Rcd 3/18/96

PROTOCOL FOR THE SULFUR DIOXIDE AIR QUALITY COMPLIANCE MODELING EVALUATION OF THE WARREN COUNTY, NEW JERSEY NONATTAINMENT AREA

Prepared by:

Pennsylvania Power & Light Company

March 15, 1996

EXECUTIVE SUMMARY

Pennsylvania Power & Light Company (PP&L), the Pennsylvania Department of Environmental Protection, New Jersey Department of Environmental Protection and United States Environmental Protection Agency have been evaluating ambient sulfur dioxide air quality levels in the Warren County, New Jersey sulfur dioxide nonattainment area. Screening studies have suggested that PP&L's Martins Creek Steam Electric Station (MCSES) may contribute to predicted exceedances of the National Ambient Air Quality Standards (NAAQS) on high terrain portions of the nonattainment area.

This document describes the air quality dispersion modeling that will be used to evaluate compliance with the sulfur dioxide NAAQS in Warren County, New Jersey through refined dispersion modeling and ultimately determine if emissions reductions from MCSES or other sources are required to assure attainment of the NAAQS. Based on the model evaluation study conducted by PP&L using continuous hourly field data collected from May 1, 1992 through May 19, 1993, the most appropriate model to use for predicting MCSES impacts on the Scotts Mountain area of the nonattainment area is the Large Power Plant Effluent Study Model (LAPPES).

Modeling of MCSES at other locations in the evaluation and modeling of other sources at all locations modeled will be conducted with the EPA guideline Rough Terrain Diffusion Model (RTDM) and Industrial Source Complex (ISC, Version 95250) models.

The ISC model will be applied to prediction locations (receptors) below stack top elevation; the RTDM model will be applied to receptors above plume elevation; and both the RTDM and ISC models will be applied to receptors between stack top and plume height, per EPA guidelines.

The compliance modeling evaluation procedures include the following:

1. Evaluate sulfur dioxide impacts throughout the Warren County nonattainment area.

2. Use the LAPPES model to evaluate MCSES impacts on Scotts Mountain. Use the RTDM and/or ISC models to model MCSES impacts in the other areas of the nonattainment area. Use the RTDM and/or ISC models to evaluate impacts from other nearby sources on both Scotts Mountain and other areas of the nonattainment area.

3. Account for the effects of aerodynamic building "downwash" effects on plume dispersion with the ISC model for the MCSES sources.

4. Represent sources not explicitly modeled with a background concentration determined from monitored data.

5. Conduct the evaluation using two years of on-site meteorological data (1992 and 1993).

6. Model PP&L's large coal-fired and No. 6 oil-fired units at three operating loads (100 percent, 75 percent and 50 percent). Model smaller sources at MCSES and other nearby sources at 100 percent operating load.

7. Analyze predicted concentrations for compliance with the NAAQS. Evaluate alternative emissions control strategies if air quality impacts exceed the NAAQS.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Pennsylvania Power & Light Company (PP&L), the Pennsylvania Department of Environmental Protection (PA DEP), New Jersey Department of Environmental Protection (NJ DEP) and United States Environmental Protection Agency (EPA) are evaluating ambient sulfur dioxide air quality levels in the Warren County, New Jersey sulfur dioxide nonattainment area. Screening studies have suggested that PP&L's Martins Creek Steam Electric Station (MCSES) may contribute to predicted exceedances of the National Ambient Air Quality Standards (NAAQS) on high terrain portions of the nonattainment area.

This document describes the air quality modeling protocol that will be used to evaluate compliance with the NAAQS in Warren County through refined dispersion modeling and ultimately determine if emissions reductions from MCSES or other sources are required to assure attainment of the NAAQS. Section 2.0 of this document presents an overview and background of the air quality issues. Sections 3.0 through 6.0 describe the study area, the emissions inventory, dispersion modeling procedures and compliance evaluation procedures that will be used for the study.

2.0 BACKGROUND

The United States Environmental Protection Agency designated portions of Warren County, New Jersey in nonattainment of the short-term sulfur dioxide NAAQS in December 1987. The designation was based on dispersion modeling using EPA's complex terrain screening models. Of particular concern were predicted concentrations from PP&L's Martins Creek Steam Electric Station (MCSES).

PP&L was concerned that the EPA screening models substantially overpredicted concentrations on high terrain portions of Warren County, New Jersey, especially on Scotts Mountain. In consultation with the PA DEP, NJ DEP and EPA, PP&L elected to conduct a model performance evaluation and comparison study in accordance with the Interim Procedures for Evaluating Air Quality Models (Revised) (EPA, 1984). An evaluation protocol was prepared by PP&L and our consultant, TRC Environmental Corporation, and approved by the PA DEP, NJ DEP and EPA. The protocol, Air Quality Model Performance Evaluation and Comparison Protocol for Martins Creek Stream Electric Station (Londergan, 1990) describes the field monitoring, emissions compilation, dispersion modeling and statistical evaluation program that was conducted to evaluate the EPA reference model and PP&L's candidate model for evaluating air quality impacts from MCSES on Scotts Mountain. The candidate model was the Large Power Plant Effluent Study (LAPPES) model, which was developed during a Western

Pennsylvania field study (Schiermeirer and Niemeyer, 1970). The reference model was a combination of EPA's Rough Terrain Diffusion Model (RTDM) and Multiple Point Gaussian Dispersion Algorithm with Terrain Adjustment Model (MPTER), applied in accordance with EPA guidelines (EPA, 1993).

The field data collection period for the model evaluation study was May 1, 1992 through May 19, 1993. During this period, continuous hourly emissions data were collected for MCSES and other nearby sources, hourly meteorological data were collected at a tower and remote sensing SODAR unit and hourly ambient sulfur dioxide data were collected at seven air quality sites on Scotts Mountain and at a background air quality measurement site in Pennsylvania. The data were subsequently used to compare predictions from the LAPPES model with predictions from the RTDM/MPTER model combination.

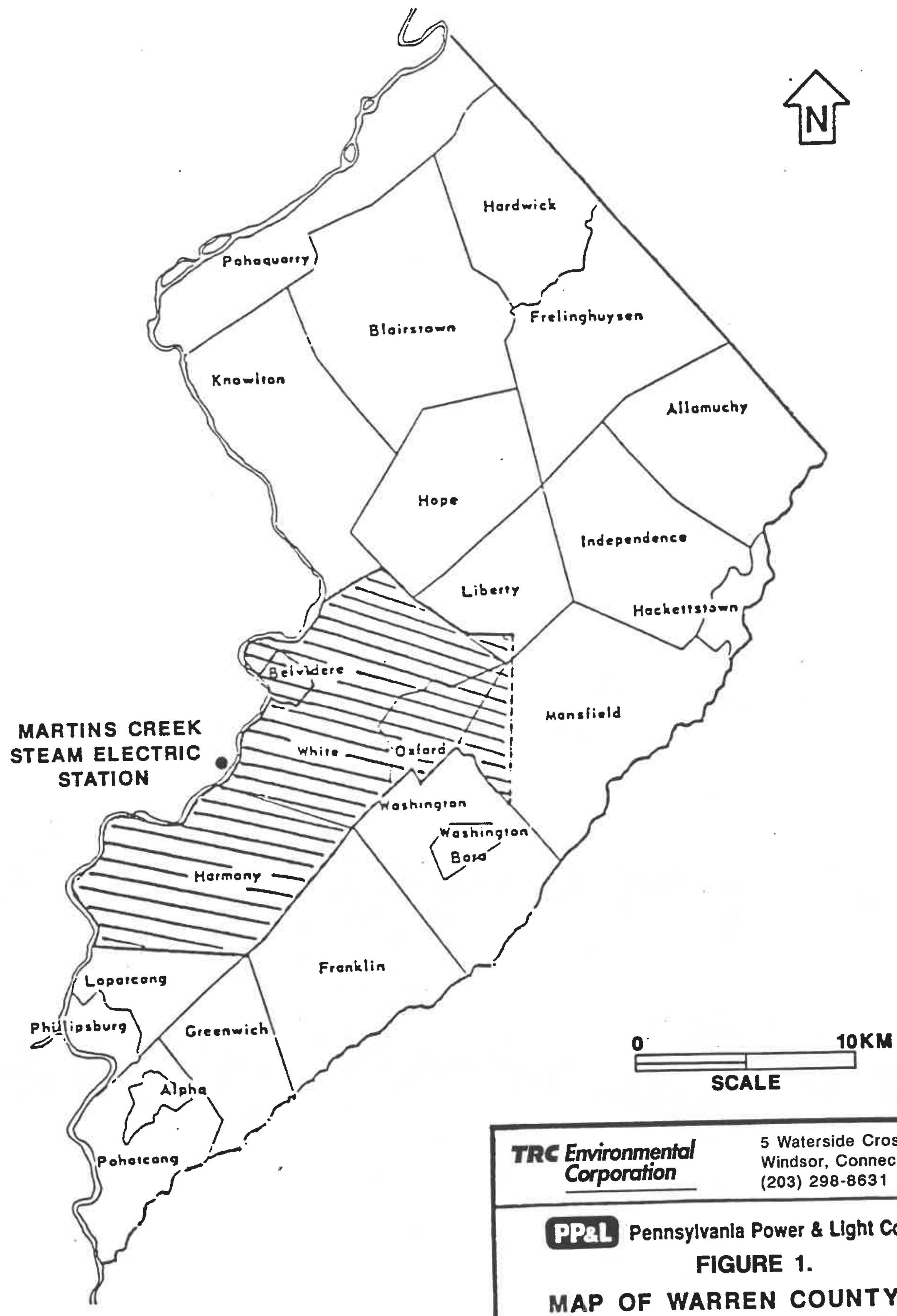
The LAPPES model outperformed the RTDM/MPTER models by a score of 41.2 to 5.17, as described and documented in the Air Quality Model Performance Evaluation and Comparison Study for Martins Creek Steam Electric Station (Murray, 1994) and subsequent responses to questions raised by the PA DEP and NJ DEP (PP&L, April 1995 and May 1995). Also, LAPPES did not have significant over- or under-prediction bias and, therefore, no model adjustment factors would be necessary in applying the model to MCSES. Based on the performance evaluation results, the LAPPES model was approved for use in predicting ambient sulfur dioxide concentrations from MCSES on Scotts Mountain.

PP&L must now evaluate the air quality impacts of MCSES and other sulfur dioxide emissions sources in the Warren County, New Jersey nonattainment area using the LAPPES model and EPA guideline models as appropriate.

3.0 STUDY AREA

MCSES is located along the Delaware River in Pennsylvania, immediately west of Warren County, New Jersey. Portions of Warren County are designated nonattainment for sulfur dioxide. The nonattainment area is shown in Figure 1. Of particular concern are predicted concentrations in high terrain areas, specifically, Scotts Mountain and Jenny Jump Mountain. The model evaluation study conducted by PP&L was restricted to Scotts Mountain, which is located 2 km to 8 km to the southwest of MCSES. Terrain on Scotts Mountain rises to a maximum elevation of 1,281 feet, which is 441 feet above the MCSES 600 foot stack tops. Jenny Jump Mountain is located 5 km to the north-northeast of Scotts Mountain, with terrain rising to a maximum elevation of 1,070 feet, which is 230 feet above the MCSES stacks. Other areas of the nonattainment area are below the stack top elevation of the MCSES 600 foot stacks.

Other large sulfur dioxide emissions sources in the study area are Metropolitan Edison Company's Portland Station, located 13 km to the north of Scotts Mountain and 8 km to the northwest of Jenny Jump Mountain, and the Warren County Resource Recovery Facility and Hoffman-LaRoche plant located in Warren County between Scotts Mountain and Jenny Jump Mountain. A layout of the study area is shown in Figure 2.

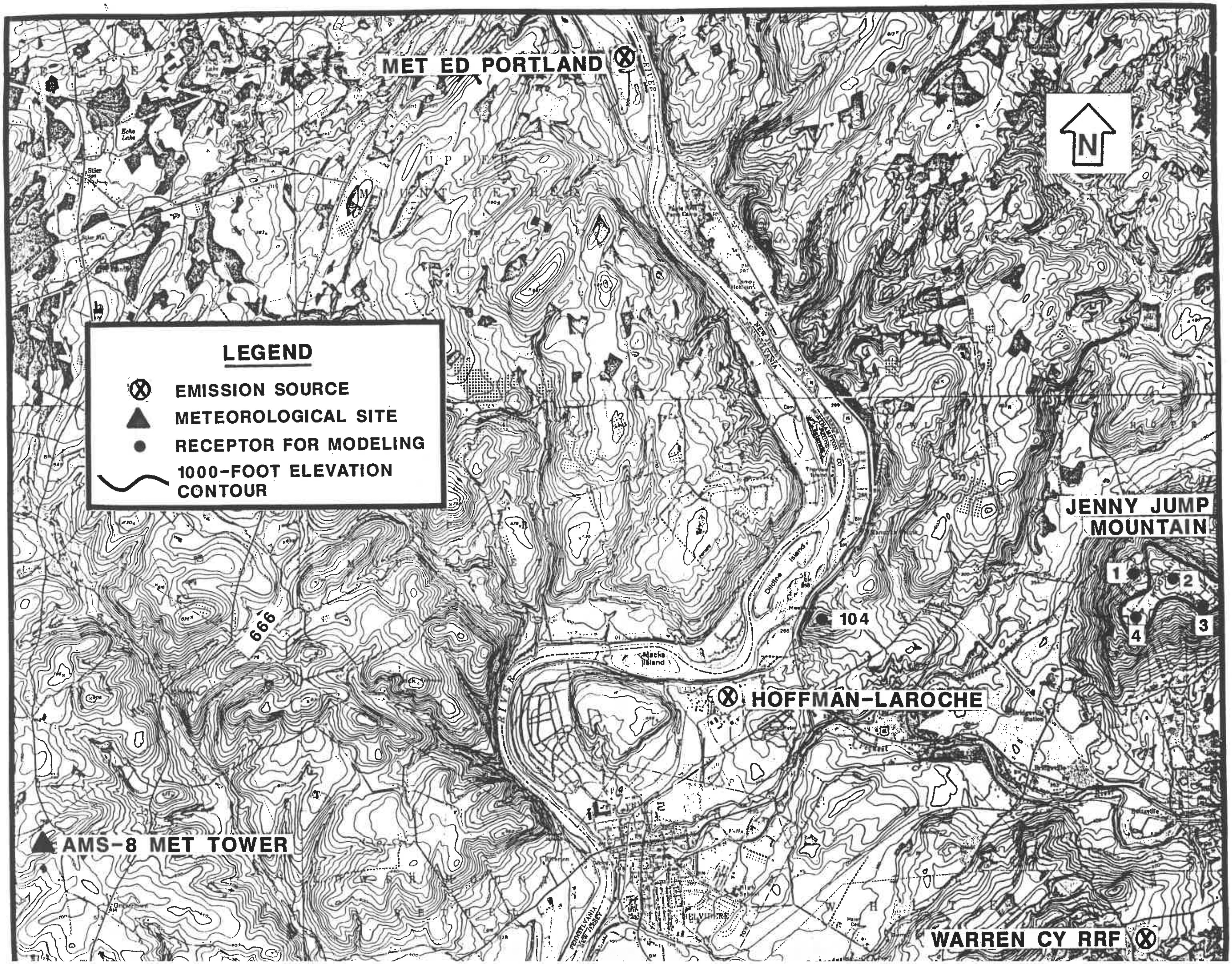


TRC Environmental Corporation
5 Waterside Crossing
Windsor, Connecticut 06095
(203) 298-8631

PP&L Pennsylvania Power & Light Company

FIGURE 1.

MAP OF WARREN COUNTY, NJ, SHOWING SULFUR DIOXIDE NON-ATTAINMENT AREA


MET ED PORTLAND
N
LEGEND
EMISSION SOURCE
METEOROLOGICAL SITE
RECEPTOR FOR MODELING
1000-FOOT ELEVATION CONTOUR
JENNY JUMP MOUNTAIN
1
2
3
4
104
666
HOFFMAN-LAROCHE
AMS-8 MET TOWER
WARREN CY RRF

4.0 EMISSIONS INVENTORY

The emissions inventory for MCSES and the emissions inventory of other nearby sources are discussed in the following subsections.

4.1 MCSES EMISSIONS INVENTORY

PP&L operates two large coal-fired units (1 and 2) and two large No. 6 oil-fired units (3 and 4) at MCSES. The coal-fired units are 150.25 megawatts (MW) each and exhaust to a common 600-foot stack. The No. 6 oil-fired units are 850.5 MW each and exhaust to separate 600-foot stacks. Operating permits restrict Units 1 and 2 to a sulfur dioxide emission limit of 4.0 lb/MMBtu and restrict the fuel oil sulfur content for Units 3 and 4 to 1 percent.

There are several comparatively smaller sulfur dioxide emission sources at MCSES. These sources operate infrequently and, therefore, were not part of the model evaluation study. They consist of two auxiliary boilers used to start-up oil-fired Units 3 and 4, two diesel generators used for start-up of the coal-fired units and four combustion turbines used for peaking purposes. All of these sources burn low sulfur (0.5%) No. 2 fuel oil. Listed below are all sulfur dioxide air emission sources at MCSES.

Type	Unit	Input Capacity (MMBTU/hr)	Fuel
Coal-fired boilers	1	1815	Bituminous coal
	2	1815	Bituminous coal
No. 6 oil-fired boilers	3	7721.2	No. 6 oil
	4	7721.2	No. 6 oil
Auxiliary boilers	3A	243	No. 2 oil
	4B	323	No. 2 oil
Combustion turbines	C-1	349.8	No. 2 oil
	C-2	349.8	No. 2 oil
	C-3	349.8	No. 2 oil
	C-4	349.8	No. 2 oil
Diesel generators	D-1	27.3	No. 2 oil
	D-2	27.3	No. 2 oil

The four combustion turbines will be included in the modeling compliance analysis. Since the two auxiliary boilers and two diesel generators only operate during low-load, start-up conditions for the respective boilers, they will only be included in the modeling analysis of low-load (50 percent) operation at the plant.

Tables 1 and 2 present the sulfur dioxide emissions and stack parameters of sources at MCSES. Stack gas exit temperatures from MCSES Units 1 & 2, 3 and 4 were determined as a function of load from measurements and curves developed in the model evaluation study. The curves are presented in Appendix B. Stack gas exit velocities from the MCSES stacks were determined as a linear function of load.

Table 1: MCSES Sulfur Dioxide Emissions Inventory

SOURCE	EMISSIONS LIMIT (lb/MMBtu)	OPERATING LEVEL (MMBtu/hr)	CONVERSION FACTOR	SHORT-TERM EMISSIONS (g/s)	ANNUAL FACTOR (%)
Unit 1	4.0	1815	0.126	914.8	61.2
Unit 2	4.0	1815	0.126	914.8	53.5
Unit 3	1.14[(1)]	7721.2	0.126	1109.1	22.3
Unit 4	1.14	7721.2	0.126	1109.1	21.1
Aux. 3A	0.52[(2)]	343	0.126	22.5	0.1
Aux. 4B	0.52	323	0.126	21.2	10.0
CT (each)	0.52	349.8	0.126	22.9	1.0
Diesel (each)	0.52	27.3	0.126	1.8	1.1

Notes:

(1) lb/MMBtu based on 1% sulfur limit and No. 6 fuel oil of 151,148 Btu/lb at 8.58 lb/gal.

(2) lb/MMBtu based on 0.5% sulfur limit and No. 2 fuel oil of 139,131 Btu/lb at 7.2 lb/gal.

Table 2: MCSES Stack Parameters

	Coal Fired Units 1 & 2	Oil Fired Unit 3	Oil Fired Unit 4	Aux. Boiler 3A	Aux. Boiler 4B	Combustion Turbine 1, 2, 3 or 4	Diesel Generator D-1 or D-2
Base Elevation (ft.)	240	240	240	240	240	240	240
UTMs							
East (km)	491.020	491.123	491.190	491.114	491.190	--	--
North (km)	4515.910	4516.030	4516.068	4516.115	4516.161	--	--
Stack Height (m)	183	183	183	80.2	80.2	16.2	5.2
Stack Diameter (m)	5.3	6.9	6.9	2.1	3.0	5.9	0.6
Velocity (m/s)							
100%	28.4	33.5	33.5	7.0	4.1	20.8	6.6
75%	21.3	25.1	25.1	--	--	--	--
50%	14.2	16.8	16.8	--	--	--	--
Temperature (K)							
100%	410	426	421	625	711	960	896
75%	405	417	413	--	--	--	--
50%	399	407	404	--	--	--	--

Notes:

Emissions presented for Units 1 and 2 are the combined total for both units.

Emissions presented for the combustion turbines and diesel generators are for a single unit. The UTMs for each unit are:

	East	North
CT1	490.875	4515.886
CT2	490.869	4515.882
CT3	490.853	4515.871
CT4	490.848	4515.868
D-1	490.965	4515.855
D-2	490.959	4515.862

4.2 BACKGROUND SOURCES

Three nearby background sources were explicitly included in the model evaluation study and also will be included in the compliance modeling evaluation. These sources are the Hoffman-LaRoche facility in Belvidere, New Jersey, the Warren County Resource Recovery Facility in Oxford, New Jersey, and Metropolitan Edison Company's Portland Station in Portland, Pennsylvania. The Hoffman-LaRoche and Warren County facilities are located in the Warren County nonattainment area, and Portland Station is located north of the nonattainment area in Pennsylvania. These sources are identified in Figure 2, which presents a layout of the study area. The emissions inventory of the background sources is presented in Tables 3 and 4.

AFF4.DWD

Table 3: Background Sources Sulfur Dioxide Emissions Inventory

SOURCE	EMISSIONS LIMIT (lb/MMBtu)	OPERATING LEVEL (MMBtu/hr)	CONVERSION FACTOR	SHORT-TERM EMISSIONS (g/s)	ANNUAL FACTOR (%)
Portland Station					
Unit 1	3.7	1464	0.126	682.5	73.3
Unit 2	3.7	2342	0.126	1091.8	77.6
CT	0.063	1461	0.126	11.6	1.3
Hoffman-LaRoche					
Stack 1[(1)]	1.06	319	0.126	42.6	38.0
Stack 2	1.08	353	0.126	48.0	86.0
Warren Co. RRF					
Unit 1	0.225	88.8	0.126	2.5	92.6
Unit 2	0.225	88.8	0.126	2.5	92.6

Notes:

(1) The information presented for Stack 1 is for four stacks and boilers combined.

Table 4: Background Sources Stack Parameters

	Met-Ed Portland Station			Hoffman-LaRoche		Warren County Res. Recov. Fac.	
	Unit 1	Unit 2	CT	Stack 1	Stack 2	Unit 1	Unit 2
Base Elevation (ft)	294	294	294	340	340	570	570
UTM Coordinates							
East (km)	493.35	493.35	493.35	494.05	494.05	498.95	498.95
North (km)	4528.37	4528.37	4528.37	4521.04	4521.04	4518.50	4518.50
Stack Height (m)	121.9	121.9	42.7	16.8	59.4	76.2	76.2
Stack Diameter (m)	3.6	3.6	6.1	1.7	2.7	1.76	1.76
Stack Exit Velocity (m/s)	27.1	40.2	31.3	12.8	16.9	16.3	16.3
Stack Exit Temperature (K)	403	405	727.6	450	419	389	389

5.0 DISPERSION MODELING PROCEDURES

5.1 OVERVIEW

Dispersion modeling will be conducted to evaluate the sulfur dioxide air quality impacts of MCSES and other sources in the Warren County, New Jersey nonattainment area. The following subsections describe the dispersion models, stack height considerations, prediction locations, meteorological data and background concentrations that will be used in the study.

5.2 DISPERSION MODELS

Dispersion modeling will be conducted at prediction locations (receptors) throughout the Warren County nonattainment area. The dispersion model used will be based on the results of the model evaluation study for receptors on Scotts Mountain. For receptors in other locations, the model used will depend on whether the receptor elevation is above stack top (complex terrain) or below stack top (simple terrain).

Scotts Mountain is in a complex terrain area relative to the MCSES stacks. The LAPPES model was shown to be superior to the EPA guideline RTDM/MPTER model combination for predicting MCSES sulfur dioxide impacts on Scotts Mountain in the model evaluation study and, therefore, will be used to model MCSES impacts on Scotts Mountain. Some smaller sources at MCSES were not included in the model evaluation study because of their infrequent operation.

However, LAPPES was clearly demonstrated to be the superior model for predicting MCSES impacts on Scotts Mountain and will be used to model impacts from all MCSES sources on Scotts Mountain.

Predicted impacts from other nearby sources were modeled with the RTDM and MPTER models rather than LAPPES in the model evaluation study. RTDM is a complex terrain model and MPTER is a simple terrain model that is also used to model impacts in complex terrain areas by representing the receptor elevation by the stack top elevation. In this compliance evaluation study, the Industrial Source Complex model (ISC, version 95250) will be used rather than MPTER. Under EPA guideline applications, ISC and MPTER produce similar results, except that ISC also allows treatment of building induced plume downwash. In areas where the terrain elevation is between stack top and plume centerline elevation, referred to as intermediate terrain, the EPA guidelines require that ISC be used in addition to RTDM and that the higher of the two concentrations be selected on an hour-by-hour basis.

Modeling impacts from MCSES in areas other than Scotts Mountain will be conducted with RTDM and ISC. This includes Jenny Jump Mountain, which is the only complex terrain area relative to the MCSES 600 foot stacks other than Scotts Mountain that is in the nonattainment area. (Jenny Jump Mountain was not included as part of the model evaluation study.) Modeling of impacts from the other nearby sources will also be conducted with RTDM and ISC. RTDM will be used in complex terrain areas, ISC will be used in simple terrain areas and both models (RTDM/ISC) will be used in intermediate terrain areas.

The use of RTDM and/or ISC will be determined individually for each stack. Both models will be run in the EPA guideline, regulatory default mode.

The LAPPES model is described more fully in the report of the model evaluation study. The RTDM and ISC models are EPA models and are described in their respective user's guides.

5.3 STACK HEIGHT ISSUES

MCSES coal-fired Units 1 and 2 exhaust to a common 600-foot stack, while No. 6 oil-fired Units 3 and 4 exhaust to separate 600-foot stacks. The smaller units at MCSES exhaust to stacks between 17 feet and 210 feet above ground level.

There are two inter-related issues concerning the stack heights and modeling procedures at MCSES:

1. The allowable, creditable stack height that can be used for regulatory dispersion modeling, based on the Federal Stack Height Regulation and nearby cooling towers.

2. Whether enhanced plume dispersion (downwash) caused by wind flow around nearby structures should be considered in the modeling analysis.

5.3.1 CREDITABLE STACK HEIGHTS

The Federal Stack Height Regulation limits the stack height that can be used for dispersion modeling to the Good Engineering Practice (GEP) stack height, which is a function of nearby obstructions to air flow. The purpose of this regulation is to prevent excessive pollutant dispersion as a means of attaining the NAAQS without reducing the total atmospheric pollutant loading. With a few technical exceptions, this stack height credit limitation applies to stacks constructed after December 31, 1970.

The only stack at MCSES for which there has been concern that the actual stack height may not be creditable for regulatory dispersion modeling is the 600-foot stack serving Units 1 and 2. The formula GEP stack height for this stack is 485 feet (115 feet below its actual height). This is based on the formula:

$$GEP = H + 1.5L,$$

where H is the building height and L is the lesser of the building height or projected width. The stacks serving Units 3 and 4 are the same height as the stack serving Units 1 and 2; however, their entire stack height is creditable because PP&L entered into contractual construction agreements prior to

December 31, 1970. The stack serving the smaller units at MCSES are below their respective formula GEP heights.

The GEP stack height formula applies to rectangular structures, but is not applicable to streamlined structures such as cooling towers. PP&L conducted a fluid modeling study to evaluate whether the entire 600-foot height of the Units 1 and 2 stack is justified, and creditable for dispersion modeling purposes, to avoid excessive effects that disturbed air flow around the cooling towers would have on plume dispersion. The conclusions of that study (Peterson, 1987) are that the entire 600-foot stack height is justified and that the actual GEP stack height is 225m 738 feet. Therefore, PP&L will use the actual Units 1 and 2 stack height, as well as the actual stack heights for the other MCSES units, in the dispersion modeling analysis.

5.3.2 PLUME DOWNWASH CONSIDERATIONS

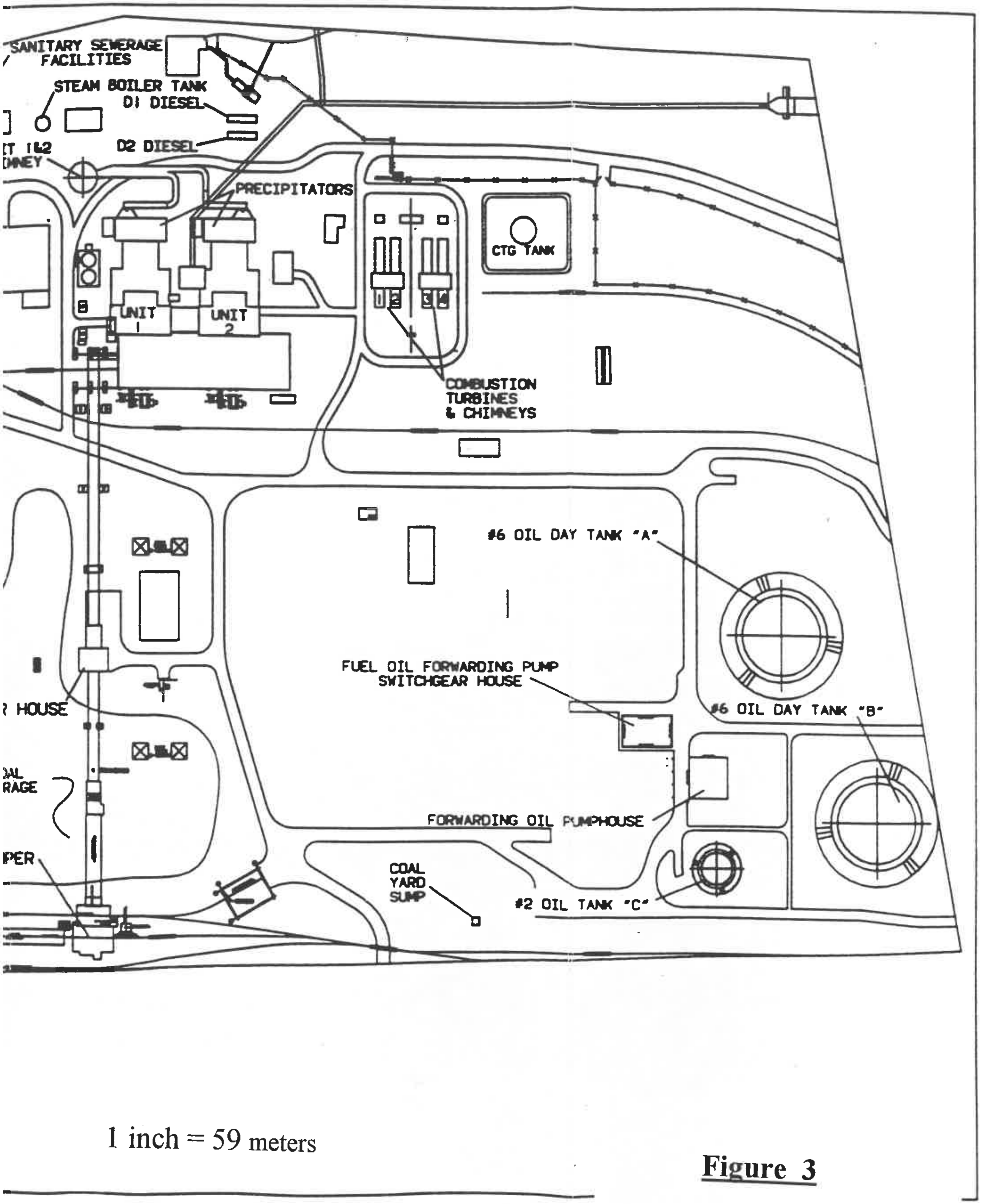
Enhanced plume dispersion effects (downwash) caused by wind flow around nearby structures at MCSES will be included in the modeling analysis with the ISC model. ISC is EPA's guideline model that incorporates downwash algorithms. In the modeling of MCSES sources, ISC will be used in simple and intermediate terrain areas of the nonattainment area, except for Scotts Mountain. The model evaluation study demonstrated that the LAPPES model predicted MCSES impacts reasonably well on Scotts Mountain without a significant over-or under-prediction tendency. Therefore, LAPPES will be used exclusively to predict MCSES impacts on Scotts Mountain.

Neither the GEP formula nor the downwash algorithms in ISC are intended to account for the streamlined design of the cooling towers. In consultation with EPA, the New Jersey DEP has suggested that a rectangular structure with a height of 90 meters, a length of 180 meters and a width of 90 meters be used to represent the cooling towers. These dimensions give a formula GEP height of 225 meters, which is consistent with the results of the fluid modeling study.

These suggested building dimensions will be used to represent the cooling towers in the modeling analysis. PP&L assumes that they will not result in unrealistic predictions. If the downwash modeling predictions appear to be unreasonable, it may be appropriate to conduct a fluid modeling demonstration to further refine the building dimensions.

Downwash modeling considerations will only be incorporated for MCSES sources.

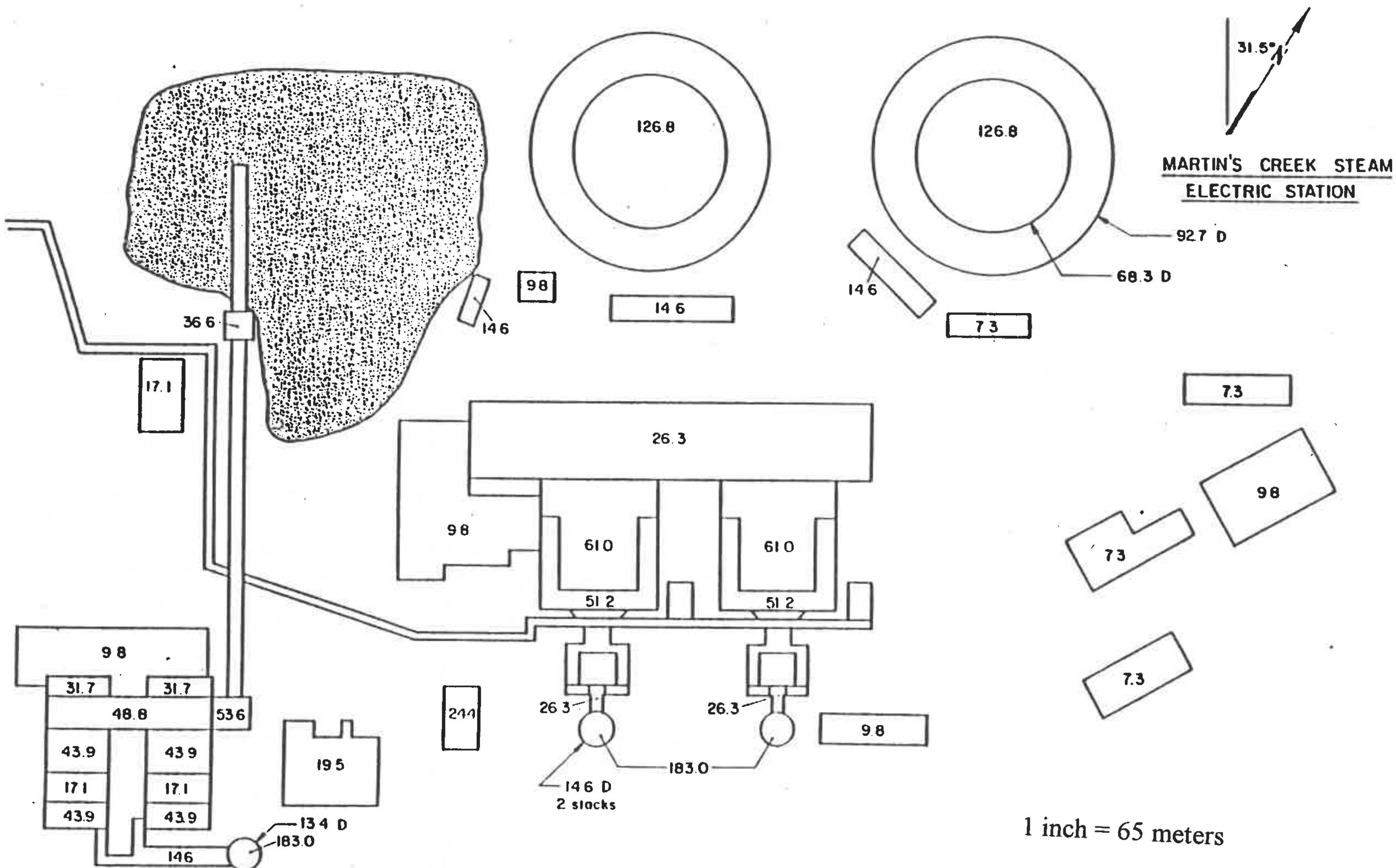
Figures 3 and 4 are diagrams of MCSES showing the orientation of structures and stacks at MCSES. Figure 3 shows the entire plant layout and Figure 4 provides a simplified, subset of the plant and provides building heights.



1 inch = 59 meters

Figure 3

MCSES Plant Layout



1 inch = 65 meters

Building heights shown in meters

Figure 4: MCSES - Building Configurations

5.4 PREDICTION LOCATIONS

Model predictions will be made at 497 prediction locations (receptors) throughout the Warren County nonattainment area. These include the set of 105 receptors that, with two exceptions, correspond to the receptors used in the preliminary analysis conducted to develop the model evaluation protocol and to site the monitors for the evaluation study. The first exception is that the receptor located at AMS-8 in Pennsylvania will not be included. Second, a receptor is being added at the location of AMS-13, which is at a location that does not correspond exactly to a receptor used in the preliminary analysis study. Also, the AMS-12 receptor elevation used will be 1209 feet, which is the same elevation used for that approximate location in the preliminary analysis and which is nine feet above 1200 foot elevation of the actual monitor site location. A total of 100 receptors in this set are on Scotts Mountain, four receptors are on Jenny Jump Mountain and one receptor is located elsewhere in the nonattainment area.

The remainder of the receptors used in this study consist of two grids that cover the remainder of the nonattainment area. A grid at 300 meter spacing consisting of 231 receptors is placed between the Scotts Mountain receptor grid and the portion of the nonattainment area closest to MCSES. This grid includes portions of Scotts Mountain that are below the 840 foot contour, which corresponds to the stack top elevation of the MCSES 600 foot stacks. Finally, a grid at 1000 meter spacing consisting of 161 receptors is placed throughout the remainder of the nonattainment area.

Appendix A presents the Universal Transverse Macerator (UTM) coordinates and elevation of each receptor. Figure 5 shows the location of all receptors and their relationship to the sources being modeled. The Scotts Mountain receptors are also shown in more detail in Figure 6 and the Jenny Jump Mountain receptors are also shown on the map of the study area in Figure 2.

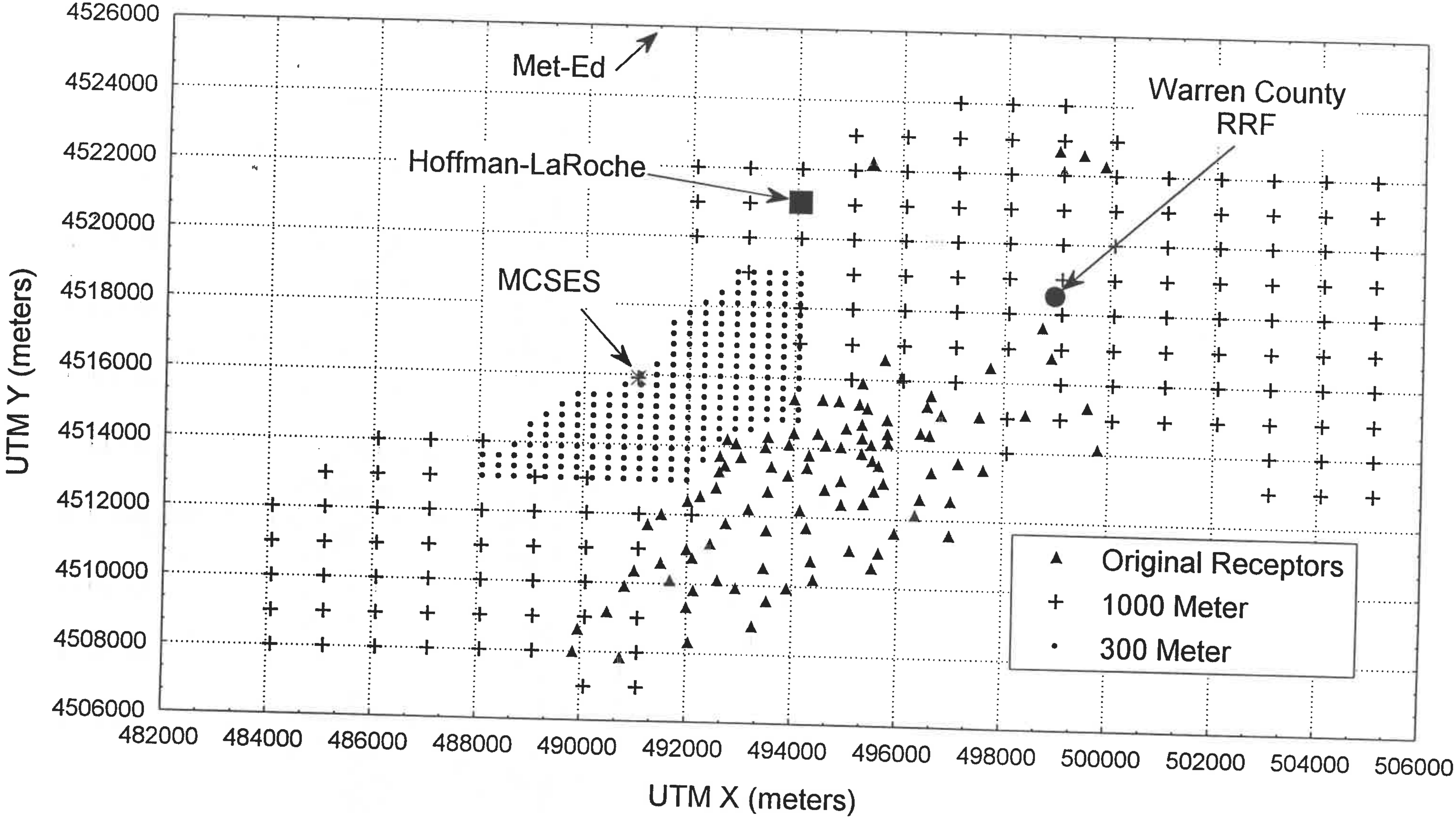
5.5 METEOROLOGICAL DATA

The dispersion modeling evaluation will be conducted using two full years of meteorological data for the years 1992 and 1993 collected onsite near MCSES and supplemented with data from the National Weather Service (NWS) Station at the Allentown-Bethlehem-Easton Airport and twice daily upper air data collected at the Albany, New York NWS Station. This period overlaps with the period of the model evaluation study (May 1, 1992 through May 19, 1993). The data will be processed using the same procedures used for the evaluation study.

The onsite data collected near MCSES consists of wind speed and wind direction data collected at 30-meter height increments up to 600 meters with an acoustic sounder (SODAR) and ambient temperature, horizontal wind direction fluctuations (sigma-theta) and back-up wind speed and wind direction data collected on a meteorological tower on a hill northwest of the plant at PP&L's air

Figure 5

Full Receptor Grid



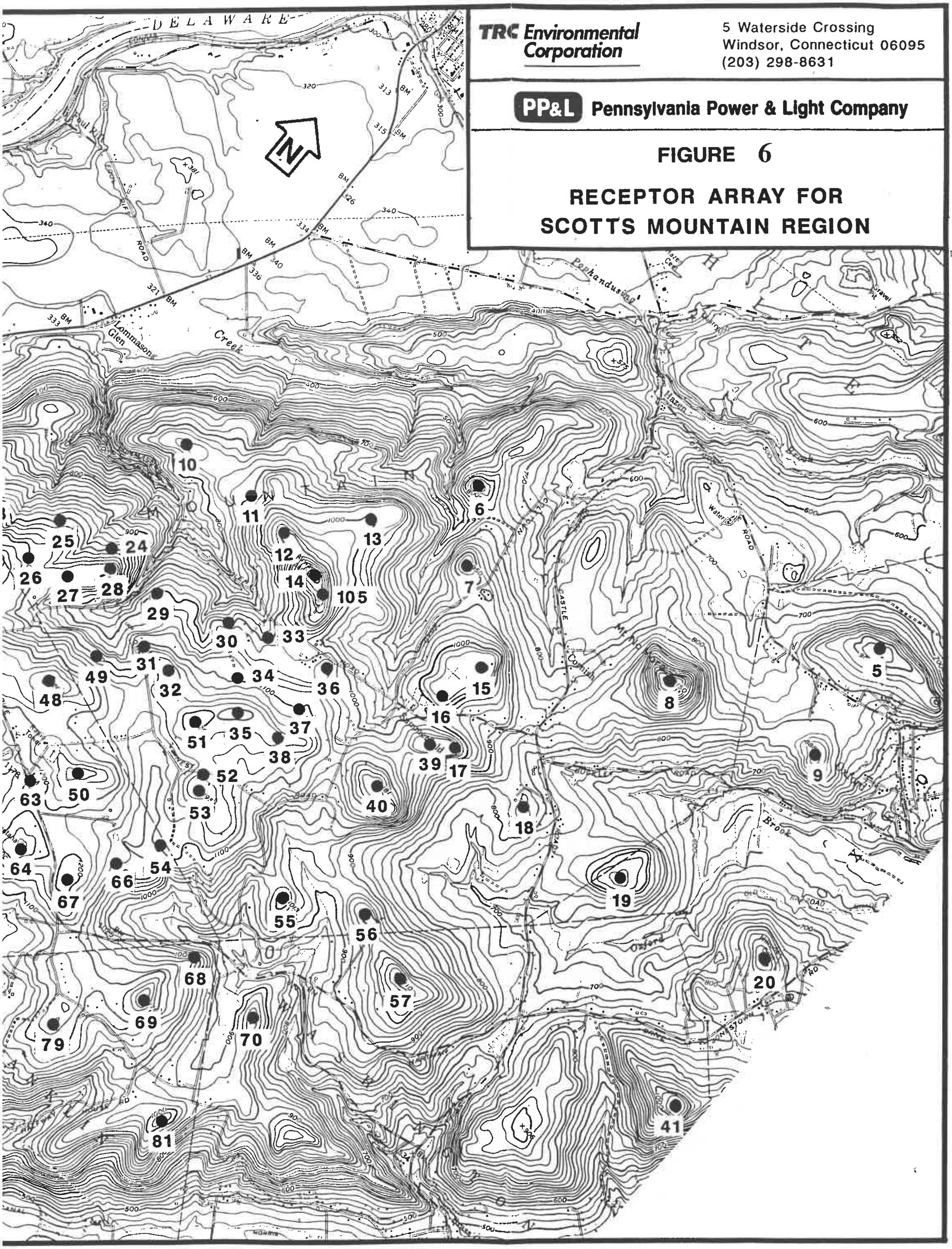
TRC Environmental Corporation

5 Waterside Crossing
Windsor, Connecticut 06095
(203) 298-8631

PP&L Pennsylvania Power & Light Company

FIGURE 6

RECEPTOR ARRAY FOR SCOTTS MOUNTAIN REGION



monitoring station #8 (AMS-8). Data on the tower were collected at the 10-meter and 20-meter tower levels until March 1993 when a taller tower was erected and data were collected at the 10-meter, 60-meter and 100-meter tower levels. The 180-meter SODAR level and the 10-meter tower level correspond to the MCSES 600-foot stack top elevation. PP&L's AMS-8 meteorological tower and SODAR sites are shown on the study area map (Figure 2).

Upper air meteorological data collected by the Albany NWS Station will be used along with ABE surface temperatures to calculate mixing heights. ABE data also provide back-up wind, temperature and stability class data.

Atmospheric stability classes will be determined from sigma-theta measurements at the 10-meter AMS-8 tower level, with the 20-meter level as back-up. A surface roughness length (Z_0) of 100 cm will be used. Pasquill/Turner stability classification using ABE data will be the final back-up and the primary backup after the 20-meter tower level was discontinued in March 1993. Stability classes will be smoothed so that the stability class does not vary by more than one category per hour. Using these procedures, the stability class frequency distribution during the 1-year model evaluation period is shown below.

Stability Class	Frequency
A	1.0
B	2.5
C	5.5
D	52.9
E	32.1
F	6.1

Separate meteorological data files will be prepared for MCSES and each of the three other sources being modeled. Separate primary wind direction levels from SODAR data will be used for each source, corresponding to a representative plume transport height for each source. For MCSES, the primary wind direction height will be 420 meters. The SODAR level corresponding to the respective stack top will be used as the primary wind speed level for each source. This wind speed level is used in LAPPES for calculation plume rise and plume dilution. For RTDM, a separate wind speed level corresponding to the representative plume height is used for calculating plume dilution and the stack top wind speed is used for calculating plume rise.

Site-specific wind speed profile exponents will be calculated and applied when missing data are substituted from other SODAR levels or from AMS-8 or the ABE NWS station, as was done for the model evaluation study meteorological data sets.

Calm wind speed hours will be treated in the modeling analysis in accordance with the EPA guideline policy. The calm determination will be made for each source meteorological file separately, so that the meteorological data could be considered calm for some sources, while not for other sources. Winds will be considered calm if the SODAR or AMS-8 tower data are less than the tower instrument starting threshold of 0.3 m/s. ABE NWS winds are considered calm if the wind speed is less than or equal to 1 m/s and the reported wind direction is persistent. The calm determination will be based on the transport level (plume height) wind speed. If data are missing at the primary level, the calm determination will be made prior to applying wind profile extrapolation. Any wind speeds less than 1 m/s after being extrapolated to either stack top or transport wind height will be set to 1 m/s.

Table 5 presents the substitution hierarchy for the meteorological data and Figure 7 presents a wind rose of the MCSES meteorological data set that was used for the model evaluation study. Details concerning the meteorological data preparation procedures (and details of the model evaluation study data subset) are provided in the model evaluation study report (Londergan, 1990) and the model evaluation protocol (Murray, 1994).

Table 5: Meteorological Data Substitution Hierarchy

Emission Source	Stack Top Wind Speed	Transport Wind Speed	Transport Wind Direction	Stability Class
MCSES	180m AMS-8(20) ABE	420-180m AMS-8(20) ABE	420-180m AMS-8(20) AMS-8(10) ABE	AMS-8(10) AMS-8(20) ABE
MetEd	120-90m AMS-8(20) ABE	300-180m AMS-8(20) ABE	300-180m AMS-8(20) AMS-8(10) ABE	AMS-8(10) AMS-8(20) ABE
WCRRF	150-90m AMS-8(20) ABE	210-180m AMS-8(20) ABE	210-180m AMS-8(20) AMS-8(10) ABE	AMS-8(10) AMS-8(20) ABE
HL	90m AMS-8(20) ABE	210-180m AMS-8(20) ABE	210-180m AMS-8(20) AMS-8(10) ABE	AMS-8(10) AMS-8(20) ABE

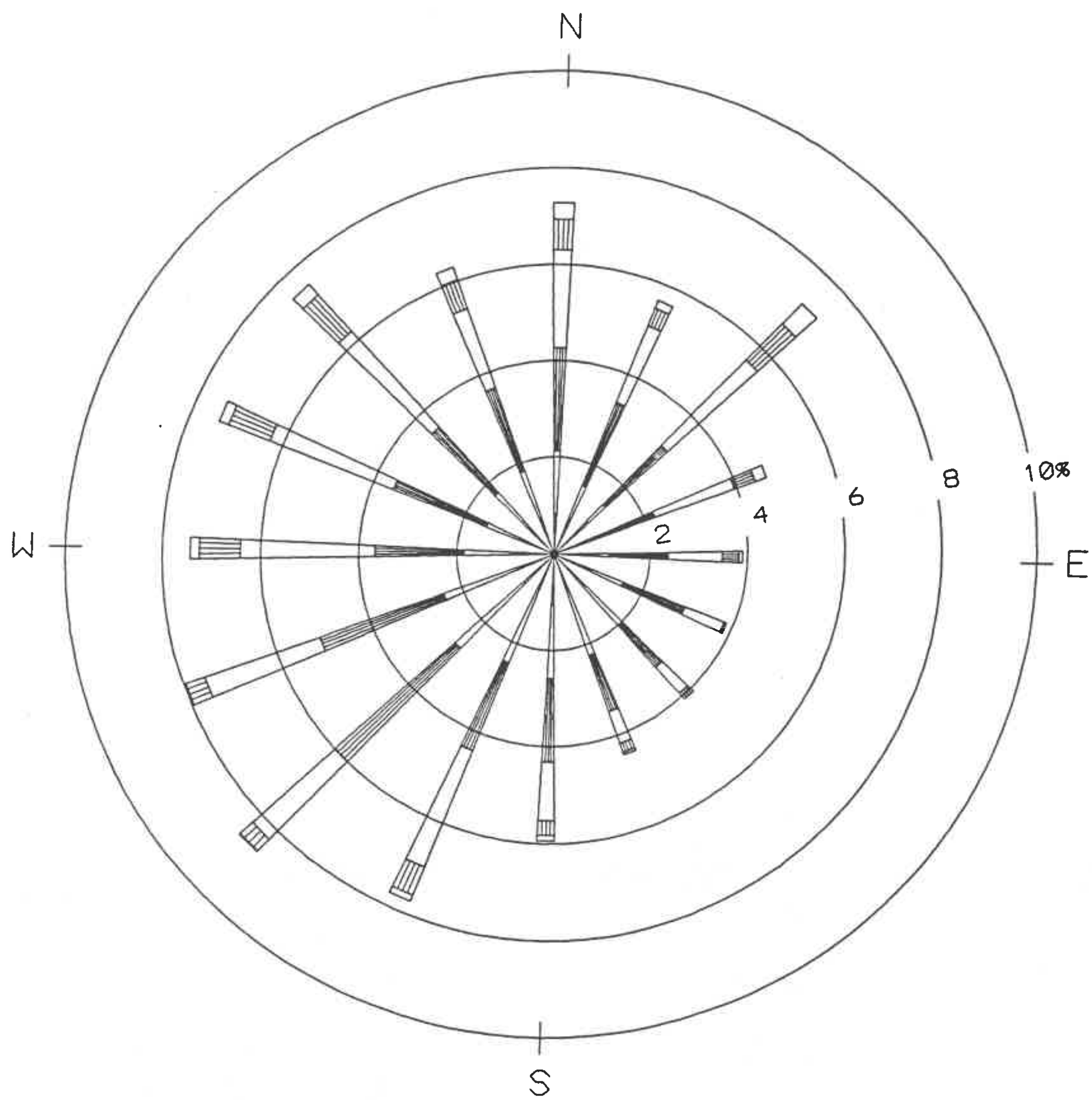
Notes:

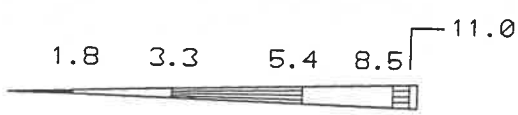
Stability class by sigma-theta from AMS-8 and by Turner's method from ABE.

The transport wind speed will be used for RMTD only.

420-180m refers to the SODAR 420m level, with missing data first substituted for with data from the closest lower level, down to a minimum height of 180m.

"AMS-8(20)" refers to the 20m level of AMS-8. The 60 meter level will be substituted for the 20 meter level after March 1993, except that the primary back-up stability classification will be replaced with ABE classification.





WIND SPEED CLASS BOUNDARIES
(METERS/SECOND)

WINDROSE

MCSES, PA.
PERIOD: 1992-93

NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING. EXAMPLE - WIND IS BLOWING FROM THE NORTH 7.3 PERCENT OF THE TIME.

Bowman Environmental Engineering

TRC Environmental Corporation
5 Waterside Crossing
Windsor, CT 06095
(203) 289-8631

PENNSYLVANIA POWER & LIGHT COMPANY

FIGURE 7
WINDROSE OF THE METEOROLOGICAL DATA

Date: 8/95 | Drawing No. 18868

5.6 BACKGROUND CONCENTRATIONS

Background ambient sulfur dioxide concentrations have been developed to account for ambient concentrations from distant, small or unidentified sources that will not be explicitly modeled in the dispersion modeling analysis. These background concentrations will be added to the predicted concentrations from the sources modeled to obtain total ambient air quality concentrations.

A background concentration matrix has been developed as a function of 28 meteorological categories to provide meteorologically dependent background concentrations. The matrix was developed from the full set of hourly measurements made at all seven Scotts Mountain monitors and the AMS-8 monitor in Pennsylvania from May 1, 1992 through April 30, 1993, during the model evaluation study. For each hour of the two year compliance modeling evaluation, the hourly background concentration will be the value in the matrix that corresponds to the meteorological conditions for the respective hour.

This procedure for representing background concentrations is intended to be consistent with EPA's modeling guidelines that recommend using data for the meteorological conditions of concern collected at monitors not impacted by the sources being modeled. A constant background concentration for 3-hour or 24-hour blocks is not used because the hourly meteorological conditions do not remain constant throughout the averaging period.

The background value for each meteorological category was determined by averaging the measurements from all monitors upwind from MCSES for each hour and then averaging over all hours in each respective category. Only monitors upwind of MCSES for each hour were used, to minimize the effects of MCSES on the background concentration. The concurrent MCSES meteorological data set used for the model evaluation study was used to categorize the meteorological conditions and to identify upwind monitors. A monitor was considered upwind if it did not fall within a 90 degree sector centered on the hourly wind flow vector relative to MCSES. Other sources were not included in identifying upwind monitors because that would have resulted in too many hours when there were no upwind monitors. In the case of MCSES, AMS-8 and the Scotts Mountain monitors are in opposite directions, so for every hour, at least one monitor would be upwind. For the few hours (17) that AMS-8 data was missing and the wind was in the direction of Scotts Mountain, the minimum measurement was used to represent the background for that hour.

The meteorological categories used represent 28 combinations of wind speed, wind direction and atmospheric stability class. Stability classes are divided into stable, neutral and unstable categories; wind direction is divided into 90 degree quadrants; and wind speed is divided into low, medium and high categories for neutral stability and low and medium/high categories for the stable and unstable stability categories as summarized below.

Wind Direction Quadrant	Stability	Wind Speed (M/S)
NE	Stable (E, F)	0-3
SE	Neutral (D)	3.01-8
SW	Unstable (A, B, C)	>8.01
NW		

The background concentration matrix is presented in Table 6.

Table 6: Background SO2 Concentrations as a Function of Meteorology

Bin Number	Flow Vector Quadrant	Stability	Wind Speed (m/s)	Average (ug/m^3)	Number of Monitor - Hours Used	Number of Hours in Bin
1	Northeast	Stable	0-3	29.5	1830	281
2	Northeast	Stable	gt 3	25.3	6061	906
3	Northeast	Neutral	0-3	30.1	1759	261
4	Northeast	Neutral	3-8	23.1	5258	796
5	Northeast	Neutral	gt 8	20.1	1249	192
6	Northeast	Unstable	0-3	32.8	1252	182
7	Northeast	Unstable	gt 3	19.7	401	59
8	Southeast	Stable	0-3	32.2	741	266
9	Southeast	Stable	gt 3	22.2	1494	573
10	Southeast	Neutral	0-3	29.4	455	170
11	Southeast	Neutral	3-8	16.4	2316	976
12	Southeast	Neutral	gt 8	12.4	1135	498
13	Southeast	Unstable	0-3	30.2	339	123
14	Southeast	Unstable	gt 3	13.3	141	47
15	Southwest	Stable	0-3	28.7	1215	166
16	Southwest	Stable	gt 3	17.5	4088	558
17	Southwest	Neutral	0-3	21.6	779	108
18	Southwest	Neutral	3-8	16.9	4360	602
19	Southwest	Neutral	gt 8	13.1	2537	347
20	Southwest	Unstable	0-3	23.9	871	125
21	Southwest	Unstable	gt 3	16.8	450	64
22	Northwest	Stable	0-3	13.1	1697	240
23	Northwest	Stable	gt 3	11.0	2522	357
24	Northwest	Neutral	0-3	15.0	1576	227
25	Northwest	Neutral	3-8	12.1	2929	421
26	Northwest	Neutral	gt 8	6.7	546	79
27	Northwest	Unstable	0-3	20.7	709	103
28	Northwest	Unstable	gt 3	14.7	226	33

6.0 COMPLIANCE EVALUATION

The compliance modeling evaluation will be conducted throughout the nonattainment area using the dispersion models and input data described in Sections 4.0 and 5.0 and summarized in the table below.

Emissions Inventory	Models	Meteorological Data
MCSES	LAPPES (MCSES on Scotts Mountain)	On-site/ABE/ALB 1992
Other Sources: Met-Ed (Portland) Hoffman-LaRoche Warren Co. Facility	RTDM, ISC (for other sources and non-Scott's for MCSES) Downwash for MCSES	1993

The MCSES large coal-fired and No. 6 oil-fired units will be modeled at 100 percent, 75 percent and 50 percent load. The smaller units at MCSES that operate during start-up and peaking conditions and the other nearby sources that will be modeled will be modeled at 100 percent load for all three of the load scenarios of the MCSES large units. Hourly background concentrations will be added to the predicted concentrations to obtain total hourly predictions at each receptor.

The total hourly predicted concentrations will be summarized into annual average and block 3-hour and 24-hour concentrations for each of the two modeled years. EPA's calms processing procedures will be used to calculate the concentration for each averaging period. Since each facility will be modeled with a source-specific meteorological data file, the calms determination will be made separately for each source before combining individual source predictions to obtain the total averaging period predictions. The highest annual average and highest, second-highest short-term predictions for each year modeled, will be compared with respective NAAQS shown below.

NAAQS

3-Hour	1300 $\mu g/m^3$
24-Hour	365 $\mu g/m^3$
Annual	80 $\mu g/m^3$

If total predicted concentrations exceed the NAAQS, source contributions will be identified for each source modeled and alternative emission scenarios will be evaluated.

REFERENCES

1. EPA (1984), Interim Procedures for Evaluating Air Quality Models (Revised), EPA-450/4-84-023, OAQPS, Research Triangle Park, NC.

2. Londergan, R. J. (1990), Air Quality Model Performance Evaluation and Comparison Protocol for Martins Creek Steam Electric Station, TRC project No. 7661-R61, TRC Environmental Consultants, Inc., Windsor, CT.

3. Schiermeier, F. A. And Niemeyer, L. E., (1970), Large Power Plant Effluent Study (LAPPES), Vol. I - Instrumentation, Procedures and Data Tabulations, APTD 70-2, U.S. Dept. Of Health, Education and Welfare, Raleigh, NC.

4. Paine, R. J. and Egan, B. A., User's Guide to the Rough Terrain Diffusion Model (RTDM) Rev. 3.20), Doc. No. P-D535-585, ERT, Acton, MA.

5. EPA (1980), User's Guide for MPTER - A Multiple Point Gaussian Dispersion Algorithm with Terrain Adjustment, EPA-600/8-80-016, OAQPS, Research Triangle Park, NC.

6. EPA (1993), Guideline on Air Quality Models (Revised) with Supplement B, EPA-450/2-78-027R, OAQPS, Research Triangle Park, NC.

7. Murray, D. R. and Ratte, M. A. (1994), Air Quality Model Performance Evaluation and Comparison Study for Martins Creek Steam Electric Station, TRC Project No. 14715-R61, TRC Environmental Consultants, Inc., Windsor, CT.

8. Peterson, R. L. (1987), Fluid Modeling for Good Engineering Stack Height at Pennsylvania Power & Light's Martins Creek Steam Electric Station, Cermak Peterka Peterson, Inc., Project No. 87-0390, CPP, Inc., Fort Collins, CO.

APPENDIX A

LIST OF RECEPTORS

Table A-1: Original Set of Prediction Locations (Receptors)

Table A-2: Refined 300M Spacing Grid

Table A-3: 1,000 Meter Spacing Grid

Table A-1: Original Set of Prediction Locations (Receptors)

Receptor No.	UTM X	UTM Y	Elevation	Comment
1	499.00	4522.70	930.	Jenny Jump
2	499.46	4522.58	1070.	Jenny Jump
3	499.88	4522.27	1050.	Jenny Jump
4	499.08	4522.12	1030.	Jenny Jump
5	498.72	4517.61	940.	
6	495.72	4516.58	860.	
7	496.05	4516.09	950.	
8	497.74	4516.43	1150.	Mount No More
9	498.90	4516.75	888.	
10	494.00	4515.40	870.	
11	494.54	4515.40	900.	
12	494.86	4515.38	1100.	
13	495.30	4515.90	1000.	
14	495.25	4515.30	1220.	Beacon
15	496.62	4515.60	1060.	
16	496.54	4515.28	1050.	
17	496.82	4515.03	1080	
18	497.54	4515.02	845.	
19	498.42	4515.10	845.	
20	499.60	4515.35	900.	Hillside
21	492.74	4514.20	900.	
22	492.90	4514.10	1000.	
23	493.00	4514.00	1100.	
24	494.00	4514.44	1000.	
25	493.51	4514.30	1000.	
26	493.46	4514.00	1110.	
27	493.91	4514.10	1090.	
28	494.10	4514.31	1090.	
29	494.46	4514.42	1000.	
30	495.00	4514.60	1000.	
31	494.61	4514.09	1100.	
32	494.90	4514.05	1170.	
33	495.30	4514.72	1000.	
34	495.31	4514.33	1100.	
35	495.48	4514.14	1210.	
36	495.78	4514.87	1040.	
37	495.79	4514.46	1100.	
38	495.80	4514.20	1185.	

Table A-1 (Continued)

Receptor No.	UTM X	UTM Y	Elevation	Comment
39	496.71	4514.92	1100.	Summerfield
40	496.60	4514.45	1181.	
41	499.81	4514.15	1080.	
42	492.60	4513.72	1000.	
43	492.59	4513.26	1100.	
44	492.70	4513.44	1215.	AMS#9
45	493.00	4513.70	1205.	
46	493.58	4513.44	1150	
47	493.90	4513.20	1236.	AMS #7
48	494.26	4513.43	1281.	
49	494.30	4513.80	1100.	
50	494.91	4513.08	1270.	
51	495.30	4513.88	1209.	AMS #12
52	495.51	4513.68	1160.	AMS #5
53	495.63	4513.54	1195.	
54	495.73	4513.04	1100.	
55	496.64	4513.37	1013.	
56	497.15	4513.66	1020.	
57	497.63	4513.49	1110.	
58	492.00	4512.40	1000.	
59	492.24	4512.54	1060.	
60	492.54	4512.81	1107.	
61	493.52	4512.72	1240.	
62	493.15	4512.20	1100.	
63	494.60	4512.82	1180.	
64	494.92	4512.40	1240.	Montana
65	494.13	4512.20	1130.	Cemetary
66	495.55	4512.80	1120.	
67	495.35	4512.43	1220.	
68	496.43	4512.60	1000.	
69	496.34	4512.14	1176.	
70	497.02	4512.56	980.	
71	491.50	4512.00	1080.	
72	491.25	4511.70	1040.	
73	491.99	4511.01	1040.	
74	492.73	4511.79	1080.	
75	492.44	4511.19	1116.	AMS #10
76	493.50	4511.60	1060.	
77	494.26	4511.70	1060.	

Table A-1 (Continued)

Receptor No.	UTM X	UTM Y	Elevation	Comment
78	495.09	4511.07	1020.	
79	495.95	4511.60	1140.	
80	495.65	4511.02	1060.	
81	497.00	4511.56	1040.	
82	491.50	4510.60	1040.	
83	491.00	4510.36	900.	
84	491.68	4510.10	1000.	
85	492.10	4510.77	1069.	
86	492.58	4510.14	1080.	
87	493.90	4509.95	1070.	
88	493.45	4510.52	1020.	
89	494.35	4510.75	1080.	
90	494.40	4510.20	1030.	
91	495.52	4510.58	1080.	
92	490.82	4509.90	940.	
93	490.50	4509.16	1020.	
94	492.00	4509.33	953.	
95	492.13	4509.83	1020.	
96	492.93	4509.92	1093.	
97	493.52	4509.56	994.	
98	489.94	4508.64	1068.	
99	489.85	4508.00	1015.	
100	492.05	4508.33	972.	
101	493.24	4508.82	907.	
102	490.75	4507.85	1000.	
103	495.43	4522.20	665	
104	495.40	4515.18	1170.	AMS #11
105	496.43	4514.50	1120	AMS #13

Table A-2

Refined 300m Spacing Grid

Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
106	491380.0	4516000.0	320.0
107	491680.0	4516000.0	320.0
108	491980.0	4516000.0	340.0
109	492280.0	4516000.0	355.0
110	492580.0	4516000.0	340.0
111	492880.0	4516000.0	340.0
112	493180.0	4516000.0	340.0
113	493480.0	4516000.0	340.0
114	493780.0	4516000.0	560.0
115	494080.0	4516000.0	620.0
116	491380.0	4516300.0	300.0
117	491680.0	4516300.0	300.0
118	491980.0	4516300.0	310.0
119	492280.0	4516300.0	340.0
120	492580.0	4516300.0	360.0
121	492880.0	4516300.0	360.0
122	493180.0	4516300.0	360.0
123	493480.0	4516300.0	360.0
124	493780.0	4516300.0	420.0
125	494080.0	4516300.0	460.0
126	491680.0	4516600.0	260.0
127	491980.0	4516600.0	340.0
128	492280.0	4516600.0	360.0
129	492580.0	4516600.0	360.0
130	492880.0	4516600.0	360.0
131	493180.0	4516600.0	360.0
132	493480.0	4516600.0	336.0
133	493780.0	4516600.0	340.0
134	494080.0	4516600.0	460.0
135	491680.0	4516900.0	320.0
136	491980.0	4516900.0	340.0
137	492280.0	4516900.0	360.0
138	492580.0	4516900.0	381.0
139	492880.0	4516900.0	360.0
140	493180.0	4516900.0	340.0
141	493480.0	4516900.0	340.0
142	493780.0	4516900.0	340.0
143	494080.0	4516900.0	340.0
144	491680.0	4517200.0	320.0
145	491980.0	4517200.0	320.0
146	492280.0	4517200.0	320.0
147	492580.0	4517200.0	320.0
148	492880.0	4517200.0	320.0

Table A-2

Refined 300m Spacing Grid

Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
149	493180.0	4517200.0	320.0
150	493480.0	4517200.0	320.0
151	493780.0	4517200.0	334.0
152	494080.0	4517200.0	340.0
153	491680.0	4517500.0	340.0
154	491980.0	4517500.0	300.0
155	492280.0	4517500.0	320.0
156	492580.0	4517500.0	320.0
157	492880.0	4517500.0	320.0
158	493180.0	4517500.0	320.0
159	493480.0	4517500.0	320.0
160	493780.0	4517500.0	326.0
161	494080.0	4517500.0	340.0
162	491980.0	4517800.0	340.0
163	492280.0	4517800.0	300.0
164	492580.0	4517800.0	320.0
165	492880.0	4517800.0	320.0
166	493180.0	4517800.0	320.0
167	493480.0	4517800.0	320.0
168	493780.0	4517800.0	320.0
169	494080.0	4517800.0	320.0
170	492280.0	4518100.0	280.0
171	492580.0	4518100.0	300.0
172	492880.0	4518100.0	320.0
173	493180.0	4518100.0	320.0
174	493480.0	4518100.0	320.0
175	493780.0	4518100.0	320.0
176	494080.0	4518100.0	320.0
177	492580.0	4518400.0	300.0
178	492880.0	4518400.0	300.0
179	493180.0	4518400.0	300.0
180	493480.0	4518400.0	313.0
181	493780.0	4518400.0	300.0
182	494080.0	4518400.0	320.0
183	492880.0	4518700.0	280.0
184	493180.0	4518700.0	300.0
185	493480.0	4518700.0	300.0
186	493780.0	4518700.0	280.0
187	494080.0	4518700.0	300.0
188	492880.0	4519000.0	260.0
189	493180.0	4519000.0	280.0
190	493480.0	4519000.0	280.0
191	493780.0	4519000.0	280.0

Table A-2

Refined 300m Spacing Grid

Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
192	494080.0	4519000.0	280.0
193	491380.0	4515700.0	340.0
194	491680.0	4515700.0	360.0
195	491980.0	4515700.0	360.0
196	492280.0	4515700.0	360.0
197	492580.0	4515700.0	320.0
198	492880.0	4515700.0	320.0
199	493180.0	4515700.0	380.0
200	493480.0	4515700.0	500.0
201	493780.0	4515700.0	740.0
202	494080.0	4515700.0	800.0
203	491380.0	4515400.0	360.0
204	491680.0	4515400.0	390.0
205	491980.0	4515400.0	380.0
206	492280.0	4515400.0	330.0
207	492580.0	4515400.0	400.0
208	492880.0	4515400.0	440.0
209	493180.0	4515400.0	560.0
210	493480.0	4515400.0	720.0
211	493780.0	4515400.0	840.0
212	491380.0	4515100.0	400.0
213	491680.0	4515100.0	400.0
214	491980.0	4515100.0	380.0
215	492280.0	4515100.0	330.0
216	492580.0	4515100.0	460.0
217	492880.0	4515100.0	700.0
218	493180.0	4515100.0	700.0
219	493480.0	4515100.0	780.0
220	493780.0	4515100.0	840.0
221	494080.0	4515100.0	840.0
222	491380.0	4514800.0	340.0
223	491680.0	4514800.0	340.0
224	491980.0	4514800.0	400.0
225	492280.0	4514800.0	420.0
226	492580.0	4514800.0	540.0
227	492880.0	4514800.0	720.0
228	493180.0	4514800.0	740.0
229	493480.0	4514800.0	820.0
230	493780.0	4514800.0	840.0
231	494080.0	4514800.0	840.0
232	491380.0	4514500.0	320.0
233	491680.0	4514500.0	340.0
234	491980.0	4514500.0	500.0

Table A-2

Refined 300m Spacing Grid

Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
235	492280.0	4514500.0	500.0
236	492580.0	4514500.0	740.0
237	492880.0	4514500.0	840.0
238	493180.0	4514500.0	840.0
239	491380.0	4514200.0	320.0
240	491680.0	4514200.0	480.0
241	491980.0	4514200.0	540.0
242	492280.0	4514200.0	640.0
243	492580.0	4514200.0	840.0
244	491380.0	4513900.0	500.0
245	491680.0	4513900.0	520.0
246	491980.0	4513900.0	620.0
247	492280.0	4513900.0	780.0
248	491380.0	4513600.0	600.0
249	491680.0	4513600.0	540.0
250	491980.0	4513600.0	800.0
251	492280.0	4513600.0	840.0
252	491380.0	4513300.0	620.0
253	491680.0	4513300.0	620.0
254	491980.0	4513300.0	840.0
255	491380.0	4513000.0	580.0
256	491680.0	4513000.0	680.0
257	491980.0	4513000.0	840.0
258	490780.0	4515700.0	280.0
259	490780.0	4515400.0	320.0
260	490480.0	4515400.0	300.0
261	490180.0	4515400.0	280.0
262	489880.0	4515400.0	260.0
263	490780.0	4515100.0	340.0
264	490480.0	4515100.0	340.0
265	490180.0	4515100.0	320.0
266	489880.0	4515100.0	280.0
267	489580.0	4515100.0	260.0
268	490780.0	4514800.0	340.0
269	490480.0	4514800.0	340.0
270	490180.0	4514800.0	320.0
271	489880.0	4514800.0	300.0
272	489580.0	4514800.0	280.0
273	489280.0	4514800.0	280.0
274	490780.0	4514500.0	320.0
275	490480.0	4514500.0	320.0
276	490180.0	4514500.0	350.0
277	489880.0	4514500.0	320.0

Table A-2

Refined 300m Spacing Grid

Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
278	489580.0	4514500.0	300.0
279	489280.0	4514500.0	240.0
280	488980.0	4514500.0	300.0
281	490780.0	4514200.0	320.0
282	490480.0	4514200.0	320.0
283	490180.0	4514200.0	353.0
284	489880.0	4514200.0	320.0
285	489580.0	4514200.0	310.0
286	489280.0	4514200.0	300.0
287	488980.0	4514200.0	280.0
288	490780.0	4513900.0	320.0
289	490480.0	4513900.0	300.0
290	490180.0	4513900.0	320.0
291	489880.0	4513900.0	300.0
292	489580.0	4513900.0	300.0
293	489280.0	4513900.0	300.0
294	488980.0	4513900.0	280.0
295	488680.0	4513900.0	280.0
296	490780.0	4513600.0	420.0
297	490480.0	4513600.0	320.0
298	490180.0	4513600.0	280.0
299	489880.0	4513600.0	300.0
300	489580.0	4513600.0	300.0
301	489280.0	4513600.0	300.0
302	488980.0	4513600.0	280.0
303	488680.0	4513600.0	320.0
304	488380.0	4513600.0	340.0
305	488080.0	4513600.0	340.0
306	490780.0	4513300.0	420.0
307	490480.0	4513300.0	500.0
308	490180.0	4513300.0	360.0
309	489880.0	4513300.0	300.0
310	489580.0	4513300.0	380.0
311	489280.0	4513300.0	280.0
312	488980.0	4513300.0	320.0
313	488680.0	4513300.0	340.0
314	488380.0	4513300.0	348.0
315	488080.0	4513300.0	340.0
316	490780.0	4513000.0	660.0
317	490480.0	4513000.0	680.0
318	490180.0	4513000.0	500.0
319	489880.0	4513000.0	360.0
320	489580.0	4513000.0	300.0

Table A-2

Refined 300m Spacing Grid

Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
321	489280.0	4513000.0	280.0
322	488980.0	4513000.0	320.0
323	488680.0	4513000.0	320.0
324	488380.0	4513000.0	340.0
325	488080.0	4513000.0	340.0
326	491080.0	4516000.0	260.0
327	491080.0	4515700.0	280.0
328	491080.0	4515400.0	300.0
329	491080.0	4515100.0	340.0
330	491080.0	4514800.0	340.0
331	491080.0	4514500.0	320.0
332	491080.0	4514200.0	310.0
333	491080.0	4513900.0	340.0
334	491080.0	4513600.0	540.0
335	491080.0	4513300.0	620.0
336	491080.0	4513000.0	680.0

Table A-3			
1000 meter Spacing Grid			
Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
337	486080.0	4514000.0	320.0
338	487080.0	4514000.0	347.0
339	488080.0	4514000.0	380.0
340	485080.0	4513000.0	260.0
341	486080.0	4513000.0	360.0
342	487080.0	4513000.0	340.0
343	489080.0	4513000.0	340.0
344	490080.0	4513000.0	780.0
345	484080.0	4512000.0	430.0
346	485080.0	4512000.0	440.0
347	486080.0	4512000.0	420.0
348	487080.0	4512000.0	395.0
349	488080.0	4512000.0	380.0
350	489080.0	4512000.0	500.0
351	490080.0	4512000.0	800.0
352	491080.0	4512000.0	840.0
353	492080.0	4512000.0	840.0
354	484080.0	4511000.0	460.0
355	485080.0	4511000.0	460.0
356	486080.0	4511000.0	440.0
357	487080.0	4511000.0	400.0
358	488080.0	4511000.0	480.0
359	489080.0	4511000.0	740.0
360	490080.0	4511000.0	740.0
361	491080.0	4511000.0	840.0
362	484080.0	4510000.0	380.0
363	485080.0	4510000.0	460.0
364	486080.0	4510000.0	440.0
365	487080.0	4510000.0	660.0
366	488080.0	4510000.0	660.0
367	489080.0	4510000.0	620.0
368	490080.0	4510000.0	840.0
369	484080.0	4509000.0	200.0
370	485080.0	4509000.0	520.0
371	486080.0	4509000.0	765.0
372	487080.0	4509000.0	760.0
373	488080.0	4509000.0	700.0
374	489080.0	4509000.0	840.0
375	490080.0	4509000.0	840.0
376	491080.0	4509000.0	840.0
377	484080.0	4508000.0	500.0
378	485080.0	4508000.0	700.0
379	486080.0	4508000.0	708.0
380	487080.0	4508000.0	640.0

Table A-3

1000 meter Spacing Grid

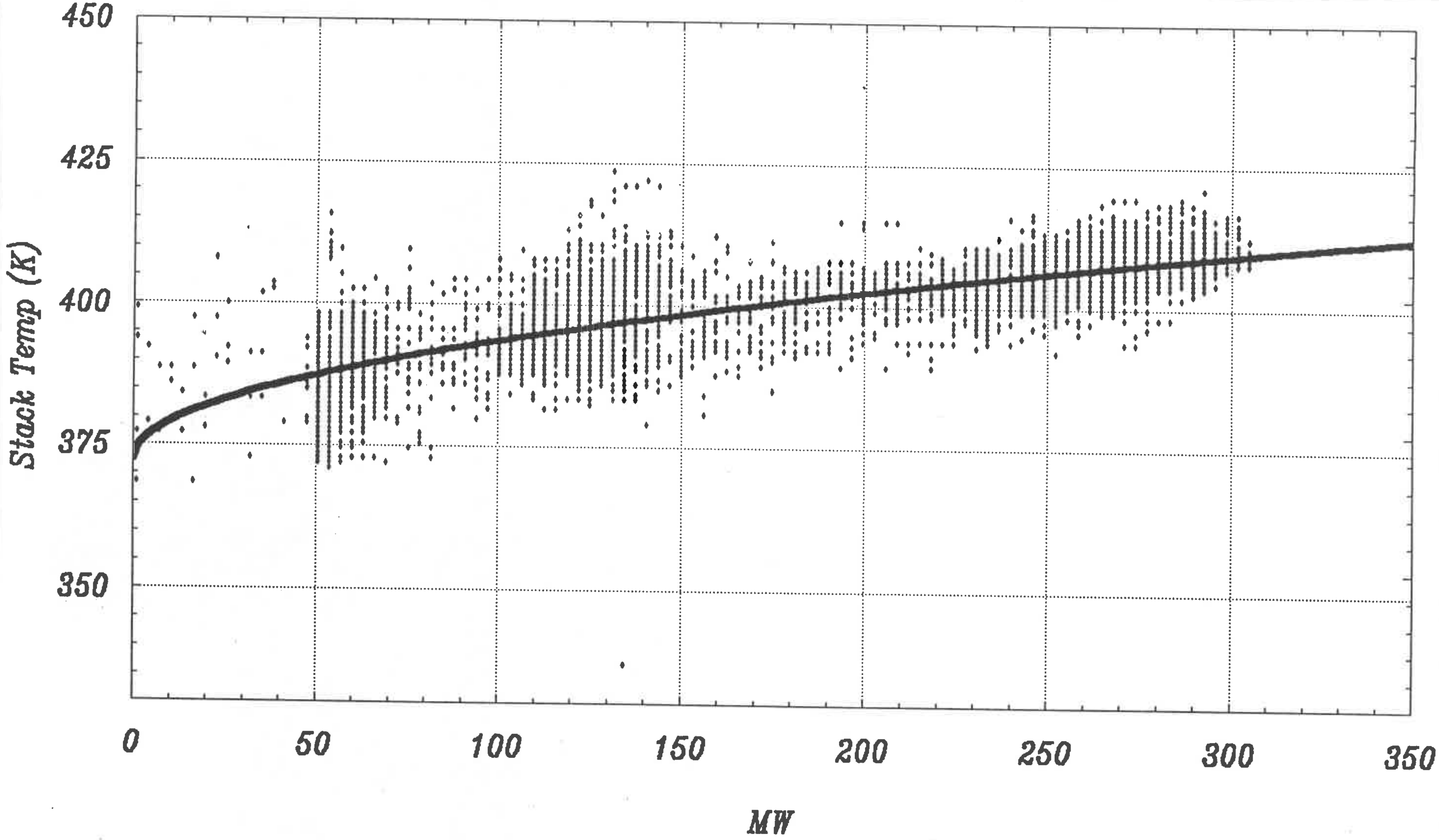
Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
381	488080.0	4508000.0	740.0
382	489080.0	4508000.0	840.0
383	491080.0	4508000.0	840.0
384	490080.0	4507000.0	840.0
385	491080.0	4507000.0	792.0
386	503080.0	4513000.0	808.0
387	504080.0	4513000.0	680.0
388	505080.0	4513000.0	820.0
389	503080.0	4514000.0	720.0
390	504080.0	4514000.0	800.0
391	505080.0	4514000.0	840.0
392	498080.0	4514000.0	840.0
393	498080.0	4515000.0	840.0
394	499080.0	4515000.0	840.0
395	500080.0	4515000.0	920.0
396	501080.0	4515000.0	960.0
397	502080.0	4515000.0	840.0
398	503080.0	4515000.0	540.0
399	504080.0	4515000.0	840.0
400	505080.0	4515000.0	940.0
401	495080.0	4516000.0	840.0
402	496080.0	4516000.0	840.0
403	497080.0	4516000.0	840.0
404	499080.0	4516000.0	800.0
405	500080.0	4516000.0	800.0
406	501080.0	4516000.0	973.0
407	502080.0	4516000.0	960.0
408	503080.0	4516000.0	940.0
409	504080.0	4516000.0	700.0
410	505080.0	4516000.0	860.0
411	494080.0	4517000.0	520.0
412	495080.0	4517000.0	680.0
413	496080.0	4517000.0	860.0
414	497080.0	4517000.0	900.0
415	498080.0	4517000.0	840.0
416	499080.0	4517000.0	930.0
417	500080.0	4517000.0	880.0
418	501080.0	4517000.0	640.0
419	502080.0	4517000.0	960.0
420	503080.0	4517000.0	1140.0
421	504080.0	4517000.0	1140.0
422	505080.0	4517000.0	740.0
423	494080.0	4518000.0	340.0
424	495080.0	4518000.0	540.0

Table A-3			
1000 meter Spacing Grid			
Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
425	496080.0	4518000.0	600.0
426	497080.0	4518000.0	680.0
427	498080.0	4518000.0	720.0
428	499080.0	4518000.0	940.0
429	500080.0	4518000.0	900.0
430	501080.0	4518000.0	640.0
431	502080.0	4518000.0	640.0
432	503080.0	4518000.0	980.0
433	504080.0	4518000.0	1080.0
434	505080.0	4518000.0	1080.0
435	493080.0	4519000.0	300.0
436	495080.0	4519000.0	400.0
437	496080.0	4519000.0	440.0
438	497080.0	4519000.0	640.0
439	498080.0	4519000.0	680.0
440	499080.0	4519000.0	740.0
441	500080.0	4519000.0	580.0
442	501080.0	4519000.0	700.0
443	502080.0	4519000.0	520.0
444	503080.0	4519000.0	720.0
445	504080.0	4519000.0	800.0
446	505080.0	4519000.0	1000.0
447	492080.0	4520000.0	320.0
448	493080.0	4520000.0	340.0
449	494080.0	4520000.0	340.0
450	495080.0	4520000.0	460.0
451	496080.0	4520000.0	460.0
452	497080.0	4520000.0	520.0
453	498080.0	4520000.0	640.0
454	499080.0	4520000.0	480.0
455	500080.0	4520000.0	540.0
456	501080.0	4520000.0	620.0
457	502080.0	4520000.0	740.0
458	503080.0	4520000.0	880.0
459	504080.0	4520000.0	580.0
460	505080.0	4520000.0	600.0
461	492080.0	4521000.0	340.0
462	493080.0	4521000.0	460.0
463	494080.0	4521000.0	468.0
464	495080.0	4521000.0	400.0
465	496080.0	4521000.0	420.0
466	497080.0	4521000.0	380.0
467	498080.0	4521000.0	400.0
468	499080.0	4521000.0	680.0

Table A-3			
1000 meter Spacing Grid			
Receptor Number	UTM X (meters)	UTM Y (meters)	Elevation (feet)
469	500080.0	4521000.0	520.0
470	501080.0	4521000.0	600.0
471	502080.0	4521000.0	940.0
472	503080.0	4521000.0	1140.0
473	504080.0	4521000.0	1140.0
474	505080.0	4521000.0	600.0
475	492080.0	4522000.0	320.0
476	493080.0	4522000.0	420.0
477	494080.0	4522000.0	320.0
478	495080.0	4522000.0	660.0
479	496080.0	4522000.0	660.0
480	497080.0	4522000.0	460.0
481	498080.0	4522000.0	540.0
482	499080.0	4522000.0	1020.0
483	500080.0	4522000.0	1040.0
484	501080.0	4522000.0	840.0
485	502080.0	4522000.0	940.0
486	503080.0	4522000.0	900.0
487	504080.0	4522000.0	1020.0
488	505080.0	4522000.0	1020.0
489	495080.0	4523000.0	460.0
490	496080.0	4523000.0	560.0
491	497080.0	4523000.0	700.0
492	498080.0	4523000.0	660.0
493	499080.0	4523000.0	1020.0
494	500080.0	4523000.0	1070.0
495	497080.0	4524000.0	700.0
496	498080.0	4524000.0	680.0
497	499080.0	4524000.0	600.0

APPENDIX B

FITTED TEMPERATURE CURVES FOR THE MCSES 600 FOOT STACKS



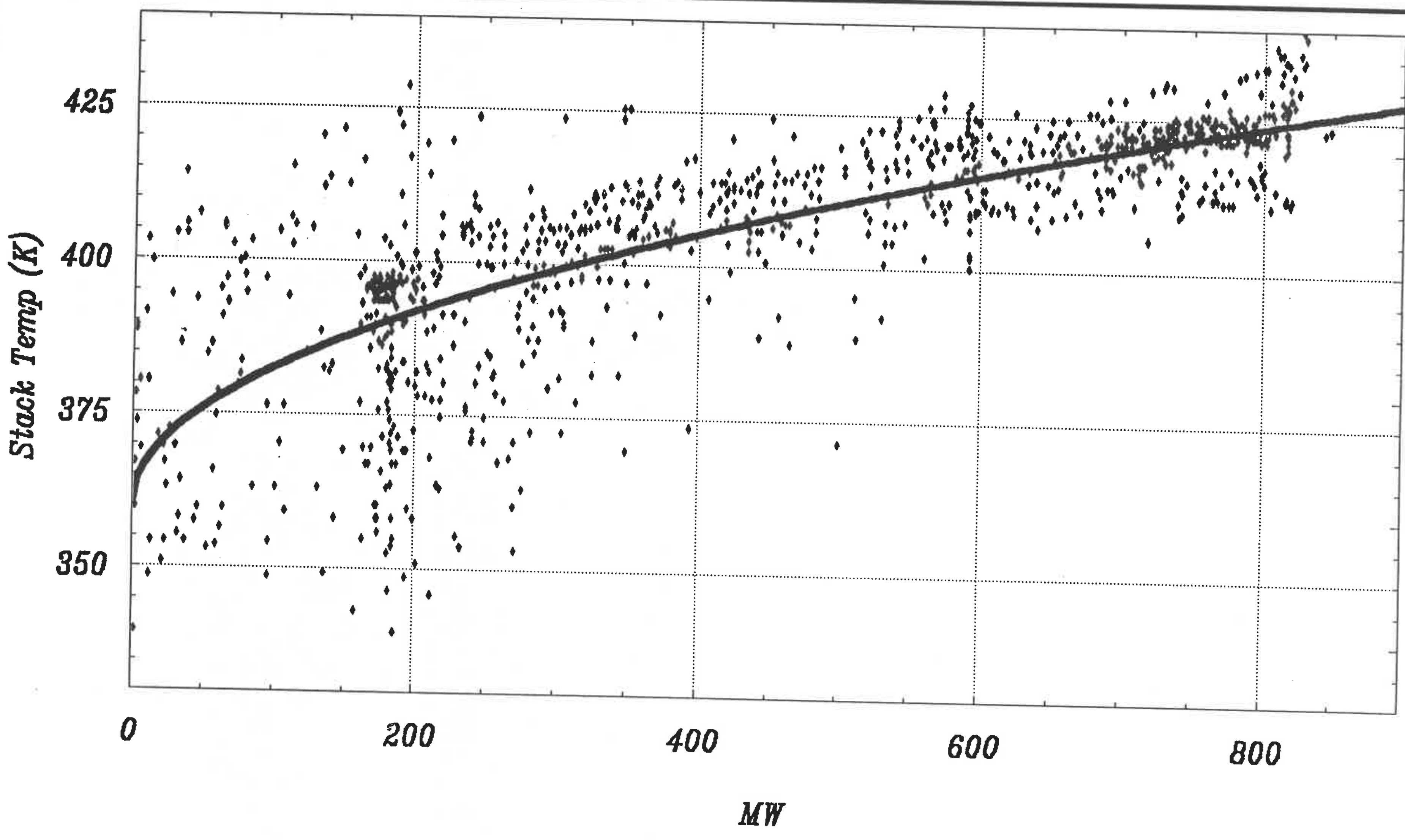
$$T = 372.41 + (2.14*SQRT(MW))$$
$$R = 0.83$$

TRC Environmental Corporation
5 Waterside Crossing
Windsor, CT 06095
(203) 289-8631

PENNSYLVANIA POWER & LIGHT COMPANY

FITTED TEMPERATURE FOR UNITS 1 AND 2

Date: 8/95 | Drawing No. 18868



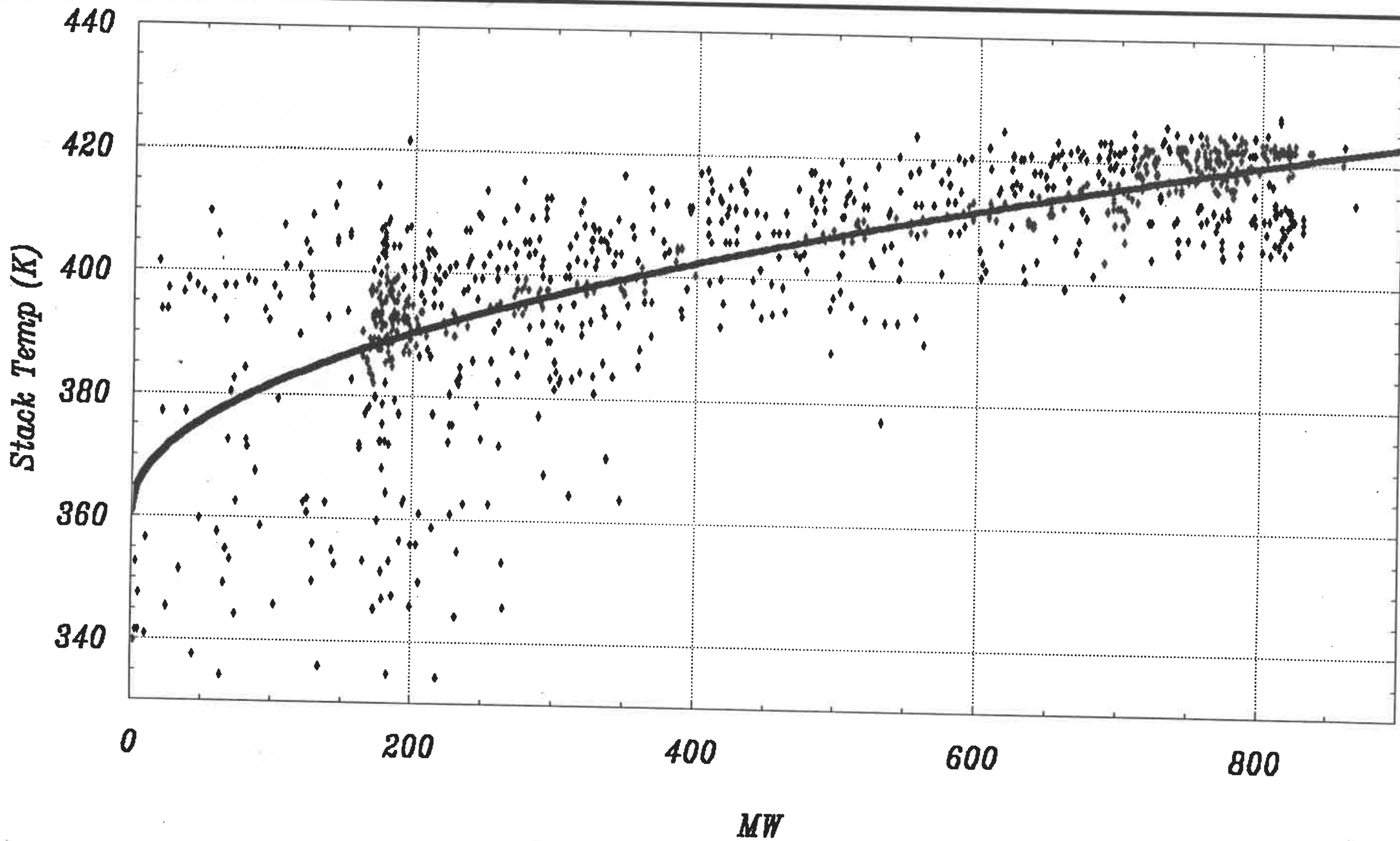
T = 360.08 + (2.26*SQRT(MW))
R = 0.79

TRC Environmental Corporation
5 Waterside Crossing
Windsor, CT 06095
(203) 289-8631

PENNSYLVANIA POWER & LIGHT COMPANY

FITTED TEMPERATURE FOR UNIT 3

Date: 8/95 | Drawing No. 18868



T = 361.14 + (2.06*SQRT(MW))
R = 0.76

TRC Environmental Corporation
5 Waterside Crossing
Windsor, CT 06095
(203) 289-8631

PENNSYLVANIA POWER & LIGHT COMPANY

FITTED TEMPERATURE FOR UNIT 4

Date: 8/95 | Drawing No. 18868