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THE APPLICATION AND VALIDATION OF THE CLIMATOLOGICAL DISPERSION MODEL AS APPLIED TO THE NEW ORLEANS METROPOLITAN AREA

The University of Oklahoma PH.D. 1979

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THE APPLICATION AND VALIDATION OF THE CLIMATOLOGICAL DISPERSION MODEL AS APPLIED TO THE NEW ORLEANS METROPOLITAN AREA

A Dissertation

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in partial fulfillment of the
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in

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by
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THE APPLICATION AND VALIDATION OF THE CLIMATOLOGICAL DISPERSION MODEL AS APPLIED TO THE NEW ORLEANS METROPOLITAN AREA

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CHAPTER I - INTRODUCTION

Mathematical models have been utilized and are being further developed to simulate air quality conditions in rural and urban areas. Modeling is one tool which can be used in developing air quality management strategies for large cities in that with the use of certain models, predictions of hourly or annual air pollutant concentrations can be made based on certain input parameters. Air pollution modeling results have been shown to be highly correlated with actual air quality measurement data, thus qualifying them as valuable predictive tools.

Air quality models have been extensively used throughout the United States to identify potential violations of the National Ambient Air Quality Standards (NAAQS). The need for air quality models in the development and revision of State Implementation Plans (SIP) and related controls strategies was identified as early as 1969. (1) However, due to the overwhelming initial requirements of the Clean Air Act of 1970, it has not generally been possible to use air quality models to the optimum extent. In recent years, however, air quality modeling has been required in new source review programs to insure attainment and maintenance of NAAQS, and to prevent significant air quality deterioration (PSD).

The 1970 Clean Air Act (as amended) mandated all states to identify areas that are in violation of the NAAQS. In addition, all states, pursuant to 40 CFR 51.12 (c), are required to identify

areas that have the potential to be in violation of any NAAQS over the 10-year period, 1975-1985. These existing and potential areas are called Air Quality Maintenance Areas (AQMA); they are identified by the states and reviewed by the EPA Administrator. (2) For each pollutant in each of the AQMAs for which analysis indicates a potential problem, tailored maintenance strategies must be submitted. In just about every state where an AQMA exists, modeling of some type is used in estimating concentrations and in assessing the adequacy of control strategies.

Of the fifty-five states and/or territories, twelve have no AQMAs. Louisiana is one of the forty-three states or territories that have AQMAs, with the location being Shreveport, which encompasses 9 percent of Louisiana's population and 5 percent of the land area in the state. (3)

Although Louisiana has three other large industrial and commercial areas (Lake Charles, Baton Rouge and New Orleans), they were not considered to pose the potential to be in violation of any NAAQS over the 10-year period, 1975-1985. The decision by the Louisiana Air Control Commission not to designate these three large areas as AQMAs is questionable.

With the many and varied types of industry in the New Orleans Standard Metropolitan Statistical Area (SMSA), an arsenal of air pollution models should be available to analyze air pollution problems which may arise. Unfortunately, urban air quality modeling has not been done in the New Orleans SMSA nor in any other Louisiana city. The Louisiana Air Control Commission does use an air pollutant dispersion model to predict atmospheric

concentrations in the immediate area around point sources. This dispersion model utilizes the emission inventories for each point source; however, it does not incorporate consideration of many other parameters that are necessary in urban diffusion modeling.

In Louisiana, judgements concerning allowable emission rates and the geographical placement of new sources that may cause specific air quality levels to be exceeded or that may contribute significantly to existing violations are made by air pollution professionals using short-term, single-source oriented dispersion modeling techniques. These procedures are probably adequate for cities and parishes where there is minimal or no growth expected; however, a program should be designed to consider the impact of future growth and development on air quality, and to develop control strategies, where needed, to ensure that air quality will not deteriorate from the NAAQS in large cities such as New Orleans, Baton Rouge, and Lake Charles. The implementation of such a program for air quality management has to involve extensive use of various available atmospheric simulation models.

The overall purpose of this study was to apply EPA's Climatological Dispersion Model to the New Orleans SMSA and validate its application for total suspended particulate (TSP) as the pollutant of interest. The application and validation of the CDM will serve as an initial step in the development of an air pollution control strategy program. Within the study design, additional parameters have been identified which, if determined, can be of practical significance to an air control agency.

To achieve the study objectives, two study areas were chosen. The CDM was applied to the entire New Orleans SMSA and validated for that study area. Then, the CDM was applied to a 3 mile by 5 mile area around the New Orleans Grain Elevator and validated for that study area. The overall statistical comparisons of data from both study areas will be evaluated for the validation process.

In order to apply the CDM to both areas, point source emissions and area source emissions were determined for each study area, meteorological data obtained, sampling data collected and compiled and area source emissions "smeared" proportionately over each parish by the use of a Computer-Assisted Area Source Emissions Gridding Procedure (CAASE). Determination of predicted air quality levels of TSP in the Grain Elevator Study as well as New Orleans SMSA study were compared statistically with 6 months sampling data in the Grain Elevator Study and yearly sampling data in the SMSA study by regression analysis.

Chapter II of this study is a literature review of the various multi-source models used in air quality analysis including CDM. Chapter III will discuss the various methods and approaches to data collection, CDM calibration, and CDM output with respect to each phase of the study. Chapter IV is a discussion of the results of the CDM runs with respect to TSP concentration in both study areas and the results of the regression analysis and correlation coefficient statistic tests. The final chapter is a summary of the study and a discussion of some general observations made by the author with respect to (1) Sampling station relocation, (2) TSP hot spots within the city, (3) New Orleans Grain Elevator, (4) Sources of error and, (5) Political effects on CDM modeling.

CHAPTER II - LITERATURE REVIEW

In order to develop and maintain an effective air quality management program in New Orleans, a methodology for relating pollutant emissions to ambient air quality is necessary. This methodology is needed so that conclusions can be drawn regarding the impact of city growth in the next ten to twenty years and the potential of selected control strategies for maintaining desirable air quality levels. The most commonly used methodology for relating emissions and air quality is an atmospheric simulation model.

An atmospheric simulation model can be defined as a mathematical description of pollutant transport, dispersion and transformation processes that occur in the atmosphere. (4) Such a model, in its simplest form, predicts atmospheric pollutant concentrations as a function of emission rates, background concentrations and atmospheric conditions. In essence, the atmospheric simulation model is used to convert pollutant emissions data, background concentrations and atmospheric conditions, into ambient air pollutant concentration estimates. The model is an analytical tool that can aid in evaluating the effectiveness of control strategies.

There are several atmospheric simulation models available to professional air quality analysts. These models vary in data requirements, complexity, accuracy, and applicability. Since this study is focused on all sources of air pollution in a

metropolitan area, and their effects on air quality, this literature review will be centered on multi-source models. There are ten multi-source models that relate emissions to air quality. (5) These models are identified and described in the following order:

(1) Rollback Model
(2) Appendix J HC-O_x Relationship
(3) Miller-Holzworth Model
(4) Hanna-Gifford Model
(5) HIWAY Model
(6) Air Quality Display Model
(7) Sampled Chronological Input Model
(8) APRAC - 1A
(9) SAI Photochemical Model
(10) Climatological Dispersion Model

There are many parameters to consider when choosing a model for air quality analysis. Data requirements, model outputs and general performance of the before-described models are summarized in Table 1. Also, Table 2 indicates the applicability of each model to an analysis of each of the NAAQS pollutants. (6)

Rollback Model

The rollback model, developed by de Nervers and Morris, (7) is based on the simple expression relating pollutant concentrations (X) to pollutant emission rates (Q) and a background concentration (b).

$$X = KQ + b.$$

The rollback model assumes that the dispersion parameter (K)

Table 1 Summary of Simulation Model Characteristics

Model Name	Pollutant Specification	Averaging Time Specification	Emission Data	Meteorological Data	Concentration Estimates	Ease of Use	Availability	Reliability	Applicability to AQAS
Rollback	Any	Any	1	1	3	1	1	3	3
Appendix J	O_x	1 hr	1	1	3	1	1	3	3
Miller-Holzworth	SO_2,TSP	1 hr Annual	1	3	3	1	1	1	3
Hanna-Gifford	SO_2,TSP CO[2]	Annual	1	2	3	1	1	1	3
Hanna-Gifford	SO_2,TSP	1-24 hr	2	5	2	2	1	1	2
w/PS[a] model	SO_2,TSP	1-24 hr	3	5	1	2	2	1	1
w/HIWAY	CO	1-24 hr	3	5	1	2	2	1	1
AQDM, CDM	SO_2,TSP	Annual	3	4	1	3	2	1	1
SCIM[b], RAM[b]	SO_2,TSP	1-24 hr	3	5	1	3	3	2	1
APRAC-1A	CO	1-24 hr	3	5	1	3	2	2	1
SAI[b]	CO,NO_2,O_x	1-10 hr	2	5	2	3	3	2	2

[a]Point Source

[b]These models are currently in a developmental and debugging phase; they are not available for general distribution as computer programs.

Key to Table 1

A. Pollutant Specification
   - Any pollutant
   - Specific Pollutants (SO_2, TSP, CO, O_x, NO_2)

B. Averaging-time Specification
   - Any averaging-time
   - Annual Average
   - 1 to 24 hour Average

C. Emission Data
   1. Area-wide Emissions Total
   2. Total emission distributed as finite area sources
   3. Detailed point, line, and area sources

D. Meteorological Data
   1. None
   2. Average wind speed
   3. Average wind speed and mixing height
   4. Frequency distribution of wind direction, wind speed, stability, and mixing height
   5. Hourly variations of wind direction, wind speed, stability, and mixing height

E. Concentration Estimates
   1. Estimates at any specified point
   2. One estimate for each area source grid
   3. One estimate applicable to entire AQMA

F. Ease of Use
   1. Slide-rule
   2. Small computer effort
   3. Major computer effort

G. Availability
   1. Open literature
   2. National Technical Information Service
   3. EPA, upon request

H. Reliability
   1. Can be verified and calibrated
   2. Verification is incomplete, possibility of calibration is uncertain
   3. Questionable; acceptable for crude estimates only

I. Applicability to Air Quality Analysis System (AQAS)
   1. Can distinguish between specific source and land use type
   2. Can distinguish between land use types only
   3. Considers no distinction between sources or land uses

Table 2 Models Applicable to Specific Pollutants and Averaging Times

Pollutant and Averaging Times	Preferred Model	Alternative Models	
		Model	Condition of Applicability
SO_2,TSP Annual Average	1. AQDM 2. CDM	1. Hanna-Gifford 2. Rollback 3. More sophisticated model 4. Miller-Holzworth	Users's computer facilities inadequate Complex topography and/or meteorology Complex topography and/or meteorology No circumstances currently envisioned permit its use
SO_2,TSP 24-hr and 3-hr Averages	1. AQDM [a] 2. CDM[a] 3. Single-source models	1. SCIM,[b] RAM 2. Hanna-Gifford w/point source[b] 3. Rollback 4. More sophisticated model 5. Miller-Holzworth	Availability Users's computer facilities inadequate Complex topography and/or meteorology Complex topography and/or meteorology No circumstances currently envisioned permit its use
CO 1-hr and 8-hr Averages	1. ARAC-1A 2. Hanna-Gifford w/HIWAY	1. Rollback	Unavailability of other models
Oxidants 1-hr Average	1. SAI 2. Appendix J	1. Rollback	Demonstration that Appendix J is not applicable to region
NO_2 Annual	1. Rollback 2. Single-source models[c]		

[a]Statistical conversion of averaging times required.

[b]Repetitious application of model to each hour under consideration is required for averaging times longer than 1-hr.

[c]Usable only when atmospheric chemical reactions are not significant over the impact area.

does not vary with time or with the source-receptor relationship, and that changes in emission rates are uniform across the area. Thus the relationship of emissions (Q_{85}) and air quality in a future year (X_{85}) to the emissions (Q_{base}) and air quality (X_{base}) in a base year can be expressed by the following proportionality:

$$\frac{X_{85}-b}{X_{base}-b} = \frac{Q_{85}}{Q_{base}}$$

The basic assumption in the model is that a given percent reduction or increase in pollutant emissions will result in a similar reduction or increase in ambient air concentrations. It is simply a tool for scaling concentrations up or down to reflect similar changes in overall pollutant emission rates.

The rollback model is applicable to most pollutants and averaging times for which appropriate data are available. (4) Input to the rollback model requires total area-wide emissions for the base year and for 1985 or other years of interest. A pollutant concentration representative of air quality for the area and the averaging time of interest is also necessary. It shoud be noted that since there is no allowance for specifying the dispersion parameter (K) or other meteorological parameters, this model cannot be used to estimate concentrations at sites where representative air quality data do not exist.

An expansion of the simple rollback procedure is called Modified Rollback. Modified rollback is a technique for considering a range of source categories for the pollutant being evaluated.

It can be expressed as:

$$\frac{x_{85} - b}{x_{base} - b} = \frac{\sum_{i=1}^{N} (Q_i\ G_i\ F_i)_{85}}{\sum_{i=1}^{N} (Q_i)_{Base}},$$

where G is a growth factor, e.g. the ratio of population projected to 1985 versus population in the base year,

F is the emission factor ratio, e.g., the ratio of expected emissions per unit of population in 1985 to emissions per unit of population in the base year,

N is the number of source categories,

i is a particular source category, e.g. light-duty vehicles, stationary sources, etc.

In cases where the area-wide pollutant emissions are contributed by a variety of source types with differing emission factors, growth rates and applicable controls, the modified model will allow the situation to be studied in more detail.

The rollback and modified rollback models are applicable anywhere for which there are data on area-wide emissions and representative air quality for a particular base year. The rollback model can be applied with simplified hand calculations and is widely used. Modified rollback has been computerized and documented, with the "Motor Vehicle Emission Estimation Program" and the "Modified Rollback Computer Program" having been made available to all EPA Regional Offices. (4)

The rollback and modified rollback models in general are valid for the simplified case of only one type of source uniformly

distributed across an area affecting a receptor. Mobile sources and associated carbon monoxide (CO) emissions are an example of the type of source which may approximate this situation. Accuracy is lost as the variability of source types and emission rates increases, and the influence of atmospheric processes on pollutant concentration increases. Thus due to the importance of point sources for total suspended particulates (TSP) and sulfur dioxide (SO_2), and the reactive nature of nitrogen dioxide (NO_2) and hydrocarbons (HC), these models provide only crude estimates of the atmospheric concentrations of these primary pollutants. Additionally, these models only yield approximations of secondary pollutant concentrations; for examples, oxidants (O_x).

Appendix J HC-O_x Relationship

Appendix J of 40 CFR Part 51, the Requirements for Preparation, Adoption, and Submittal of Implementation Plans (36 F.R. 15486), contains a graphical presentation of the percent reduction in hydrocarbon (HC) emissions required to reduce an observed peak hourly average oxidant (O_x) concentration to the National Ambient Air Quality Standard (NAAQS) for O_x (0.08 ppm over a 1-hour period). (8) The relationship assumes that the maximum 1-hour O_x concentration is directly affected by the quantity of HC emitted during the morning hours. This assumption is based on the maximum observed relationship of HC and O_x concentrations for selected cities. (4) This relationship can be used to determine the effect a change in HC emissions will have on peak oxidant concentrations.

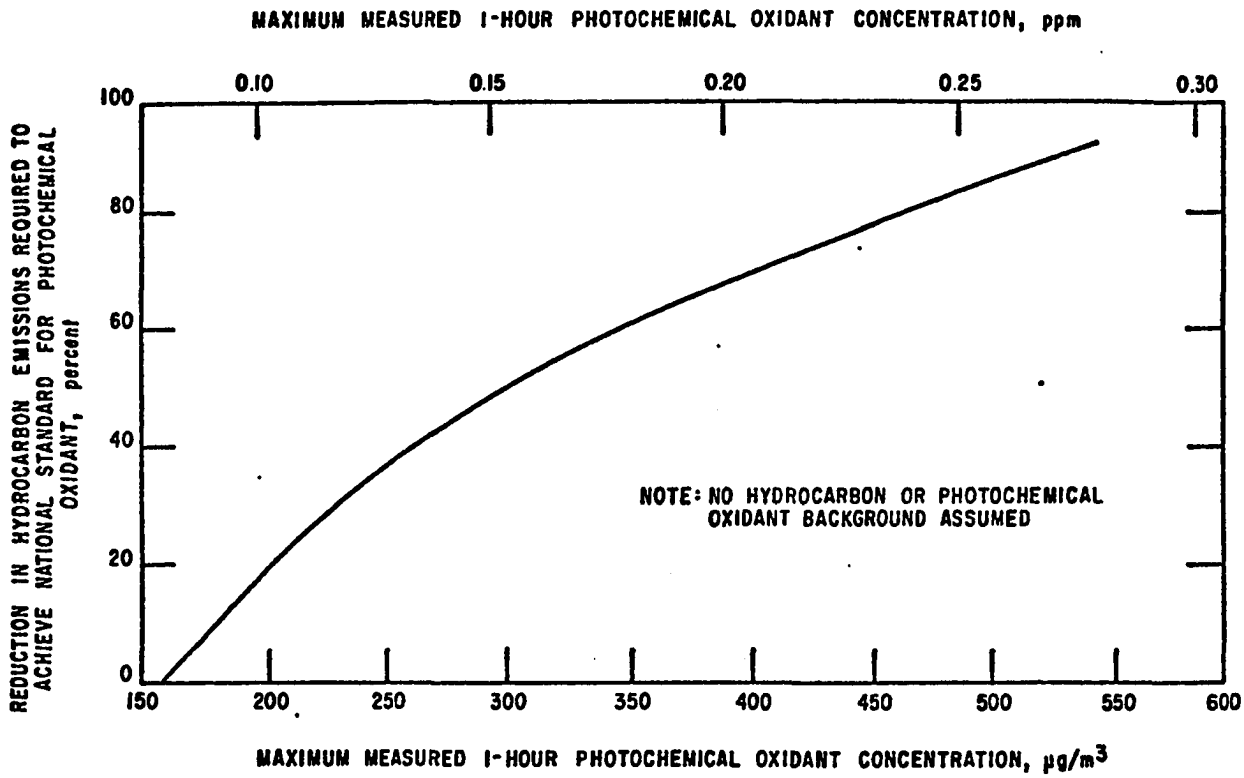


Figure 1

To use the Appendix J graph shown in Figure 1, it is assumed that HC emissions are uniform across the whole area and that the peak O_x concentration in the area has been identified. Inherent in the use of this approach is the assumption that meteorological conditions and the source-receptor relationship are invariant. Thus there is no need for input of meteorological data. The Appendix J approach cannot be used to estimate concentrations at sites where air quality data does not exist. Conversely, like the rollback and modified rollback models, it is simply a means for scaling O_x concentrations to variations in HC emissions. Its application is restricted to peak hourly average O_x concentrations.

The reliability of this approach for determining the effect of HC emissions on O_x concentrations has not been identified. There is no allowance for variations in photochemical reaction rates which take place between HC and oxides of nitrogen (NO_x), and no consideration of O_x concentrations due to natural sources. Thus any conclusions concerning the HC reductions required to achieve given O_x levels should be considered as first approximations.

Miller-Holzworth Model

The Miller-Holzworth dispersion model represents a step in sophistication above the basic rollback model for estimating pollutant concentrations. In this model dispersion is expressed in terms of mixing height, wind speed and the geographical size of the city. The model can be used to estimate 1-hour integrated area-wide average concentrations for relatively stable pollutants such as SO_2 and particulate matter. The model has been calibrated for a wide sample of areas so that annual average concentrations of these pollutants can be estimated. It is superior in concept to the rollback model since it can be used to estimate concentrations for an area where no air quality data are available. This is possible since atmospheric dispersion is accounted for in the model.

The model relates pollutant concentrations to emissions and meteorological conditions through integration of a Gaussian-type dispersion model across an urban area. The Miller-Holzworth model is expressed as $X/Q = 3.994\ (S/U)^{0.115}$

where no pollutants have achieved a uniform vertical distribution, and as $X/Q = 3.613H^{0.130} + \frac{2}{2HU} - \frac{0.088UH^{1.26}}{S}$

where a uniform vertical distribution has begun to form. The basic inputs include the uniform average area emission rate (Q) in grams per second per square meter, mixing height (H) in meters, wind speed through the mixing layer (U) in m sec^{-1} and city size (S) expressed as kilometers across the city for a given direction. A discussion of this dispersion model and appropriate seasonal average mixing heights and wind speeds is given in EPA publication AP-101. (9) This publication also provides median, upper quartile and upper decile X/Q values for various city sizes. Thus a range of pollutant concentrations can be estimated for the more restrictive meteorological dispersion conditions. However, it is not possible to estimate spatial variations in pollutant concentrations across an area. In this sense, any set of emission control strategies which yield similar total area-wide pollutant emissions will result in the same air quality for the area. No matter how different the strategies are, if the total emissions are the same, then the air quality estimated will be the same with this model.

The reliability of this dispersion model when applied to specific areas to estimate 1-hour concentrations has not been determined. However, as noted earlier, the model has been calibrated, and the results are presented in Appendix A to Requirements for Preparation, Adoption and Submittal of Implementation Plans (36 F.R. 15486) for a range of city sizes so that estimates of annual average concentrations can be made. (10)

Hanna-Gifford Model

The Hanna-Gifford dispersion model is the next step upward in dispersion model sophistication. The Hanna-Gifford model is most readily applicable to stable pollutants such as SO_2, particulates, and CO. It has been used to estimate 1-hour and annual average concentrations of these pollutants. (11) The model can be used to estimate an average concentration for any defined area. This model differs from the previous models in the form of accounting for atmospheric dispersion. Dispersion is considered to be a function of atmospheric stability, wind speed and the size and number of area sources. The equation relating atmospheric concentration to emissions is

$$X = \left[\frac{2}{\pi}\right]^{\frac{1}{2}} \frac{(\Delta w/2)^{1-b}}{a(1-b)\ U} \left[Q_o + \sum_{i=1}^{N} Q_i \left[(2i+1)^{1-b} - (2i-1)^{1-b} \right] \right]$$

where a, b are empirically determined determined constants used to specify dispersion, they are functions of the atmospheric stability. The values are those recommended by M.E. Smith (1968) for neutral stability.

Δw is the size (width) of the area sources,

N is the number of upwind sources,

i is a specific upwind source,

Q_o is the pollutant emissions for the area in which the receptor site is located,

Q_i are the emissions for upwind areas.

The model is applied to each area which encompasses a receptor site. The application is made for the wind direction, wind speed and stability class for each meteorological situation under consideration. All sources upwind of the receptor area are included in determining the pollutant concentration. This approach can be used to estimate hourly average concentrations for all situations of interest. If data on diurnal variations in emission rates are available, they can be used with the model. Concentrations for other averaging times can be obtained by estimating concentrations for each hour of the period and averaging the hourly concentrations.

Annual average concentrations can be obtained in a manner similar to that described subsequently for the Air Quality Display Model (AQDM). However, the Hanna-Gifford simplified the AQDM procedure by substituting a more elementary form of the dispersion equation. For annual average concentrations the model takes the simplified form of $x = \frac{C}{\bar{u}} Q$, where C is a constant dependent on the pollutant, $\bar{u}$ is the annual average wind speed ($m\ sec^{-1}$), and Q is the average emission density ($g/sec/m^2$) for the whole area of interest. This form can only be used to estimate a representative average concentration for the whole area.

In examinations of the reliability of the Hanna-Gifford model, it has been shown that the more detailed formulation provides an accuracy similar to that of more sophisticated models. (4) Correlations generally varying between 0.60 and 0.95, depending

on the pollutant, averaging time and area, have been found. For the simplified annual average and model application to a large number of areas, average values of the constant C equal to 225 and 50, respectively, for TSP and SO_2 were found. However the standard deviation of the error in concentration estimates obtained when the mean value for the constant is used has been found to be about 50μg/m^3 for TSP. Further analysis has shown that use of the constant C is overly simplistic, and that a relationship of $x = 52 + 91.7\ Q/\bar{u}$ provides a better estimate for TSP. The use of this relationship in place of an average for C reduces the standard deviation of the error to 10μg/m^3. For SO_2 a similar relationship could not be derived because the variation of the constant C was too random. This reflects the importance of large point source emissions in determining SO_2 concentrations, and indicates that caution should be exercised in using a mean value of 50 for C.

The Hanna-Gifford model is basically applicable for areas where there is no point source information available, thus requiring that all emissions be grouped into area source emissions. However, if specific point sources or line sources are known, the impact of these sources can be estimated independently through the use of an appropriate model and the resultant concentrations added to those caused by area sources. If the data is available, diurnal variations in emission rates should be considered in the application of specific models to point and line sources. Appropriate point source models are discussed in the Guidelines for

Reviewing New Stationary Sources. (12) These models are generally accepted to be accurate within a factor of two. Basic point source dispersion models are available through the National Technical Information Service. (13) An appropriate line source model is discussed next under the HIWAY model. Detailed discussions of the Hanna-Gifford dispersion model are available from various literature sources. (11, 14)

HIWAY Model

The HIWAY model, by Zimmerman and Thompson (15), is a line source dispersion model. It is for mobile source pollutant emissions along highways and streets, and is applicable only to stable pollutants (CO and fine particulate matter) from automotive sources. The model can be used to estimate 1-hour average concentrations of these pollutants. By repetitively simulating each hour in an 8-hour or 24-hour period, 8-hour and 24-hour average concentrations of the pollutants of interest can be estimated.

The basic formulation of the HIWAY model is

$$X = \frac{q_e}{u} \int_A^B \frac{1}{\pi \sigma_y(d) \sigma_z(d)} \exp -1/2 \left[\frac{y}{\sigma_y}\right]^2 dL$$

where X is the atmospheric concentration at the receptor

u is wind speed, m sec^{-1}

q_e is the constant line source emission rate, g sec^{-1} m^{-1}

σ_y, σ_z are the standard deviations of the concentration distribution in the crosswind and vertical directions, meters; they are dependent on atmospheric stability and on downwind distance (d) from sources to the receptor

A, B are the endpoints of the line source, meters

L is the length of the line source from point A to the ith element of the line source, meters

y is the cross wind distance from source element to the receptor, meters.

The model is applied to each lane of traffic which constitutes the line source to estimate the contribution to concentrations at specified downwind distances. Concentrations can be calculated for any specified combination of meteorological conditions.

A basic input for this model is the emissions in terms of grams per meter per second for each lane making up the roadway for each hour being considered. Due to the diurnal variations in emission rates from automotive sources, emissions should be appropriately varied with time of day. In addition, the length of roadway, its width, and other physical parameters of the roadway need to be specified. Meteorological inputs into the model are stability class, wind direction and wind speed for the hour of interest. The output of the model is 1-hour average concentrations at specified points downwind from the roadway. Concentrations estimated for each hour in a given sequence of hours make it possible to obtain 8-hour and 24-hour concentrations of pollutants. The model is not readily applicable for estimating

annual average concentrations.

To determine the impact of line sources in addition to more generalized area source emissions, the HIWAY model can be used in conjunction with the Hanna-Gifford model. The Hanna-Gifford model is used to determine the impact of all other sources in an area while the HIWAY model is used to determine the impact of specific nearby roadways. The HIWAY model is available from the National Technical Information Service. (13) Predictions from the HIWAY model have been compared with field monitoring data and the results indicate that this model has an accuracy comparable to that of point source dispersion models.

Air Quality Display Model

The Air Quality Display Model (AQDM) is a long-term average concentration urban dispersion model which is best used to determine the impact of a wide variety of stationary source classes on annual average concentrations of SO_2 and TSP. (16) The model has been applied to areas with numerous point and area sources; and it has been validated and calibrated for these applications.

The model is based on the standard long-term concentration equation:

$$X = \sum_S \sum_N \left\{ \frac{2Q f(\Theta, R, N,)}{\sqrt{2\pi}\, \sigma_z\, u_n \left[\frac{2\pi d}{16}\right]} \exp\left[-\left[\frac{1}{2} \frac{H}{\sigma_z} \right]^2 \right] \right\}$$

where $f(\theta,R,N,)$ is frequency during the period of interest that the wind is from direction θ, for the stability condition R, and the wind speed class n, meters/sec.,

σ_z is the vertical dispersion parameter at distance (d) for stability condition R, meters,

u is the representative wind speed for class N, meters/sec.,

H is the effective stack height for wind speed u, meters.

The model is used to determine the impact of all sources at a given receptor, for a given set of meteorological conditions. It then wieghts this concentration by the frequency with which that particular set of meteorological conditions occurs and then sums over all meteorological conditions, thus producing a long-term average concentration. Basic inputs to the model are a comprehensive emissions inventory, including both point sources and area sources; and the frequency distribution of wind speed (6 classes), wind direction (16 cardinal points), and stability class (Pasquill classes A-E) along with an annual average mixing height. The AQDM can be used to estimate concentrations at any specified point downwind.

When adequate point source information is not abailable, a properly calibrated model could be used with only area source emissions. However, it must be recognized that the reliability of this model, or any other model, will be adversely affected

by the assumption that all point sources can be considered in the area source emissions.

It should be noted that the AQDM was originally developed with the Holland plume rise equation for calculating effective stack heights. A change to the computer program is now available for the inclusion of the Briggs' plume rise equation. This latter equation is preferred, especially for large sources such as power plants. The AQDM has been calibrated using regression analysis techniques. In numerous applications of the model a correlation coefficient of 0.8 or greater has been found.

Sampled Chronological Input Model

The Sampled Chronological Input Model (SCIM) is one of several dispersion models which are applicable to both point and area source emissions in urban areas. (17) These models as a class are basically used to estimate hourly average concentrations of SO_2 and TSP which are emitted from stationary sources. The SCIM specifically determines the frequency distribution of 1-hour concentrations. While this model does not specifically estimate 24-hour concentrations, it provides a summary of all estimated hourly concentrations. Thus estimates of concentrations for averaging times longer than 1-hour can be tabulated.

The model is based on the standard Gaussian dispersion equation:

$$X = \frac{Q}{\pi \sigma_y \sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^z\right] \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

where all terms are as previously defined.

Like the AQDM, the SCIM accepts as input specific parameters on point sources and area sources. Although the SCIM estimates hourly concentrations, the emissions data used are annual averages; thus there is no allowance for diurnal variations in emissions. Limited tests with variations in emissions based on time of day did not show a consistent improvement in concentration estimates. (4)

The meteorological data required are specific hourly data on wind speed, wind direction, stability class and mixing height. The model does provide the option of estimating concentrations for

selected intervals, for example, every 3 hours, to lessen the computational burden. A judiciously selected interval, which insures that estimates for all times of day for a sufficiently long period of time, will not adversely influence the frequency distribution for hourly concentrations. The reliability of this model has not been widely determined; however, application to three cities indicates that the frequency distrubitions of 1-hour concentrations estimated by the SCIM approximately reporduce the observed frequency distributions.

APRAC-1A Model

APRAC-1A is a dispersion model which is applicable only to line and area sources of stable automotive pollutants (CO and particulate matter). The model can be used to determine 1-hour averages of these pollutant concentrations, and it can also be used to estimate concentrations for longer time periods by averaging a series of hourly estimates.

APRAC-1A is based on a modification of the Gaussian dispersion equation. The basic input to this dispersion model is in terms of individual street segments or line sources. The model takes these segments and determines area source emissions from these line sources; these emissions are then combined with other specified area source emissions to determine total emissions. A method for determining diurnal variations in emissions is also included in this model. These area sources are oriented in the upwind direction. A logarithmic spacing of the area sources allows nearby sources to be considered in greater detail than

those further away since their individual contributions tend to be merged during longer travel. Meteorological input to the model is the same as with other dispersion models, namely, wind direction, wind speed, stability class and mixing height on an hourly basis.

This model also incorporates a street-effects submodel. This submodel allows determination of the impact of localized emissions and wind circulations on pollutant concentrations. It basically takes the form of a box model with slightly different methods for calculating concentrations on opposite sides of the street. This difference is an attempt to reflect the impact of complex wind circulation patterns which have been identified in street canyons.

Detailed descriptions of APRAC-1A are available from references 13, 18, and 19. This dispersion model has been applied to St. Louis and San Jose, and the calculated concentrations compared favorably with observed data. In general, APRAC-1A can be expected to have a reliability similar to that of other dispersion models.

SAI Photochemical Model

The SAI model is a photochemical dispersion model. (20) It not only considers the transport and dispersion of pollutants, but also the transformation of HC and NO_x into photochemical oxidants (O_x). It can be used to estimate the hourly concentration variations for CO, HC, nitric oxide (NO), NO_2, and O_x.

The mathematical formulation for this model is considerably different from that discussed for the other dispersion models. This model uses finite difference techniques over a grid of area sources to solve the classical equations of conservation of mass which include local changes, advection, diffusion, photochemical reactions and emissions.

The emissions input is specified as uniform gridded area sources, with hourly emission rates and their diurnal variations being required. Meteorological inputs include hourly data on the spatial variation of wind direction, wind speed and mixing height. The model is capable of estimating for each hour an average concentration for each area identified as an area source. This model is most applicable when large amounts of data are available for sophisticated analysis of a region. To date it has only been applied to areas in California. (4)

The SAI model is considered to be one of the better photochemical models currently available. However, its reliability has not been thoroughly examined.

Climatological Dispersion Model

The Climatological Dispersion Model (CDM) is purposely presented last because it was the simulation model used in this research study. The CDM has been successfully used to develop air quality estimates for Ankara, Turkey, St. Louis, Missouri, and many other cities within the United States. Among various existing models the CDM is generally regarded as the most adequate, and it is widely used for existing refineries. (21)

The CDM determines long-term (seasonal or annual) quasi-stable pollutant concentrations at any ground level receptor using average emissions rates from point and area sources, and a joint frequency distribution of wind direction, wind speed, and atmospheric stability for the same period. (22) The CDM describes the spreading of a plume as it is transported downwind from a continuously emitting source. The effects on each identified receptor for the observed combination of wind direction, wind speed, and atmospheric stability are calculated with the aid of a computer. The relative frequency of occurrence of each such meteorological combination is then used to weigh the calculated concentrations. The resulting weighted concentrations are summed over all meteorological conditions and all sources. The plume is assumed to have a Gaussian distribution in the vertical direction and a uniform distribution in the horizontal direction. The resulting mathematical expression for calculating point and area source contributions to each receptor is an unvariant Gaussian (in the vertical only) equation.

The average concentration $\bar{C}_A$ due to area sources at a particular receptor is given by:

$$\bar{C}_A = \frac{16}{2\pi} \int_0^{\infty} \left[\sum_{K=1}^{16} q_k(p) \sum_{\ell=1}^{6} \sum_{m=1}^{6} \phi(k,\ell,m) S(p,z;U_\ell,P_m) \right] d_p$$

where k = index identifying wind direction sector

$q_k(p) = \int Q(p,\Theta)\, d\Theta$ for the k sector

$Q(p,\Theta)$ = emission rate of the area source per unit time, grams/second

p = distance from the receptor to an infinitesimal area source, meters

Θ = angle relative to polar coordinates centered on the receptor

ℓ = index identifying the wind speed class

m = index identifying the class of the Pasquill stability category

$\phi(k,\ell,m)$ = joint frequency function

$S(p,z;\ U_\ell,P_m$ = dispersion function defined in Equations 3 and 4

z = height of receptor above ground level, meters

U_ℓ = represnetative wind speed, meters/seconds

P_m = Pasquill stability category

For point sources, the average concentration $\bar{C}_p$ due to n point sources is given by:

$$\bar{C}_p = \frac{16}{2\pi} \sum_{n=1}^{n} \sum_{\ell=1}^{6} \sum_{m=1}^{6} \frac{\phi(k_n,\ell,m) G_n S(p_n,z;U_\ell,P_m)}{p_n}$$

where

k_n = wind sector appropriate to the n^{th} point source

G_n = emission rate of the n^{th} point source, grams/second

p_n = distance from the receptor to the n^{th} point source, meters

If the receptor is preseumed to be at ground level, that is, z=0, then the functional form of $S(p,z;U_{\ell}P_{m})$ will be:

$$S(p,0;U_{\ell},P_{m}) = \frac{2}{\sqrt{2\pi}U_{\ell}\sigma_{z}(p)} \exp\left[-\left(\frac{1}{2}\frac{h}{\sigma_{z}(p)}\right)^{2}\right] \exp\left(\frac{-0.692p}{U_{\ell}T_{\frac{1}{2}}}\right)$$

if $\sigma_{z}(p) \leq 0.8\ L$ and

$$S(p,0;U_{\ell},P_{m}) = \frac{1}{U_{\ell}L} \exp\left(\frac{-0.692p}{U_{\ell}T_{\frac{1}{2}}}\right)$$

if $\sigma_{z}(p) > 0.8L$. New terms in Equations 3 and 4 are defined as follows:

$\sigma_{z}(p)$ = vertical dispersion function, i.e., the standard deviation of the pollution concentration in the vertical plane, meters,

h = effective stack height of source distribution, i.e., the average height of area source emissions in the k^{th} wind direction sector at radial distance p from the receptor, meters,

L = the afternoon mixing height, meters,

$T_{\frac{1}{2}}$ = assumed half life of pollutant, hours.

The possibility of pollutant removal by physical or chemical processes is included in the program by the decay expression $\exp(-0.602p/U_{\ell} T_{\frac{1}{2}})$.

Although similar in many respects to the AQDM, the CDM is a refined version of the AQDM with several distinct features. In the CDM, area sources are calculated using the narrow plume hypothesis applied for winds within a sector which involves an upwind integration over the area sources. (23,24) Emission rates at various upwind distances, using an expanding scale, are average over an arc within the sector. A power law for the vertical wind profile which is a function of stability is used to extrapolate surface winds to the source height. Estimation of effective height sources is by the Brigg's plume rise equation. (25) The total concentration at each receptor is the sum of 32 concentrations. These concentrations are those from point and from area sources for each of the 16 wind directions. The values are retained and are useful in plotting direction contribution pollution rises. The computer computational time of the CDM is about 73% of that required by the AQDM.

The CDM is not without its shortcomings. Although the model is conceptually quite simple, the superposition of the effects produced by a complex distribution of pollutant emissions under a complex sequence of meteorological conditions quickly obscure the simple quantitative properties of the model in the massive details of particular applications. Under these circumstances, the numerical properties, that is, the

relationship between model output and its numerous inputs, are only poorly understood. (24) To gain a better understanding of the CDM, it was subjected to an input-output sensitivity analysis in 1972 by Turner, Zimmerman and Busse. (26) The results indicated that the CDM gives a good estimate of the mean and maximum concentration for SO_2, but somewhat underestimates the TSP concentrations, particularly the maximum. It should also be noted that of the two more complex models (AQDM and CDM) tested, the data indicated that the CDM yield better results.

General Comments

Emissions inventory estimates are inherently crude and subject to uncertainties. One shortcoming of air pollution modelling in its present form is that a constant emissions inventory is used even though significant variations occur diurnally, weekly, and seasonally. The fact that diurnally constant emission rates may lead to over-prediction of concentrations has been previously noted by Clarke (27) and Turner (28), both of whom indicated the need for lower emission rates at night.

Another possible source of error may be in the meteorological data used in air pollution modelling. Most meteorological data is collected at a nearby airport weather station, with the assumption that this is roughly representative of the urban area being modeled. This meteorological data may be a poor indication of the urban meteorological conditions, and particular caution should be exercised in applying models to locales where the topography is complicated. Finally, the method for estimating mixing depths is not exact. Better modelling should result when data based on actual atmospheric soundings can be utilized.

CHAPTER III- METHODS AND APPROACH

In order to apply the CDM to the study areas, various parameters had to be determined and data collected. This chapter explains in detail the various methods and approaches to data collection, CDM calibration, and CDM output with respect to each phase of the study.

STUDY AREA

In this research project, two areas of the city were designated as the study areas. In the beginning of this research study political as well as community concern was being expressed about the quality of air in a 2.8 mile by 4.7 mile area around the New Orleans Grain Elevator. As a result of the political interests, this smaller intercity area was incorporated in the CDM study in order to provide statistical comparisions on particulate matter (TSP) with the other CDM study area. The New Orleans Grain Elevator study area is shown in Figure 2 and 3.

The other CDM study area is the entire New Orleans SMSA which encompasses the 18.9 mile by 24.6 mile metro area. This area includes the city of New Orleans as well as the surrounding suburban areas both industrial and residential. The New Orleans SMSA study area is shown in Figure 4.

In order to apply the CDM to these areas of the city, a rectangular grid array of uniform-sized squares was used to overlay the regions of interest. The main purpose of this grid is to catalog the emission inventories by area sources. A total of 60 grid squares (6 X 10) was used in the New Orleans Grain Elevator study (NOGE) and 520 grid squares (20 X 26) was used in the New Orleans SMSA study (NOSMSA). For the NOGE study, each

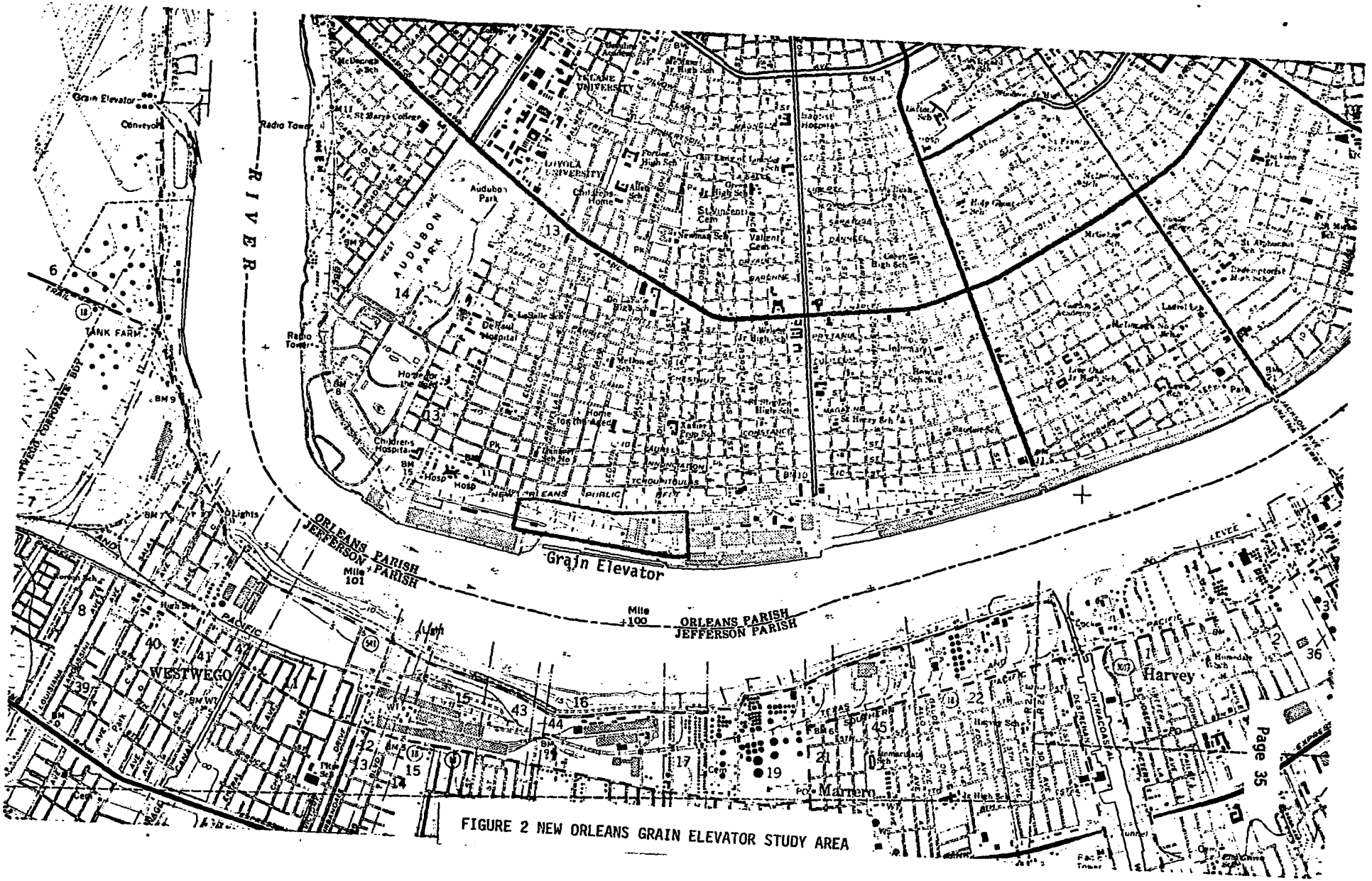


FIGURE 2 NEW ORLEANS GRAIN ELEVATOR STUDY AREA

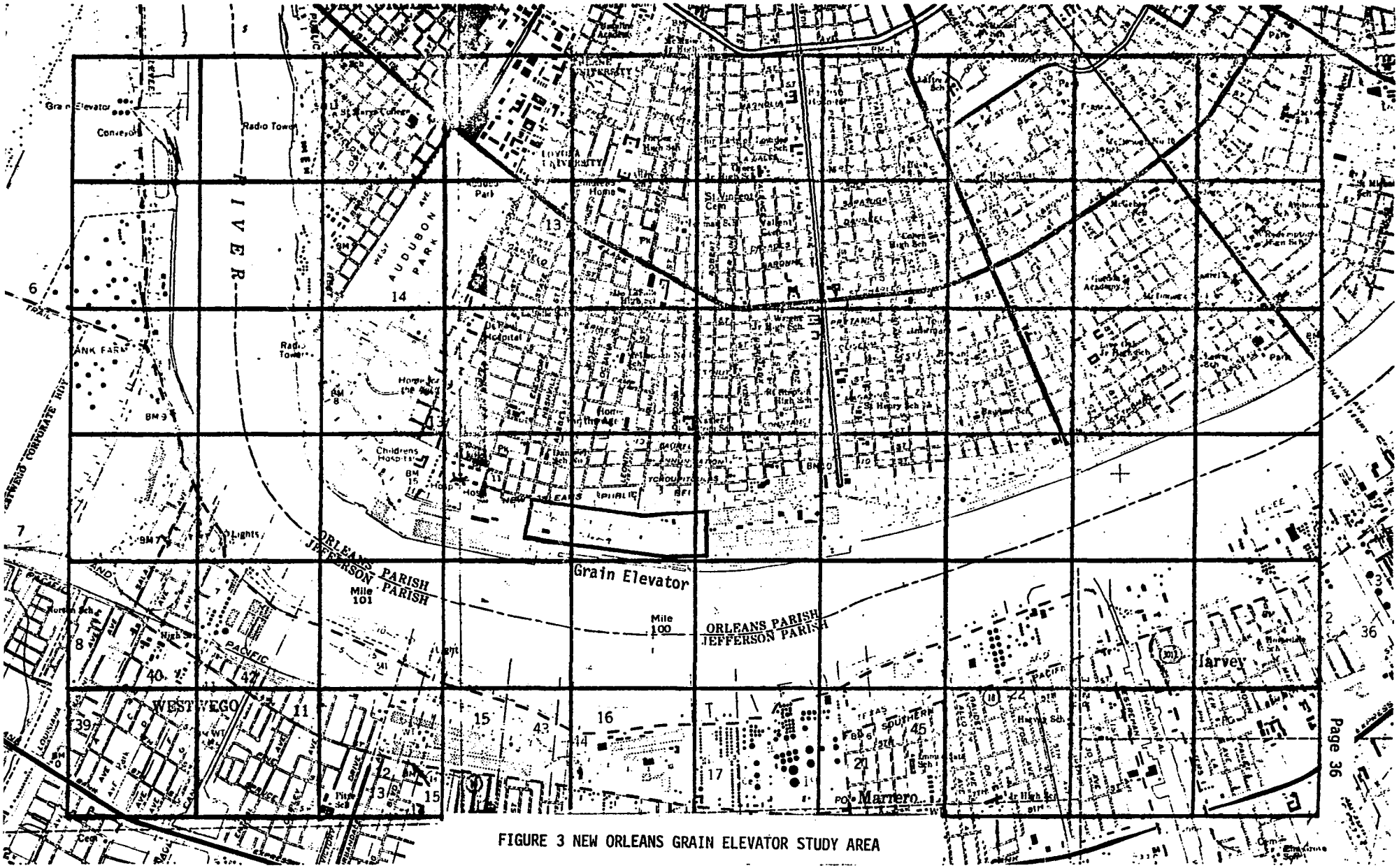
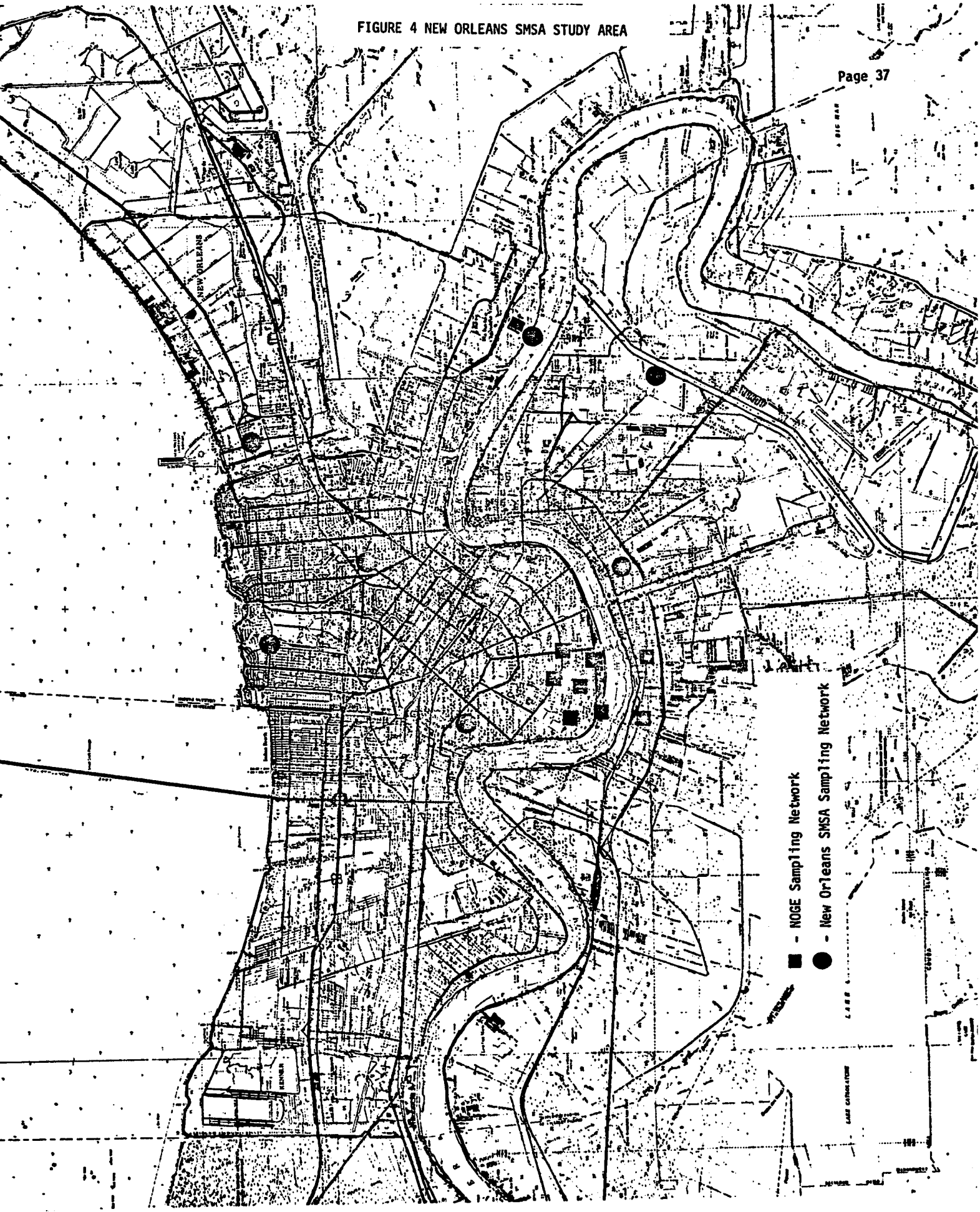


FIGURE 3 NEW ORLEANS GRAIN ELEVATOR STUDY AREA

FIGURE 4 NEW ORLEANS SMSA STUDY AREA



grid square is 762 meters on a side, and for the NOSMSA each grid is 1524 meters on a side. The locations where each grid line of an array crosses another grid line is called a receptor. The model allows the user to choose additional receptors anywhere in the study area by designating the proper X and Y coordinates of the location of interest. The receptors have assigned X and Y coordinates and the CDM will calculate TSP concentrations for each receptor. The origin of each overlay grid is located in the lower left-hand corner of the array with the X-axis pointing toward the east and the Y-axis pointing toward the north. With respect to the map coordinates of this region, the NOGE study has its origin at X-coordinate 775.24 and Y-coordinate 3310.82, and the NOSMSA study has its origin at X-coordinate 761.68 and Y-coordinate 3298.4.

DATA COLLECTION

Meteorology

Certain meteorological parameters are necessary input for the CDM. Wind direction, wind speed and a stability category are funnelled together to form a joint frequency function ϕ (K,ℓ,m). This function gives the joint frequency of occurrence of a wind direction sector K, a wind speed class ℓ, and a stability category index m. There are 576 entries in the table for the joint frequency function. This number of values results from 16 different wind vectors, six wind speed classes, and six stability classes used in determing the frequency function.

Weather observations are taken hourly by meteorologists of the National Weather Service at Moisant Airport in New Orleans and forwarded to the National Climatic Center (NCC) in Asheville, North Carolina for compilation

SECTOR	U1	U2	U3	U4	U5	U6
			THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS 1			
1	.109000-02	.272000-02	.000000	.000000	.000000	.000000
2	.177000-02	.204000-02	.000000	.000000	.000000	.000000
3	.270000-03	.680000-03	.000000	.000000	.000000	.000000
4	.540000-03	.136000-02	.000000	.000000	.000000	.000000
5	.000000	.000000	.000000	.000000	.000000	.000000
6	.000000	.000000	.000000	.000000	.000000	.000000
7	.270000-03	.680000-03	.000000	.000000	.000000	.000000
8	.000000	.000000	.000000	.000000	.000000	.000000
9	.950000-03	.000000	.000000	.000000	.000000	.000000
10	.000000	.000000	.000000	.000000	.000000	.000000
11	.000000	.000000	.000000	.000000	.000000	.000000
12	.000000	.000000	.000000	.000000	.000000	.000000
13	.270000-03	.680000-03	.000000	.000000	.000000	.000000
14	.000000	.000000	.000000	.000000	.000000	.000000
15	.000000	.000000	.000000	.000000	.000000	.000000
16	.950000-03	.000000	.000000	.000000	.000000	.000000
			THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS 2			
1	.224000-02	.106700-01	.106700-01	.000000	.000000	.000000
2	.190000-03	.122300-01	.611000-02	.000000	.000000	.000000
3	.770000-03	.543000-02	.543000-02	.000000	.000000	.000000
4	.880000-03	.679000-02	.476000-02	.000000	.000000	.000000
5	.730000-03	.272000-02	.680000-03	.000000	.000000	.000000
6	.400000-04	.272000-02	.000000	.000000	.000000	.000000
7	.700000-03	.680000-03	.136000-02	.000000	.000000	.000000
8	.200000-04	.136000-02	.000000	.000000	.000000	.000000
9	.212000-02	.340000-02	.136000-02	.000000	.000000	.000000
10	.730000-03	.272000-02	.204000-02	.000000	.000000	.000000
11	.740000-03	.340000-02	.680000-03	.000000	.000000	.000000
12	.300000-04	.204000-02	.680000-03	.000000	.000000	.000000
13	.800000-04	.543000-02	.408000-02	.000000	.000000	.000000
14	.142000-02	.272000-02	.340000-02	.000000	.000000	.000000
15	.213000-02	.408000-02	.000000	.000000	.000000	.000000
16	.354000-02	.611000-02	.543000-02	.000000	.000000	.000000
			THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS 3			
1	.540000-03	.408000-02	.108700-01	.204000-02	.000000	.000000
2	.360000-03	.272000-02	.543000-02	.136000-02	.000000	.000000
3	.270000-03	.204000-02	.115500-01	.204000-02	.000000	.000000
4	.270000-03	.204000-02	.543000-02	.204000-02	.000000	.000000
5	.270000-03	.204000-02	.543000-02	.000000	.000000	.000000
6	.000000	.000000	.204000-02	.000000	.000000	.000000
7	.180000-03	.136000-02	.272000-02	.136000-02	.000000	.000000
8	.000000	.000000	.204000-02	.680000-03	.000000	.000000
9	.860000-03	.680000-03	.611000-02	.204000-02	.000000	.000000
10	.360000-03	.272000-02	.136000-02	.000000	.000000	.000000
11	.000000	.000000	.340000-02	.000000	.000000	.000000
12	.900000-04	.680000-03	.204000-02	.680000-03	.000000	.000000
13	.285000-02	.408000-02	.136000-02	.136000-02	.000000	.000000
14	.113000-02	.272000-02	.204000-02	.000000	.000000	.000000
15	.122000-02	.340000-02	.476000-02	.680000-03	.000000	.000000
16	.450000-03	.340000-02				

THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS 4

SECTOR	U1	U2	U3	U4	U5	U6
1	.000000	.543000-02	.815000-02	.406000-02	.000000	.000000
2	.000000	.679000-02	.680000-03	.680000-03	.000000	.000000
3	.000000	.136000-02	.611000-02	.406000-02	.000000	.000000
4	.680000-03	.340000-02	.340000-02	.406000-02	.000000	.000000
5	.680000-03	.204000-02	.204000-02	.747000-02	.000000	.000000
6	.000000	.680000-03	.680000-03	.204000-02	.680000-03	.000000
7	.000000	.204000-02	.611000-02	.340000-02	.000000	.000000
8	.000000	.000000	.815000-02	.272000-02	.000000	.000000
9	.000000	.543000-02	.679000-02	.611000-02	.680000-03	.000000
10	.000000	.204000-02	.406000-02	.136000-02	.000000	.000000
11	.000000	.406000-02	.204000-02	.136000-02	.000000	.000000
12	.000000	.000000	.204000-02	.204000-02	.000000	.000000
13	.000000	.204000-02	.680000-03	.272000-02	.000000	.000000
14	.000000	.136000-02	.680000-03	.000000	.000000	.000000
15	.000000	.204000-02	.136000-02	.136000-02	.680000-03	.000000
16	.000000	.136000-02	.543000-02	.272000-02	.680000-03	.000000

THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS 5

SECTOR	U1	U2	U3	U4	U5	U6
1	.740000-03	.680000-03	.129100-01	.543000-02	.000000	.000000
2	.000000-04	.136000-02	.136000-02	.406000-02	.000000	.000000
3	.000000	.000000	.815000-02	.476000-02	.000000	.000000
4	.145000-02	.680000-03	.611000-02	.476000-02	.000000	.000000
5	.770000-03	.136000-02	.272000-02	.340000-02	.000000	.000000
6	.300000-04	.680000-03	.340000-02	.204000-02	.000000	.000000
7	.300000-04	.680000-03	.611000-02	.680000-03	.000000	.000000
8	.300000-04	.680000-03	.679000-02	.136000-02	.000000	.000000
9	.000000	.000000	.815000-02	.000000	.000000	.000000
10	.000000	.000000	.272000-02	.000000	.000000	.000000
11	.000000	.000000	.340000-02	.000000	.000000	.000000
12	.300000-04	.680000-03	.272000-02	.136000-02	.000000	.000000
13	.145000-02	.680000-03	.136000-02	.000000	.000000	.000000
14	.600000-03	.204000-02	.204000-02	.000000	.000000	.000000
15	.300000-04	.680000-03	.204000-02	.136000-02	.000000	.000000
16	.000000	.000000	.272000-02	.340000-02	.000000	.000000

THE JOINT FREQUENCY FUNCTION FOR STABILITY CLASS 6

SECTOR	U1	U2	U3	U4	U5	U6
1	.187100-01	.122300-01	.115500-01	.000000	.000000	.000000
2	.389000-02	.611000-02	.340000-02	.000000	.000000	.000000
3	.914000-02	.815000-02	.204000-02	.000000	.000000	.000000
4	.914000-02	.815000-02	.272000-02	.000000	.000000	.000000
5	.219000-01	.135900-01	.136000-02	.000000	.000000	.000000
6	.641000-02	.815000-02	.136000-02	.000000	.000000	.000000
7	.644000-02	.163000-01	.543000-02	.000000	.000000	.000000
8	.461000-02	.135900-01	.883000-02	.000000	.000000	.000000
9	.622000-02	.183400-01	.476000-02	.000000	.000000	.000000
10	.737000-02	.190200-01	.272000-02	.000000	.000000	.000000
11	.130300-01	.142700-01	.136000-02	.000000	.000000	.000000
12	.125900-01	.183400-01	.272000-02	.000000	.000000	.000000
13	.377100-01	.387200-01	.680000-03	.000000	.000000	.000000
14	.162000-01	.101900-01	.204000-02	.000000	.000000	.000000
15	.889000-02	.476000-02	.680000-03	.000000	.000000	.000000
16	.661000-02	.340000-02				

and tabulation. The weather data collected at Moisant is representative of the meteorological conditions of adjacent communities within our study areas. The Day-Night version of the NCC program called STAR gives the proper form of the joint frequency function which is used directly as input into the CDM. The joint frequency function is shown in Table 3.

The stability classification of the Day-Night STAR program differs from the original STAR program in that the Pasquill-Gifford stability class 4 has been separated into two classes, 4 and 5, representing neutral (P-G stability class 4) daytime conditions and neutral (P-G stability class 4) nighttime conditions, respectively. In addition, in the revised program the remaining nighttime Pasquill-Gifford stability classes (5 and 6) are lumped into class 6. The relation between the Pasquill-Gifford stability classes and those used in the Climatological Dispersion Model is shown in Table 4.

TABLE 4

PASQUILL-GIFFORD AND CLIMATOLOGICAL DISPERSION MODEL STABILITY CLASSES

Pasquill-Gifford	P_m
1	1
2	2
3	3
4 daytime	4
4 nighttime	5
5, 6 }	6

The wind speed U for the various weather bureau classes (Table 5) is taken as the central wind speed of the class. It should be noted that the central wind speed of the lowest wind speed class was arbitrarily taken as

1.5 meters per second. This means that light winds reported in the first wind speed class were rounded up to this value, since most operational wind instruments do not sense low wind speeds accurately. Operational wind instruments are designed for durability and also to withstand exposure to strong, gusty airflow. For these reasons, most wind sensors have a high starting speed, which can lead to the erroneous reporting of light winds as calms (Truppi, 1968).

TABLE 5

CENTRAL WIND SPEEDS

Wind Speed Class	Speed Interval, Knots	Class Wind Speed, m/sec
1	0 to 3	1.50
2	4 to 6	2.46
3	7 to 10	4.47
4	11 to 16	6.93
5	17 to 21	9.61
6	> 21	12.52

Wind Profile

To account for an increase of wind with height above a height of 10 meters (anemometer height) to the level of emission, a power law relation of the form

$$U(z) = U_{\ell}(z/z_o)^p$$

is used in the computational program. The exponent p, as determined by DeMarrais (1959), depends on the stability class and is given in Table 6.

TABLE 6

EXPONENTS FOR WIND PROFILE

Stability Class	Exponent (p)
1	0.1
2	0.15
3	0.20
4	0.25
5	0.25
6	0.30

Mixing Height

The magnitude of the mixing height undergoes considerable diurnal, seasonal, and annual variation. It is impractical to account for all such variations in detail. Nevertheless, some recognition is given to changes in the magnitude of the mixing height by assigning values to different stabilities according to Table 7.

TABLE 7

MIXING HEIGHT

Stability Class	Mixing Height, Meters
1	1.5 x HT
2	HT
3	HT
4 day	HT
4 night	(HT + HMIN)/2
5	HMIN
6	HMIN

In Table 7, HT is the climatological mean value of the mixing height as tabulated by Holzworth (1972) and HMIN is the nocturnal mixing height.

Stability Classes

The lower layer of the urban atmosphere is generally more unstable than is the corresponding adjacent rural atmosphere. To account for this, modifications have been made to the stability class applied in the calculation of concentration from area sources. This modification consists of decreasing the stability class by one class with the exception of P_1, which is unaltered. This correction is not applied to point sources.

During the night with a surface inversion condition and a rural class stability of P_5, the neutral stability class P_4 is assumed for both point and area sources. Otherwise, there is no modification of the stability classes applied to point source calculations.

Dispersion Functions

An analytical approximation to the curves of Pasquill (1961) and Gifford (1961) for the vertical dispersion function $\sigma_z(p)$ is made by using an empirical power law in the form

$$\sigma_z(p) = a_p^b$$

The parameters a and b for various stabilities and ranges of distance p are given in Table 8.

TABLE 8

PARAMETRIC VALUES FOR $\sigma_z(p)$

	Distance, Meters					
	100 to 500		500 to 5,000		5,000 to 50,000	
Stability Class	a	b	a	b	a	b
1	0.0383	1.2812	0.2539×10^{-3}	2.0886	-	-
2	0.1393	0.9467	0.4936×10^{-1}	1.1137	-	-
3	0.1120	0.9100	0.1014	0.9260	0.1154	0.9109
4	0.0856	0.8650	0.2591	0.6869	0.7368	0.5642
5	0.0818	0.8155	0.2527	0.6341	1.2969	0.4421
6	0.0545	0.8124	0.2017	0.6020	1.5763	0.3606

An initial value of the dispersion function $\sigma_z(0)$ is used in the program to represent the vertical dispersion created by the roughness of urban topography (buildings). For area sources, it is possible to input a different value of initial σ_z for each stability class, that is, six different values. Normally, however, and as shown in the illustrative example, the

same value (30 meters) is used for all stability classes.

The value of initial σ_z for point sources has been made a function of the height of the stack above the ground. For stacks at ground level to 20 meters above the ground level, initial σ_z is assumed to be 30 meters. For stack heights between 20 and 50 meters above the ground level, initial σ_z is decreased linearly according to the equation

$$\sigma_z(0) = 50 - H$$

where H is the stack height in meters. For stacks 50 meters above the ground or higher, the value of initial σ_z is zero.

Plume Rise

There are provisions in the program for the user to have a choice in estimating the plume rise. The first option makes use of the "2/3 law" due to Briggs (1971). The formula is given by

$$\Delta h = 1.6F^{1/3} U^{-1} p^{2/3} \quad p \leq 3.5X^*$$

and

$$\Delta h = 1.6F^{1/3} U^{-1} (3.5X^*)^{2/3} \quad p > 3.5X^*$$

$$X^* = 14F^{5/8} \text{ if } F \leq 55$$

$$X^* = 34F^{2/5} \text{ if } F > 55.$$

where Δh = plume rise, meters

$F = gV_sR_s^2 \{(T_s - T_a)/T_s\}$

g = acceleration due to gravity, m/sec^2

V_s = average exit velocity of gases of plume, m/sec

R_s = inner radius of stack, meters

T_s = average temperature of gases in plume, ^oK

T_a = ambient air temperature, ^oK

U = wind speed at stack height, m/sec

p = distance from source to receptor, meters

As suggested by Briggs, p/X* was not allowed to exceed the limiting value of 3.5.

For the other option on plume rise, the value of the product of the average wind speed and the height of plume rise may be used. This option permits no variation of this product with distance from the stack and the magnitude of the plume rise is at the discretion of the user. The aforementioned interrelationships can be seen in the User's Guide for the Climatological Dispersion Model.

Emissions Inventory

The air pollutant emission inventory forms the basis of making an assessment of air quality management problems in any study area. For the purposes of this study, pollutant sources were separated into point sources and area sources.

Point sources

In both the NOGE and NOSMSA, 66 major point sources were used which combined for 498 individual point sources. The CDM considers each stack at each company as an individual point source. This point source emission inventory was obtained by surveying the 1975 updated inventory files of the Louisiana Air Control Agency. The 66 major point sources are shown in Table 9.

In order to run the CDM, specific data is required as input into the dispersion model. For a point source the following minimum data are

TABLE 9

POINT SOURCES IN STUDY AREA

New Orleans Public Grain Elevator

Celotex Corporation

National Gypsum Co. (Tchoutitoulas St.)

Allied Chemical Corp.

Witco Chemical Corp.

Continental Can Co.

Continental Grain Co.

Southern Johns-Manville Products Corp. (4th St.)

Kaiser Aluminum and Chemical Corp.

Avondale--Standard Paint and Varnish Division

Avondale--Stan-Blast Division

Avondale--Westwego Yard

Avondale--Main Yard

Seventh Street Incinerator

Gulf States Asphalt Co.

National Gypsum Co. (Louisiana St.)

Amerada Hess Corp.

Louisiana Power and Light Co. (Ninemile Point Steam Electric Station)

American Sugar Co.

Tennoco Oil Co.

Murphy Oil Corp.

New Orleans Public Service Inc. (A.B. Peterson Steam Electric Station)

Florida Avenue Incinerator

Equitable Equipment Co.

TABLE 9 Continued

New Orleans Public Service Inc. (Michoud Steam Electric Station)

Southern Johns-Manville Products Corp. (North Galvez St.)

Publicker Chemical Corp.

Bol Bros. Construction Inc.

American Cyanamid Co.

Amax Nickel Refining Co.

T.L. James Co.

Lambert Industries

Jimco Inc. (Airline Hwy)

Simonson Bros. Construction Co.

Air Products and Chemical Inc.

Louisiana Cement

Gulf Soap Corp.

Dockside Floating Elevators

Sewerage and Water Board of New Orleans (Power House No. 2)

Plexco

Jimco Incl (Paris Road)

Standard Brands Inc.

Folger Coffee Co.

Jacat Corp.

Algiers Incinerator

New Orleans East Incinerator

Hobson Galvanizing Corp.

St. Louis Street Incinerator

Oronite

Dresser Industries Inc.

American Standard Inc.

Avondale--Service Foundry

Lone Star Industries

Owens--Illinois Inc.

U.S. Gypsum Co.

Radcliff Materials Inc.

Carlo Ditta Inc.

American Can Co. (North Cortez Street)

Zonolite Co.

New Orleans Asphalt Plant

New Orleans Public Service (Market Street Steam Electric Station)

AMF Tuboscope

Jahncke Service Inc.

R.E. Schanzer

American Coffee

Dixie Building Materials

required: pollutants emitted; source emission rate; physical stack parameters such as stack diameter, stack height, stack exit velocity and stack exit temperatures; and location of the source in appropriate grid coordinates. The data collection form used in this research is shown in Table 10.

Area sources

All source emissions that are not included in point source emission inventory are usually attributed to area sources. Area sources include the multitude of minor sources whose small emissions make them impractical to consider as individual point sources. Such area sources are typically treated as a grid network of specific area, with pollutants emissions distributed uniformly within each grid square. Commonly, emissions from such sources are prorated over areas of one to one-hundred square kilometers, depending on the available detail of emission data and desired refinement of modeling results. Required area source information would be (1) types and amount of pollutant emissions, (2) the physical size of the area (grid square) over which emissions are apportioned, (3) a representative average stack height for the area sources, and (4) the location of each area source or grid square in the modeling analysis area.

For this modeling study the most current area source emission inventory for each parish was obtained from EPA in the National Emissions Data System (NEDS). The area source emission inventory (NEDS Data) was brought up to the most recent time period for which adequate data was available. The updated NEDS - Area Source data for each parish is shown in Tables 11, 12, 13, and 14. Additional summarization can be found in Chapter IV, Page 105; Table 22.

NAME _____

ADDRESS _____

_____

UTMX _____ UTMY _____

TIME PERIOD _____

Pollutant Type: 1 - Particulates
2 - SO_2
3 - CO

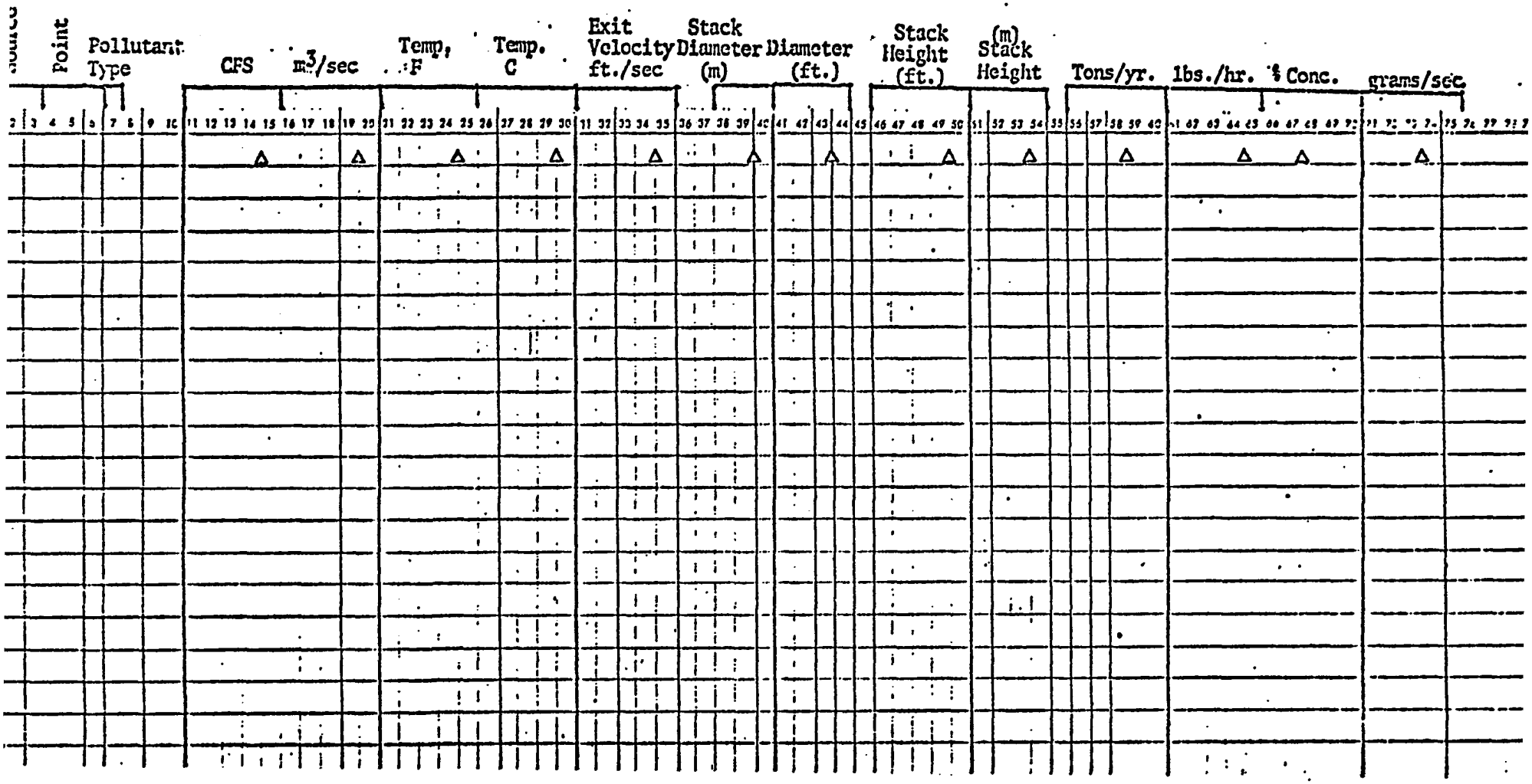


TABLE 10 DATA COLLECTION FORM

NATIONAL EMISSIONS DATA SYSTEM (NEDS)
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR PROGRAMS

Area Source Input Form

Date ________

Name of Person Completing Form: Joel Massey
Orleans Parish

State	County	AQCR
1–2	3–6	7–9
19	2140	106

Card 1

Year of Record (10–11)	Emission Estimates (10^2 tons): Particulate (12–16)	SO_2 (17–21)	NO_x (22–25)	HC (26–30)	CO (31–35)	Sulfur Content (%): Anth. Coal / Bitum. Coal / Dist. Oil / Resid. Oil (36–43)	Ash Content (%): Anth. Coal / Bitum. Coal (44–49)	Residential Fuel: Anth. 10^1 tons (50–53)	Bitumin. 10^1 tons (54–58)	Dist. Oil 10^4 Gal. 74 (59–63)	Resid. Oil 10^4 Gal. (64–68)	Nat. Gas 10^7 ft^3 (69–73)	Wood 10^2 tons 72 (74–77)	Action (78)	(79)	cd (80)
75	47.77	95								133		1110	2	A	A	1

Card 2 — Commercial and Institutional Fuel / Industrial Fuel

Comm. Anth. 10^1 tons (10–14)	Comm. Bitumin. 10^1 tons (15–19)	Comm. Dist. Oil 10^4 Gals. 74 (20–24)	Comm. Resid. Oil 10^4 Gals. 74 (25–29)	Comm. Nat. Gas 10^7 Ft^3 (30–33)	Comm. Wood 10^2 tons (34–35)	Ind. Anth. Coal 10^1 tons (36–41)	Ind. Bitum. Coal 10^1 tons (42–47)	Ind. Coke 10^1 tons (48–51)	Ind. Dist. Oil 10^4 Gals. 74 (52–56)	Ind. Resid. Oil 10^4 Gals. 74 (57–61)	Ind. Nat. Gas 10^7 Ft^3 (62–66)	Ind. Wood 10^2 tons (67–69)	Ind. Process Gas 10^7 ft^3 (70–73)	(74–77)	Action (78)	(79)	cd (80)
		2218	1958	1030					4428	452	780				A	A	2

Card 3 — On Site Incineration / Open Burning / Gasoline Fuel / Diesel Fuel

On Site Incin. Residential 10^1 tons (10–15)	On Site Incin. Industrial 10^2 tons (16–20)	On Site Incin. Comm. Inst. 10^2 tons (21–24)	Open Burning Residential 10^2 tons 72 (25–30)	Open Burning Industrial 10^2 tons (31–36)	Open Burning Comm'l-Instit'l. 10^2 tons (37–42)	Gasoline Light Vehicle 10^3 Gals. 72 (43–49)	Gasoline Heavy Vehicle 10^3 Gals. 73 (50–54)	Gasoline Off Hiway 10^3 Gals. 73 (55–59)	Diesel Heavy Vehicle 10^3 Gals. 72 (60–64)	Diesel Off Hiway 10^4 Gals. 74 (65–67)	Diesel Rail Locomotive 10^4 Gals. 73 (68–72)	County Population 10^3 (73–76)	(77)	Action (78)	(79)	cd (80)
			2288			246422	23065	62600	21266	2200	1870		9	A	A	3

Card 4 — Aircraft / Vessels / Evaporation / Measured Vehicle Miles

Aircraft '73 Military LTO CYC 10^2 (10–13)	Civil LTO CYC 10^1 (14–18)	Commercial LTO CYC 10^1 (19–23)	Vessels Anth. Coal 10^1 tons (24–27)	Vessels Diesel Oil 10^4 Gals. 72 (28–31)	Vessels Resid. Oil 10^4 Gals. 72 (32–36)	Vessels Gasoline 10^3 Gals. 73 (37–40)	Evaporation '73 Solvent Purchased tons/yr (41–46)	Gasoline Marketed 10^5 Gals. (47–51)	Measured Vehicle Miles '72 Limited Access Road 10^4 Miles (52–57)	Rural Roads 10^4 Miles (58–63)	Suburban Roads 10^4 Miles (64–69)	Urban Roads 10^4 Miles (70–76)	(77)	Action (78)	(79)	cd (80)
364	13890	135		4090	2429	484	16000	1860	141.1		204.8	44.6		A	A	4

Card 5

Dirt Roads Traveled '73 10^3 Miles/year (10–16)	Dirt Air Strips LTO CYCLES (17–21)	Construction Land Area 10^3 Acres '73 (22–26)	Land Tilling 10^3 Acres (27–31)	Forest Fires Area - Acres (32–38)	Forest Fires Quant. ton/acre (39–41)	Slash Burning Area - Acres (42–47)	Slash Burning Quant. tons/acre (48–50)	Frost Control Orchard Heaters 10^2 (51–54)	Frost Control Days Fired days/yr (55–57)	Structure Fires #/year (58–61)	Coal Refuse Burning Size of Bank 10^2 yard^3 (62–67)	Coal Refuse Burning #/year (68–70)	(71–77)	Action (78)	(79)	cd (80)
1450		5990	· 3											A	A	5

Card 6

COMMENTS (10–77)	Action (78)	(79)	cd (80)
	A	A	6

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TABLE 11 UPDATED NEDS - AREA SOURCE DATA FOR ORLEANS PARISH

NATIONAL EMISSIONS DATA SYSTEM (NEDS)
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR PROGRAMS

AREA SOURCE
Input Form
Date _____

Name of Person
Completing Form Joel Massey--Jefferson Parish

State		County			AQCR		
1	2	3	4	5	6	7	8	9
1	9	1	3	4	0	1	0	6

Year of Record	EMISSION ESTIMATES (10^2 tons)					SULFUR CONTENT (%)				ASH CONTENT (%)		RESIDENTIAL FUEL						Action
	Particulate	SO_2	NO_x	HC	CO	Anth. Coal	Bitum. Coal	Dist. Oil	Resid. Oil	Anth. Coal	Bitum. Coal	Anth. 10^1 tons	Bitumin. 10^1 tons	Dist. Oil 10^4 Gal. 74	Resid. Oil 10^4 Gal.	Nat. Gas 10^7 ft^3	Wood 10^2 tons 72	
75	2	2	.4	7			2	8						6	3			7 3 6 . 8

Year of Record	COMMERCIAL AND INSTITUTIONAL FUEL							INDUSTRIAL FUEL												Action
	Anth. 10^1 tons	Bitumin. 10^1 tons	Dist. Oil 10^4 Gals. 74	Resid. Oil 10^4 Gals. 74	Nat. Gas 10^7 Ft^3	Wood 10^2 tons		Anth. Coal 10^1 tons	Bitum. Coal 10^1 tons	Coke 10^1 tons	Dist. Oil 10^4 Gals. 74	Resid. Oil 10^4 Gals. 74	Nat. Gas 10^7 Ft^3	Wood 10^2 tons	Process Gas 10^7 ft^3				
		i	6 2 8	5 5 5	1 4 9						2 5 8 1	2 6 5	5 4 7 . 4						A A

Year of Record	ON SITE INCINERATION			OPEN BURNING			GASOLINE FUEL				DIESEL FUEL				County Population 10^3	Heavy Veh. Gal.	Action
	Residential 10^1 tons	Industrial 10^2 tons	Comm. Inst. 10^2 tons	Residential 10^2 tons 72	Industrial 10^2 tons	Comm'l - Institl. 10^2 tons	Light Vehicle 10^3 Gals. 72	Heavy Vehicle 10^3 Gals. 73	Off Hiway 10^3 Gals. 73	Heavy Vehicle 10^3 Gals. 73	Off Hiway 10^3 Gals. 73	Rail Locomotive 10^4 Gals. 73					
				1 2 9 4			7 9 0 2 6	7 3 9 7	4 0 0 0	0 1 2 0 9 6	1 3 8 4	1 2 1 0				9	A A

Year of Record	AIRCRAFT 73			VESSELS				EVAPORATION '73			MEASURED VEHICLE MILES 72				Action
	Military LTO CYC 10^3	Civil LTO CYC 10^1	Commercial LTO CYC 10^1	Anth. Coal 10^1 tons	Diesel Oil 10^3 Gals. 72	Resid. Oil 10^4 Gals.	Gasoline 10^3 Gals. 73	Solvent Purchased tons/yr	Gasoline Marketed 10^5 Gals.	Limited Access Road 10^4 Miles	Rural Roads 10^4 Miles	Suburban Roads 10^4 Miles	Urban Roads 10^4 Miles		
	1 4	2 3 5 0	5 8 0 9		1 3 1 5		1 5 6 0	8 0 7 0	1 6 9 0		5 3 . 7	6 9 . 9	1 7 1 . 1		A A

Year of Record	Dirt Roads Traveled 10^3 Miles VMT 73	Dirt Air Strips LTO CYCLES	Construction Land Area 10^3 Acres 73	Land Tilling Ranching & Storing 10^3 Acres 72	FOREST FIRES		SLASH BURNING		FROST CONTROL		Structure Fires #/year	COAL REFUSE BURNING		Action
					Area - Acres	Quant. ton/acre	Area - Acres	Quant. tons/acre	Orchard Heaters 10^2	Days Fired days/yr		Size of Bank 10^2 yard^3	# year	
	8 0 6 0		5 2 7 0	. 2										A A

COMMENTS

Action
A A

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TABLE 12 UPDATED NEDS - AREA SOURCE DATA FOR JEFFERSON PARISH

NATIONAL EMISSIONS DATA SYSTEM (NEDS)
ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR PROGRAMS

Input Form
Date _____

Name of Person Completing Form: Joel Massey

St. Bernard Parish

State	County	AQCR
19	25	106

EMISSION ESTIMATES (10^2 tons)

Year of Record	Particulate	SO_2	NO_x	HC	CO
75	14.9				6

SULFUR CONTENT (%)

Anth. Coal	Bitum. Coal	Dist. Oil	Resid. Oil

ASH CONTENT (%)

Anth. Coal	Bitum. Coal

RESIDENTIAL FUEL

Anth. 10^1 tons	Bitumin. 10^1 tons	Dist. Oil 10^4 Gal. 74	Resid. Oil 10^4 Gal.	Nat. Gas 10^7 ft.^{3}	Wood 10^2 tons 72
		36		19.7	

Action		cd
A	A	1

COMMERCIAL AND INSTITUTIONAL FUEL

Anth. 10^1 tons	Bitumin. 10^1 tons	Dist. Oil 10^4 Gals.' 74	Resid. Oil 10^4 Gals.' 74	Nat. Gas 10^7 Ft^3	Wood 10^2 tons
		55	50	16.7	

INDUSTRIAL FUEL

Anth. Coal 10^1 tons	Bitum. Coal 10^1 tons	Coke 10^1 tons	Dist. Oil 10^4 Gals. 74	Resid. Oil 10^4 Gals. 74	Nat. Gas 10^7 Ft.^{3}	Wood 10^2 tons	Process Gas 10^7 ft^3
			31		3140.3		

Action		cd
A	A	2

ON SITE INCINERATION

Residential 10^1 tons	Industrial 10^2 tons	Comm. Inst. 10^2 tons

OPEN BURNING

Residential 10^2 tons	Industrial 10^2 tons	Comm'l - Instit. 10^2 tons

GASOLINE FUEL

Light Vehicle 10^3 Gals. 72	Heavy Vehicle 10^3 Gals. 73	Off Hiway 10^3 Gals. 73
119829	11074	22660

DIESEL FUEL

Heavy Vehicle 10^3 Gals. 72	Off Hiway 10^3 Gals. 74	Rail Locomotive 10^1 Gals. 73
1834	94	58

County Population 10^3	Illegible Code	Action		cd
	9	A	A	3

AIRCRAFT '73

Military LTO CYC 10^1	Civil LTO CYC 10^1	Commercial LTO CYC 10^1
73		

VESSELS

Anth. Coal 10^1 tons	Diesel Oil 10^4 Gals. 72	Resid. Oil 10^4 Gals. 74	Gasoline 10^3 Gals. 73
	2574	21	4810

EVAPORATION, 73

Solvent Purchased tons/yr	Gasoline Marketed 10^5 Gals.
19 6	229

MEASURED VEHICLE MILES, 72

Limited Access Road 10^4 Miles	Rural Roads 10^4 Miles	Suburban Roads 10^4 Miles	Urban Roads 10^4 Miles
	.53	35.7	

Action		cd
A	A	4

Land Tilling

Dirt Roads 73 Traveled 10^3 Miles (VMT)

	1	0	3	0	0	

Dirt Air Strips LTO CYCLES

Construction Land Area 10^3 Acres

	8	85

FOREST FIRES

Area - Acres	Quant. ton/acre
1 8	

SLASH BURNING

Area - Acres	Quant. tons/acre

FROST CONTROL

Orchard Heaters 10^2	Days Fired days/yr

Structure Fires #/year

COAL REFUSE BURNING

Size of Bank 10^2 yard^3	# year

Action		cd
A	A	5

COMMENTS

Action		cd
A	A	6

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TABLE 13 UPDATED NEDS - AREA SOURCE DATA FOR ST. BERNARD PARISH

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR PROGRAMS

Input Form
Date _____

Name of Person Completing Form: Joel Massey--Plaquemines Parish

State	County	AQCR
19	24	106

Year of Record	EMISSION ESTIMATES (10^2 tons) Particulate	SO_2	NO_x	HC	CO	SULFUR CONTENT (%) Anth. Coal	Bitum. Coal	Dist. Oil	Resid. Oil	ASH CONTENT (%) Anth. Coal	Bitum. Coal	RESIDENTIAL FUEL Anth. 10^1 tons	Bitumin. 10^1 tons	Dist. Oil 10^4 Gal. 74	Resid. Oil 10^4 Gal.	Nat. Gas 10^7 ft.3	Wood 10^2 tons	Action
75	14.9				3									31		1.4		A

COMMERCIAL AND INSTITUTIONAL FUEL Anth. 10^1 tons	Bitumin. 10^1 tons	Dist. Oil 10^4 Gals. 74	Resid. Oil 10^4 Gals. 74	Nat. Gas 10^7 Ft3	Wood 10^2tons	INDUSTRIAL FUEL Anth. Coal 10^1 tons	Bitum. Coal 10^1 tons	Coke 10^1 tons	Dist. Oil 10^4 Gals. 74	Resid. Oil 10^4 Gals. 74	Nat. Gas 10^7 Ft.3	Wood 10^2 tons	Process Gas 10^7 ft3	Action
		58	61	5.1					637	65	32.1			A

ON SITE INCINERATION Residential 10^1 tons	Industrial 10^1 tons	Comm. Inst. 10^2 tons	OPEN BURNING Residential 10^2 tons 72	Industrial 10^2 tons	Comm'l-Institl. 10^2 tons	GASOLINE FUEL Light Vehicle 10^3 Gals. 72	Heavy Vehicle 10^3 Gals. 73	Off Hiway 10^3 Gals. 73	DIESEL FUEL Heavy Vehicle 10^3 Gals. 72	Off Hiway 10^3 Gal's 74	Rail Locomotive 10^3 Gals. 73	County Population 10^3	Action
			64			1190	115	2780	90	98	82		A

AIRCRAFT 73 Military LTO CYC 10^3	Civil LTO CYC 10^1	Commercial LTO CYC 10^1	VESSELS 73 Anth. Coal 10^1 tons	Diesel Oil 10^4 Gals. 72	Resid. Oil 10^4 Gals.	Gasoline 10^3 Gals. 73	EVAPORATION Solvent Purchased tons/yr	Gasoline Marketed 10^5 Gals.	MEASURED VEHICLE MILES 72 Limited Access Road 10^4 Miles	Rural Roads 10^4 Miles	Suburban Roads 10^4 Miles	Urban Roads 10^4 les	Action
51	1	1		2479		7090	992	151		27.5		13	A

Dirt Roads Traveled 10^3 Miles (VMT) 73	Dirt Air Strips LTO CYCLES	Construction Land Area 10^6 Acres 73	Land Tilling Rock Handling & Storing 10^3 Acres	FOREST FIRES Area - Acres	Quant. ton/acre	SLASH BURNING Area - Acres 73	Quant. tons/acre	FROST CONTROL Orchard Heaters 10^2	Days Fired days/yr	Structure Fires #/year	COAL REFUSE BURNING Size of Bank 10^2 yard^3	# year	Action
12	0	0				7							A

COMMENTS	Action
	A

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TABLE 14 UPDATED NEDS - AREA SOURCE DATA FOR PLAQUEMINES PARISH

In order to utilize the updated NEDS - Area Source data, the individual parish-wide emissions had to be disaggregated and appropriately allocated (as emissions) to smaller areas to provide an adequately detailed input for CDM.

The CAASE programs (CAASE 1 through CASSE 5) with associated subroutines and offline procedures provide an objective method for allocating parish-level data to grid squares selected on the basis of demographic features and sized to give appropriate detail for input to air quality modeling programs. CAASE is an acronym made up of the first letters of Computer Assisted Area Sources Emissions Gridding Procedures.[29]

The objective of the CAASE method is the improvement of the characterization of area sources. Basic data for the determination of area source emissions seldom, if ever, are available for geographic or political units or areas smaller than the parish, or in some casses, the large city which functions politically independently of the surrounding parishes. These basic data (NEDS-AREA Source) are in the form of, for example, annual fuel consumption, by fuel type for residential, for commercial and institutional and for industrial heating; acreage burned by forest fires; landing-take-off cycles for military, for commercial and for civil air craft; gasoline or diesel fuel consumed by light, heavy and off-high vehicles, or vehicle miles traveled by road classification, etc. These data can be converted to pollutant emissions by the application of appropriate emission factors.

The geographic size of a parish, however, is too large for practical use in simulation models for AQCR's. Logical procedures are required for distributing the parish totals basic data or derived emissions data to smaller areas. Further constraints imposed by the simulation models require

that these small areas be squares, although they need not be of uniform size. Various criteria have been proposed as basis for selecting the sizes and distribution of the emission area squares. Urbanization, land use, housing counts, and population have all been used subjectively to grid AQCR's into emission area squares (hereafter called grid squares) and subsequently to apportion parish totals of pollutant emissions into each grid square. In general, the philosophy followed has required that urbanized or industrialized portions of the parish or AQCR be gridded into small squares to provide for detailed representation of concentration of pollution sources. Conversely, rural areas with few pollution sources are adequately represented by large grid squares. Essentially, application of this philosophy results in apportioning county total emissions to grid squares according to subjective estimates of the distribution of population. Since air pollution derives from human activity this procedure provides a reasonable approach to developing area source emission distributions.

The development of the CAASE programs began as an effort to reduce the subjectivity inherent in distributing population into pre-selected grid squares. Success in this effort would concurrently reduce the time and effort required to complete the area source emission distribution.

The Bureau of the Census of the U.D. Department of Commerce has prepared a modified Master Enumeration District List (MEDList) which includes, in addition to the district identification, population count, housing count, etc., the geographic coordinates of the center of area of each of the enumeration districts. A computer plot of these population centers, coded to graphically represent population count used in conjunction with U.S. Geological Survey maps providing topographic and terrain features, furnishes

a relatively detailed information base for constructing a parish grid square system.

In both study areas, the grid squares system was fixed at 762 meters (NOGE) and 1524 meters (NOSMSA) on a side. Since off-line gridding is done in the procedure steps between the execution of CAASE 2 and CAASE 3, only CAASE 1, CAASE 4, and CAASE 5 programs were used in the research study.

CAASE 1 strips the MED-X* census tape files for all of the enumeration district population entries for all parishes in the Air Quality Control Region (AQCR) being processed. CAASE 1 also converts the coordinates of the center of each enumeration district from latitude and longitude (in degrees) to Universal Traverse Mercator (UTM) coordinates which are used in dispersion modeling programs. CAASE 1 also writes tape files to be used as input to the CAASE 2 and the CAASE 4 programs.

Since the grid square system is fixed and grid description cards have been prepared, the next step in the procedure is to use the CAASE 4 program which assigns apportioning values to each of the grid squares. For each area source emission category included on the area source input form, an apportioning factor has been assigned using objective data when possible. The area source emissions category numbers and their objective apportioning factor are shown in Table 15.

CAASE 4 program logic has been written to permit the user to subjectively override any of the objective apportioning factors. The actual apportioning factor for each source category used within the program, is

---

*Master Enumeration District Listing extended with geographic coordinates (MED-X).

TABLE 15 AREA SOURCE EMISSIONS CATEGORY NUMBERS AND THEIR OBJECTIVE APPORTIONING FACTOR

CATEGORY NUMBER	MAJOR CLASSIFICATION	MINOR CLASSIFICATION	OBJECTIVE APPORTIONING FACTOR*
1	RESIDENTIAL FUEL	ANTH. COAL	HOUSING UNITS
2	RESIDENTIAL FUEL	BITUM. COAL	HOUSING UNITS
3	RESIDENTIAL FUEL	DIST. OIL	HOUSING UNITS
4	RESIDENTIAL FUEL	RESID. OIL	HOUSING UNITS
5	RESIDENTIAL FUEL	NAT. GAS	HOUSING UNITS
6	RESIDENTIAL FUEL	WOOD	HOUSING UNITS
7	COMM'L & INSTITL FUEL	ANTH. COAL	POPULATION
8	COMM'L & INSTITL FUEL	BITUM. COAL	POPULATION
9	COMM'L & INSTITL FUEL	DIST. OIL	POPULATION
10	COMM'L & INSTITL FUEL	RESID. OIL	POPULATION
11	COMM'L & INSTITL FUEL	NAT. GAS	POPULATION
12	COMM'L & INSTITL FUEL	WOOD	POPULATION
13	INDUSTRIAL FUEL	ANTH. COAL	POPULATION
14	INDUSTRIAL FUEL	BITUM. COAL	POPULATION
15	INDUSTRIAL FUEL	COKE	POPULATION
16	INDUSTRIAL FUEL	DIST. OIL	POPULATION
17	INDUSTRIAL FUEL	RESID. OIL	POPULATION
18	INDUSTRIAL FUEL	NAT. GAS	POPULATION
19	INDUSTRIAL FUEL	WOOD	POPULATION
20	INDUSTRIAL FUEL	PROCESS GAS	POPULATION
21	ON-SITE INCINERATION	RESIDENTIAL	HOUSING UNITS
22	ON-SITE INCINERATION	INDUSTRIAL	POPULATION
23	ON-SITE INCINERATION	COMM'L & INSTITL	POPULATION
24	OPEN BURNING	RESIDENTIAL	HOUSING UNITS
25	OPEN BURNING	INDUSTRIAL	POPULATION
26	OPEN BURNING	COMM'L & INSTITL	POPULATION
27	GASOLINE FUEL	LIGHT VEHICLE	POPULATION
28	GASOLINE FUEL	HEAVY VEHICLE	POPULATION
29	GASOLINE FUEL	OFF HIGHWAY	1/POPULATION DENSITY
30	DIESEL FUEL	HEAVY VEHICLE	POPULATION
31	DIESEL FUEL	OFF HIGHWAY	1/POPULATION DENSITY
32	DIESEL FUEL	RAIL LOCOMOTIVE	GRID SQ. SIDE LENGTH
33	AIRCRAFT	MILITARY	AREA
34	AIRCRAFT	CIVIL	AREA
35	AIRCRAFT	COMMERCIAL	AREA
36	VESSELS	ANTH. COAL	GRID SQ. SIDE LENGTH
37	VESSELS	DIESEL OIL	GRID SQ. SIDE LENGTH
38	VESSELS	RESID. OIL	GRID SQ. SIDE LENGTH
39	VESSELS	GASOLINE	GRID SQ. SIDE LENGTH
40	EVAPORATION	SOLVENT PURCHASED	POPULATION
41	EVAPORATION	GAS MARKETED	POPULATION
42	MEASURED VEH MILES	LIMITED ACCESS RDS	1/POPULATION DENSITY
43	MEASURED VEH MILES	RURAL ROADS	1/POPULATION DENSITY
44	MEASURED VEH MILES	SUBURBAN RDS	POPULATION
45	MEASURED VEH MILES	URBAN ROADS	POPULATION
46	DIRT RDS TRAVELED	...	1/POPULATION DENSITY
47	DIRT AIRSTRIPS	...	1/POPULATION DENSITY
48	CONSTRUCT LAND AREA	...	AREA
49	ROCK HANDLG & STORAGE	...	AREA
50	FOREST FIRES	AREA-ACRES	1/POPULATION DENSITY
51	SLASH BURNING	AREA-ACRES	1/POPULATION DENSITY
52	FROST CONTROL	ORCHARD HEATERS	1/POPULATION DENSITY
53	STRUCTURE FIRES	NO. YEAR	POPULATION
54	COAL REFUSE BURNING	SIZE OF BANK	AREA

*Each of the above apportioning factors is multiplied by a weighting factor where some are initialized as zero for all grid squares and some are initialized as 1.0 for all grid squares. These initial weighting factors can be overridden with input data if desired.

the product of a weighting factor and the assigned objective factor. This allows the user to override the programmed (or objective) apportioning factor within any particular parish (or parishes) if information to do so is available. The output of the CAASE 4 program includes binary tape files which are used as input files to the CAASE 5 program. CAASE 4 output files contain, for each grid square and source category combination for each parish, a number which can be used to apportion a fraction of the parish. Each parish within the AQCR is processed separately through the CAASE 4 program using the grid squares associated with the parish, the MED-X census data and any overriding weighting factors provided as additional input data.

The CAASE 5 program, using "fuel" totals for each of the emission source categories for area sources, apportions these "fuels" into the individual grid squares. CAASE 5 uses the same methods as those used in the EPA program NEO3 to calculate the emissions using fuel totals and emission factors for each of the source emissions categories. The term "SMEAR" has generally been used when describing the process of apportioning the total emissions for a parish into the grid squares within a parish. The CAASE 5 program does the "SMEARING" by using apportioning factors assigned by CAASE 4. CAASE 5 first "SMEARS" the "fuel" for each of the categories into each of the grid squares and outputs (prints) a tabular listing (and writes a binary magnetic tape) for all grid squares within the parish for each emissions source category. For each area source emissions category, each grid square receives a fraction of the parish total - that fraction being the number associated with that particular grid square and "fuel" category divided by the sum of all apportioning numbers for that "fuel" category within the parish. For any area source category, the apportioning fractions summed over all grid squares for that parish equals unity.

Procedurely, the pollutant emissions are calculated for the parish totals and then "SMEARED". This procedure is used, rather than calculating emissions for each grid square using "SMEARED" fuels, because the calculations for "SMEARING" do not require as much computer time as the calculations of the emissions. For each source category, emissions are calculated for the five pollutants: suspended particles (SP), sulfur dioxide (SO_2), oxides of nitrogen (NO_x), hydrocarbons (HC), and carbon monoxide (CO). As emissions of each pollutant are calculated and "SMEARED", a tabular listing is output (printed) of the "SMEARED" emissions for each pollutant as was done with the fuels. The parish totals for each emissions source category are output to indicate the contribution of each of them to the total emissions for each pollutant. For each grid square the "SMEARED" emissions from all source categories are summed for each pollutant for output in the Implementation Planning Program (IPP) expanded card format for area source inputs. A binary magnetic tape is also written containing all data items in the tabular listings and card decks. The output from CAASE 5, then includes tables of "SMEARED" fuel totals and "SMEARED" emissions for each of the five pollutants of interest, where for each grid square a separate value is printed for each source category.

Figures 5 through 9 are examples of tables of apportioned fuels for Orleans Parish, Louisiana; five tables are always necessary to output apportioned fuels for all source categories. Apportioned emissions tables are output in a format similar to the apportioned fuels tables, and Figure 10 is an example of the first page of the first table for particulate emissions for Orleans Parish, Louisiana. Figure 11 is an example of the table printed in the CAASE 5 program to depict the contributions of each source category to the parish totals for each pollutant; pollutants numbered 1 through 5

Grid SOURCE NUMBER	REGION	POLIT JURIS	COUNTY	COORDINATES X(KM)	Y(KM)	(SQ.KM)	********** RESIDENTIAL FUEL ********** ANTH. 10F1T	BITUM. 10E1T	DIST.OIL 10E4GALS	RES.OIL 10E4GALS	NAT.GAS 10E7ET3	WOOD 10E2T
180	106	1	ORLE	796.6	3308.1	2.32	0.	0.	0.	0.	0.	0.
181	106	1	ORLE	798.1	3308.1	2.32	0.	0.	0.	0.	0.	0.
201	106	1	ORLE	789.0	3309.5	2.32	0.	0.	0.	0.	0.	0.
205	106	1	ORLE	795.1	3309.6	2.32	0.	0.	0.	0.	0.	0.
206	106	1	ORLE	796.6	3309.6	2.32	0.	0.	0.	0.	0.	0.
207	106	1	ORLE	798.1	3309.6	2.32	0.	0.	0.	0.	0.	0.
220	106	1	ORLE	778.3	3310.9	2.32	0.	0.	0.	0.	0.	0.
226	106	1	ORLE	787.4	3311.0	2.32	0.	0.	0.	0.	0.	0.
227	106	1	ORLE	789.0	3311.0	2.32	0.	0.	0.	0.	1.	0.
228	106	1	ORLE	790.5	3311.0	2.32	0.	0.	0.	0.	0.	0.
229	106	1	ORLE	792.0	3311.1	2.32	0.	0.	0.	0.	0.	0.
230	106	1	ORLE	793.5	3311.1	2.32	0.	0.	0.	0.	0.	0.
231	106	1	ORLE	795.1	3311.1	2.32	0.	0.	0.	0.	3.	0.
232	106	1	ORLE	796.6	3311.1	2.32	0.	0.	0.	0.	0.	0.
233	106	1	ORLE	798.1	3311.1	2.32	0.	0.	0.	0.	0.	0.
244	106	1	ORLE	775.2	3312.3	2.32	0.	0.	0.	0.	0.	0.
245	106	1	ORLE	776.7	3312.4	2.32	0.	0.	1.	0.	10.	0.
246	106	1	ORLE	778.3	3312.4	2.32	0.	0.	3.	0.	29.	0.
247	106	1	ORLE	779.8	3312.4	2.32	0.	0.	3.	0.	22.	0.
248	106	1	ORLE	781.3	3312.4	2.32	0.	0.	2.	0.	13.	0.
251	106	1	ORLE	785.9	3312.5	2.32	0.	0.	0.	0.	3.	0.
252	106	1	ORLE	787.4	3312.5	2.32	0.	0.	1.	0.	11.	0.
253	106	1	ORLE	788.9	3312.5	2.32	0.	0.	1.	0.	6.	0.
254	106	1	ORLE	790.5	3312.6	2.32	0.	0.	0.	0.	0.	0.
255	106	1	ORLE	792.0	3312.6	2.32	0.	0.	0.	0.	0.	0.
256	106	1	ORLE	793.5	3312.6	2.32	0.	0.	0.	0.	0.	0.
257	106	1	ORLE	795.0	3312.6	2.32	0.	0.	0.	0.	0.	0.
258	106	1	ORLE	796.6	3312.6	2.32	0.	0.	0.	0.	0.	0.
270	106	1	ORLE	775.2	3313.9	2.32	0.	0.	0.	0.	0.	0.
271	106	1	ORLE	776.7	3313.9	2.32	0.	0.	2.	0.	15.	0.
272	106	1	ORLE	778.2	3313.9	2.32	0.	0.	3.	0.	28.	0.
273	106	1	ORLE	779.8	3313.9	2.32	0.	0.	6.	0.	48.	0.
274	106	1	ORLE	781.3	3314.0	2.32	0.	0.	6.	0.	52.	0.
275	106	1	ORLE	782.8	3314.0	2.32	0.	0.	2.	0.	16.	0.
276	106	1	ORLE	784.3	3314.0	2.32	0.	0.	1.	0.	9.	0.
277	106	1	ORLE	785.9	3314.0	2.32	0.	0.	1.	0.	9.	0.
278	106	1	ORLE	787.4	3314.0	2.32	0.	0.	1.	0.	6.	0.
279	106	1	ORLE	788.9	3314.1	2.32	0.	0.	0.	0.	0.	0.
280	106	1	ORLE	790.4	3314.1	2.32	0.	0.	0.	0.	0.	0.
296	106	1	ORLE	775.2	3315.4	2.32	0.	0.	0.	0.	4.	0.
297	106	1	ORLE	776.7	3315.4	2.32	0.	0.	4.	0.	30.	0.
298	106	1	ORLE	778.2	3315.4	2.32	0.	0.	2.	0.	19.	0.
299	106	1	ORLE	779.7	3315.5	2.32	0.	0.	6.	0.	50.	0.
300	106	1	ORLE	781.3	3315.5	2.32	0.	0.	6.	0.	49.	0.
301	106	1	ORLE	782.8	3315.5	2.32	0.	0.	0.	0.	3.	0.

FIGURE 5 TABLES OF APPORTIONED FUELS FOR ORLEANS PARISH

Grid SOURCE NUMBER	COUNTY	****** COMMERCIAL AND INSTITUTIONAL FUEL ****** ANTH. 10E1T	BITUM. 10E1T	DIST.OIL 10E4GALS	RES.OIL 10E4GALS	NAT.GAS 10E7FT3	WOOD 10E2T	********** INDUSTRIAL FUEL ********** ANTH. 10E1T	BITUM. 10E1T	COKE 10E1T	DIST.OIL 10E4GALS	RES.OIL 10E4GALS	NAT.GAS 10E7FT3	WOOD 10E2T	PROC.GAS 10E7FT3
180	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
191	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
201	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
205	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
206	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
207	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
220	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
226	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
227	ORLE	0.	0.	2.	2.	1.	0.	0.	0.	0.	5.	0.	1.	0.	0.
228	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
229	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
230	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
231	ORLE	0.	0.	5.	5.	2.	0.	0.	0.	0.	10.	1.	2.	0.	0.
232	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
233	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
244	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
245	ORLE	0.	0.	21.	18.	9.	0.	0.	0.	0.	41.	4.	7.	0.	0.
246	ORLE	0.	0.	55.	48.	25.	0.	0.	0.	0.	109.	11.	19.	0.	0.
247	ORLE	0.	0.	40.	35.	18.	0.	0.	0.	0.	79.	8.	14.	0.	0.
248	ORLE	0.	0.	27.	23.	12.	0.	0.	0.	0.	53.	5.	9.	0.	0.
251	ORLE	0.	0.	3.	3.	1.	0.	0.	0.	0.	7.	1.	1.	0.	0.
252	ORLE	0.	0.	22.	19.	10.	0.	0.	0.	0.	43.	4.	8.	0.	0.
253	ORLE	0.	0.	16.	14.	7.	0.	0.	0.	0.	33.	3.	6.	0.	0.
254	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
255	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.
256	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
257	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
258	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
270	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
271	ORLE	0.	0.	41.	36.	19.	0.	0.	0.	0.	82.	8.	15.	0.	0.
272	ORLE	0.	0.	53.	47.	24.	0.	0.	0.	0.	106.	11.	19.	0.	0.
273	ORLE	0.	0.	86.	76.	39.	0.	0.	0.	0.	172.	18.	30.	0.	0.
274	ORLE	0.	0.	81.	72.	37.	0.	0.	0.	0.	163.	17.	29.	0.	0.
275	ORLE	0.	0.	46.	40.	21.	0.	0.	0.	0.	91.	9.	16.	0.	0.
276	ORLE	0.	0.	16.	14.	7.	0.	0.	0.	0.	32.	3.	6.	0.	0.
277	ORLE	0.	0.	25.	22.	11.	0.	0.	0.	0.	49.	5.	9.	0.	0.
278	ORLE	0.	0.	17.	15.	8.	0.	0.	0.	0.	34.	3.	6.	0.	0.
279	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
280	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
296	ORLE	0.	0.	7.	6.	3.	0.	0.	0.	0.	13.	1.	2.	0.	0.
297	ORLE	0.	0.	55.	48.	25.	0.	0.	0.	0.	110.	11.	19.	0.	0.
298	ORLE	0.	0.	36.	32.	16.	0.	0.	0.	0.	72.	7.	13.	0.	0.
299	ORLE	0.	0.	106.	93.	48.	0.	0.	0.	0.	211.	22.	37.	0.	0.
300	ORLE	0.	0.	91.	80.	41.	0.	0.	0.	0.	181.	19.	32.	0.	0.
301	ORLE	0.	0.	6.	5.	3.	0.	0.	0.	0.	12.	1.	2.	0.	0.

FIGURE 6 TALBES OF APPORTIONED FUELS FOR ORLEANS PARISH

Grid Source Number	County	* On Site Incineration * Resid. 10E1T	Industr. 10E2T	C-Inst. 10E2T	****** Open Burning ****** Resid. 10E2T	Industr. 10E2T	Com.Inst. 10E2T	****** Gasoline Fuel ****** Lt.Veh. 10E3GAL	Hv.Veh. 10E3GAL	Off Hiwy 10E3GAL	******** Diesel Fuel ******** Hv.Veh. 10E3GAL	Off Hiwy 10E4GAL	Rail Loco. 10E4GAL
180	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
181	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
201	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
205	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
206	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
207	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	4.
220	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	14.
226	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
227	ORLE	0.	0.	0.	2.	0.	0.	269.	25.	169.	23.	6.	10.
228	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
229	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
230	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
231	ORLE	0.	0.	0.	6.	0.	0.	568.	53.	80.	49.	3.	10.
232	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
233	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
244	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	24.
245	ORLE	0.	0.	0.	21.	0.	0.	2279.	213.	20.	197.	1.	48.
246	ORLE	0.	0.	0.	60.	0.	0.	6071.	568.	8.	524.	0.	48.
247	ORLE	0.	0.	0.	46.	0.	0.	4406.	412.	10.	380.	0.	39.
248	ORLE	0.	0.	0.	27.	0.	0.	2946.	276.	15.	254.	1.	10.
251	ORLE	0.	0.	0.	6.	0.	0.	368.	34.	124.	32.	4.	10.
252	ORLE	0.	0.	0.	22.	0.	0.	2391.	224.	19.	206.	1.	10.
253	ORLE	0.	0.	0.	12.	0.	0.	1815.	170.	25.	157.	1.	10.
254	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
255	ORLE	0.	0.	0.	0.	0.	0.	32.	3.	1407.	3.	49.	10.
256	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
257	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
258	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	7.
270	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	34.
271	ORLE	0.	0.	0.	31.	0.	0.	4583.	429.	10.	396.	0.	10.
272	ORLE	0.	0.	0.	58.	0.	0.	5916.	554.	8.	511.	0.	10.
273	ORLE	0.	0.	0.	100.	0.	0.	9573.	896.	5.	826.	0.	10.
274	ORLE	0.	0.	0.	109.	0.	0.	9054.	847.	5.	781.	0.	10.
275	ORLE	0.	0.	0.	34.	0.	0.	5068.	474.	9.	437.	0.	39.
276	ORLE	0.	0.	0.	18.	0.	0.	1758.	165.	26.	152.	1.	20.
277	ORLE	0.	0.	0.	18.	0.	0.	2734.	256.	17.	236.	1.	10.
278	ORLE	0.	0.	0.	12.	0.	0.	1872.	175.	24.	162.	1.	10.
279	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
280	ORLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	10.
296	ORLE	0.	0.	0.	8.	0.	0.	737.	69.	62.	64.	2.	34.
297	ORLE	0.	0.	0.	62.	0.	0.	6098.	571.	7.	526.	0.	10.
298	ORLE	0.	0.	0.	41.	0.	0.	4021.	376.	11.	347.	0.	10.
299	ORLE	0.	0.	0.	105.	0.	0.	11728.	1098.	4.	1012.	0.	10.
300	ORLE	0.	0.	0.	102.	0.	0.	10092.	945.	5.	871.	0.	7.
301	ORLE	0.	0.	0.	6.	0.	0.	682.	64.	67.	59.	2.	20.

FIGURE 7 TABLES OF APPORTIONED FUELS FOR ORLEANS PARISH

Grid SOURCE NUMBER	COUNTY	****** AIRCRAFT ****** MILIT. LC10E2	CIVIL LC10E1	COMM'L. LC10E1	********** VESSELS ********** BITUM. 10E1T	DE. OIL 10E4GAL	PES.OIL 10E4GAL	GAS 10E3GAL	*** EVAPORATION *** SOL.PUR. TONS/YR	GAS.MKTD. 10E5GALS	******* MEASURED VEHICLE MILES ****** LTD.ACC. 10E4MI	RUR.RDS. 10E4MI	SUB.RDS. 10E4MI	URB.RDS. 10E4MI
180	ORLE	2.	92.	1.	0.	14.	8.	2.	0.	0.	0.	0.	0.	0.
181	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
201	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
205	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
206	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
207	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
220	ORLE	2.	92.	1.	0.	3.	2.	0.	0.	0.	0.	0.	0.	0.
226	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
227	ORLE	2.	92.	1.	0.	28.	17.	3.	18.	2.	0.	0.	0.	0.
228	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
229	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
230	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
231	ORLE	2.	92.	1.	0.	28.	17.	3.	37.	4.	0.	0.	0.	0.
232	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
223	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
244	ORLE	2.	92.	1.	0.	3.	2.	0.	0.	0.	0.	0.	0.	0.
245	ORLE	2.	92.	1.	0.	7.	4.	1.	149.	17.	0.	0.	2.	0.
246	ORLE	2.	92.	1.	0.	7.	4.	1.	396.	46.	0.	0.	5.	1.
247	ORLE	2.	92.	1.	0.	7.	4.	1.	287.	33.	0.	0.	4.	1.
248	ORLE	2.	92.	1.	0.	3.	2.	0.	192.	22.	0.	0.	2.	1.
251	ORLE	2.	92.	1.	0.	28.	17.	3.	24.	3.	0.	0.	0.	0.
252	ORLE	2.	92.	1.	0.	28.	17.	3.	156.	18.	0.	0.	2.	0.
253	ORLE	2.	92.	1.	0.	28.	17.	3.	118.	14.	0.	0.	2.	0.
254	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
255	ORLE	2.	92.	1.	0.	28.	17.	3.	2.	0.	3.	0.	0.	0.
256	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
257	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
258	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
270	ORLE	2.	92.	1.	0.	3.	2.	0.	0.	0.	0.	0.	0.	0.
271	ORLE	2.	92.	1.	0.	28.	17.	3.	299.	35.	0.	0.	4.	1.
272	ORLE	2.	92.	1.	0.	28.	17.	3.	386.	45.	0.	0.	5.	1.
273	ORLE	2.	92.	1.	0.	28.	17.	3.	624.	72.	0.	0.	8.	2.
274	ORLE	2.	92.	1.	0.	28.	17.	3.	590.	68.	0.	0.	8.	2.
275	ORLE	2.	92.	1.	0.	3.	2.	0.	330.	38.	0.	0.	4.	1.
276	ORLE	2.	92.	1.	0.	28.	17.	3.	115.	13.	0.	0.	1.	0.
277	ORLE	2.	92.	1.	0.	28.	17.	3.	178.	21.	0.	0.	2.	0.
278	ORLE	2.	92.	1.	0.	28.	17.	3.	122.	14.	0.	0.	2.	0.
279	ORLE	2.	92.	1.	0.	14.	8.	2.	0.	0.	0.	0.	0.	0.
280	ORLE	2.	92.	1.	0.	28.	17.	3.	0.	0.	0.	0.	0.	0.
296	ORLE	2.	92.	1.	0.	3.	2.	0.	48.	6.	0.	0.	1.	0.
297	ORLE	2.	92.	1.	0.	28.	17.	3.	397.	46.	0.	0.	5.	1.
298	ORLE	2.	92.	1.	0.	28.	17.	3.	262.	30.	0.	0.	3.	1.
299	ORLE	2.	92.	1.	0.	28.	17.	3.	764.	89.	0.	0.	10.	2.
300	ORLE	2.	92.	1.	0.	28.	17.	3.	659.	76.	0.	0.	8.	2.
301	ORLE	2.	92.	1.	0.	3.	2.	0.	44.	5.	0.	0.	1.	0.

FIGURE 8 TABLES OF APPORTIONED FUELS FOR ORLEANS PARISH

Grid SOURCE NUMBER	COUNTY	DIRT RDS TRAVELED 10E3MI	DIRT AIR STRIPS LTO CYC	CONSTR. LAND ACR 10E3ACR	ROCK HAND. AND STORG. 10E3T	* FOREST FIRES * AR.ACRES	QUANT. T/ACR	SLASH BURNING AR.ACRES	QUANT. T/ACR	FROST ORCH. HEAT. 10E2	CONTROL DAYS FIRED DY/YR	STRUC. FIRES #/YR	COAL REF. BANK SIZE 10E2YD3	BURN. NUMBER PER YEAR
180	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
181	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
201	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
205	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
206	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
207	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
220	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
226	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
227	ORLE	4.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
228	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
229	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
230	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
231	ORLE	2.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
232	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
233	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
244	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
245	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
246	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
247	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
248	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
251	ORLE	3.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
252	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
253	ORLE	1.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
254	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
255	ORLE	33.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
256	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
257	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
258	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
270	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
271	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
272	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
273	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
274	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
275	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
276	ORLE	1.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
277	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
278	ORLE	1.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
279	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
280	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
296	ORLE	1.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
297	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
298	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
299	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
300	ORLE	0.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
301	ORLE	2.	0.	38.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

FIGURE 9 TABLES OF APPORTIONED FUELS FOR ORLEANS PARISH

SOURCE NUMBER	REGION	POLIT JURIS	COUNTY	COORDINATES X(KM)	Y(KM)	(SQ.KM)	RESIDENTIAL FUEL ANTH.	BITUM.	DIST.OIL	RES.OIL	NAT.GAS	WOOD
180	106	1	ORLE	796.6	3308.1	2.32	0.	0.	0.	0.	0.	0.
181	106	1	ORLE	798.1	3308.1	2.32	0.	0.	0.	0.	0.	0.
201	106	1	ORLE	789.0	3309.5	2.32	0.	0.	0.	0.	0.	0.
205	106	1	ORLE	795.1	3309.6	2.32	0.	0.	0.	0.	0.	0.
206	106	1	ORLE	796.6	3309.6	2.32	0.	0.	0.	0.	0.	0.
207	106	1	ORLE	798.1	3309.6	2.32	0.	0.	0.	0.	0.	0.
220	106	1	ORLE	778.3	3310.9	2.32	0.	0.	0.	0.	0.	0.
226	106	1	ORLE	787.4	3311.0	2.32	0.	0.	0.	0.	0.	0.
227	106	1	ORLE	789.0	3311.0	2.32	0.	0.	0.	0.	0.	0.
228	106	1	ORLE	790.5	3311.0	2.32	0.	0.	0.	0.	0.	0.
229	106	1	ORLE	792.0	3311.1	2.32	0.	0.	0.	0.	0.	0.
230	106	1	ORLE	793.5	3311.1	2.32	0.	0.	0.	0.	0.	0.
231	106	1	ORLE	795.1	3311.1	2.32	0.	0.	0.	0.	0.	0.
232	106	1	ORLE	796.6	3311.1	2.32	0.	0.	0.	0.	0.	0.
233	106	1	ORLE	798.1	3311.1	2.32	0.	0.	0.	0.	0.	0.
244	106	1	ORLE	775.2	3312.3	2.32	0.	0.	0.	0.	0.	0.
245	106	1	ORLE	776.7	3312.4	2.32	0.	0.	0.	0.	1.	0.
246	106	1	ORLE	778.3	3312.4	2.32	0.	0.	0.	0.	1.	0.
247	106	1	ORLE	779.8	3312.4	2.32	0.	0.	0.	0.	1.	0.
248	106	1	ORLE	781.3	3312.4	2.32	0.	0.	0.	0.	1.	0.
251	106	1	ORLE	785.9	3312.5	2.32	0.	0.	0.	0.	0.	0.
252	106	1	ORLE	787.4	3312.5	2.32	0.	0.	0.	0.	1.	0.
253	106	1	ORLE	788.9	3312.5	2.32	0.	0.	0.	0.	0.	0.
254	106	1	ORLE	790.5	3312.6	2.32	0.	0.	0.	0.	0.	0.
255	106	1	ORLE	792.0	3312.6	2.32	0.	0.	0.	0.	0.	0.
256	106	1	ORLE	793.5	3312.6	2.32	0.	0.	0.	0.	0.	0.
257	106	1	ORLE	795.0	3312.6	2.32	0.	0.	0.	0.	0.	0.
258	106	1	ORLE	796.6	3312.6	2.32	0.	0.	0.	0.	0.	0.
270	106	1	ORLE	775.2	3313.9	2.32	0.	0.	0.	0.	0.	0.
271	106	1	ORLE	776.7	3313.9	2.32	0.	0.	0.	0.	1.	0.
272	106	1	ORLE	778.2	3313.9	2.32	0.	0.	0.	0.	1.	0.
273	106	1	ORLE	779.8	3313.9	2.32	0.	0.	0.	0.	2.	0.
274	106	1	ORLE	781.3	3314.0	2.32	0.	0.	0.	0.	3.	0.
275	106	1	ORLE	782.8	3314.0	2.32	0.	0.	0.	0.	1.	0.
276	106	1	ORLE	784.3	3314.0	2.32	0.	0.	0.	0.	0.	0.
277	106	1	ORLE	785.9	3314.0	2.32	0.	0.	0.	0.	0.	0.
278	106	1	ORLE	787.4	3314.0	2.32	0.	0.	0.	0.	0.	0.
279	106	1	ORLE	788.9	3314.1	2.32	0.	0.	0.	0.	0.	0.
280	106	1	ORLE	790.4	3314.1	2.32	0.	0.	0.	0.	0.	0.
296	106	1	ORLE	775.2	3315.4	2.32	0.	0.	0.	0.	0.	0.
297	106	1	ORLE	776.7	3315.4	2.32	0.	0.	0.	0.	1.	0.
298	106	1	ORLE	778.2	3315.4	2.32	0.	0.	0.	0.	1.	0.
299	106	1	ORLE	779.7	3315.5	2.32	0.	0.	0.	0.	2.	0.
300	106	1	ORLE	781.3	3315.5	2.32	0.	0.	0.	0.	2.	0.
301	106	1	ORLE	782.8	3315.5	2.32	0.	0.	0.	0.	0.	0.

FIGURE TO TABLE FOR PARTICULATE EMISSIONS FOR ORLEANS PARISH

TOTALS BY SOURCE CATEGORY FOR POLLUTANT NUMBER 1

0.0	0.0	6.650	0.0	54.500	2.500	0.0	0.0	166.350	225.170
50.000	0.0	0.0	0.0	0.0	332.100	51.980	39.900	0.0	0.0
0.0	0.0	0.0	1830.400	0.0	0.0	0.0	0.0	334.910	0.0
366.300	233.750	362.180	39.517	1.208	0.0	490.800	234.398	0.0	0.0
0.0	0.940	0.0	1.364	0.297	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0						

TOTALS BY SOURCE CATEGORY FOR POLLUTANT NUMBER 2

0.0	0.0	0.0	0.0	3.270	0.150	0.0	0.0	0.0	0.0
3.000	0.0	0.0	0.0	0.0	0.0	0.0	2.340	0.0	0.0
0.0	0.0	0.0	114.400	0.0	0.0	0.0	0.0	175.290	0.0
327.800	532.950	69.160	7.848	1.728	0.0	613.500	3473.468	1.525	0.0
0.0	0.356	0.0	0.517	0.113	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0						

TOTALS BY SOURCE CATEGORY FOR POLLUTANT NUMBER 3

0.0	0.0	7.980	0.0	436.000	1.000	0.0	0.0	665.400	587.400
600.000	0.0	0.0	0.0	0.0	1328.400	135.600	702.000	0.0	0.0
0.0	0.0	0.0	686.400	0.0	0.0	0.0	0.0	3818.600	0.0
4058.998	3459.499	173.992	35.697	17.010	0.0	4580.797	507.661	6.631	0.0
0.0	9.406	0.0	12.460	2.539	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0						

TOTALS BY SOURCE CATEGORY FOR POLLUTANT NUMBER 4

0.0	0.0	1.995	0.0	43.600	2.000	0.0	0.0	33.270	29.370
40.000	0.0	0.0	0.0	0.0	66.420	6.780	11.700	0.0	0.0
0.0	0.0	0.0	3422.000	0.0	0.0	0.0	0.0	10767.199	0.0
444.400	878.900	842.660	175.014	22.342	0.0	1202.460	35.220	225.302	16060.000
2045.999	10.744	0.0	17.177	4.421	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0						

TOTALS BY SOURCE CATEGORY FOR POLLUTANT NUMBER 5

0.0	0.0	3.325	0.0	109.000	2.000	0.0	0.0	44.360	39.160
100.000	0.0	0.0	0.0	0.0	88.560	9.040	66.300	0.0	0.0
0.0	0.0	0.0	9724.000	0.0	0.0	0.0	0.0	122069.938	0.0
1144.000	1215.500	904.540	1000.079	46.102	0.0	1603.280	17.003	716.320	0.0
0.0	52.355	0.0	96.305	28.628	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0						

FOR POLLUTANT= SP TOTAL EMISSIONS= 4824.305

FIGURE 11 CONTRIBUTIONS OF EACH SOURCE CATEGORY TO PARISH TOTALS FOR EACH POLLUTANT

represent TSP, SO_2, NO_x, HC and CO, respectively, and each table is read row-wise for the 54 categories; the last line in the figure appears in the output on a separate page (it was placed in the figure to conserve space) and represents the total particulate emissions for the parish for all area source categories. Also, a card deck is punched in the IPP format, containing, for each grid square, the total suspended particles, sulfur dioxide, oxides of nitrogen, hydrocarbon, and carbon monoxide emissions "SMEARED" into each grid square for all source categories. Figure 12 is a flow chart of the overall CAASE System.

Sampling data

The NOGE presented a unique air pollution problem in the uptown area of New Orleans. As a result, a special TSP sampling network was utilized from May 1976 through October 1976 by the author and employees of the Louisiana Air Control Agency. This sampling network was initially established due to political pressure, but after considerable community pressure, the Louisiana Air Control Agency claimed the on-going sampling network as part of a program to monitor the New Orleans Grain Elevator.

Initially, nine sampling locations were used to monitor the air around the grain elevator. They were as follows:

1. St. Elizabeth Home
2. City Maintenance Building
3. Tennis Club
4. De LaSalle High School
5. DePaul's Hospital
6. Lighthouse For The Blind

CAASE SYSTEM DESCRIPTION

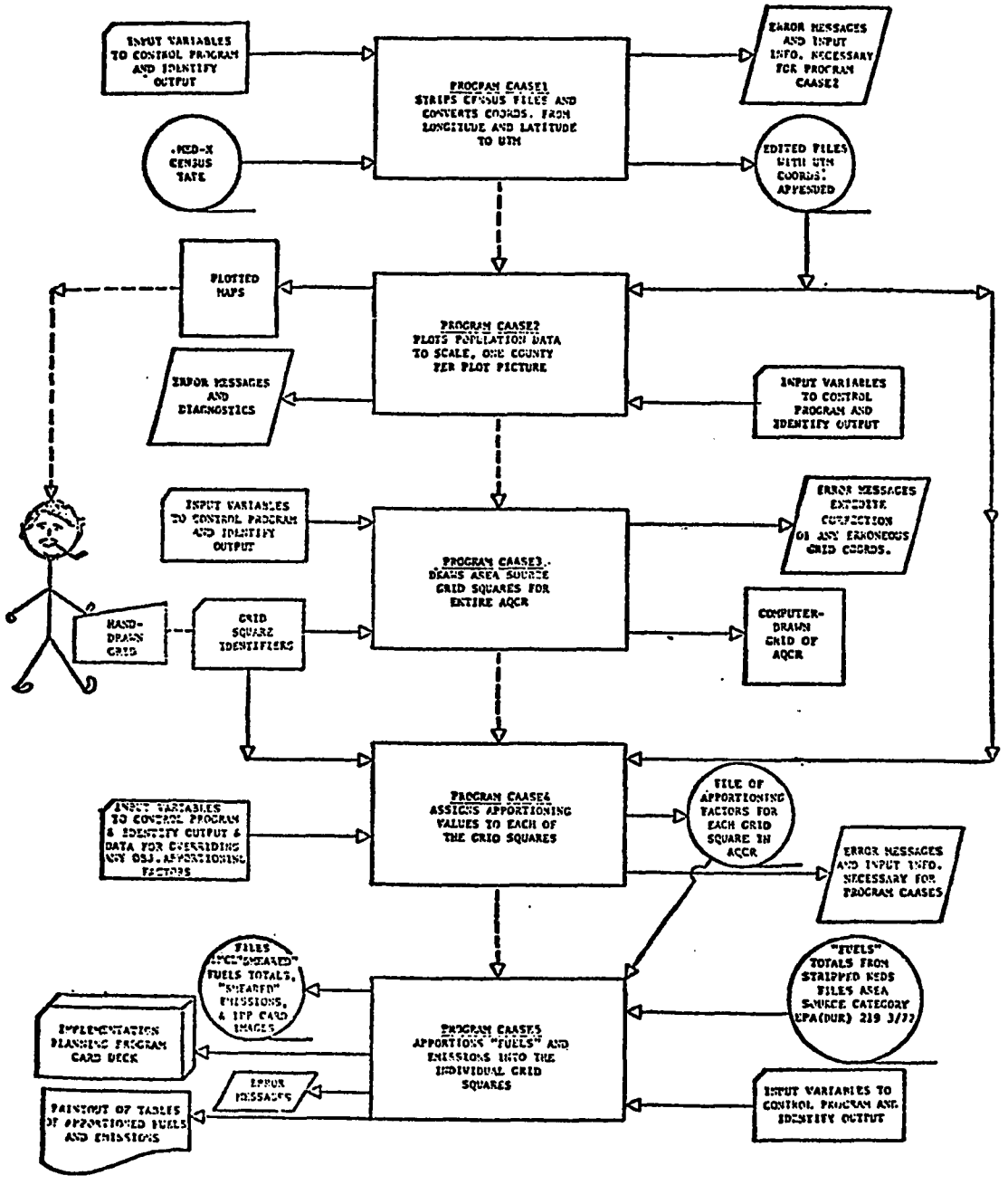


FIGURE 12 FLOWCHART OF CAASE SYSTEM

7. Used Car Lot
8. West Bank Boat
9. Continental Cars

Because the Louisiana Air Control Agency found that the sampler at the Continental Cars location was supposedly biased, no data was collected at that site after the first month. Other strange things occurred later in the use of the sampling network, and these occurrences will be discussed in a later chapter. Table 16 shows the final eight sampling locations and their six month geometric means.

The NOSMSA study used sampling data from 11 sites located in the metro area. These sites were chosen because they all had several years of data and were considered as an integral part of the state's air sampling network in 1975. Each TSP monitor in both sampling networks was located within the two to 15 meters height above the ground as required in Volume 44, No. 92 of the Federal Register. Table 17 is a listing of the sites and the TSP annual geometric means for 1975.

CDM CALIBRATION

After the study areas were selected, emissions and sampling data collected, and all other necessary data compiled, the CDM was debugged and utilized. The model outputs for each receptor location in the initial runs in both study grids are referred to as the calculated (unadjusted) TSP concentrations. These concentrations are not valid in this form.

To be certain that the CDM estimates are as accurate as possible, validation-calibration is required. Any model may have faults which cause estimated concentrations to be in error. Therefore, it was necessary to validate and calibrate the model estimates.

Table 16 NOGE Sampling Network Sites
(1976 6-Month Geometric Means, ug/m3)

TSP Sampling Site	Location (Kilometers) Horiz. (East)	Vert. (North)	TSP Observed ($\mu g/m^3$)
St. Elizabeth Home	779.68	3313.73	57
City Maintenance Bldg.	779.09	3312.85	93
Tennis Club	778.65	3313.12	73
De LaSalle High School	778.82	3314.02	62
DePaul's Hospital	777.64	3313.83	54
Lighthouse For Blind	777.72	33312.73	74
Used Car Lot	779.57	3310.86	73
West Bank Boat	777.33	3311.15	99

Table 17 NOSMSA Sampling Network Sites
(1975 Annual Geometric Means ug/m3)

TSP Sampling Site	Location (Kilometers) Horiz. (East)	Vert. (North)	TSP Observed ($\mu g/m^3$)
Kaiser	791.55	3315.58	62
Harvey	782.87	3311.72	58
Metairie	775.63	3319.15	65
Civic Center	782.18	3316.79	71
Magazine Street	782.84	3316.06	66
Algiers Pump Station	789.94	3310.82	40
Robert E. Lee Blvd.	779.82	3324.24	40
Downman Road	787.10	3324.86	61
Water Purification Plant	776.96	3317.58	70
North Broad	782.91	3320.93	61
City Maintenance Bldg.	779.09	3312.85	110

Correlation Analysis

In the CDM validation process, the dispersion model is affected by the location, exposure, and representativeness of the air quality sampling sites and by the accuracy and completeness of the air quality data itself. In order to validate the CDM for the NOGE and NOSMSA study, the correlation coefficient was used as the indicator of validity. In the NOGE study, the computed correlation coefficient was 0.896 and a 0.5% confidence correlation was 0.819. This means that greater than 99.5% of the time, the CDM can account for 80.3% of the variations between calculated concentrations and observed concentrations. In the NOSMSA study, the computed correlation coefficient was 0.781 and a 0.5% confidence correlation was 0.726. This means that greater than 99.5% of the time, the CDM can account for 61% of the variations between calculated concentrations and observed concentrations in that study.

Regression Analysis

Once the CDM estimates have been determined to be acceptable, they must be calibrated. The calibration should account for systematic errors in estimates. A model is calibrated by comparing the calculated concentration estimates to observed air quality. Then by use of a regression equation, a means for adjusting the individual model estimates is developed. If calibration constants of the linear expression

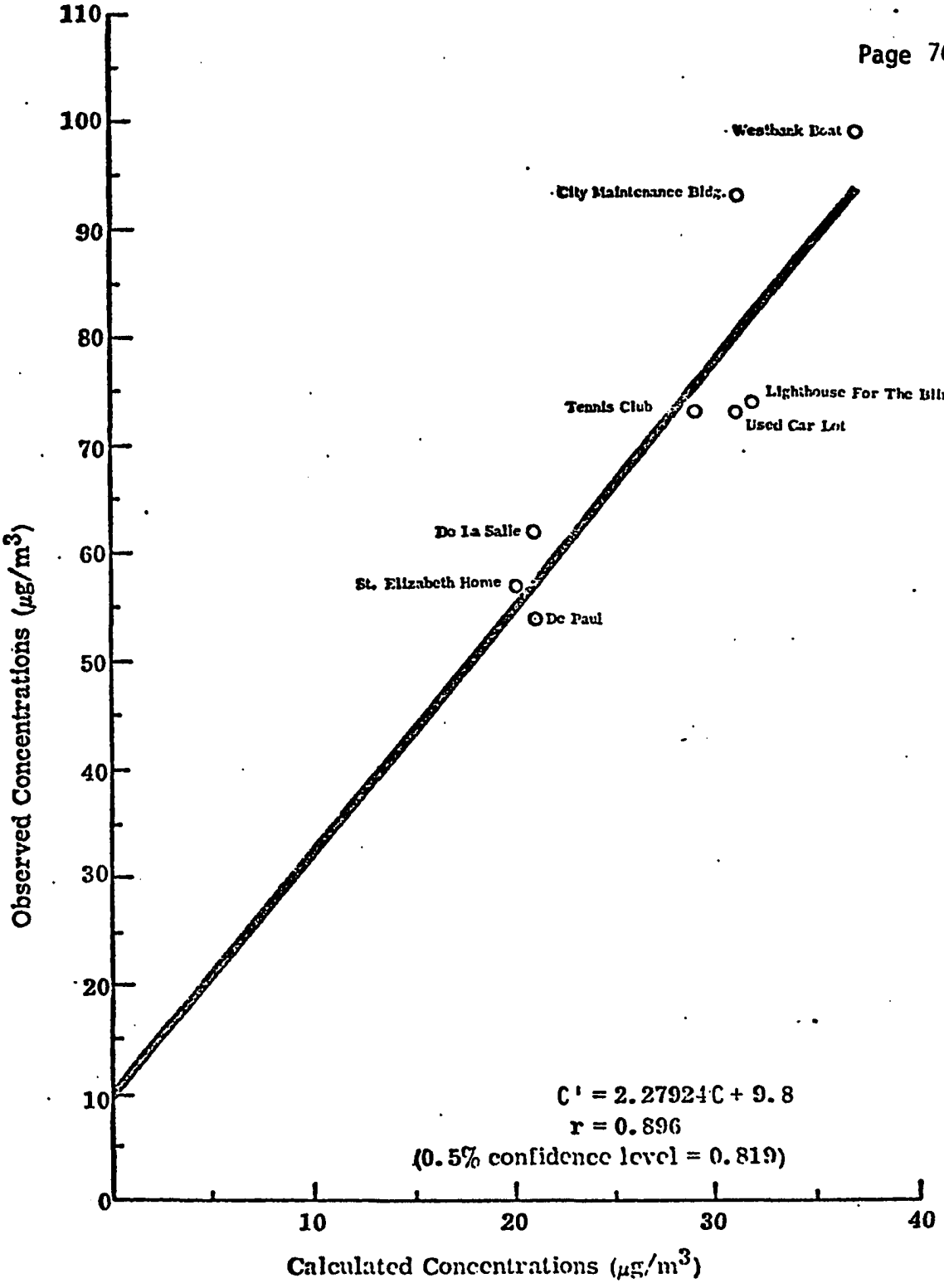
$$C' = A + BC$$

where C' = calibrated concentration

A,B = Calibration constants

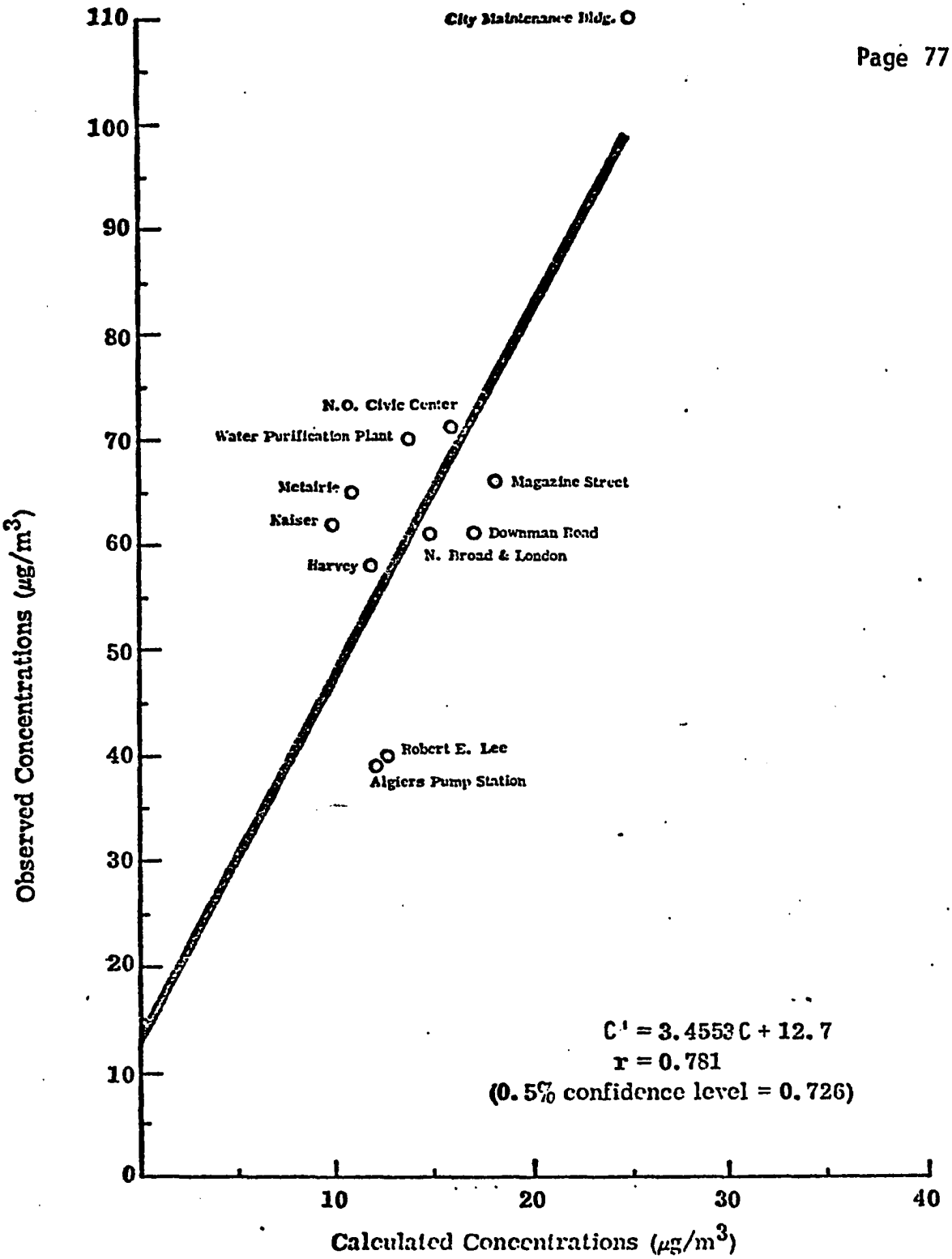
C = computed concentration

are known, they may be entered into the CDM program and used to obtain a calibrated concentration.



Grain Elevator Final Calibration, Total Suspended Particles
1976 6-month Geometric Mean (CAASE Area Sources)

Figure 13



New Orleans Metro Final Calibration, Total Suspended Particles
1975 Annual Geometric Mean (CAASE Area Sources)

Figure 14

The final NOGE CDM calibration run calculated a regression equation with a slope of 2.279 and an intercept of 9.8. Figure 13 is the NOGE graph of the CDM (unadjusted) calculated concentrations (X-axis), observed concentrations (Y-axis), and the least squares best fit regression line (equation).

The final NOSMSA CDM calibration run calculated a regression equation with a slope of 3.455 and an intercept of 12.7. Figure 14 is the NOSMSA graph of the CDM (unadjusted) calculated concentrations (X-axis), observed concentrations (Y-axis), and the least squares best fit regression line (equation).

With the known calibration constants for each study area, the model can output the calculated (adjusted) TSP concentrations for each receptor site of interest. For example, Tables 18 and 19 show the observed concentrations, calculated (unadjusted) concentrations, and calculated (adjusted) concentrations for the NOGE sampling sites and NOSMSA sampling sites respectively.

CDM Output

After validity tests were conducted and calibration constants determined, the CDM was used with study parameters for a valid run. In this final run, output data from the CDM comes in the form of punched cards and computer print-out sheets. For each receptor location the coordinates can be shown in tables along with the calculated (unadjusted) contribution due to area and point sources in micrograms per cubic meter to the nearest whole number. The tables also contain the calculated (adjusted) concentrations and any previously observed concentrations for each receptor. Table 20 is an example of the output data for some receptor locations in Orleans Parish.

Table 18 Final CDM Calibration Run Results for Grain Elevator Study (1976 6-Month Geometric Means, ug/m3)

TSP Sampling Site	Location (Kilometers) Horiz. (East)	Vert. (North)	TSP Concentration (Micrograms/cu meter) Observed	Calculated (Unadjusted)	Calculated (Adjusted)
St. Elizabeth Home	779.68	3313.73	57	20	55
City Maintenance Bldg.	779.09	3312.85	93	31	80
Tennis Club	778.65	3313.12	73	31	80
De LaSalle High School	778.82	3314.02	62	21	59
DePaul's Hospital	777.64	3313.83	54	21	57
Lighthouse For Blind	777.72	33312.73	74	32	84
Used Car Lot	779.57	3310.86	73	29	76
West Bank Boat	777.33	3311.15	99	37	95

Table 19 Final CDM Calibration Run Results for Orleans, Jefferson St. Bernard and Plaquemine Parishes
(1975 Annual Geometric Means ug/m3)

TSP Sampling Site	Location (Kilometers) Horiz. (East)	Vert. (North)	TSP Concentration (Micrograms/ cu meter) Observed	Calculated (Unadjusted)	Calculated (Adjusted)
Kaiser	791.55	3315.58	62	10	48
Harvey	782.87	3311.72	58	12	55
Metairie	775.63	3319.15	65	11	51
Civic Center	782.18	3316.79	71	16	70
Magazine Street	782.84	3316.06	66	18	74
Algiers Pump Station	789.94	3310.82	40	12	54
Robert E Lee Blvd.	779.82	3324.24	40	13	57
Downman Road	787.10	3324.86	61	17	71
Water Purification Plant	776.96	3317.58	70	14	62
North Broad	782.91	3320.93	61	15	65
City Maintenance Bldg.	779.09	3312.85	110	25	99

TABLE 20 RECEPTOR LOCATIONS OUTPUT BY CDM

COM VERSION 74114, RUN 1
(MICROGRAMS PER CUBIC METER)

COORDINATES		AREA		POINT		TOTAL		CALIBRATED		OBSERVED	
		P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2
775.24	3310.82	3.	7.	12.	7.	15.	14.	43.	14.	0	0
776.00	3310.80	3.	8.	19.	8.	22.	15.	61.	15.	0	0
776.75	3310.82	3.	8.	16.	7.	19.	15.	53.	15.	0	0
777.53	3310.84	4.	9.	28.	9.	32.	17.	82.	17.	0	0
778.28	3310.86	4.	9.	41.	7.	45.	16.	113.	16.	0	0
779.06	3310.85	4.	9.	33.	7.	37.	16.	95.	16.	0	0
779.81	3310.87	4.	9.	21.	7.	25.	16.	67.	16.	0	0
780.56	3310.89	4.	9.	14.	7.	18.	17.	51.	17.	0	0
781.34	3310.91	4.	9.	18.	8.	22.	17.	61.	17.	0	0
782.09	3310.90	4.	10.	14.	6.	18.	16.	51.	18.	0	0
782.87	3310.92	4.	10.	11.	8.	15.	19.	45.	19.	0	0
775.23	3311.55	3.	7.	14.	8.	17.	14.	49.	14.	0	0
775.98	3311.57	3.	8.	26.	8.	29.	16.	76.	16.	0	0
776.75	3311.59	3.	9.	19.	7.	23.	15.	61.	15.	0	0
776.75	3311.59	3.	9.	19.	7.	23.	15.	61.	15.	0	0
777.51	3311.61	4.	9.	24.	10.	28.	19.	74.	19.	0	0
778.29	3311.60	4.	9.	47.	7.	51.	17.	127.	17.	0	0
779.04	3311.62	4.	10.	52.	8.	56.	17.	138.	17.	0	0
779.79	3311.64	4.	10.	23.	7.	27.	17.	72.	17.	0	0
780.57	3311.66	4.	11.	27.	8.	31.	16.	81.	18.	0	0
781.32	3311.65	4.	11.	19.	8.	23.	19.	63.	19.	0	0
782.10	3311.67	4.	11.	15.	9.	19.	20.	53.	20.	0	0
782.85	3311.69	4.	11.	13.	9.	17.	21.	49.	21.	0	0
775.21	3312.33	3.	7.	19.	8.	22.	15.	61.	15.	0	0
775.99	3312.35	4.	8.	22.	8.	26.	16.	69.	16.	0	0
776.74	3312.36	4.	9.	16.	7.	21.	16.	57.	16.	0	0
777.49	3312.35	5.	11.	21.	8.	27.	19.	71.	19.	0	0
778.27	3312.37	6.	12.	25.	7.	31.	19.	80.	19.	0	0
779.02	3312.39	6.	14.	36.	7.	42.	22.	105.	22.	0	0
779.60	3312.41	6.	15.	23.	7.	29.	23.	76.	23.	0	0
780.55	3312.40	6.	15.	17.	8.	22.	23.	61.	23.	0	0
781.30	3312.42	6.	15.	13.	9.	18.	24.	52.	24.	0	0
782.08	3312.44	5.	14.	11.	12.	16.	26.	46.	26.	0	0
782.83	3312.46	5.	14.	9.	13.	14.	27.	43.	27.	0	0
775.21	3313.10	3.	7.	15.	9.	18.	16.	52.	16.	0	0
775.96	3313.11	4.	8.	37.	9.	41.	17.	104.	17.	0	0
776.72	3313.10	5.	9.	29.	7.	34.	17.	86.	17.	0	0
777.50	3313.12	6.	12.	23.	8.	29.	20.	76.	20.	0	0
778.25	3313.14	6.	14.	21.	7.	28.	21.	73.	21.	0	0
779.03	3313.16	7.	16.	23.	8.	30.	24.	77.	24.	0	0
779.78	3313.15	7.	17.	16.	7.	23.	24.	63.	24.	0	0
780.53	3313.17	7.	18.	13.	8.	20.	25.	56.	25.	0	0
781.31	3313.19	7.	17.	11.	8.	18.	26.	50.	26.	0	0
782.06	3313.21	6.	16.	10.	9.	16.	26.	46.	26.	0	0
782.84	3313.20	6.	15.	9.	10.	15.	25.	43.	25.	0	0
775.19	3313.87	4.	8.	17.	9.	21.	17.	57.	17.	0	0
775.95	3313.85	4.	9.	29.	7.	33.	16.	85.	16.	0	0
776.72	3313.87	5.	10.	17.	8.	22.	17.	59.	17.	0	0
777.48	3313.89	7.	13.	14.	7.	21.	21.	57.	21.	0	0
778.23	3313.91	7.	15.	14.	7.	22.	22.	60.	22.	0	0
779.01	3313.90	8.	18.	14.	8.	22.	25.	60.	25.	0	0

TABLE 20 (CONTINUED). RECEPTOR LOCATIONS OUTPUT BY CDM

CDM VERSION 74114, RUN 1
(MICROGRAMS PER CUBIC METER)

COORDINATES		AREA		POINT		TOTAL		CALIBRATED		OBSERVED	
		P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2	P 1	P 2
779.76	3313.92	8.	19.	11.	8.	19.	27.	53.	27.	0	0
780.54	3313.94	8.	22.	10.	8.	18.	30.	52.	30.	0	0
781.29	3313.96	8.	23.	10.	9.	19.	32.	52.	32.	0	0
782.07	3313.95	8.	23.	9.	9.	18.	32.	50.	32.	0	0
782.82	3313.96	8.	21.	9.	11.	17.	32.	48.	32.	0	0
775.18	3314.61	4.	8.	12.	10.	15.	18.	45.	18.	0	0
775.96	3314.62	4.	9.	15.	8.	19.	17.	53.	17.	0	0
776.71	3314.64	5.	11.	11.	7.	17.	18.	48.	18.	0	0
777.46	3314.66	7.	14.	11.	7.	18.	22.	51.	22.	0	0
778.24	3314.65	8.	16.	11.	7.	19.	23.	53.	23.	0	0
778.99	3314.67	8.	18.	11.	7.	19.	26.	53.	26.	0	0
779.76	3314.69	9.	20.	9.	8.	18.	26.	50.	26.	0	0
780.52	3314.71	9.	24.	8.	8.	17.	32.	49.	32.	0	0
781.27	3314.70	9.	25.	8.	8.	17.	33.	48.	33.	0	0
782.05	3314.72	9.	25.	8.	10.	17.	35.	48.	35.	0	0
782.80	3314.73	9.	23.	7.	11.	16.	34.	46.	34.	0	0
775.16	3315.37	4.	8.	9.	9.	13.	17.	39.	17.	0	0
775.94	3315.39	4.	9.	11.	8.	15.	17.	45.	17.	0	0
776.69	3315.41	5.	11.	9.	7.	14.	18.	42.	18.	0	0
777.46	3315.40	7.	16.	9.	7.	16.	23.	47.	23.	0	0
778.22	3315.42	8.	18.	9.	7.	18.	25.	50.	25.	0	0
778.97	3315.44	9.	18.	9.	7.	18.	25.	50.	25.	0	0
779.75	3315.46	9.	20.	8.	8.	17.	28.	49.	28.	0	0
780.50	3315.45	9.	25.	8.	9.	17.	34.	49.	34.	0	0
781.28	3315.47	9.	26.	7.	10.	17.	36.	48.	36.	0	0
782.03	3315.49	9.	26.	7.	11.	17.	36.	48.	36.	0	0
782.80	3315.51	9.	23.	7.	11.	16.	35.	46.	35.	0	0

Punch cards containing the calculated concentrations at each receptor were punched for use in computer programs that analyze the information produced by the CDM. In this study, the punched cards were input into a computer program to obtain concentration contours which will be discussed in the next chapter.

CHAPTER IV - RESULTS AND DISCUSSION

In order to better understand the results of the CDM for both study areas, it will be necessary to analyze the isopleth maps of each area. By using the isopleth maps of each study area, a complete picture is presented to compare TSP concentrations in various parts of each study area.

NOGE Study

A modified approach was used in the NOGE study for plotting isopleths of concentration contours. An accumulative contour of this area is produced by running the CDM 15 times and each time adding an additional point source that is located in the NOGE study area. Figures 15 thorugh 29 shows the accumulated TSP concentration contours as each one of the 15 point sources in the NOGE was added to the CDM. Table 21 is a list of all the point sources located in the NOGE study area. One can see from viewing the isopleths that only minimal changes in TSP concentrations occur until the Johns-Manville plant emissions are input into the CDM. At that point the TSP concentrations are primarily located in two centers in the 50$\mu g/m^3$ range and immediately spread into a large circular pattern centered in the 130$\mu g/m^3$ range. From this point on the TSP concentrations continue to increase into a final isopleth which shows six circular pollutant patterns ranging from a low of 60$\mu g/m^3$ to a high of 138$\mu g/m^3$.

Figure 15 TSP Concentration Contour of NOGE Study Area
Without Point Sources

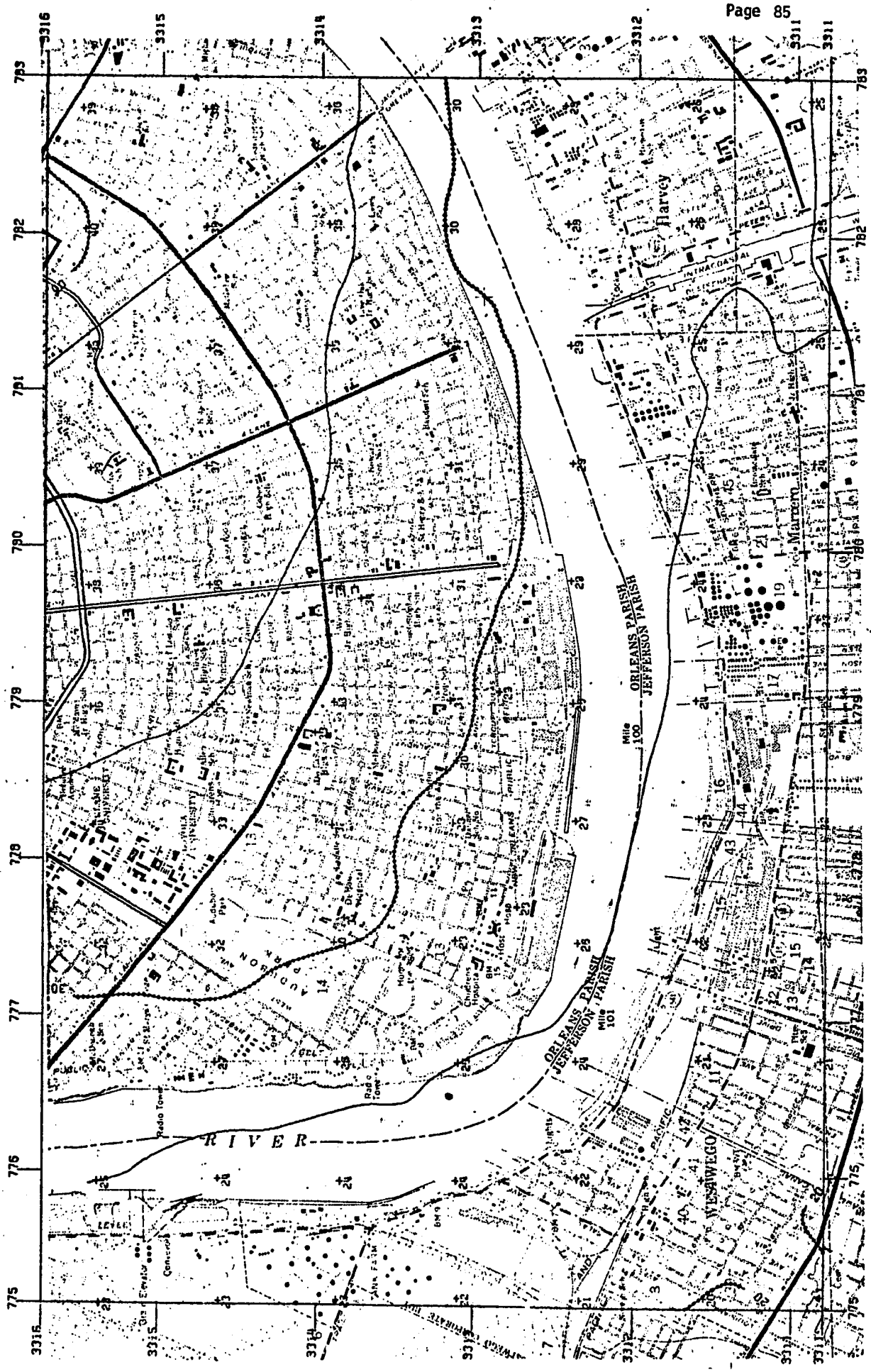


Figure 16 TSP Concentration Contour of NOGE Study Area
With New Orleans Grain

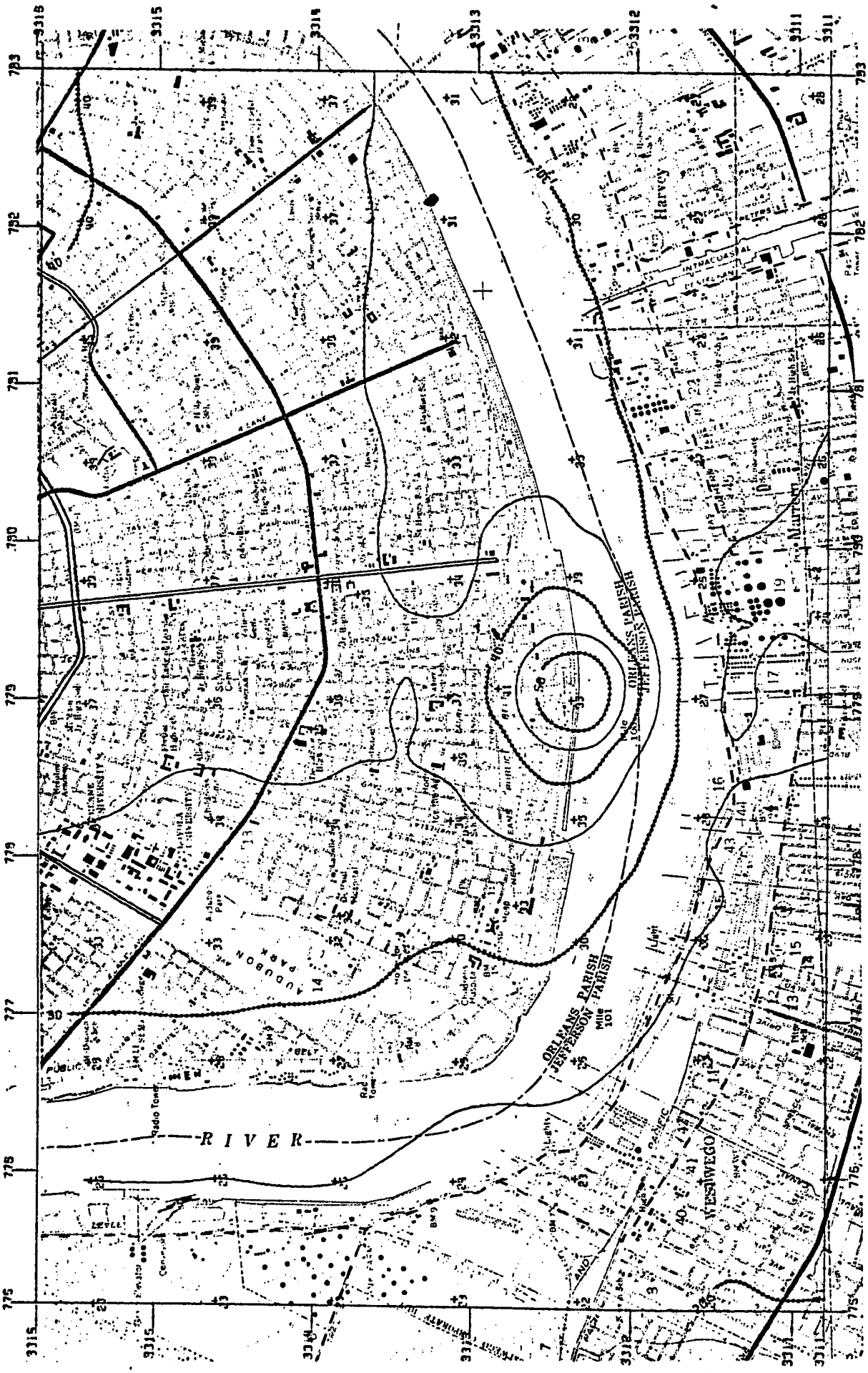


Figure 17 TSP Concentration Contour of NOGE Study Area
With the Addition of Celotex Corporation

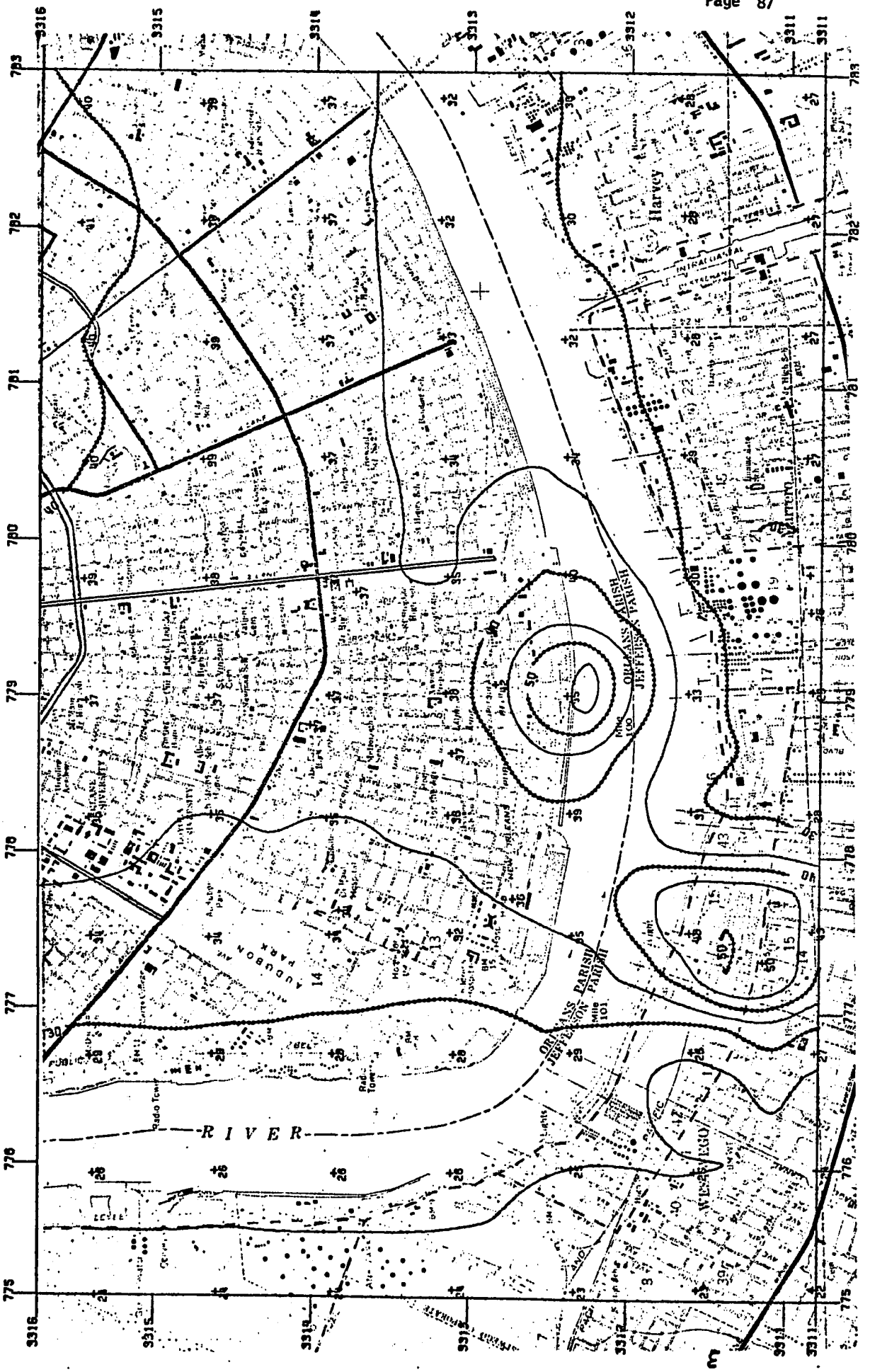


Figure 18 TSP Concentration Contour of NOGE Study Area
With the Addition of National Gypsum

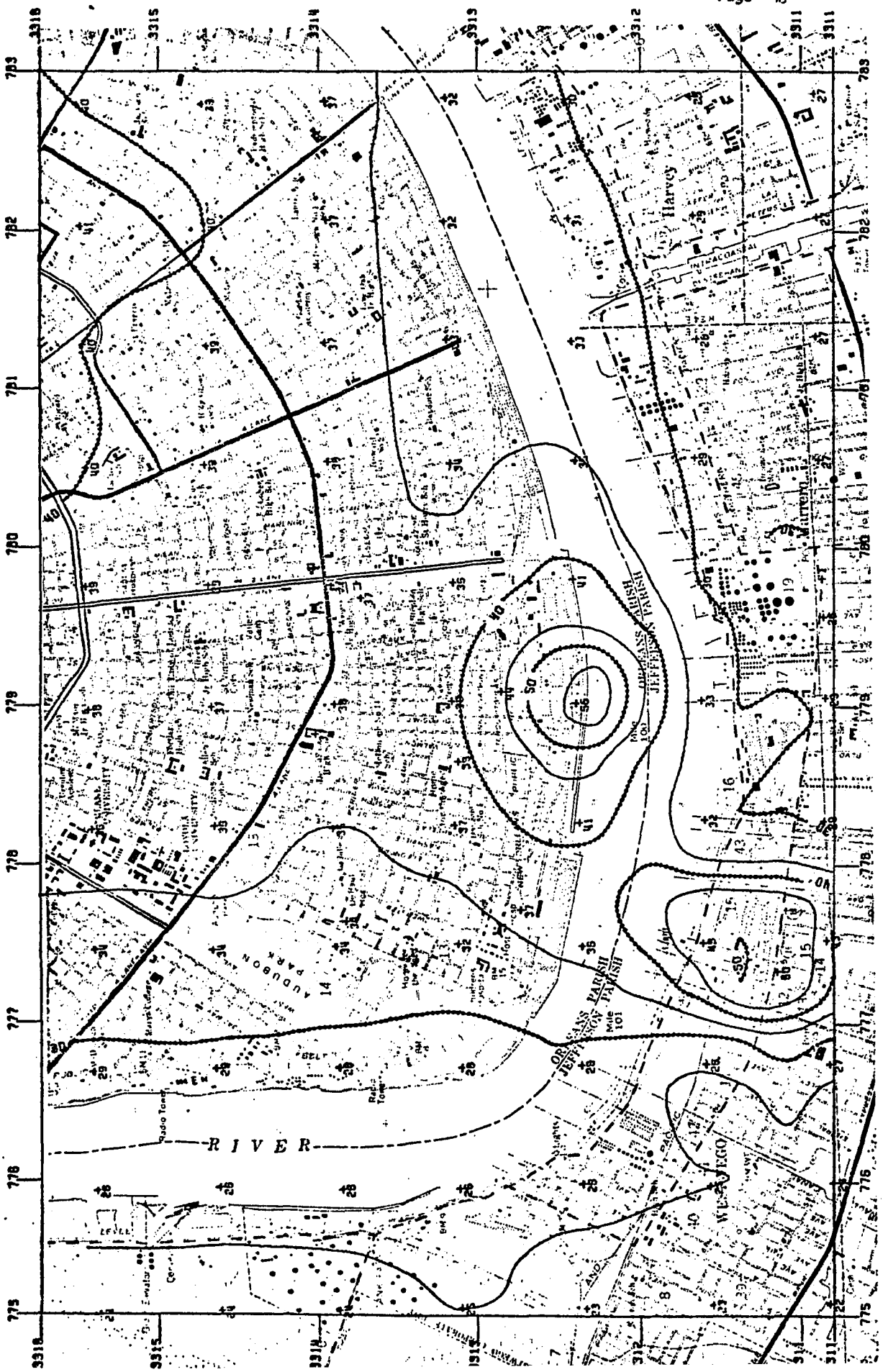


Figure 19 TSP Concentration Contour of NOGE Study Area
With the Addition of Allied Chemical

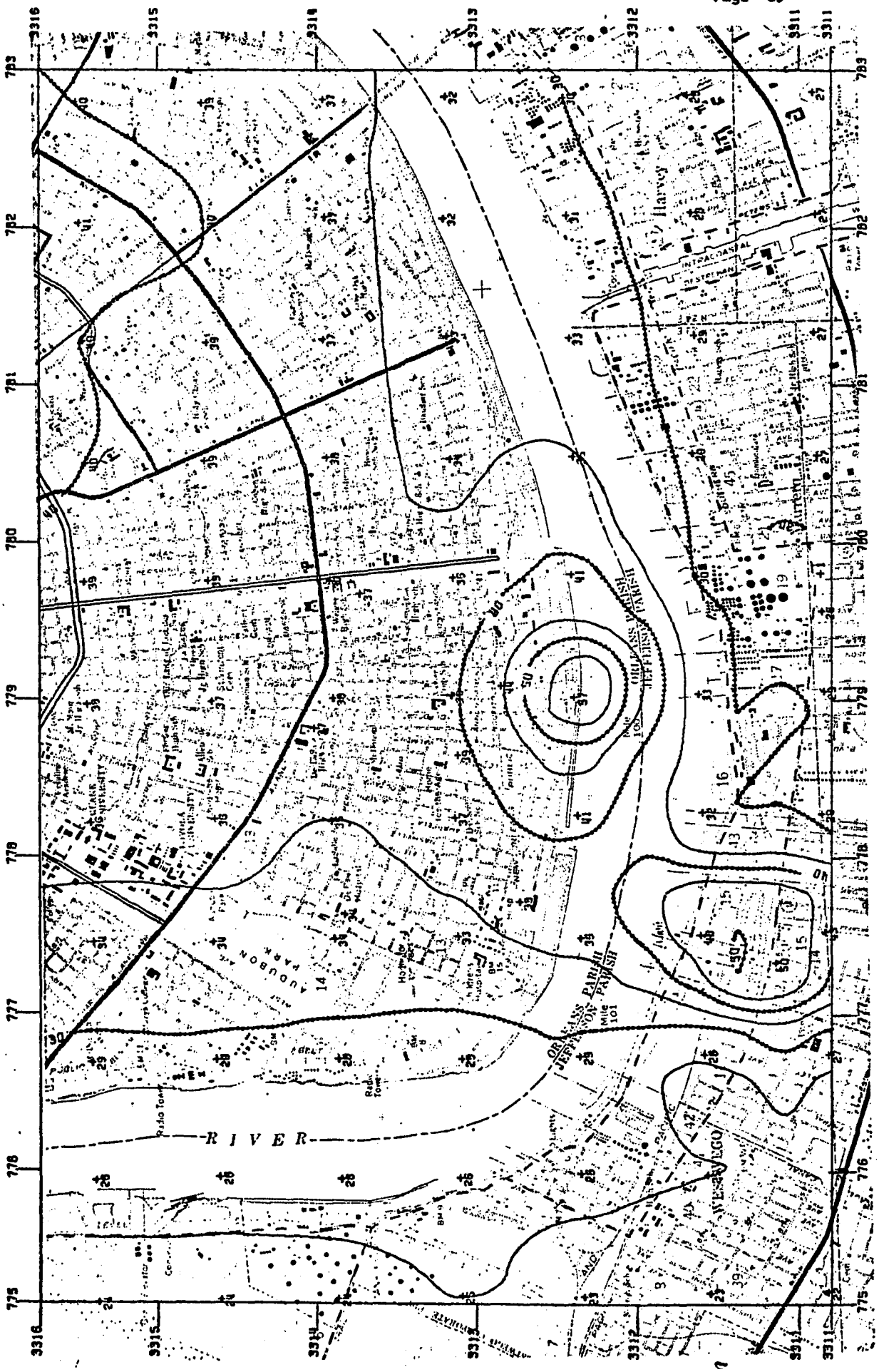


Figure 20. TSP Concentration Contour of NOGE Study Area
With the Addition of Witco Chemical

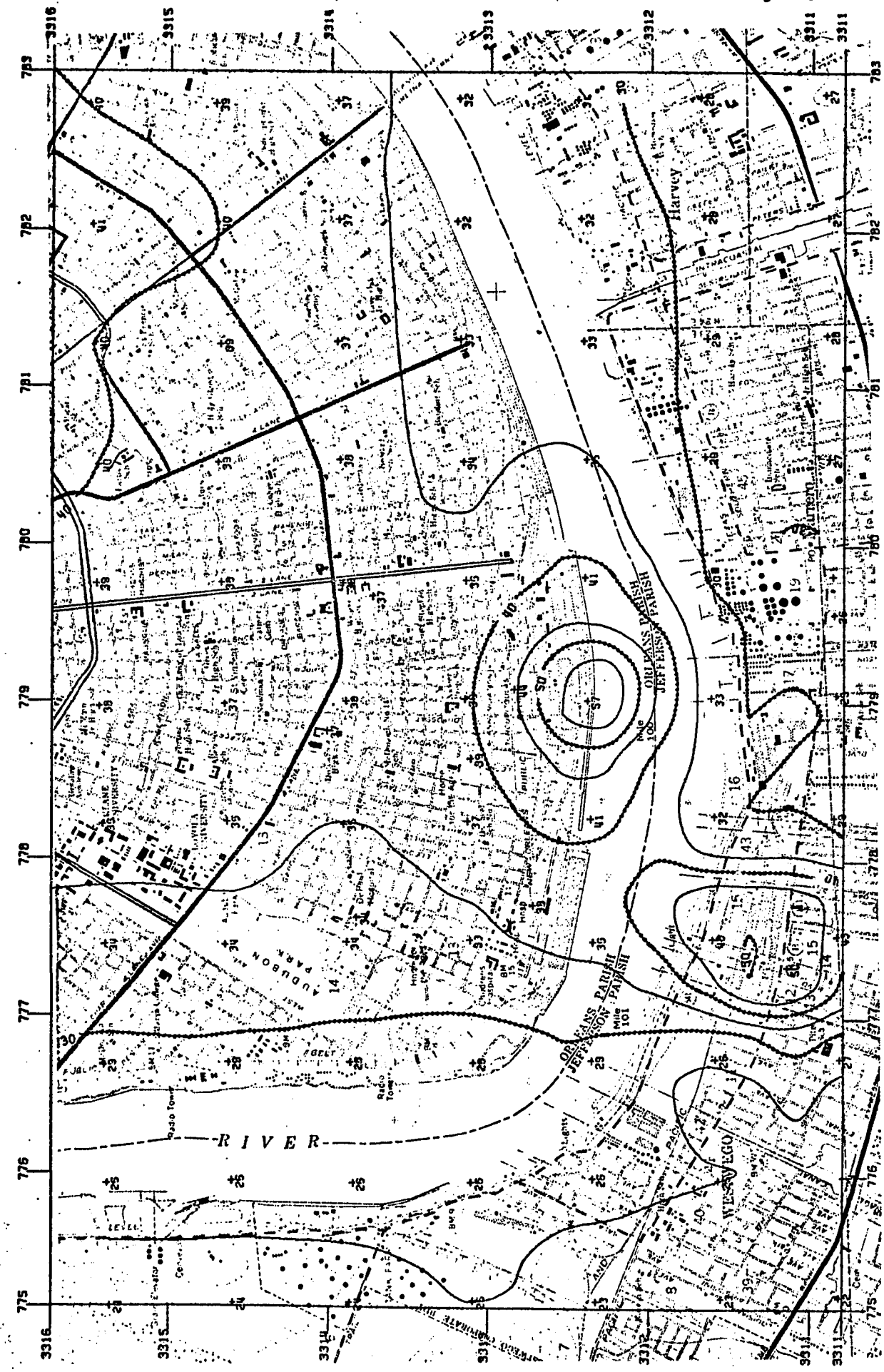


Figure 21 TSP Concentration Contour of NOGE Study Area
With the Addition of Continental Can

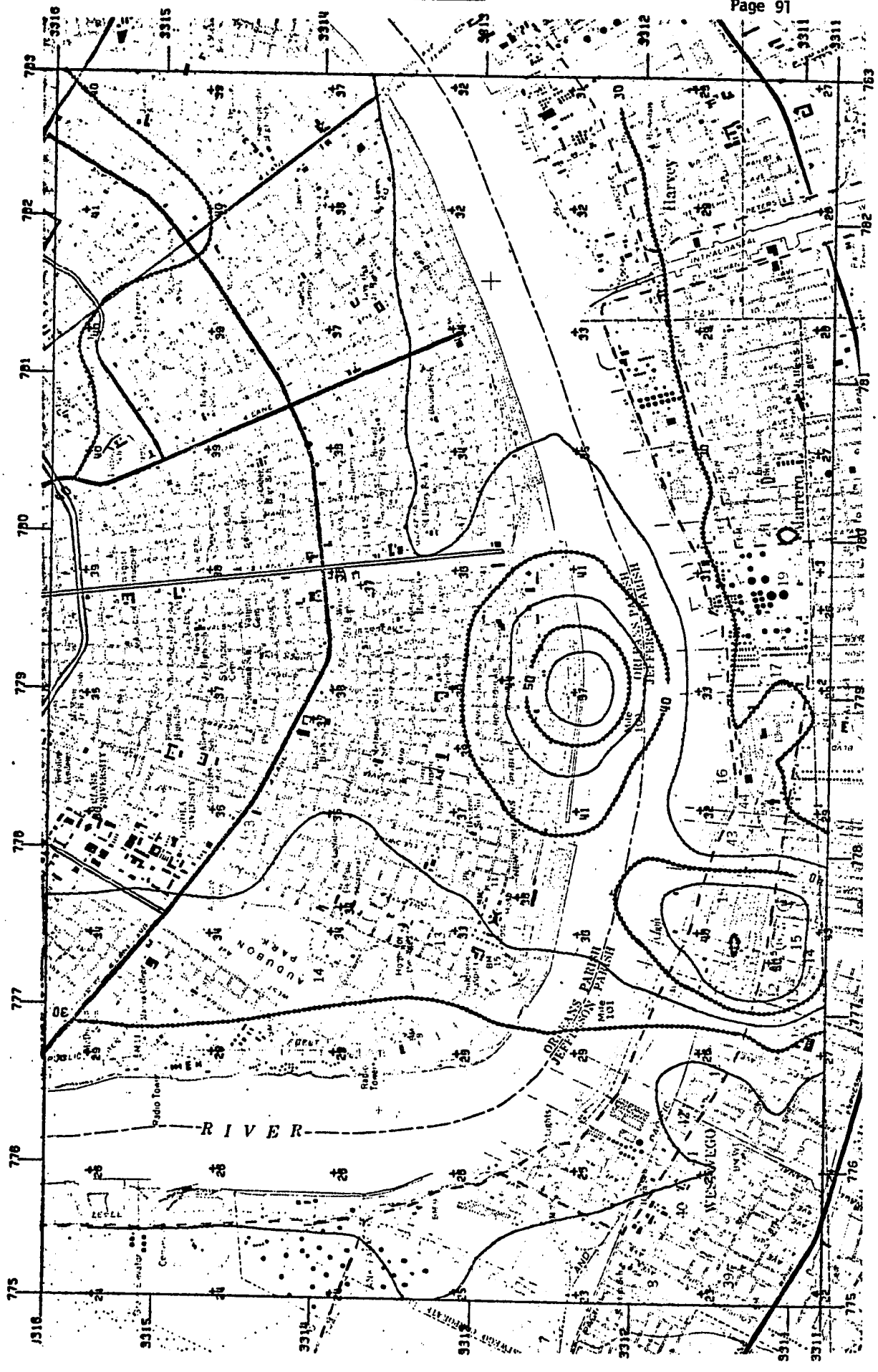


Figure 22 TSP Concentration Contour of NOGE Study Area
With the Addition of Continental Grain

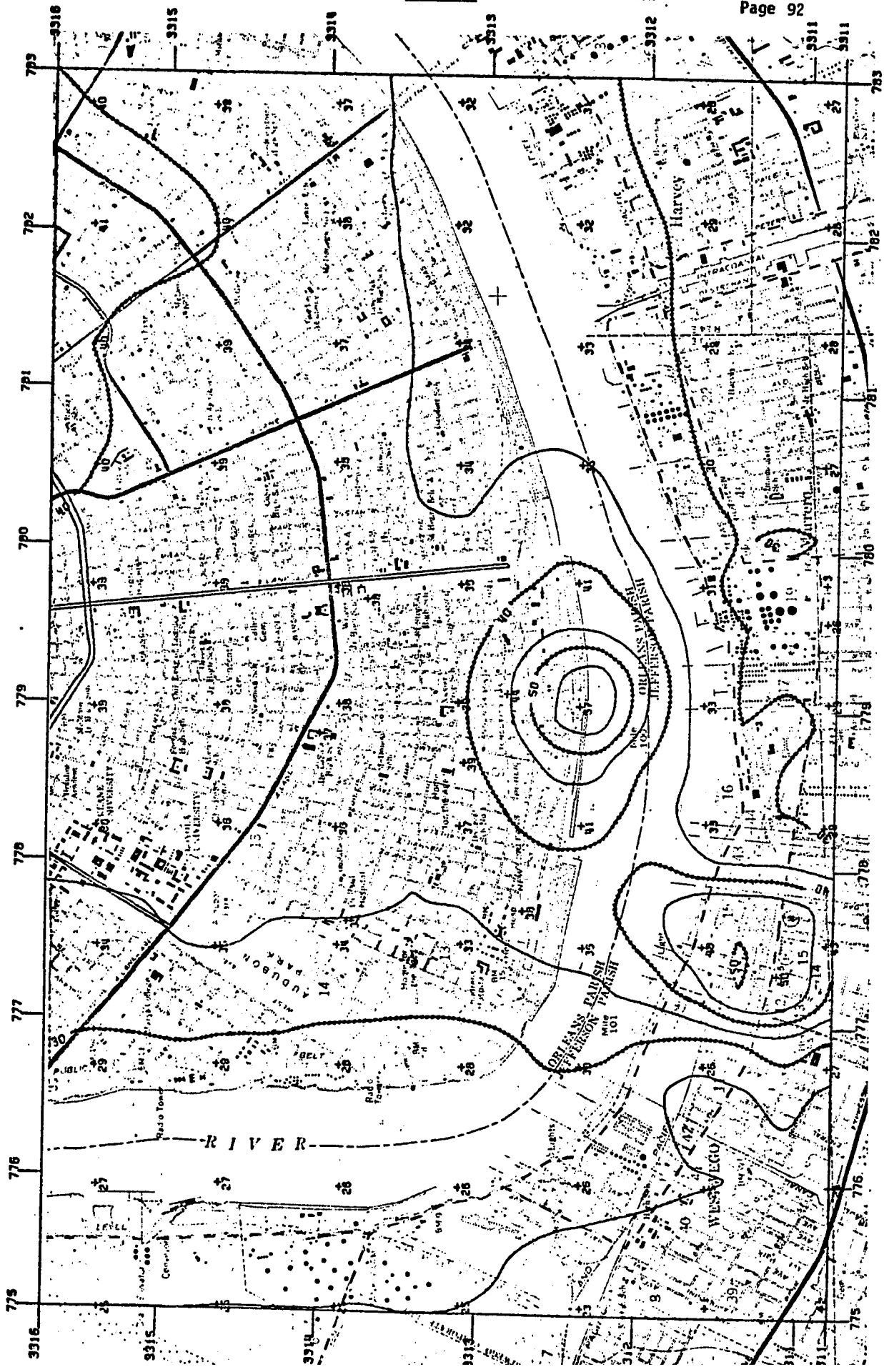


Figure 23 TSP Concentration Contour of NOGE Study Area
With the Addition of Johns-Manville (Marrero)

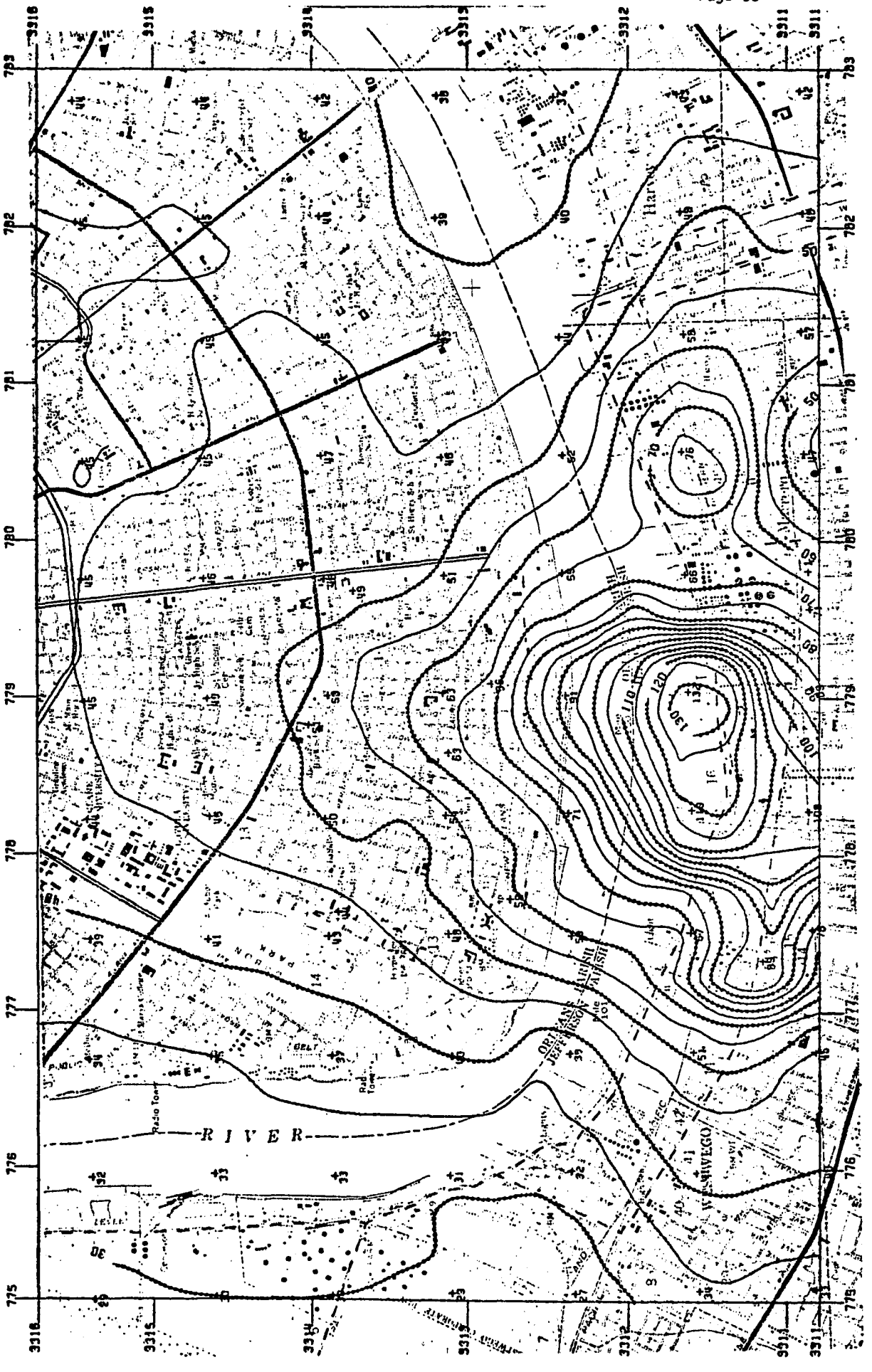


Figure 24 TSP Concentration Contour of NOGE Study Area
With the Addition of Avondale (Westwego)

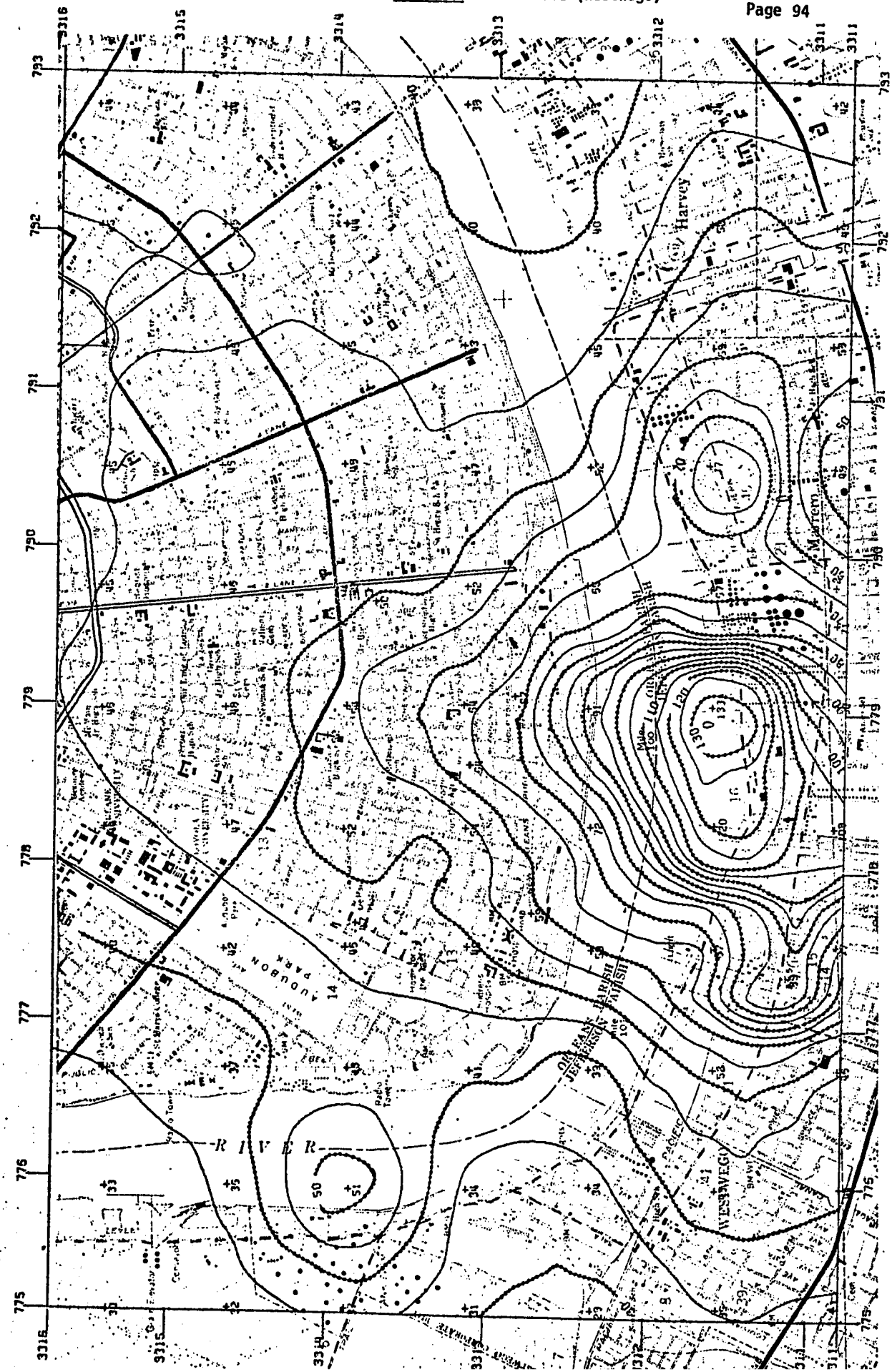


Figure 25 TSP Concentration Contour of NOGE Study Area With the Addition of Seventh Street Incinerator

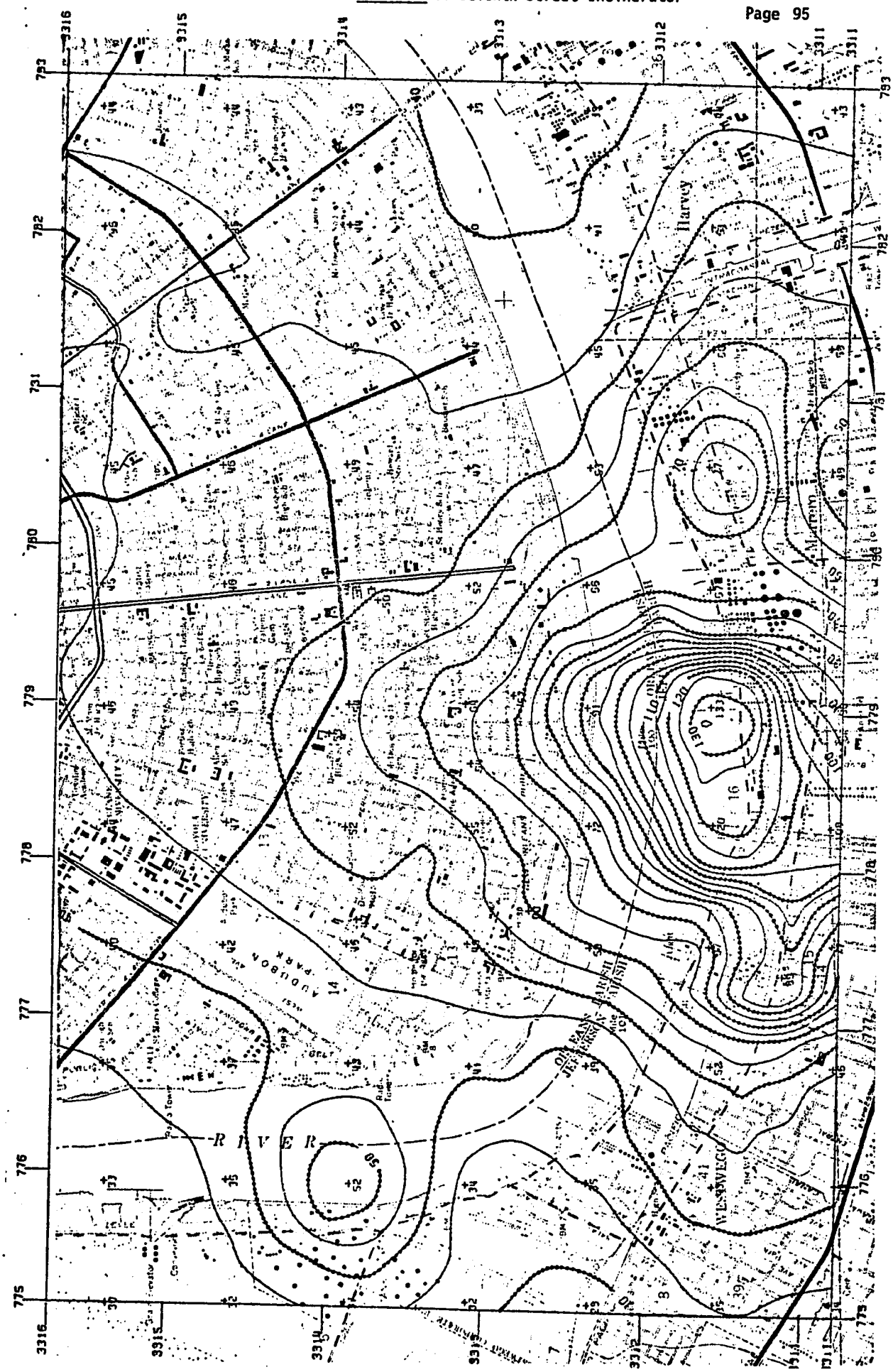


Figure 26 TSP Concentration Contour of NOGE Study Area
With Addition of Gulf States Asphalt

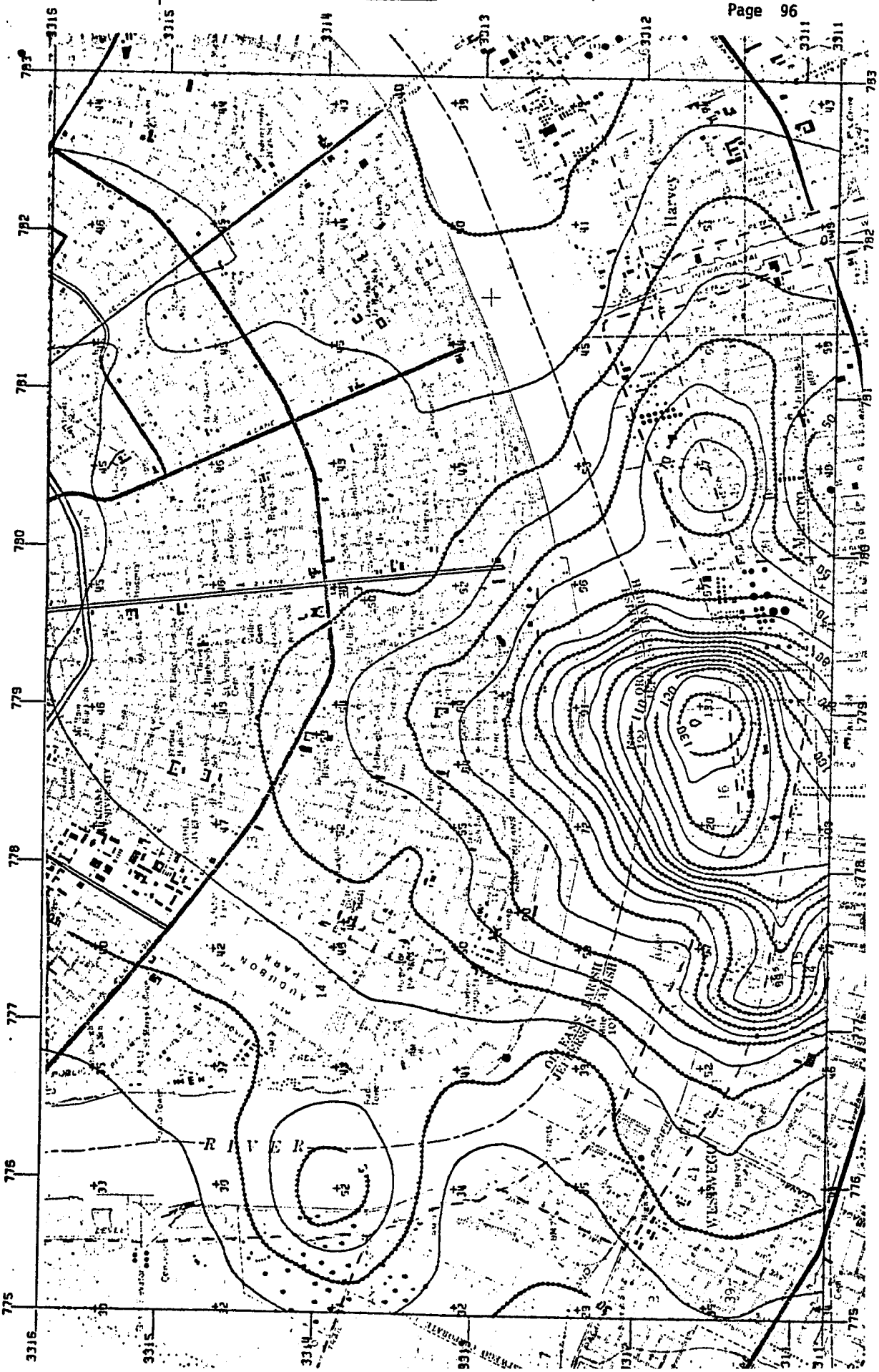


Figure 27 TSP Concentration Contour of NOGE Study Area With the Addition of National Gypsum (Westwego)

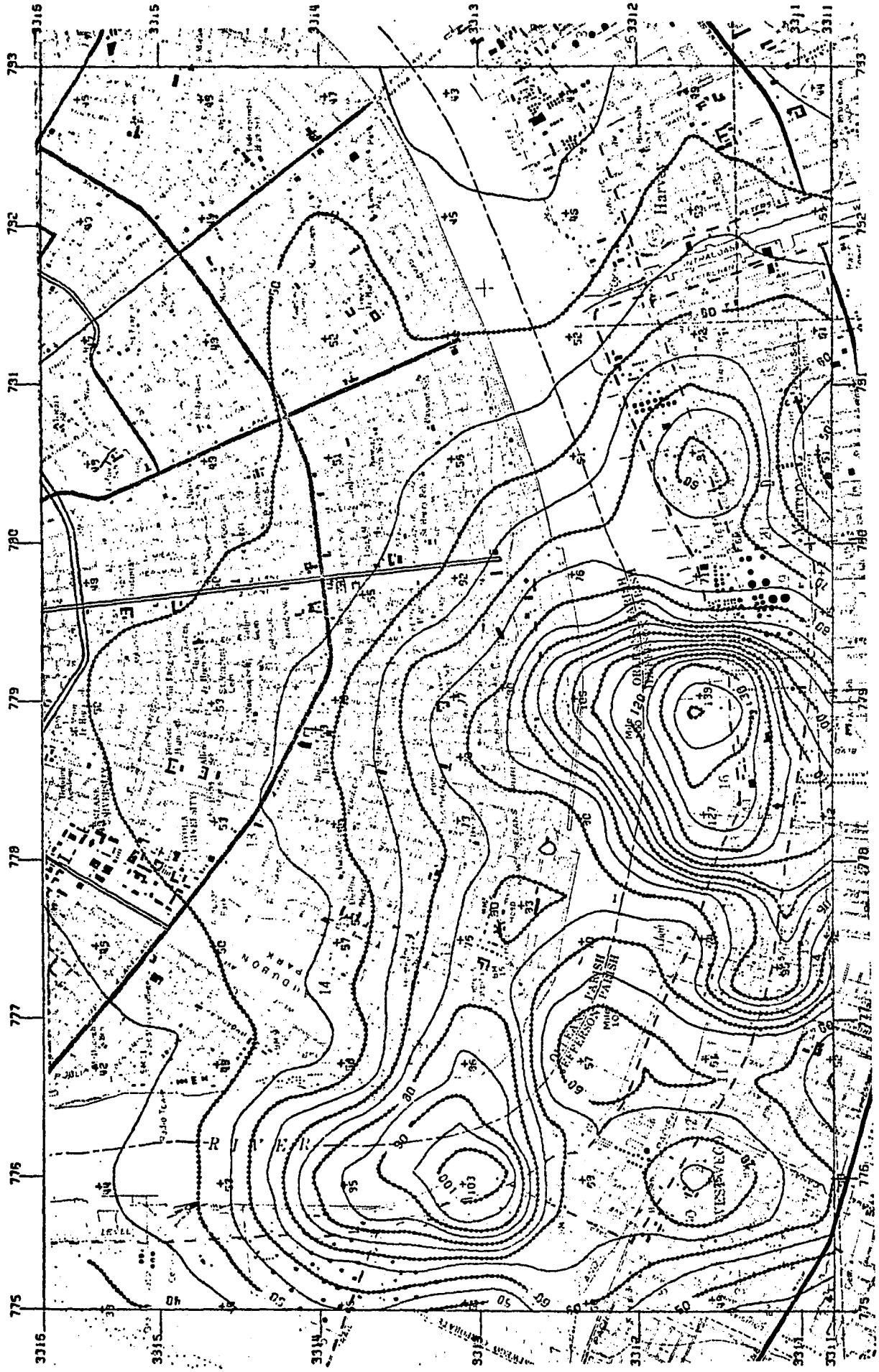


Figure 28 TSP Concentration Contour of NOGE Study Area
With Addition of Amerada Hess

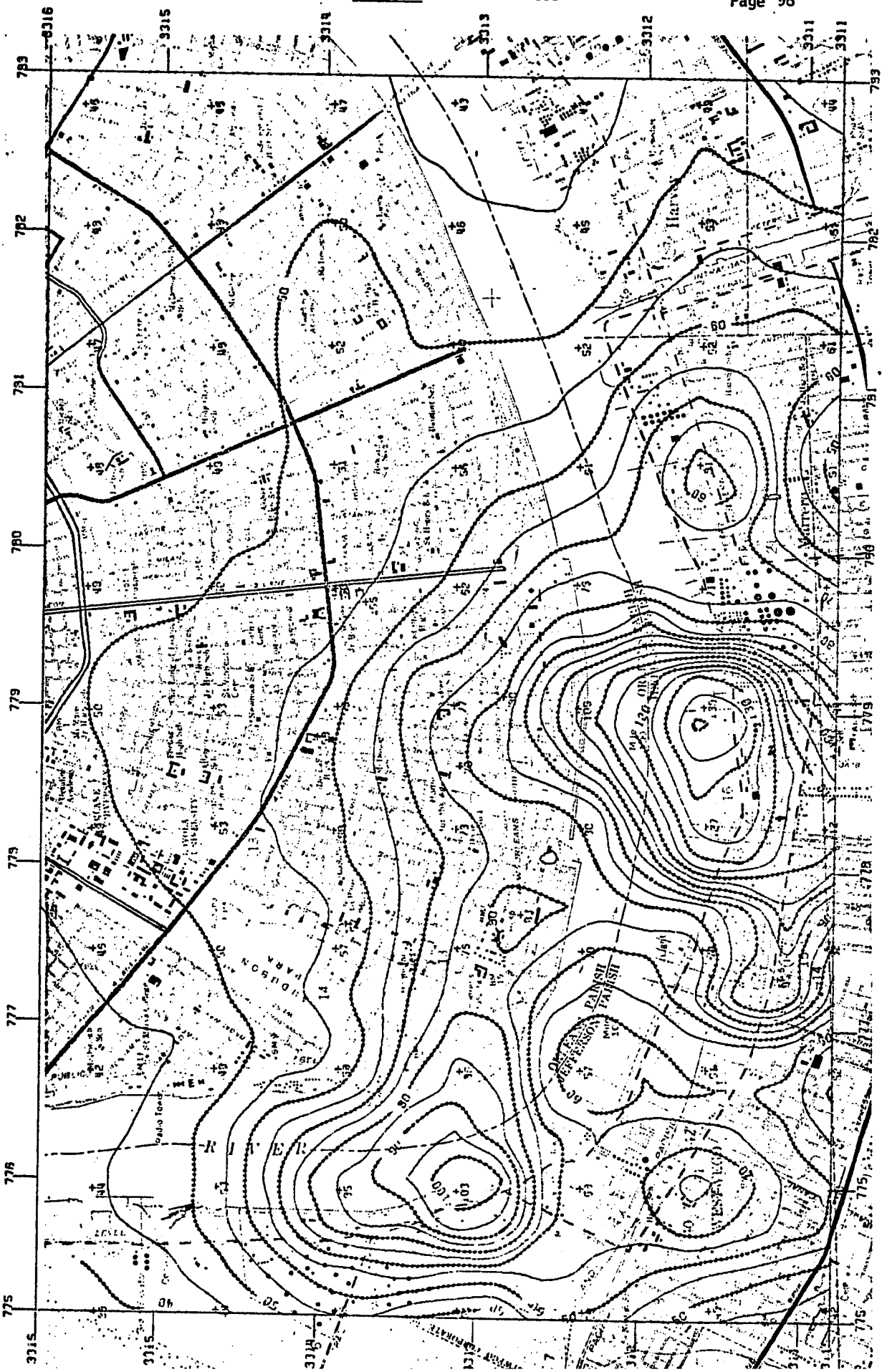


Figure 29 TSP Concentration Contour of NOGE Study Area With the Addition of Louisiana Power and Light - Nine Mile Point

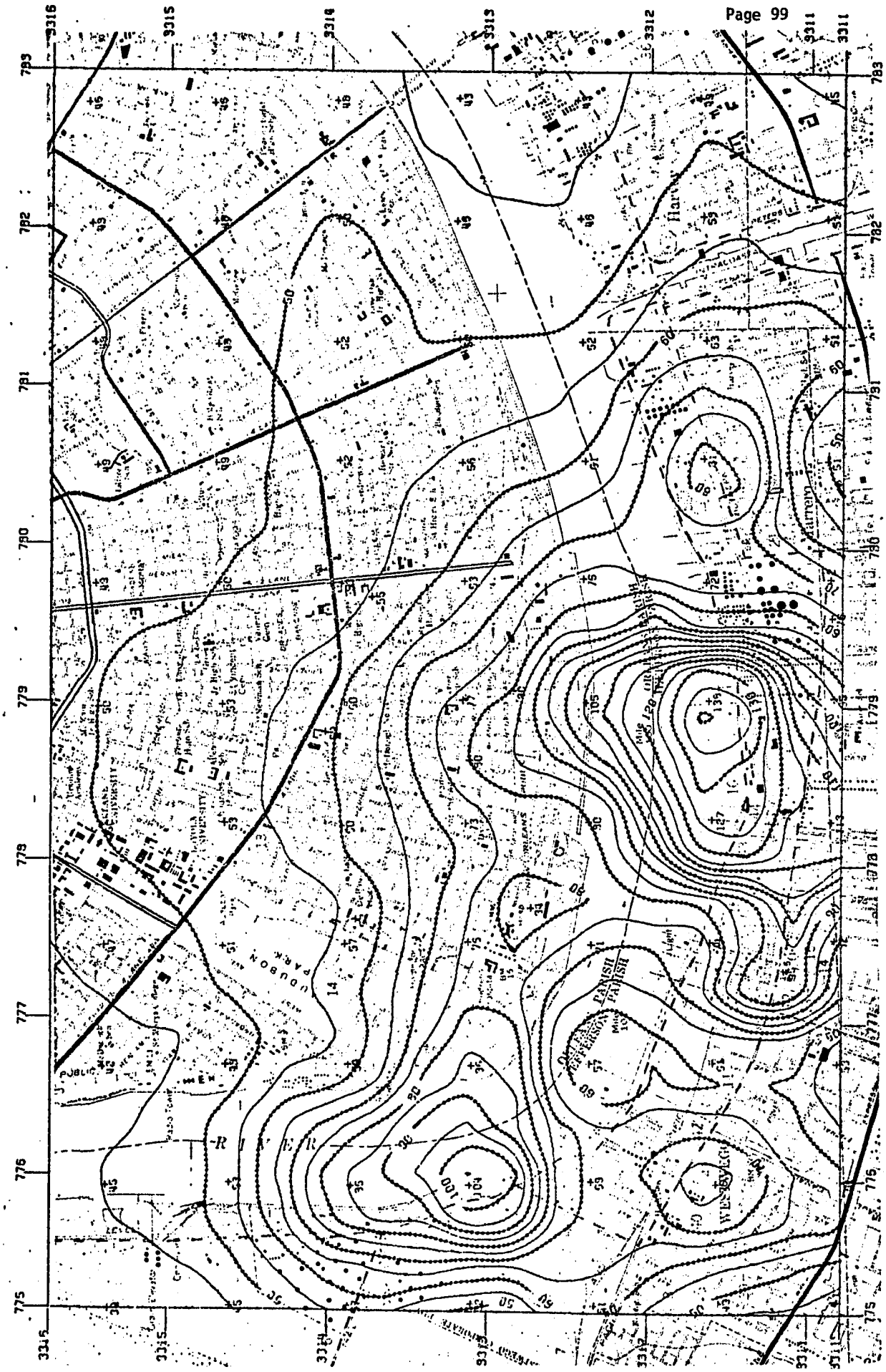


Table 21

POINT SOURCES IN NOGE STUDY AREA

1. No Point Sources
2. New Orleans Grain
3. Celotex
4. National Gypsum
5. Allied Chemical
6. Witco Chemical
7. Continental Can
8. Continental Grain
9. Johns-Manville (Marrero)
10. Avondale (Westwego)
11. Seventh Street Incinerator
12. Gulf States Asphalt
13. National Gypsum (Westwego)
14. Amerada Hess
15. Louisiana Power and Light - Nine Mile Point

Since the time that the actual study was completed and presented to the Louisiana Air Control agency, the Louisiana Air Control agency has written a letter to Johns-Manville implying that they had made a mistake in their plant emissions inventory and they should rework their emissions to reflect a lower emissions inventory. Therefore, if Johns-Manville in fact made a mistake, their TSP concentration contours are slightly in error and should be rerun in the CDM.

When one reviews the final TSP isopleth concentration contour, it is evident that there is the distinct possibility that many areas within the NOGE study area are in violation of the National Ambient Air Quality Standards for TSP 75$\mu g/m^3$ (Primary) and 60$\mu g/m^3$ (secondary). Since the sampling network in the NOGE study area for this study was only for six months, and removed immediately after that time, additional sampling is necessitated to reaffirm these findings.

It should be mentioned that the high volume sampler located on top of the New Orleans Maintenance building has been indicating violations of the NAAQS since January 1975. It should be pointed out that the Louisiana Air Control agency quickly removed this sampler upon declaring it "biased" after only 3½ months of sampling in the NOGE study. After several attempts to show the Louisiana Air Control agency methods to validate this sampler's data and prove that the data was valid failed, the data was used in the NOGE study regardless. Their actions seemed to be a deliberate attempt to "can" meaningful TSP data in the study area.

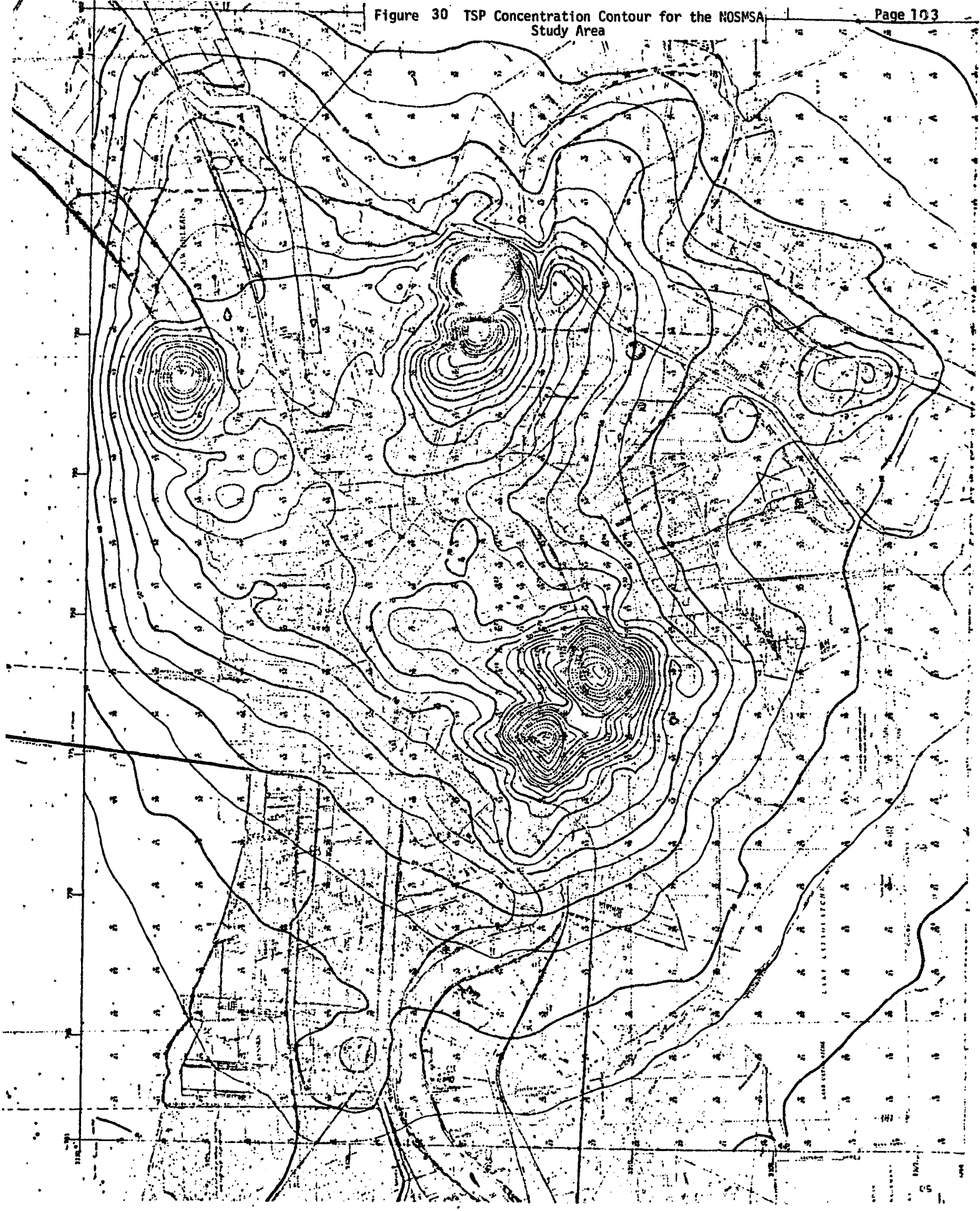
NOSMSA Study

In the NOSMSA study, the CDM was run only once with all emission sources included. The results were plotted using isopleths of TSP concentration contours for the entire study area. Figure 30 shows the concentration contours overlayed over a map of the NOSMSA study area. The TSP concentration contours indicate an area in Chalmette in the 300μg/m^3 range, an area around the Industrial Canal in New Orleans East in the 130μg/m^3 range, and another area uptown along the Mississippi River in the 200μg/m^3 range. The CDM's calculated (adjusted) TSP concentrations seems to indicate that these areas within the NOSMSA study possibility exceed NAAQS standards.

A Kaiser Aluminum plant is located in the high concentration Chalmette area. The CDM was initially run with the most up-to-date emission inventory available. Since then, Kaiser has put into use new air pollution control equipment and these study results do not reflect the change in the emission inventory. Even without the new Kaiser emissions, this Chalmette area will probably still experience high concentrations because of its highly industrialized community. From the isopleth pictures, it is evident that the CDM model is indicating the major "hot spots" as those that are indicative of highly industrialized areas. These "hot spot" areas are all large centers of industry along the Mississippi River which are very indicative of high particulate emission densities.

When analyzing the metropolitan area with the CDM, all

Figure 30 TSP Concentration Contour for the NOSMSA Study Area



sources of particulate emissions should be included in the study. In this research study, the CDM which was used for estimating ambient concentrations of TSP assumes that the particles disperse as a gases and emanate from well defined sources. Unfortunately, in many areas, particularly where the air quality standards are not being attained, these assumptions may not hold. Windblown dusts, unpaved roads, agricultural tilling, aggregated storage piles and heavy construction operations, all of which are often referred to as fugitive dust sources, can be significant sources of particulate matter. (30) EPA has several on-going studies concerned with fugitive sources of dust. However, at this time no widely applicable model is available for routinely estimating particulate matter concentrations where fugitive sources are significant or deposition of matter is a major factor. (31) Because of this and the lack of a proven method of determining the emissions from fugitive sources, the four parish fugitive source emissions were not included in the CDM runs.

However, we should take a brief hypothetical look at the inclusion of the four parish fugitive source emissions and their effects on the regression slope and intercept. In each of the four parishes in our study, the fugitive dust emissions from unpaved roads were significantly higher than the emissions from the other sources of fugitive dusts.

Table 22 indicates a general comparision of the contributions of source categories to TSP emissions for each of the

Table 22 Comparisons of Contributions of Source Categories to TSP Emissions (Tons/Year)

Parishes	Total Emissions (Tons/Year)	Point Sources (Tons/Year)	Percentage of Total Emissions	Area Source (Tons/Year)	Percentage of Total Emissions
Orleans	8272.3	3448	41.7	4824.3	58.3
Jefferson	6609.8	4330.4	65.5	2279.4	34.5
Plaquemine	985.5	572.2	58.1	413.3	41.9
St. Bernard	6048	5677.9	93.3	370.1	6.1

four parishes in the study. Table 23 indicates the significant percentages of contribution that unpaved roads would make to the area source emissions of each parish if added into the CDM runs. In an EPA paper written by Haws and by telephone conversations with him, it was indicated that the effect of the removal of a various percentages of total TSP emissions from unpaved roads is linear although the percentage reduction across several monitoring stations may vary. (32) The removal of such significant percentages of the total emissions in the inventory would cause an expected decrease in the regression slope and intercept. In this case the emissions from unpaved roads, if added, would amount to approximately a 30 percent increase in total emission of the overall study area.

Ideally we are searching for a regression slope of one and regression intercept of zero, but in this research study we could possibly lower the regression slopes and intercepts by as much as 30 percent with the addition of unpaved roads. This would then explain why we have the higher regression slope and intercept numbers for our current regression equations.

Table 23 Comparisons of Contributions of Unpaved Roads to Other Source Category Emissions (Tons/Year)

Emissions Source Categories	Orleans	Jefferson	Plaquemines	St. Bernard
Total Emissions (Tons/Year)	8272.3	6609.8	985.5	6048.0
Point Sources (Tons/Year)	3448.0	4330.4	572.2	5677.9
Percentage of Total Emissions	41.7	65.5	58.1	93.3
Area Sources (Tons/Year)	4824.3	2279.4	413.3	370.1
Percentage of Total Emissions	58.3	34.5	41.9	6.1
Unpaved Roads (Tons/Year)	423.0	2354.0	3504.0	3008.0
Percentage of Area Source Emissions	8.8	103.3	847.8	812.7
Percentage of Total Emissions	5.1	35.6	355.5	49.7

CHAPTER V - SUMMARY AND CONCLUSION

The application of the CDM to the New Orleans area was the first attempt at air pollution modeling in Louisiana in which the Louisiana Air Control agency participated in a co-operative effort. As of this writing, it still is the only attempt of any kind of modeling which relates TSP emissions in the New Orleans Metropolitian area to air quality.

Acquiring and inputting the CDM into the computer system at the Slidell NASA Computer Center was probably the easiest part of the application process. The task of obtaining the necessary input data for the CDM run was the more complicated requirement of the research project. This began with searching through emission inventory questionaires files on all industries in the study area. Compiling all existing air sampling data, and collecting new air sampling data for eventual comparison to CDM calculated concentrations for various locations in the study areas, was next on a long list of data requirements. Finally, all the data requirements were met and CDM was eventually applied to two study areas, NOGE and NOSMSA. The CDM's application to both study areas was to serve as a validation method of the CDM and to demonstrate the application of the CDM with certain sub-objectives in mind.

The most practical procedure for describing the accomplishments of the CDM's application and making valid conclusions therein, will be to refer back to the purpose and scope of this

research project as mentioned on pages 03 and 04. Therefore, the accomplishments and conclusions of this CDM application are summarized as follows:

1. The CDM was applied to the NOGE study area and NOSMSA study area and determinations of overall quality levels of TSP were calculated. The model has specifically calculated TSP concentrations for various receptor locations in both study areas. The isopleths provide a pictorial view of TSP concentrations in the respective studies.
2. When comparing ambient air quality levels in the NOGE and NOSMSA to the calculated (adjusted) TSP concentrations for each study area, one must keep in mind that the calculated (adjusted) concentrations are only as good as the input data. It is realized that all air quality input data should cover the same annual period to be ideally representative of that area. In this research project, it was impossible to have all input data representing the same annual period. Valid types of air pollution data for the same time period was not available. Thus valid data for each category was collected and coordinated to apply as closely as possible to the year 1975.
3. Obviously, the CDM does tend to over calculate TSP concentrations in some areas. The reasons for these discrepancies have already been discussed in Chapter Two on the CDM shortcomings. But, if we take all

these shortcomings into consideration, the CDM has provided us with initial baseline air quality concentrations for the New Orleans area that was nonexistent until now. Hopefully, the Louisiana Air Control agency will utilize and build upon this data base for future simulation modeling.

4. The application of the CDM to the New Orleans Metropolitan area certainly points out two areas in the city which have unusually high TSP concentrations. These "hot spots" have been identified by the concentration contours in Figure 30. Additional sampling or relocation of existing sampling stations can be used as a means of verification of "hot spot" existence.
5. In the Grain Elevator study, it was initially thought that there was just one main source of pollution in that study area. The model has shown through a series of isopleths of TSP concentration contours that more than one source is contributing to the overall air quality in the Grain Elevator study area.
6. This research study has opened the door to several future studies that would be pertinent to the overall development of an air pollution control strategy program. Some examples are:
   (a) Study the effects that varying the wind speed and direction would have on predicted concen-

trations and shifting of TSP "hot spot" areas.

(b) Examine the washout effects of yearly rainfall amounts on TSP concentrations in New Orleans SMSA.

(c) Analyze the TSP sampling filters from the TSP sampling network in the NOGE study for particulate identification with respect to grain dust versus other types of particulates.

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