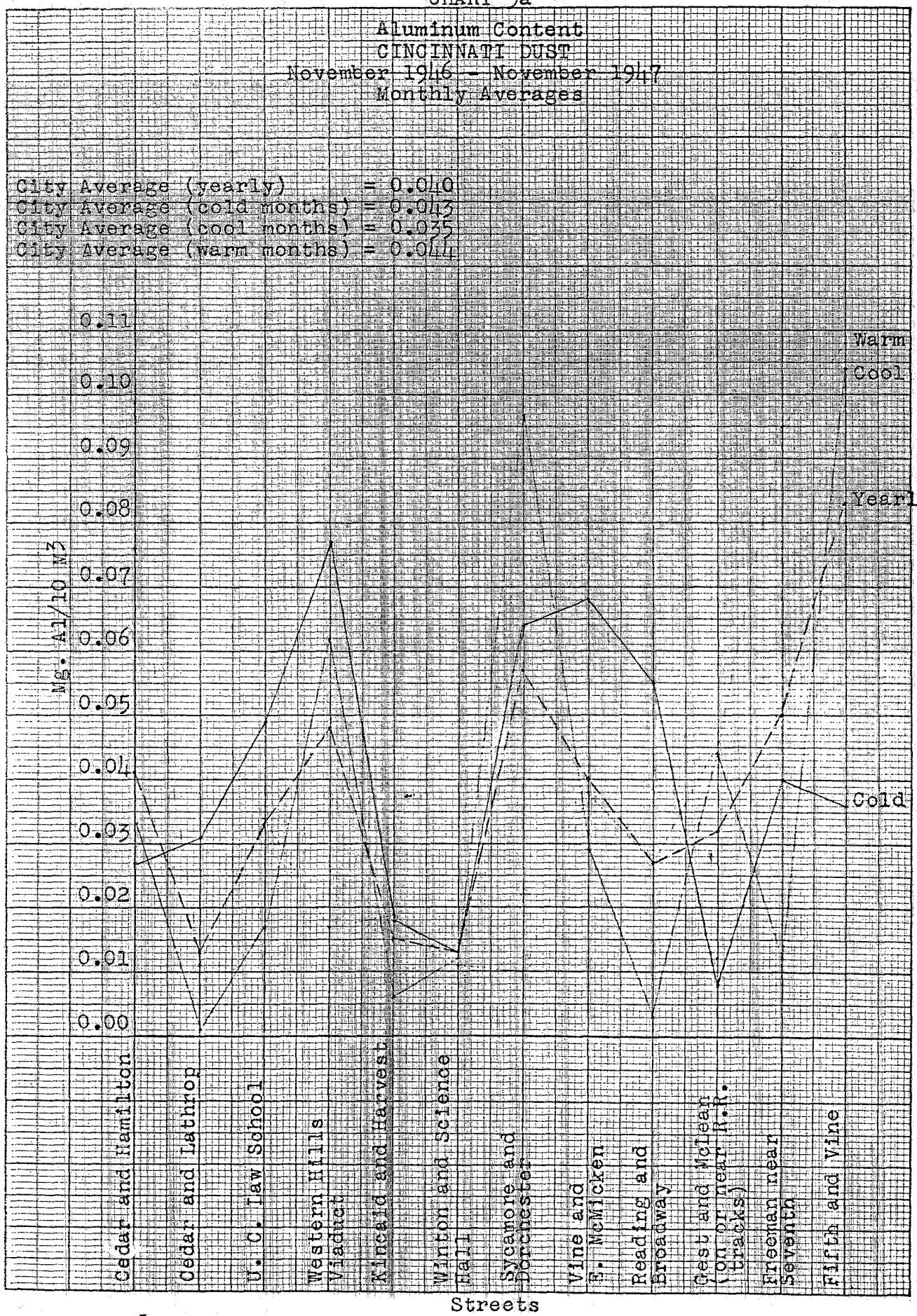
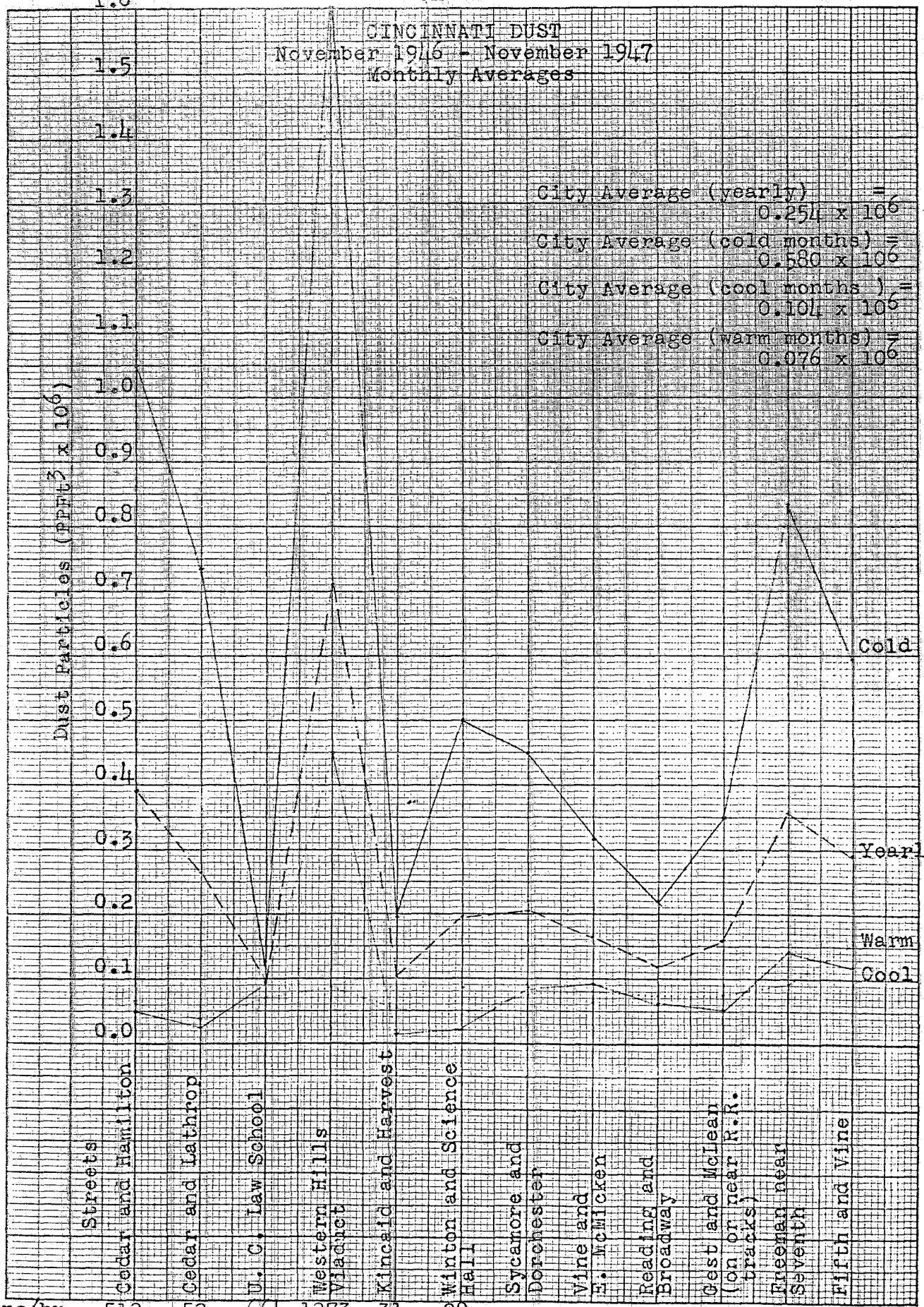


CHART 1



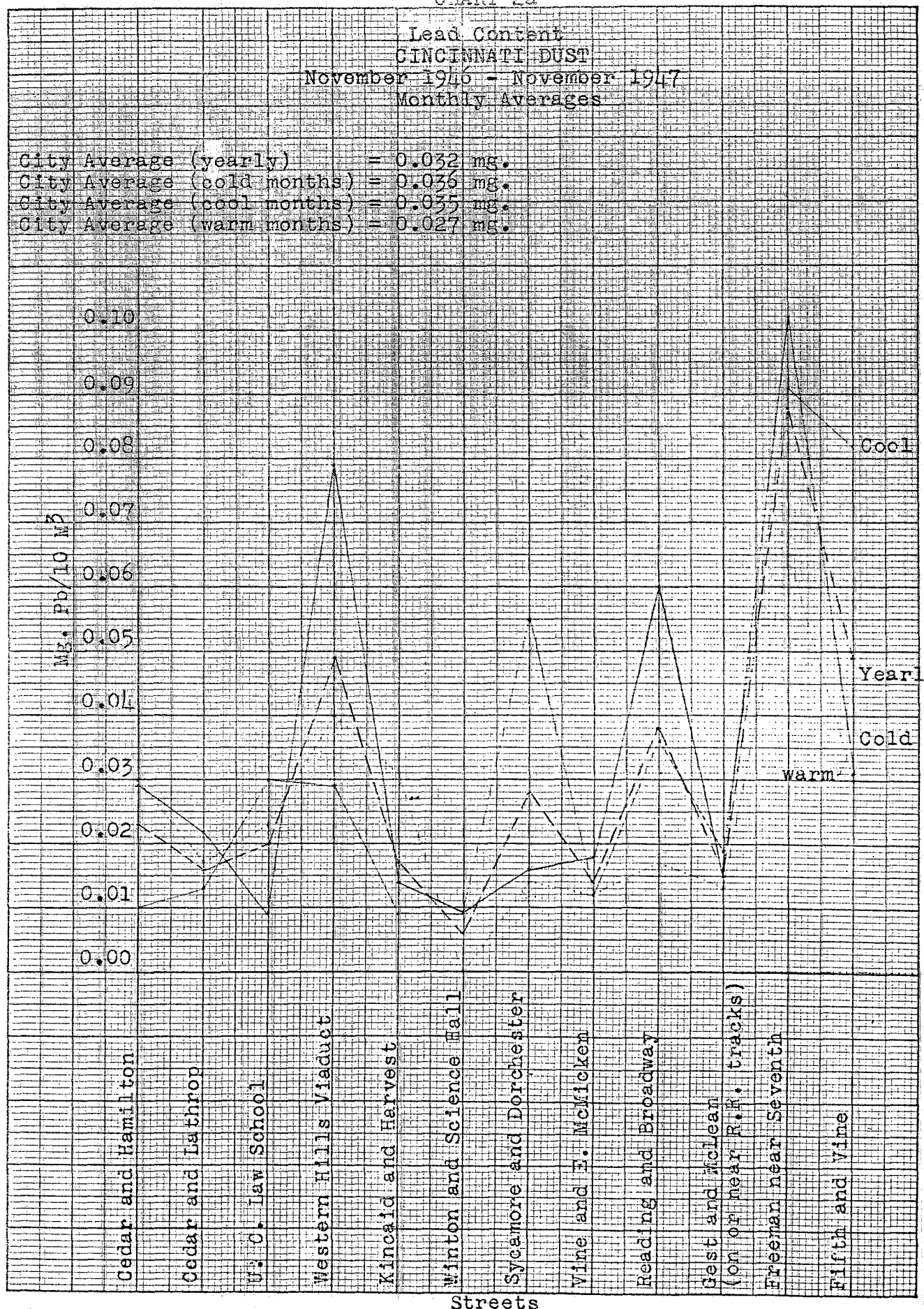
Elevation above

KE 0015959

CHART 2a

Lead Content
CINCINNATI DUST
November 1946 - November 1947
Monthly Averages

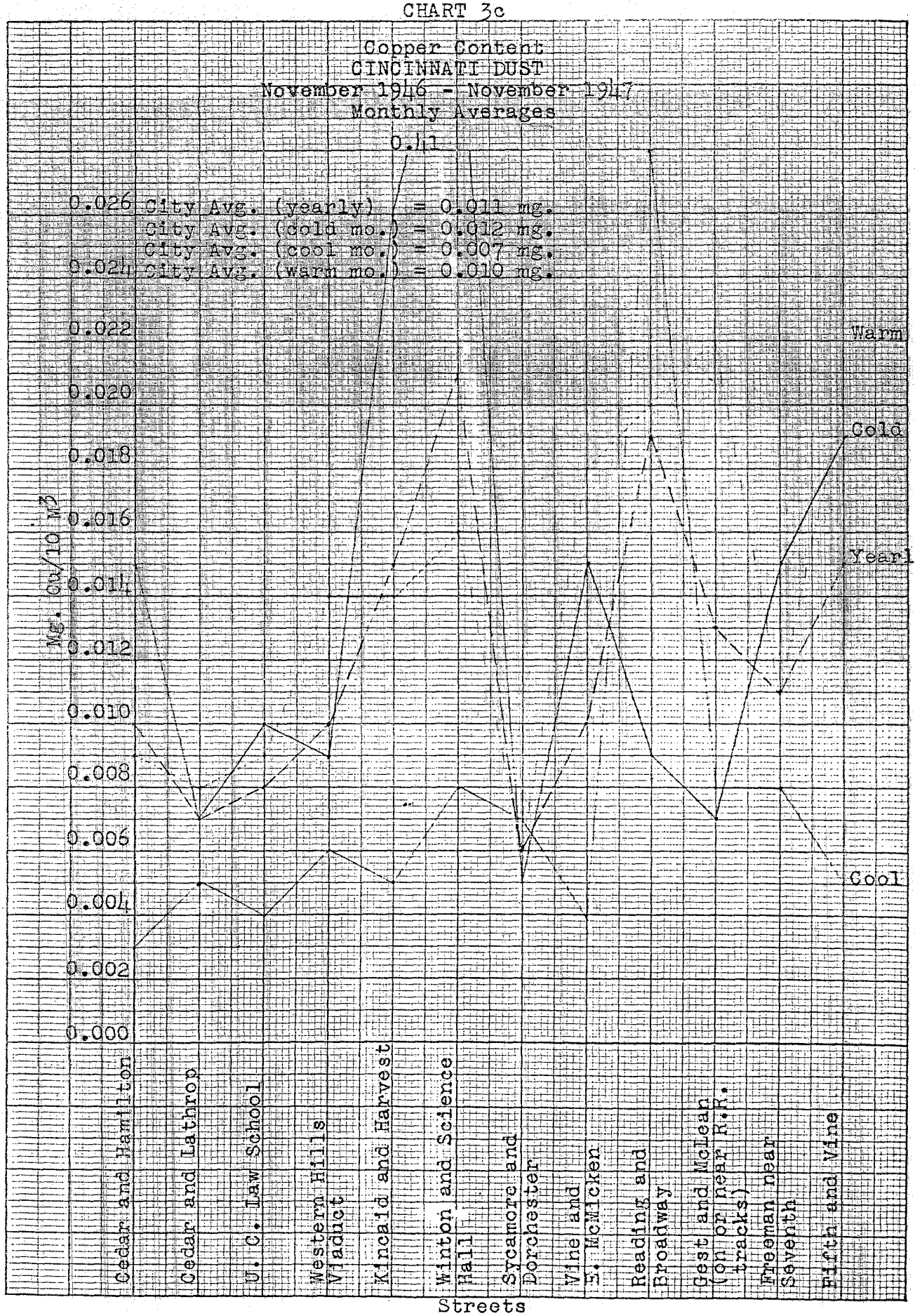
City Average (yearly) = 0.032 mg.
City Average (cold months) = 0.036 mg.
City Average (cool months) = 0.035 mg.
City Average (warm months) = 0.027 mg.



KEUFFEL & ESSER CO., N. Y. NO. 358-11
10 X 10 to the Inch, 5th lines accented.
Engraving, 7 X 10 in.
MADE IN U.S.A.

KE 0015960

CHART 3c



KE 0015961