United States
Environmental Protection
Agency

Region II Office
26 Federal Plaza
New York, N.Y. 10278

EPA-902/6-84-003
March 1985

Air

EPA

Control Measures to Assure Attainment of the TSP and Proposed PM_{10} NAAQS in the Cataño Air Basin

CONTROL MEASURES TO ASSURE ATTAINMENT OF THE TSP AND PROPOSED PM_{10} NAAQS IN THE CATANO AIR BASIN

by

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Contract No. 68-02-3890
Work Assignment No. 3
PN 3655-3

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March 1985

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EXECUTIVE SUMMARY

Many sources contribute to the TSP in the ambient air in the Catano Air Basin. At the maximum receptor location, however, four specific source categories stand out as major contributors to predicted annual average TSP concentrations. These sources and their estimated contributions to ambient TSP concentrations are as follows: Molinos De Puerto Rico, 54 percent; area-wide sources, 16 percent; roadways, 6 percent; and Central Soya, 3 percent. The estimated contributions of these same sources to predicted annual PM_{10} concentrations are 55, 16, 6, and 4 percent, respectively. All other sources combined contribute 6 percent of the TSP and 8 percent of the PM_{10} concentrations, and background levels make up the remaining portion of the particulate concentrations.

The 24-hour average standard is the most difficult to meet. For the maximum predicted 24-hour TSP concentration in 1982, it was estimated that Molinos De Puerto Rico contributed 82 percent of the predicted value at the maximum receptor location. For the second-highest 24-hour TSP concentration, Molinos contributed an estimated 53 percent, and Central Soya 35 percent at the maximum receptor location.

As a result of this analysis, Molinos De Puerto Rico, Central Soya, and (to a lesser extent) area roadways were singled out for the control strategy assessment. An actual detailed analysis of the controls in place at the grain-handling facilities was unavailable. Also, only general data were

available on the roadway conditions; however, because roadways are relatively minor contributors, this was not a great concern.

Although the data inadequacy precluded a detailed control strategy plan itemizing every source at each of the grain-handling facilities, development of a more general plan was possible. By applying the suggested controls to the grain-handling facilities and implementing a moderate road-cleaning plan, it is believed that bringing the Catano Air Basin into compliance with existing TSP standards and potential new PM_{10} standards would entail $656,000 in capital costs and $194,000 in annual expenses (1984 dollars).

SECTION 1

INTRODUCTION

In 1978, the U.S. Environmental Protection Agency (EPA) and the Environmental Quality Board (EQB) of the Commonwealth of Puerto Rico agreed that the Catano Air Basin near San Juan was not attaining the National Ambient Air Quality Standards (NAAQS) for total suspended particulate (TSP) matter. Although TSP air quality generally improved between 1979 and 1984, with 1983 values showing ambient concentrations below the NAAQS, the annual average and second-highest 24-hour TSP concentrations at the Amelia station continue to exceed levels prescribed by the NAAQS. This trend is shown in Figures 1-1 and 1-2.

In addition to the TSP standard, the EQB must also be concerned about the probable attainment status of the Basin with respect to particulate matter that is less than 10 micrometers (μm) in diameter, i.e., PM_{10}. In preparation for the likely adoption of an air quality standard for PM_{10} concentrations, all EPA regions have employed a probability model to predict the probable attainment status of various air basins with respect to this standard. Using 3 years of TSP data ending in 1982, the PM_{10} levels in the Catano Basin were predicted to exceed the proposed 24-hour standard (84 percent probability) and to meet the annual standard (88 percent probability of attainment). Updating the analysis using 1983 TSP data yielded a 9 and 4 percent probability of exceeding the 24-hour and annual PM_{10} standard,

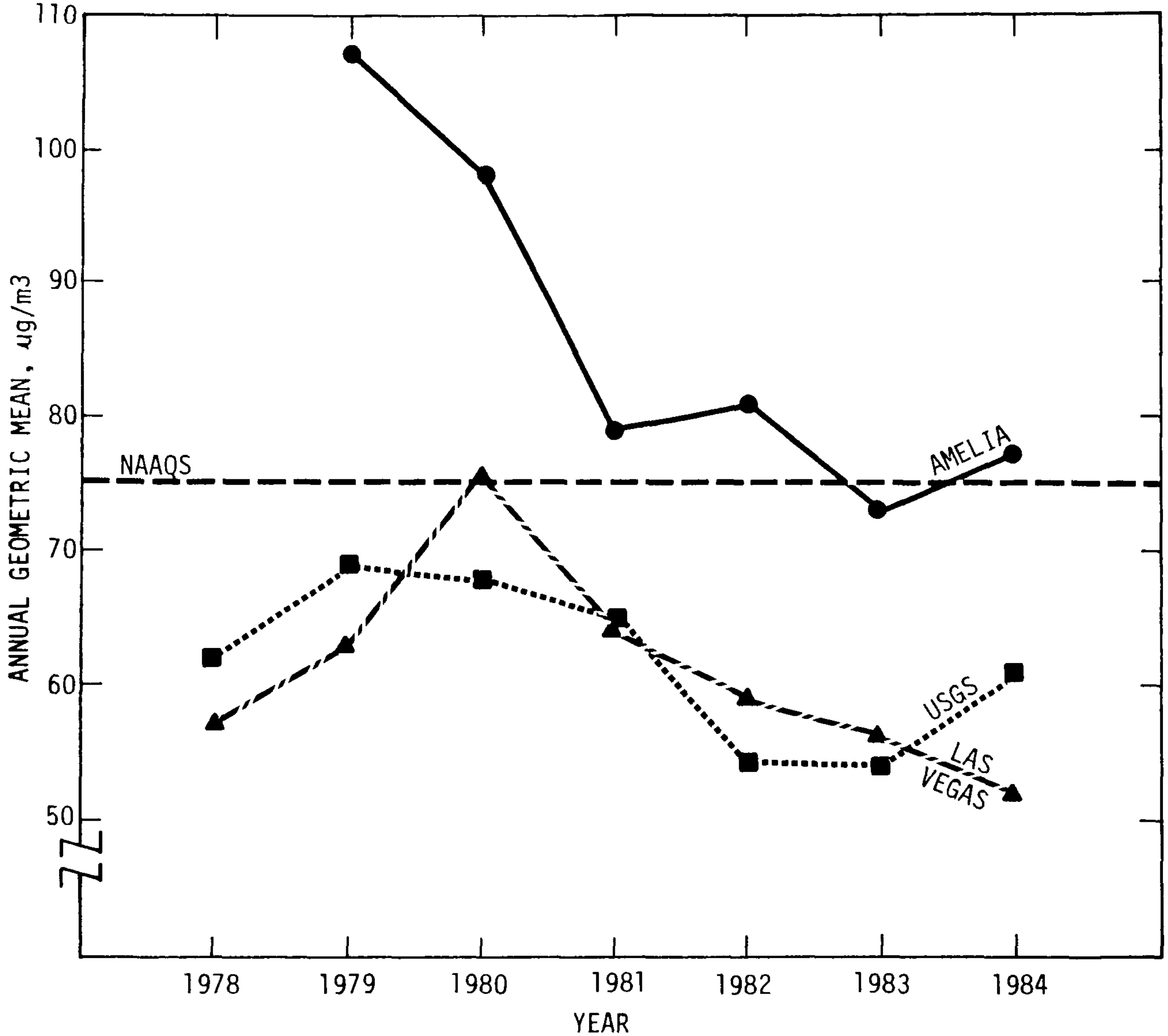


Figure 1-1. Trend in annual TSP concentrations for the Catano Basin.

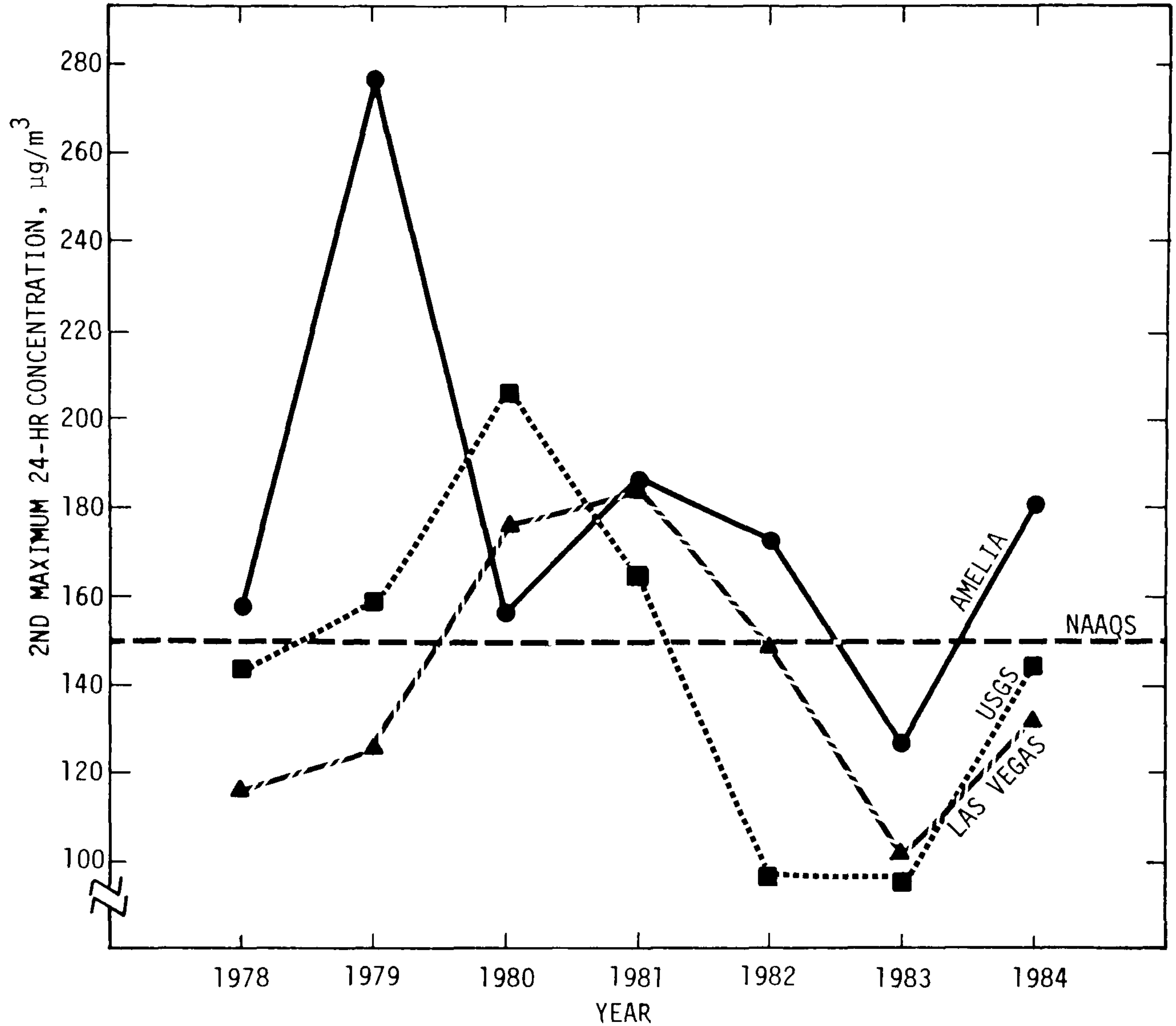


Figure 1-2. Trend in second highest 24-hour TSP concentrations in the Catano Air Basin.

respectively. Because of the first prediction, the EQB is slated to receive two monitors to begin the collection of a PM_{10} data base that will be used to establish the actual attainment status of the Catano area. These monitors were reportedly placed in service in March 1985. The area of primary concern is near the existing high-volume sampler located at the Amelia pump house station.

In an effort to assist the EPA and EQB in understanding and eventually controlling the sources impacting ambient air quality in the Catano Basin, the EPA asked PEI Associates, Inc., to prepare a series of reports. This report was preceded by the three reports listed below:

- Examination of Factors and Potential Sources Impacting Three Total Suspended Particulate Monitoring Stations in the Catano Air Basin of Puerto Rico. EPA-902/4-84-002, July 1984.
- Estimation of the Probable Impact of Sources in the Catano Air Basin on PM_{10} Standards. EPA-902/6-84-001, November 1984.
- Estimated Relative Impacts of TSP and PM_{10} Emissions From Maritime Vessels and Oil-Fired Powerplants in the Catano Area. EPA-902/6-84-002, November 1984.

Inasmuch as the sources surrounding the Amelia monitoring station have been identified and their relative impacts determined in previous reports, the purpose of this evaluation is to outline control measures for the sources that will ensure compliance with the existing TSP and proposed PM_{10} NAAQS. The following sections of this report detail these measures. Annual average TSP's are analyzed in terms of geometric means and PM_{10} as arithmetic means throughout the text.

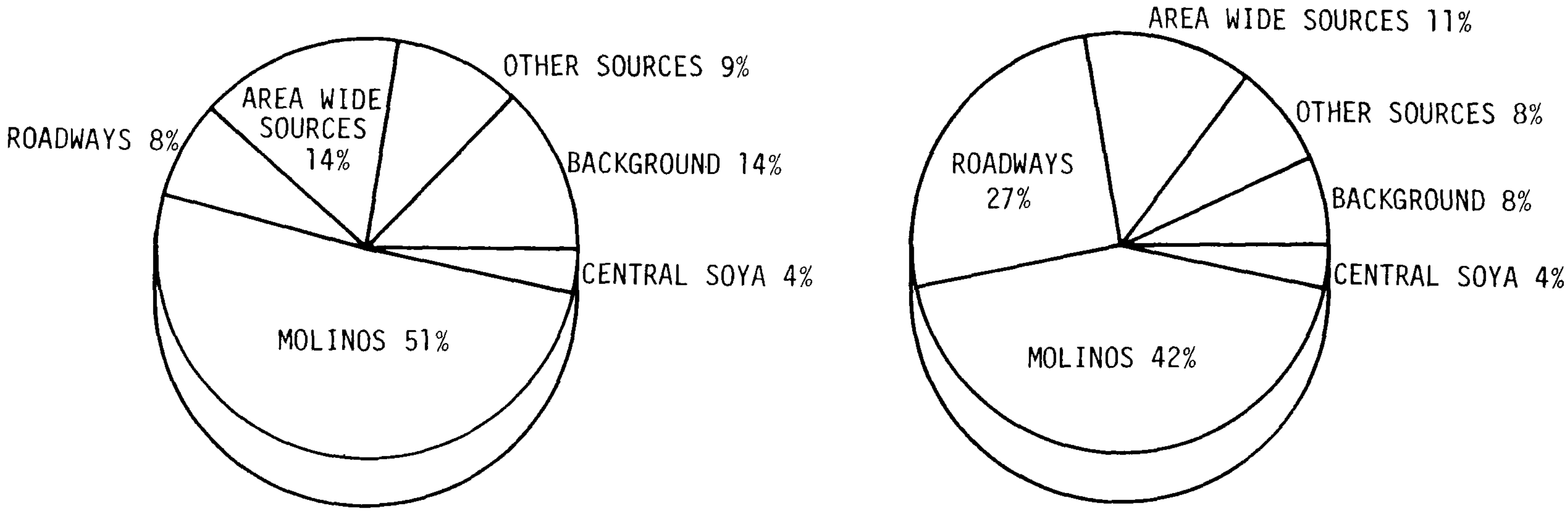
SECTION 2

PROPOSED CONTROL MEASURES

2.1 MAJOR SOURCES OF TSP AND PM_{10} EMISSIONS

For this analysis, a worst-case scenario must be considered to provide a safety factor that will ensure compliance with TSP and PM_{10} standards. The air quality analysis presented in Reference 1 made use of the Industrial Source Complex Model (ISC) in both the short-term (ST) and long-term (LT) modes. The short-term model was used in conjunction with 1982 meteorological data and yielded better 1982 predictions than the long-term version. The predicted 1982 ISCST annual geometric mean for the Amelia station was 81 $\mu g/m^3$, exactly equal to observed levels. At the maximum impact location, however, the ISCST predicted an annual geometric mean TSP concentration of 136 $\mu g/m^3$. For this reason, the results developed for the maximum receptor are used for control strategy evaluation wherever possible; otherwise, focus is on the Amelia station results.

The control measure effects are based on predicted impacts of the 1982 emissions data, which were the highest recorded within the past few years. Figure 2-1 shows the relative contributions of various source categories to ISCST-predicted TSP and PM_{10} concentrations recorded at the maximum receptor in 1982. A tabular summary is presented in Table 2-1. The sources include Central Soya, Molinos, nearby roadways, areawide sources, and background.



a) TSP (Geometric mean)
(Total TSP = 136.1 $\mu g/m^3$)

b) PM_{10} (Arithmetic mean)
(Total PM_{10} = 97.2 $\mu g/m^3$)

Figure 2-1. Relative contribution of major sources to the 1982 TSP and PM_{10} annual average concentrations at the Catano Air Basin maximum receptor.

TABLE 2-1. ANNUAL TSP AND PM_{10} CONCENTRATIONS PREDICTED BY THE ISCST MODEL AT THE WORST-CASE (MAXIMUM) RECEPTOR IN 1982[a]

Source	TSP concentration, µg/m³		PM_{10} concentration, µg/m³
	Arithmetic mean	Geometric mean	
Central Soya	5.1	4.7	3.5
Bulk receiving filters/ elevators	4.5	4.2	3.1
Grain/product handling	0.3	0.3	0.2
Dockside fugitives	0.3	0.2	0.2
Molinos de Puerto Rico	78.9	73.1	53.6
Grain elevators	6.2	5.7	4.2
Corn/wheat cleaning and milling	15.4	14.3	10.5
Flour mills	3.9	3.6	2.6
Grain/product handling	51.8	48.0	35.2
Dockside fugitives	1.6	1.5	1.1
Roadways	9.0	8.3	6.2
Areawide sources	23.6	21.8	15.3
Other sources	8.8	8.2	8.0
Background	21.6	20.0	10.7
Total	147.0	136.1	97.3

[a] Adapted from Reference 1.

Areawide sources consist of smaller low-level sources of dispersed particulate emissions. These emissions include fugitive dust from reentrained dust, materials handling, agricultural, residential, and other sources. The application of emission controls to this group of sources is not impractical, but enforcing control measures is difficult and is expected to produce negligible changes in ambient particulate concentrations. The sources included under "other" also involve dispersed emissions. Included in this group are ships at dock, ships moving in the channels, and powerplants. The powerplants (PREPA) are moderately significant sources from the standpoint of overall average annual TSP emissions; however, they have only a small impact on the Amelia station or on the maximum receptor where periodic TSP excursions are a particular concern.

A review of the 24-hour average TSP data from a preceding study[1] (shown in Table 2-2) makes selection of sources for control more apparent. The data are also displayed in Figure 2-2. This figure, which gives the first and second highest TSP-concentration days in 1982, illustrates that Central Soya and Molinos are the primary contributors to predicted TSP concentrations and areawide sources and roadways are only minor contributors. Because PM_{10} emissions are directly related to TSP, the same relationship prevails. These results indicate that Central Soya, Molinos, and nearby roadways should be the prime targets for a particulate emission control strategy.

2.2 COMPLIANCE STRATEGIES

The ambient data generated at the Amelia station in 1983 suggest that control measures implemented at Molinos in 1983 have brought about an improvement in the observed TSP concentrations. This is even in light of the

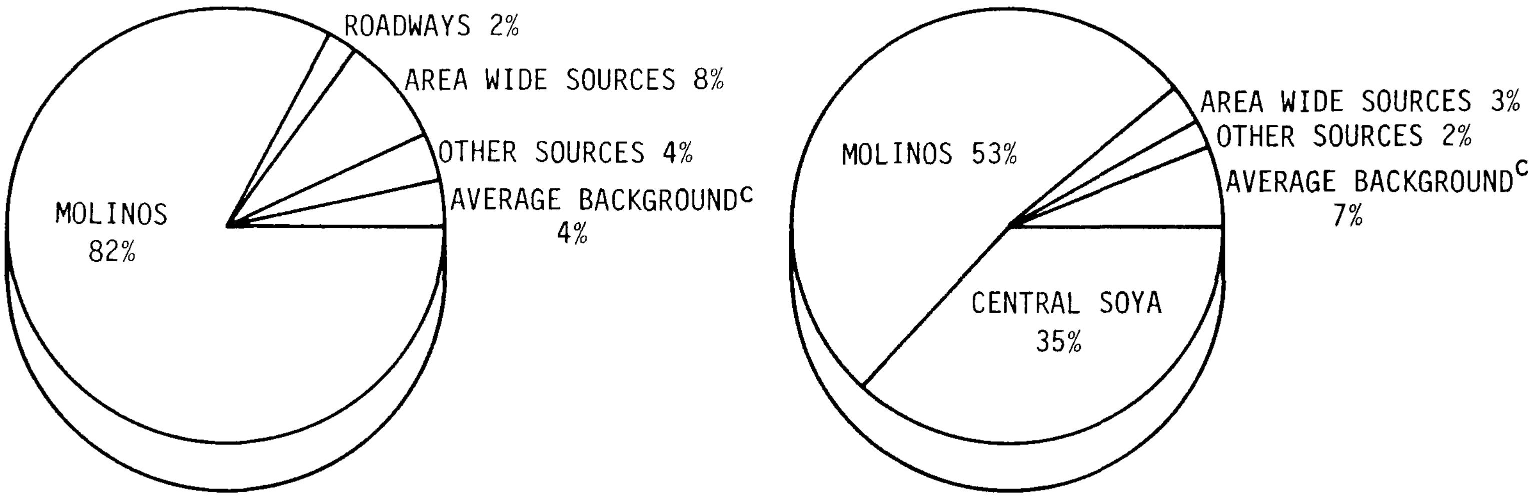
TABLE 2-2. SHORT-TERM TSP AND PM_{10} CONCENTRATIONS PREDICTED BY THE ISCST MODEL AT THE WORST-CASE (MAXIMUM) RECEPTOR IN 1982[a]

Source	TSP concentration, µg/m³		PM_{10} concentration, µg/m³	
	Maximum[b] 24-h	Second maximum 24-h[c]	Maximum[b]	Second maximum[c]
Central Soya	0.6	101.0	0.4	68.7
Bulk receiving filters/ elevators	0.5	89.6	0.4	61.0
Grain/product handling	<0.1	6.2	-	4.2
Dockside fugitives	<0.1	5.2	-	3.5
Molinos de Puerto Rico	411.7	151.6	280.0	103.1
Grain elevators	32.1	11.8	21.8	8.0
Corn/wheat cleaning and milling	80.7	29.8	54.9	20.2
Flour mills	20.2	7.4	13.7	5.1
Grain/product handling	270.5	99.6	184.0	67.7
Dockside fugitives	8.2	3.0	5.6	2.1
Roadways	7.6	0.6	5.3	0.4
Areawide sources	42.3	9.1	27.4	5.9
Other sources	19.2	4.6	13.0	3.7
Background	20.0	20.0	10.7	10.7
Total	501.4	286.9	336.8	192.5

[a] Adapted from Reference 1.

[b] Day 11, 1982.

[c] Day 348, 1982.



a) Highest 24-hour concentration[a]   b) Second highest 24-hour concentration[b]

[a] Central Soya was estimated to have contributed less than 1 percent on the highest TSP concentration day.

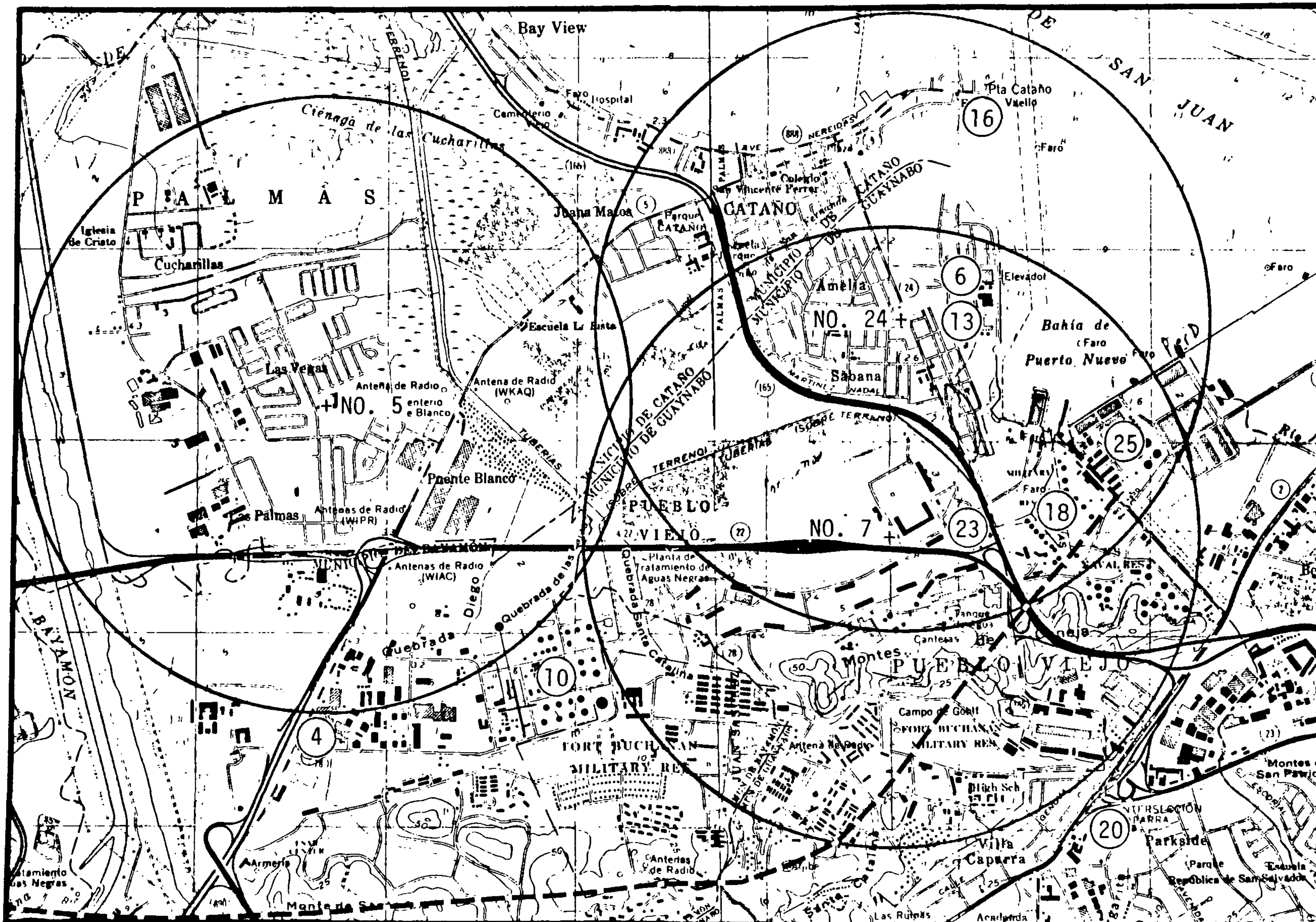
[b] The roadways contributed less than 1 percent to the total TSP emissions on the second highest TSP concentration day.

[c] In both cases the average background is 20 $\mu g/m^3$; however, the relative percent shown above differs from "a" to "b" since the overall magnitude of the TSP concentrations for each day was quite different.

Figure 2-2. Estimated TSP 24-hour relative source contribution at the maximum receptor in the Catano Air Basin for 1982.

fact that 1983 precipitation amounts are one of the lowest on record. These occurrences, i.e., reduced TSP under drier meteorological conditions, indicate that a major portion of the TSP problem is indeed caused by emissions from stationary sources rather than fugitive dust sources. The 1984 data, however, show an increase in TSP levels despite the greater amounts of precipitation. The results obtained at the Amelia station, however, only partially address particulate air quality in the Catano Basin. This is because dispersion modeling has identified an area near the Amelia monitor that will probably display higher ambient concentrations. The Catano Basin is shown in Figure 2-3. The area around the Amelia monitor (Site 24) is shown in Figure 2-4. The long-term results shown in Figure 2-4 were generated by ISCLT, and show that at receptor max (200,150), the TSP concentrations are about 10 percent higher than at the Amelia station. The suspicion that the grain facilities are responsible for the higher concentrations at receptor max is easily derived by observing the proximity of the sources to the receptor location.

The benefit afforded by the particulate control placed on Molinos sources after 1982 was evaluated in the previous work using ISCLT.[1] These results predicted that the Amelia station would display TSP concentrations that were less than the NAAQS. This indeed was the case. The effect on the short-term results is presented in Tables 2-3 and 2-4. Using the best information available, an 80 percent reduction of Molinos emissions was assumed for selected sources. As shown in Table 2-3, the annual TSP concentration is predicted to be less than the 75 $\mu g/m^3$ standard at the maximum receptor. The PM_{10} concentrations, however, are still predicted to exceed the 50 $\mu g/m^3$ annual arithmetic mean.



- - = BOUNDARY OF THE CATANO AIR BASIN
+ = HI - VOLUME SAMPLER
(4) = POINT SOURCE

SCALE 1"≈0.5 MILES

Figure 2-3: The Catano air basin.

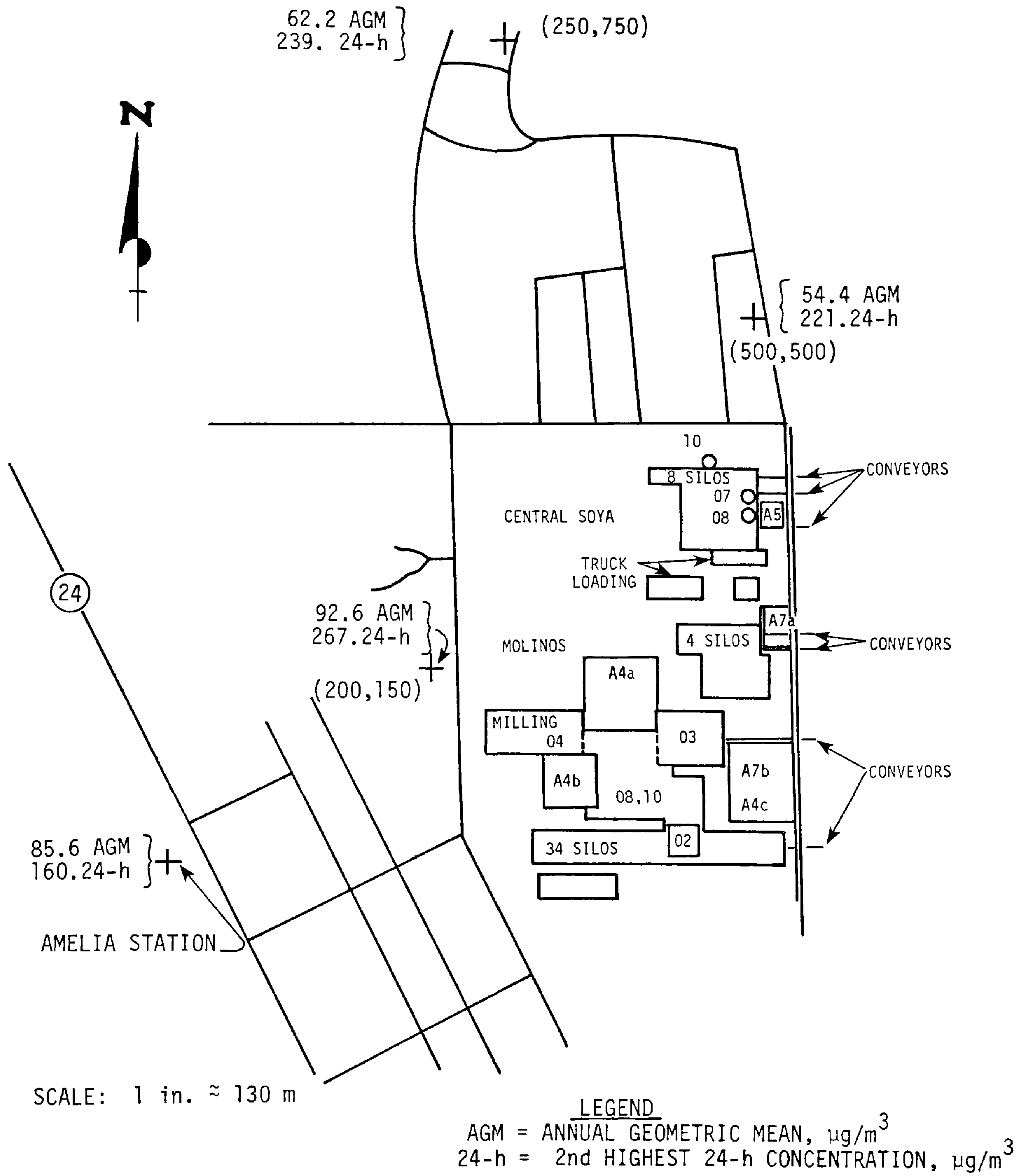


Figure 2-4. Distribution of predicted TSP concentrations near the Amelia station using 1982 data.

TABLE 2-3. PREDICTED ANNUAL CONCENTRATIONS OF TSP AND PM_{10} BASED ON CONTROLS IMPLEMENTED AFTER 1982 and ISCST MODEL RESULTS

Source	Percent control applied[a]	TSP concentration, μg/m³		PM_{10} concentration, μg/m³
		Arithmetic mean	Geometric mean	
Central Soya		5.1	4.7	3.5
Bulk receiving filters/ elevators	0	4.5	4.2	3.1
Grain/product handling	0	0.3	0.3	0.2
Dockside fugitives	0	0.3	0.2	0.2
Molinos de Puerto Rico		18.9	17.5	12.7
Grain elevators	80	1.2	1.1	0.8
Corn/wheat cleaning and milling	80	3.1	2.9	2.1
Flour mills	0	3.9	3.6	2.6
Grain/product handling	80	10.4	9.6	7.0
Dockside fugitives	80	0.3	0.3	0.2
Roadways	0	9.0	8.3	6.2
Areawide sources	0	23.6	21.8	15.3
Other sources	0	8.8	8.2	8.0
Background		21.6	20.0	10.7
Total		87.0	80.5	56.4

[a] Relative to 1982 situation.

TABLE 2-4. PREDICTED SECOND-HIGHEST 24-HOUR CONCENTRATIONS OF TSP AND PM_{10} BASED ON CONTROLS IMPLEMENTED AFTER 1982 and ISCST MODEL RESULTS

Source	Percent control applied[a]	TSP concentration, μg/m³	PM_{10} concentration, μg/m³
Central Soya		101.0	68.7
Bulk receiving filters/ elevators	0	89.6	61.0
Grain/product handling	0	6.2	4.2
Dockside fugitives	0	5.2	3.5
Molinos de Puerto Rico		36.3	24.6
Grain elevators	80	2.4	1.6
Corn/wheat cleaning and milling	80	6.0	4.0
Flour mills	0	7.4	5.1
Grain/product handling	80	19.9	13.5
Dockside fugitives	80	0.6	0.4
Roadways	0	0.6	0.4
Areawide sources	0	9.1	5.9
Other sources	0	4.6	3.7
Background		20.0	10.7
Total		171.6	114.0

[a] Relative to 1982 situation.

Likewise, the second-highest 24-hour TSP value is predicted to still exceed the NAAQS. It is noted in these tables, as in Tables 2-1 and 2-2, that fugitive grain emissions are the major predicted contributors.

The results presented in Tables 2-3 and 2-4 indicate that additional controls are needed to ensure compliance with the particulate standards. Several control measures should be considered. These include more efficient measures at both Molinos and Central Soya and control strategies for minimizing roadway-generated TSP and PM_{10}. With respect to the latter, controls to both the Central Soya and Molinos operations will help the roadway emissions problem because these emissions consist in part of reentrained particles originating from the grain-handling operations. This is not taken into account in the emissions reduction estimates included here; therefore, it adds to the built-in safety factor in the overall estimates.

Table 2-5 shows the relative percentage of uncontrolled emissions contributed by each area of an idealized facility. Fugitive dust sources and typical and alternative particulate controls are listed in Table 2-6, along with their efficiencies and costs.

TABLE 2-5. RELATIVE CONTRIBUTION TO TOTAL FUGITIVE EMISSIONS OF THE VARIOUS SOURCES FOUND AT AN IDEALIZED UNCONTROLLED GRAIN MILL FACILITY

Source	Percentage of contribution
Receiving	18
Transferring/conveying	64
Cleaning	13
Drying	4
Shipping	1
	100

TABLE 2-6. SUMMARY OF THE CONTROL ALTERNATIVES, THEIR EFFICIENCIES, AND THEIR COSTS FOR FUGITIVE DUST EMISSIONS FROM SOURCES AT GRAIN TERMINALS

Fugitive dust source	Control alternatives	Control efficiency, %	Control costs, January 1980 $	
			Capital	Annual
Receiving				
Truck unloading	Hopper vented to cyclone	90	28,200[a]	6,100[a]
	Enclosure[b]/fabric filter	99	53,500[a]	11,700[a]
Railcar unloading	Enclosure[c]/cyclone	90	34,200[d]	6,200[d]
	Enclosure[c]/fabric filter	99	71,800[a]	33,900[a]
Barge unloading	Enclosure/cyclone	90	32,200[e]	11,200[e]
	Enclosure/fabric filter	99	55,000[a]	12,300[a]
Transferring and conveying	Vent to cyclones	90	260,600[f]	68,700[f]
	Vent to fabric filters	99	265,300[g,h]	73,500[g,h]
Cleaning	Vent to cyclones	90	29,400[i]	6,200[i]
	Vent to fabric filters	99	43,400[i]	9,600[i]
Drying				
Rack	Screens (24 mesh)	63	11,000[j]	2,300[j]
	Vacuum screen system (50 mesh)	93	51,800	11,300
Column	Limit perforation plate hole diameter to 0.084 in.	Unavailable	-	-
Shipping				
Truck loading	Adjustable chutes	75	NA[k]	NA[k]
	Enclosure/cyclone	90	NA[k]	NA[k]
	Enclosure/fabric filter	99	NA[k]	NA[k]
Railcar loading	Adjustable chutes	75	NA	NA
	Hood/cyclone	90	62,200[d]	13,000[d]
	Enclosure/fabric filter	99	103,900[d]	22,100[d]
Barge loading	Telescoping spout/choked feed/ cyclone	90	NA[l]	NA[l]
	Telescoping spout/choked feed/fabric filter	99	NA[l]	NA[l]

(continued)

TABLE 2-6 (continued)

Fugitive dust source	Control alternatives	Control efficiency, %	January 1980 $	
			Capital	Annual
Ship loading	Tarpaulin cover[m]/cyclone	90	41,200[a,n]	11,300[a,n]
	Tarpaulin cover[m]/fabric filter	99	57,000[a,h]	12,400[a,i]
	Choke feed[o]/cyclone	90	65,700	13,600
	Choke feed[o]/fabric filter	99	86,100	19,600

Source: Adapted from Orleman, et al. 1983 (Reference 2).

[a] Terminal capacity = 40,000,000 bushels annual throughput. Capital costs include purchase, auxiliaries, direct and indirect equipment installation costs. Annual costs include capitalization, electrical (at $0.03/kWh), maintenance, property taxes/insurance/administrative costs at 4 percent total capital investment.

[b] Shed with one quick-closing door.

[c] Shed with one end closed.

[d] Based on terminal with capacity of 15,000,000 bushels annual throughput.

[e] Costs estimated for two cyclones of 3/16-inch-thick carbon steel each at 10,000 acfm. Capital cost includes purchase price plus direct and indirect installation costs. Annual costs consider direct (at 11 percent turnkey) and indirect (overhead at 1 percent direct operating and capitalization at 17 percent turnkey) costs.

[f] Particulate control costs based on facility with 15,000,000-bushel annual throughput capacity and 10 percent retrofit penalty.

[g] Based on emissions control for scale and surge bins operations only. Facility capacity throughput of 15,000,000 bushels annually. No retrofit penalty.

[h] Also includes cost of barge loading controls. Facility capacity throughput of 15,000,000 bushels annually. No retrofit penalty.

[i] Based on facility with 15,000,000-bushel annual throughput capacity. No retrofit penalty.

[j] Estimated at 20 percent of vacuum system costs.

[k] Costs should be similar to truck unloading emissions control.

[l] Costs included in above figures for transferring/conveying.

[m] Usage except during topping-off periods in the ship hold or for loading of tween-deckers or tankers.

[n] Costs included for 6825 ft^2 (195 ft x 35 ft typical barge size) tarpaulin at $0.29 per ft^2. Steel-reinforced polyethylene, 4 mils thick.

[o] Typical choke-feed system includes "dead box" or bullet-type loading spouts.

Every facility is unique, of course, and many variables control the contribution of sources at a specific facility. Nevertheless, this may serve as a general guideline.

Estimates of relative contributions of the particulate emission sources at the two grain facilities, which were derived from the Puerto Rico Emission Inventory System (EIS) computer printout and in-house calculations, are itemized in Tables 2-7 and 2-8. These tables show that the two grain facilities have approximately the same total TSP emissions. The emission factor used to calculate uncontrolled TSP emissions is based on the amount of grain handled. A percent reduction estimated for the control equipment in use is then applied to the uncontrolled emissions in order to obtain actual emissions from the facility. Molinos, although it processes 3 times more grain than Central Soya, implemented an improved control strategy in 1983 that resulted in an estimated 80 percent reduction in emissions. Thus, even though it is a larger facility, Molinos emits approximately the same amount of TSP as Central Soya, which is still in the process of implementing an improved control strategy. The geographic locations of these sources were shown in Figure 2-4. The sources in Tables 2-7 and 2-8 do not correspond exactly with those in Table 2-5, as the latter indicates the types of operations that generate emissions and their relative impacts. Taking this lack of correspondence into account, however, one sees that the inventory of Central Soya and Molinos sources matches fairly well with the distribution of emissions at a typical facility.

Inadequacy of the data precluded outlining a point-by-point strategy for reducing emissions from the grain milling/handling operations in the Catano Air Basin. The inadequacy stems from the fact that 1) the compliance plans for Molinos and Central Soya are not reflected in the EIS, and 2) adherence

TABLE 2-7. RELATIVE CONTRIBUTION OF THE IDENTIFIED SOURCES AT CENTRAL SOYA TO THE TOTAL ESTIMATED 1982 PARTICULATE EMISSIONS

Source identification	Source Code	Particulate contribution, tons/yr			
		TSP	Percent of total	PM_{10}	Percent of total
Bulk receiving filters	7	1.0	1	1.0	1
Barge unloading area	8	1.0	1	0.9	1
Bulk elevators	10	113.0	83	76.8	82
Grain/product handling area	A5	14.4	10	9.8	11
Dockside fugitive emissions	A7a	7.2	5	4.9	5
	Total	136.6	100	93.4	100

TABLE 2-8. RELATIVE CONTRIBUTION OF THE IDENTIFIED SOURCES AT MOLINOS DE PUERTO RICO TO THE TOTAL ESTIMATED PARTICULATE EMISSIONS

Source identification	Source Code	Particulate contribution, tons/yr			
		TSP	Percent of total	PM_{10}	Percent of total
Grain elevator area	02	11.0	8	9.2	9
Corn mills	03	25.0	18	17.0	17
Wheat cleaning/grinding area	04	3.0	2	2.7	3
Flour mills	08	21.6	16	18.4	18
Flour mills	10	14.4	11	12.3	12
Grain/product handling area	A4a	30.6	22	20.8	21
Grain/product handling area	A4b	15.3	11	10.4	10
Dockside fugitive emissions	A4c	15.3	11	10.4	10
Dockside fugitive emissions	A7b	0.2	<1	0.1	0
	Total	136.4	100	101.3	100

to the stated compliance plans should have reduced emissions to levels that would be in attainment of the NAAQS at the Amelia station. Compliance plans and dates are in effect for Molinos (baghouse control of material handling operations by December 1984) and Central Soya (pellet system controlled by August 1984; bulk receiving controlled by February 1985; unloading facilities controlled by April 1985), but measured TSP data show higher levels in 1984 than in 1983, and in fact the second-highest 24-hour value occurred at the Amelia station in December 1984, when Molinos was to be in compliance with its plan. Readings at the other stations in the Catano Basin were less than 65 $\mu g/m^3$ on the same day the Amelia station recorded its second-highest value of 181 $\mu g/m^3$. This represents a very local phenomenon.

To overcome the inadequacies of the existing documentation, a point-by-point description of each source should be generated. A questionnaire is provided in Appendix A for this purpose.

Regardless of the accuracy of existing information, conservative estimates indicate total emissions from both the Molinos and Central Soya operation can be reduced by more than 90 percent over 1982 levels as a result of the proposed measures contained in the compliance plans. Emphasis should be on the large contributing fugitive sources. Reducing reentrained particulate matter from roadways is possible, but can prove to be a difficult task because few reliable options are available and the available options may interfere with normal traffic flows. Moreover, the application of such control measures by purchasing street cleaning equipment and hiring operating personnel may not assure satisfactory emission reductions. Because only a minimal emission reduction would be necessary in the Catano Air Basin, however, attention can be focused on those specific areas prone to high levels of debris accumulation (e.g., areas where carryout from industrial sites occurs from the truck tires). Reentrainment may be reduced by washing truck tires before the trucks leave industrial sites and enter city streets and highways. Roads that are chronically dirty could be cleaned on a regular schedule, whereas others could be serviced less frequently. Inspection of vehicles leaving industrial areas (particularly the grain facilities) to be sure all loads are properly covered and loose residual material in or on the vehicle is removed would prevent spillage on the highways or wind dispersion of this material on the highways. Table 2-9 summarizes dust-control measures that may be applied to paved roads, their control efficiencies, and their costs.

TABLE 2-9. SUMMARY OF TECHNIQUES, THEIR EFFICIENCIES, AND THEIR COSTS FOR CONTROLLING FUGITIVE DUST FROM PAVED SURFACES[a]

Control method	Estimated efficiency, %	Capital cost, 1980 dollars	Annual cost, 1980 dollars
Sweeping			
Broom	70	5,000-15,000[b]	22,000/year
Vacuum	75	27,000	25,000/year
Flushing with water	80	13,000[c]	22,000/year

[a] Adapted from Orleman et al., 1983 (Reference 2).
[b] The lower value is for a trailer-type sweeper; the upper value is for a self-propelled unit.
[c] Value represents cost of 3000 gal-capacity unit, excluding truck chassis.

2.3 PREDICTED IMPROVEMENTS IN AIR QUALITY

If it is assumed that the compliance plans of Molinos and Central Soya are completed and implemented, it is possible to predict the net improvements in particulate concentrations at the maximum receptor. Given emission improvements at the maximum receptor, benefits will also be observed at the

Amelia station and other nearby receptors. The estimated ambient concentrations expected when all sources at the two grain facilities are controlled are given in Tables 2-10 (annual) and 2-11 (24-hour). Because some sources had controls prior to 1982, an 80 percent reduction is applied in some cases rather than a 90 percent reduction.

As shown in Table 2-10, the existing compliance plans are expected to result in particulate concentrations at the maximum receptor that are in compliance with the annual standard for both TSP and PM_{10}. Attainment of the annual standards will require strict adherence to the compliance plans, with adequate provisions for ensuring proper operation and maintenance (O&M) of the equipment. Based on the 1984 air quality data, it is suspected that improper O&M or failure to meet compliance schedules has lead to a violation of the NAAQS in 1984. This suspicion is further verified when one examines the 1984 particulate data for the Basin. At the Amelia station, only two values are observed to exceed the 24-hour standard of 150 $\mu g/m^3$. Without these two values, not only would the station be in compliance with the 24-hour standard (the next highest concentration was 144 $\mu g/m^3$), but the station would also be in compliance with the annual standard (the calculated geometric mean would have been 74.4 $\mu g/m^3$). The two high readings occurred on days when no data were available for the other two stations, or when the values at the other two stations were very low. Thus, a local problem is suspected. Baseline modeling indicated that the excursions were due to particulate contributions from Molinos and Central Soya. As shown in Table 2-11, the existing compliance plans are expected to significantly reduce the contribution of these two sources to the 24-hour particulate concentrations. The reduction

TABLE 2-10. PREDICTED ANNUAL CONCENTRATIONS OF TSP AND PM_{10} BASED ON FULL IMPLEMENTATION OF CONTROLS PROPOSED IN THE COMPLIANCE PLANS

Source	Percent control applied[a]	TSP concentration, μg/m³		PM_{10} concentration, μg/m³
		Arithmetic mean	Geometric mean	
Central Soya		0.5	0.5	0.4
Bulk receiving filters/ elevators	90	0.4	0.4	0.3
Grain/product handling	90	<0.1	<0.1	<0.1
Dockside fugitives	90	<0.1	<0.1	<0.1
Molinos de Puerto Rico		13.6	12.6	9.1
Grain elevators	80	1.2	1.1	0.8
Corn/wheat cleaning and milling	80	3.1	2.9	2.1
Flour mills	0	3.9	3.6	2.6
Grain/product handling	90	5.2	4.8	3.5
Dockside fugitives	90	0.2	0.2	0.1
Roadways	0	9.0	8.3	6.2
Areawide sources	0	23.6	21.8	15.3
Other sources	0	8.8	8.2	8.0
Background		21.6	20.0	10.7
Total		77.1	71.4	49.7

[a] Relative to 1982 situation.

TABLE 2-11. PREDICTED 24-HOUR CONCENTRATIONS OF TSP AND PM_{10} BASED ON FULL IMPLEMENTATION OF CONTROLS PROPOSED IN THE COMPLIANCE PLANS

Source	Percent control applied[a]	TSP concentrations,[b] μg/m³	PM_{10} concentrations,[b] μg/m³
Central Soya		10.1	6.9
Bulk receiving filters/ elevators	90	9.0	6.1
Grain/product handling	90	0.6	0.4
Dockside fugitives	90	0.5	0.4
Molinos de Puerto Rico		26.1	17.7
Grain elevators	80	2.4	1.6
Corn/wheat cleaning and milling	80	6.0	4.0
Flour mills	0	7.4	5.1
Grain/product handling	90	10.0	6.8
Dockside fugitives	90	0.3	0.2
Roadways	0	0.6	0.4
Areawide sources	0	9.1	5.9
Other sources	0	4.6	3.7
Background		20.0	10.7
Total		70.5	45.3

[a] Relative to 1982 situation.

[b] Based on predicted second-highest 24-hour concentrations.

achieved will result in ambient concentrations well below the 24-hour standard. The predicted 24-hour concentrations shown in Table 2-11 are greater than the predicted annual concentrations shown in Table 2-10 because the 24-hour predictions are based on the day when most of the ambient concentrations will be the result of emissions from grain facilities. After emissions are reduced at the facilities, the second-highest 24-hour concentrations recorded at these receptors will no longer be the result of emissions from the two grain facilities. Also, following the reduction of emissions at the grain facilities, no other sources are predicted to cause an exceedance of the annual or 24-hour NAAQS for TSP at the Amelia Station, the maximum receptor location, or any other location in the Catano Air Basin.

Recent inspections by EQB have shown that Central Soya is not meeting its compliance schedule. EQB is also investigating Molinos to determine whether marine tower controls are in place and operating. The importance of proper O&M is therefore demonstrated here, when only one excursion of high ambient concentrations determines whether the Amelia station is greater than or less than levels prescribed by the NAAQS.

SECTION 3

SUGGESTED CONTROL MEASURES FOR APPLICATION TO SOURCES IN THE CATANO AIR BASIN

Based on the analysis given in Section 2, it seems reasonable to focus on Central Soya, Molinos, and to a lesser extent, on the area roadways for TSP and PM_{10} emissions reduction. It is possible to comply with short-term TSP and PM_{10} regulations with minimal controls to the grain facilities. Some additional control of roadway reentrainment or a slightly higher reduction in grain facility emissions will provide greater air quality benefits. To assure compliance with the annual TSP and PM_{10} standards, however, may require more extensive but relatively moderate control measures and an awareness of proper operating and maintenance procedures.

An estimated reduction of 90 percent in fugitive emissions from the grain facilities would assure a proposed PM_{10} compliance with no controls applied to roadways. A control level of 80 percent on the grain facilities and 10 percent control of the roadways would achieve the same goal. Either of these options can be recommended. The latter is addressed in the section on costs that follows.

SECTION 4

COSTS OF PROPOSED CONTROL MEASURES

If a 90 percent reduction in the 1982 emissions at Central Soya and Molinos were achieved on grain terminal receiving, 90 percent on transferring and conveying, and 90 percent on shipping, the overall reduction would bring particulate concentrations below the NAAQS. Tradeoffs could be made in other areas to achieve the same result; however, this scenario is assumed for cost estimating purposes. Based on the costs shown in Table 2-6, the total capital and annual costs for an idealized grain facility are estimated to be:

	Cost (1980 dollars)	
Source	Capital	Annual
Receiving	39,200	11,200
Transferring/conveying	260,600	68,700
Shipping	26,800*	5,900*
	326,600	85,800

Escalated to 1984 dollars, capital costs become $412,100, and annual costs become $108,300.

The throughput capacity of the Central Soya facility is estimated to be approximately 5.2 million bushels per year, and the capacity of Molinos is estimated to be 17.2 million bushels per year. The costs in Table 2-6 for grain receiving are based on a 40-million-bushels-per-year facility, and those for transfer/conveying and shipping are based on a 15-million-bushels-per-year facility. A direct proportioning of the receiving costs to the

* Estimate represents one-half enclosure/fabric filter option presented in Table 2-6.

sizes of these two facilities was not done because the economies of scale must be taken into consideration; instead, a more conservative scaling factor is used. The costs for a 90 percent reduction in particulate emissions at Central Soya and Molinos are given in Tables 4-1 and 4-2.

TABLE 4-1. ESTIMATED EMISSIONS CONTROL EQUIPMENT COSTS OF REDUCING CENTRAL SOYA FACILITY EMISSIONS

Sources	Cost (1980 dollars)	
	Capital	Annual
Receiving	10,200	3,000
Transferring/conveying	135,500	35,700
Shipping	13,900	3,100
	$159,600[a]	$39,100[a]

[a] When escalated to 1984 dollars, capital cost becomes $201,400, and annual costs become $49,300.

TABLE 4-2. ESTIMATED EMISSIONS CONTROL EQUIPMENT COSTS OF REDUCING MOLINOS DE PUERTO RICO FACILITY EMISSIONS

Sources	Cost (1980 dollars)	
	Capital	Annual
Receiving	25,300	7,200
Transferring/conveying	298,800	78,800
Shipping	30,700	6,800
	$354,800[a]	$92,800[a]

[a] When escalated to 1984 dollars, capital cost becomes $447,800, and annual costs become $117,100.

Because some emissions control devices were in place in 1982 and others have since been installed, these costs do not reflect actual incremental costs to the facilities in question. The costs are based on the application of particulate control devices to uncontrolled sources, and therefore the costs to the sources in question will probably be less.

The cost to obtain an air quality benefit is based on an assumed 10 percent reduction in roadway fugitive emissions. Because the reduction is small, a least-cost option is assumed, which should be more than adequate. Cleanup of the roadways may be performed by a trailer-type sweeper attached to an existing truck. The costs for the purchase and operation of this equipment are presented in Table 4-3.

TABLE 4-3. ROADWAY EMISSIONS CONTROL EQUIPMENT COSTS

Source	Cost (1980 dollars)	
	Capital	Annual
Trailer type broom sweeper	5,000	22,000

Escalated to 1984 dollars, capital costs become $6,300, and annual costs become $27,800.

SECTION 5

CONCLUSIONS

The Catano Air Basin is very close to being in compliance with ambient TSP concentrations at existing sampling stations. In fact, the elimination of two values would show compliance with the NAAQS. Computer modeling results, however, have suggested that a compliance problem could exist if a sampling station were installed in a specified location (designated "maximum receptor") adjacent to the Central Soya and Molinos facilities.

The Catano Air Basin can be brought into compliance with a proposed PM_{10} standard of 55 $\mu g/m^3$ (annual mean) and 150 $\mu g/m^3$ (24-hour limitation not to be exceeded more than twice per year) by the application of conventional particulate control equipment on the major point sources at the Central Soya and Molinos De Puerto Rico grain facilities. Additional assurances can be obtained by implementing a moderate street-cleaning plan focusing on the areas surrounding the grain-handling facilities. In 1984 dollars, the costs of compliance measures could be in the neighborhood of $656,000 (capital) and $194,000 (annual).

EQB has conducted recent inspections showing that Central Soya is not meeting its compliance schedule. By the end of August 1985, all plant emission points must be in compliance, including corrections cited in the compliance plan and deficiencies detected during the recent EQB investigations. Also, Central Soya must submit biweekly progress reports for verification and review.

EQB plans to reinspect the Molinos facility to determine whether the marine tower controls are installed and operating. These compliance plans, if properly followed, will reduce ambient concentrations to below levels specified by the NAAQS. The 1984 observations indicate, however, that even after controls are in place, attainment can only be ensured by conscientious adherence to the operating and maintenance requirements of the installed equipment.

REFERENCES

1. PEI Associates, Inc. Estimation of the Probable Impact of Sources in the Catano Air Basin on PM_{10}. EPA-902/6-84-001, November 1984.

2. Orlemann, J. A., et al. Fugitive Dust Control Technology (Pollution Technology Review, ISSN 0090-516X; No. 96). Noyes Data Corporation. 1983.

APPENDIX A

EXAMPLE OF EMISSIONS INVENTORY QUESTIONNAIRE

GRAIN AND FEED INDUSTRY EMISSIONS INVENTORY

QUESTIONNAIRE

I. Plant Identification

1. Parent Corporation Name:____________________

   Mailing Address: ____________________
   Street

   ____
   City State Zip

2. Plant or Facility Name:____________________

   Mailing Address: ____________________
   Street

   ____
   City State Zip

3. Person to contact regarding information supplied in questionnaire:

   Name:____________________

   Title:____________________

   Telephone Number:____________________

4. What is the normal operating schedule for this plant?

   (a) _____Hr/Day (b)_____Day/Week (c)_____Days/Year

5. Would you be willing, on a voluntary basis, to permit access by a contractor of EPA to your plant to conduct stack gas source measurements?

   Yes _______

   No _______

INSTRUCTIONS FOR RESPONDING TO QUESTIONS ON GRAIN HANDLING, PROCESSING INFORMATION, AND WASTE DISPOSAL

A. General

Answer all questions for which you have knowledge or information. If certain questions are not applicable to your facility or you have no information, please indicate Not Available or Not Applicable.

B. Specific

Answer questions on grain receiving only if soybeans are the only whole grain handled. Do not answer if soybeans are received from an elevator on the premises which operates as a subterminal or terminal facility handling other grains.

1. Grain Receiving Pattern: Indicate the average number of bushels of soybeans received at plant during each calendar month. Base answer on last 5 years of plant operation.

2. Grain Receiving: List various methods by which grain shipments arrive and approximate amounts received by each method annually. Base answer on last 5 years of plant operation.

3. Grain Unloading: List various methods used for grain unloading and approximate amount unloaded by each method annually. Base answer on last 5 years of plant operation.

4. Grain Drying: List amount of grain dried. Base answer on last 5 years of plant operation.

5. Provide as much detailed information as is available on grain drying equipment.

6. Grain Cleaning: List amount of grain cleaned and method of cleaning (e.g., scalping, aeration, grading shaker screens, etc.). Base answer on last 5 years of plant operation.

7. Refuse Disposal: If you practice on-site refuse disposal, list refuse types and disposal procedures.

8-15. Process Operations: Indicate the general nature of process operations at this plant by answering Questions 8-15.

PLEASE READ INSTRUCTIONS ON PAGE A-3
BEFORE COMPLETING THIS SECTION

II. Grain Handling, Processing Information, and Waste Disposal

1. Grain Receiving Pattern:

Month	Soybeans, Bu/Month
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

2. Grain Receiving:

	Bu/Year
(a) Hopper Bottom Railroad Car	________
(b) Boxcar	________
(c) Truck	________
(d) Barge	________
(e) Other (Describe)	________

3. Grain Unloading:

	Bu/Year
(a) Gravity, Unrestricted to Grate	________
(b) Gravity, Choked-Feed to Grate	________
(c) Mechanical Conveyor	________
(d) Pneumatic Conveyor	________
(e) Dumping Platform (Boxcar)	________
(f) Power Shovel (Boxcar)	________

4. Grain Drying:

	Amount Dried (bu/year)

5. Grain Drying Equipment:

Manufacturer________________________________ Date Installed_______

Type___________________________ Model______________________________

Rated Capacity for Soybeans_______ Bu/Hr

Water Evaporated___________ Lb/Hr

Average Operating Rate________ Bu/Hr

Fuel Type_____________ Rated Capacity_____________ Btu/Hr

Sulfur Content of Fuel____

Annual Fuel Consumption____

6. Grain Cleaning:

Method of Cleaning	Amount Cleaned (bu/year)
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

7. Refuse Disposal:

(a) Kinds and Disposal Method

	Open Burning (lb/year)	Incineration* (lb/year)	Other (lb/year)
(1) Paper, Cardboard	________	________	________
(2) Plastic	________	________	________
(3) Wooden Crates, Lumber	________	________	________
(4) Collected Grain Dust	________	________	________
(5) Other	________	________	________

(b) Incinerator Type

(1) Single Chamber____________

(2) Double Chamber____________

(c) Auxiliary Fuel Consumed in Incineration

(1) Type of Fuel______________________

(2) Amount of Fuel Used______Gal/Year, Ft^3/Year

(3) Sulfur Content of Fuel ____________________

---

* With gas or oil burner (burning in an enclosure without a burner is classed as "Open Burning").

8. (a) What is rated capacity of plant? _______ Bu/Day

(b) How many bu/year are processed? ________ (5-year average)

9. What type of extraction process is used at this plant?

(a) Expeller or rotary screw pressing ______

(b) Batch type hydraulic pressing_______

(c) Solvent extraction _______

10. If plant utilizes solvent extraction, what type of solvent is used for extraction? __________________________

11. How much solvent is used annually? _____ Gal/Year

12. What type of solvent extractor is used?

13. Are primary solvent recovery condensers vented to a supplementary vent recovery system? If so, indicate type:

(a) Refrigerated vent cooler ______

(b) Mineral oil absorber _______

(c) Activated carbon absorber_____

14. Are meal finishing operations conducted at this plant?

Yes__________ No___________

If answer is Yes, what is annual production of soybean meal?

_________ Tons/Year

15. Are soyflour or soygrits or soyprotein concentrate (i.e., concentrate or isolated) produced at this plant?

Yes__________ No __________

If answer is Yes, what are annual production rates of flour, grits and protein?

(a) Flour____Tons/Year; (b) Soygrits_____Tons/Year; (c) Protein_____Tons/Year

INSTRUCTIONS FOR RESPONDING TO QUESTIONS ON AIR POLLUTION CONTROL EQUIPMENT

I. Extent of Control (Page A-9)

Indicate extent to which plant is equipped with dust control systems.

II. Air Pollution Control Systems (Page A-11)

Part I - Control Systems and Dust Load

A. General

Describe current air pollution control systems by providing information requested on pages A-11 and A-12.

B. Specific

1. Indicate grain handling or processing equipment served by each dust control system (e.g., System I - Truck and rail unloading pits, System II - Meal dryer). Attach additional sheets as needed.

2. Indicate type of control device, manufacturer, and model number on each dust control system. If multiple control devices are utilized (e.g., cyclone and fabric filter) on a single source, indicate this fact. Also, provide as much information as is available on the cost of air pollution control equipment in your plant.

3. Provide any information you may have on dust loads into and out of control systems.

Part II - Effluent Properties and Control System Exhaust Configuration

4. Provide any information you may have on the designated chemical and physical properties of the gas stream associated with each control system.

5. Provide as much information as possible regarding points where dust is exhausted to the atmosphere.

PLEASE READ INSTRUCTIONS ON PAGE A-8
BEFORE COMPLETING THIS SECTION

III. Air Pollution Control Equipment Information

A. Extent of Control

1. Indicate if the following specific dust sources are ducted to an air pollution control device.

Dust Source	Ducted To Control Device: Yes	Ducted To Control Device: No	Type of Air Pollution Control Equipment to Which Source is Ducted: Cyclone	Fabric Filter	Settling Chamber	Other
I. Grain Receiving						
1. Grain Unloading						
a. Truck						
b. Boxcar						
c. Hopper Car						
d. Barge						
2. Grain Cleaning						
3. Grain Dryer						
4. Grain Handling						
a. Conveyor Transfer Points						
b. Garner and Scale						
c. Elevator Leg Vents						
d. Tripper						
II. Bean Preparation						
1. Cracking Mill						
2. Hull Grinder						
3. Cracked Bean Conditioner						
4. Flaking Mill						

III. Air Pollution Control Equipment Information (Concluded)

Dust Source	Ducted To Control Device: Yes	No	Type of Air Pollution Control Equipment to Which Source is Ducted: Cyclone	Fabric Filter	Settling Chamber	Other
III. Meal Finishing						
1. Dryer						
2. Cooler						
3. Hammer Mill						
4. Screening						
5. Bagging Operation						
6. Bulk Loading						
7. Other (Describe)						
IV. Flour and Protein Production						
1. Flour Mill						
2. Protein Concentrate Dryer						

B. Air Pollution Control Systems

Part I - Control Systems and Dust Load

List each air emission control system concerned with grain handling and soybean processing

System Name ________ ________ ________ ________ ________

A. Grain Handling or Processing Equipment Served by This System

B. Control Equipment or System

a. Primary Control Equipment
   (1) Type (Cyclone, Fabric Filter, Wet Scrubber)
   (2) Manufacturer
   (3) Model No.
   (4) Capital Cost
   (5) Year of Purchase
   (6) Annual Utilities Cost
   (7) Annual Maintenance Cost
   (8) Installation Cost

b. Secondary Control Equipment
   (1) Type (As Above)
   (2) Manufacturer
   (3) Model No.
   (4) Capital Cost
   (5) Year of Purchase
   (6) Annual Utilities Cost
   (7) Annual Maintenance Cost
   (8) Installation Cost

B. Air Pollution Control Systems (Concluded)

System Name ______ ______ ______ ______ ______

C. Dust Load Data

a. Measured
(1) Dust Load to Control Equipment___Lb/Hr
(2) Dust Load from Control Equipment___Lb/Hr

b. Estimated
(1) Dust Load to Control Equipment___Lb/Hr
(2) Dust Load From Control Equipment___Lb/Hr

Part II - Effluent Properties and Control System Exhaust Configuration

System Name					
A. Effluent Properties					
a. Type of Dust Entering Control Equipment					
b. CFM Discharged to Atmosphere					
c. Particle Size of Dust (Microns), if Known					
d. Temperature of Gas Stream					
e. Humidity of Gas Stream					
B. Control System Exhaust Configuration					
a. Exhaust Duct Diameter					
b. Height of Exhaust Above Grade					
c. Velocity of Exit Gas					

IV. Source Test Information

1. Have the emissions from any of the control equipment in your plant been measured by a source test?

Yes_____________

No______________

If answer is Yes, please attach copy of test results if available. Also indicate methods used to conduct source test.

2. Do you have any data, obtained by actual measurements at plant, on the chemical and physical properties (i.e., particle size, composition, etc.) of dust emitted from specific equipment in your plant (e.g., grain dryer, meal dryer, cracking roll, flaking roll, etc.)?

Yes______________

No_______________

If answer is Yes, please attach copy of data, and if known, indicate method used to sample dust and method used to measure specific properties.

BIBLIOGRAPHIC DATA SHEET	1. Report No. EPA 902/6-84-003	2.	3. Recipient's Accession No.

4. Title and Subtitle	5. Report Date
Control Measures to Assure Attainment of the TSP and PM_{10} NAAQS in the Catano Air Basin	March 1985
	6.
7. Author(s) Carvitti, J., and M. Melia	8. Performing Organization Rept. No. 3655-3
9. Performing Organization Name and Address PEI Associates, Inc. 11499 Chester Road Cincinnati, Ohio 45246	10. Project/Task/Work Unit No. W.A. No. 3 11. Contract/Grant No. 68-02-3890
12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency Air and Waste Management Division 26 Federal Plaza, Room 1005 New York, New York 10278	13. Type of Report & Period Covered Final 14.

15. Supplementary Notes

EPA Project Officer: Dr. Vinh Cam

16. Abstracts

This is the fourth of a series of reports studying particulate air quality near San Juan, Puerto Rico. This report makes use of information presented in the previous three reports to study particulate control strategies that can be used to ensure attainment of the TSP and PM_{10} standards in the area. The report emphasizes that grain handling facilities are major contributors to TSP levels and somewhat adaptable to control. The benefits and costs of various control options are presented. Benefits achievable through street cleaning programs are also studied.

17. Key Words and Document Analysis. 17a. Descriptors

Air pollution

Particles

17b. Identifiers/Open-Ended Terms

San Juan, Puerto Rico
Air Quality
Dispersion Modeling
PM_{10}
Emission Inventory

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited	UNCLASSIFIED	39
	20. Security Class (This Page) UNCLASSIFIED	22. Price