South Coast Air Quality Management District
Monitoring and Analysis

Rule 1158 Follow-Up Study #2

Sampling Conducted
May and June, 2000

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EXECUTIVE SUMMARY

Purpose

In June 1999, Rule 1158 affecting storage, handling and shipment of petroleum coke, coal, and sulfur was amended to further reduce particulate emissions from these sources. This study is one of an ongoing series, examining targeted compounds contained in the inhalable particulate fraction (PM_{10}) in the greater Long Beach/Wilmington Area. This series of studies consists of PM_{10} sampling in the spring/summer and fall/winter, observing trends in the elemental carbon content of collected samples.

Results generated by the current study were compared to results obtained in 1997, which were reported in the study *Report of Micrometeorological and Ambient Air Quality Monitoring Conducted Simultaneously in the Vicinity of the Los Angeles and Long Beach Harbors* (September 1997). As the sampling periods of the two studies differed and limited carbon analysis was conducted on the 1997 samples, only general observations pertaining to the trends in PM_{10} carbon content can be made. However, these observations are reasonable indicators of changes in airborne elemental carbon particulate over the three-year span of time. Also, the current study will provide baseline observations for future springtime studies.

Sampling

Sampling was conducted coincident with the AQMD PM_{10} monitoring network one-in-six day schedule between May 24, 2000 to June 29, 2000. Sampling locations were identical to those utilized for the Fall/Winter 1999 study. It is intended that these sites be used throughout the entire series of Rule 1158 Follow-up Studies. Field operations were contracted to RES Enviornmental, Inc. (Colton, CA), while all laboratory operations and data analysis were performed by AQMD personnel. Twenty-one samples were collected over seven non-consecutive sampling days.

Key Findings

1. Ambient PM_{10} concentrations in the study area have decreased between 24% and 31% since the spring 1997 study.

2. Not only is less PM_{10} in the air of the study area, the amount of elemental carbon in the particulate has fallen between 16% and 34%.

3. So far, consistent improvement in the amount of elemental carbon in PM_{10} has been observed subsequent to the amendment of Rule 1158 (June 1999).

1.0 INTRODUCTION

From May 24, 2000 to June 29, 2000, PM_{10} monitoring was conducted at three locations in the cities of Long Beach (two sites) and Wilmington (one site). This study constituted the second of multiple studies evaluating improvements in local air quality precipitated by implementation of Rule 1158, as amended on June 11, 1999. The next sampling event is slated to begin in November 2000.

This study builds on a base of knowledge established by three previous studies: *Micrometeorological and Ambient Air Quality Monitoring Conducted Simultaneously in the Vicinity of the Los Angeles and Long Beach Harbors* (September 1997) and (March 1999), and Rule 1158 Follow-Up Study #1 (May 2000). The primary objectives of the current study were to collect data suitable for the evaluation of:

Current inhalable particulate (PM_{10}) ambient concentration trends for the study area.

Speciation of the carbonaceous component of the collected particulate samples for elemental carbon content.

Comparison of 2000 concentration and carbon data with that obtained during the 1997 study.

Seasonal PM_{10} and elemental carbon trends for the study area.

The prevailing winds in the study area place portions of the community downwind of coal and coke production and/or storage facilities, and fugitive dust from these activities has been a longstanding community concern. This fugitive dust contributes to increases in the ambient inhalable (PM_{10}) particulate concentration. Mobile sources such as diesel trucks, trains and ships in the area also contribute to the overall ambient particulate matter concentrations.

The June 1999 amendment of Rule 1158 affected storage, handling and shipment practices for petroleum coke, coal, and sulfur. Removal and enclosure of open coke storage piles, and modification to equipment and work practices to comply with Rule 1158 requirements is ongoing. The Rule 1158 compliance schedule mandates implementation of the majority of control measures by August 1999, with full implementation of all measures by June 2004. It is anticipated that full implementation of Rule 1158 will contribute to a decrease in ambient PM_{10} concentrations in the local area. Compliance field staff have documented a high rate of compliance with the initial rule implementation requirements. These measures have included covered transport, truck washing, and prompt roadway/spill clean-up that has resulted in the reduction of fugitive coke emissions from storage, handling, and shipping operations.

2.0 BACKGROUND

Samples were scheduled for collection at three sites over seven different days, producing a data set consisting of twenty-one samples. Site selection and the sampling calendar were influenced by several factors.

All three sites in the current study were included in the 1998 and 1999 studies, while two were included in the 1997 study. The monitoring sites were chosen based upon their location relative to coal and coke facilities with respect to the local prevailing wind patterns, their PM_{10} concentration rankings within the 1998 study, and their importance as locations containing student populations.

The sampling was scheduled to coincide with the EPA one-in-six monitoring schedule utilized by the AQMD in its PM_{10} monitoring network. Consequently, the results obtained by the project can be compared to network results from Long Beach as well as locations distributed throughout the Basin.

3.0 TOPOGRAPHY AND CLIMATOLOGY

Wind speed and direction were monitored during the study using one MRI continuous wind speed and direction monitor installed at Study Site #1, School Building Services Facilities/Hudson School (HUD) at 2401 Webster Avenue, Long Beach. The prevailing winds measured during the study dates were onshore flows from the south and west, with 24-hour average speeds ranging from 3.3 to 7 mph for six of the seven sampling days, and a 24-hour average of 9 mph for the seventh and final sampling day. Wind roses generated by the sampling contractor (RES Enviornmental, Inc) are attached as Appendix 4. Temperatures for the study period included daytime highs ranging from 70 to 83 degrees F., and nighttime lows from 60 to 66 degrees F.

The topography of the study area was extensively examined in the 1998 study, and is reproduced here[1].

3.1 TOPOGRAPHY

The harbor areas of San Pedro, Wilmington, Los Angeles and Long Beach are part of the relatively flat coastal plane. This plane averages 20 feet above mean sea level (msl) at all AQMD sampling sites ... San Pedro is situated in the eastern foothills of the Palos Verdes Peninsula. The peninsula rises gradually from the coast to approximately 300 feet above msl. To the west and north of San Pedro, the Palos Verdes Hills reach elevations exceeding 1,000 feet above msl. Industrial businesses command the San Pedro coastline while the city becomes increasingly residential as the foothills rise in elevation. Los Angeles Harbor and Wilmington are heavily industrialized with small pockets of

[1] South Coast Air Quality Management District. (1999). *Micrometeorological and Ambient Air Quality Monitoring Conducted Simultaneously in the Vicinity of the Los Angeles and Long Beach Harbors.* Diamond Bar, CA.

residential areas dispersed throughout. Long Beach is a mixture of heavy industry close to the coastline and a mix of industry and residential neighborhoods further inland.

3.2 CLIMATOLOGY

During the late spring season, the airmass becomes more stable in the South Coast Air Basin (Basin). Synoptic-scale systems are still apt to penetrate south of the blocking mountains, continuing the higher than average percentage of cloud cover, but with little rain. Further, the "Catalina Eddy," a low-level cyclonic flow centered over Santa Catalina Island, is prevalent in both spring and summer months. The eddy is a localized southeasterly flow along the coast during morning hours.

A definite daytime sea breeze of moderate intensity is the norm, with light and variable winds at night. Southerly or southeasterly winds in the mid-morning will back to the southwest as the day progresses, adding a more westerly wind that overshadows the southern winds and remains throughout the afternoon. As the day progresses to night, downslope flow from Palos Verdes Hills induces northwesterly winds over Terminal Island.

Temperatures in May are generally mild, with the seasonal increase in effective radiational warming beginning to offset the cooler winter weather. Warming in the land-locked areas occurs noticeably quicker than in coastal parts, but is moderated by a higher than average percentage of cloud cover. Temperatures in the area of Wilmington are moderate, varying from an average low of 48 degrees Fahrenheit (°F) to an average high of 72 °F in May.

Two types of temperature inversions occur in the Basin: (1) a surface inversion, produced by offshore descending air and nighttime radiational cooling, and (2) a low level elevated inversion, which caps the intruding marine layer. Clouds are still more persistent over coastal areas in the spring than in the other seasons.

4.0 EQUIPMENT LOCATION, DESCRIPTION, AND COLLECTION METHODOLOGY

The sampling locations were unchanged from those utilized in *Rule 1158 Follow-Up Study #1*. (See Figure 1.)

They include:

Site 1: School Building Services Facilities/Hudson School (HUD)
2401 Webster Avenue
Long Beach, California

Site 2: Edison Elementary School (EDI)
625 Maine Avenue
Long Beach, California

Site 3: Wilmington Childcare Center (WIL)
1419 Young Street
Wilmington, California

RES Environmental, Inc. (RES), was contracted by the AQMD to perform field operations for the current study. The consultant described the sampling locations as follows[2]:

- **PM_{10} Monitoring Site #1 (HUD)**
  The monitoring site is located at the Long Beach School Building Services facility (maintenance yard), adjacent to the Hudson Middle School. The PM_{10} sampler was installed on top of two adjoining steel containers. Meteorological exposures were composed of: (1) Henry Ford Freeway, which runs parallel to the monitoring site to the west, and (2) maintenance yard to the north, east and south of the monitoring site. The maintenance yard consists of repairs and fabrication of materials, including welding. Vehicle traffic ranges from light during most of the day to moderate at the beginning and ending of each day, Monday through Friday.

- **PM_{10} Monitoring Site #2 (EDI)**
  Site #2 was located at the Edison Elementary School in Long Beach. The PM_{10} sampler was located on a steel container at the western side of the school and playground. The sampler was also installed on a five-foot platform to clear the school building to the east. The meteorological exposure consists of: (1) a main street artery (16^{th} Street) which carries heavy vehicle traffic, is located to the north, (2) school buildings to the east and south, and (3) a small bus terminal to the west of the monitoring site.

[2] RES Environmental, Inc. (August 2000) *The South Coast Air Quality Management District – Follow up to the Rule 1158 PM-10 Monitoring Study.* Colton, CA.

- **PM_{10} Monitoring Site #3 (WIL)**
  The monitoring site was installed on the roof of the Childcare Center, near a elementary and middle school in the City of Wilmington. The meteorological exposure consists of (1), a residential area to the north (2), commercial/industrial development to the east (3), school to the south and (4) parking area/residential area to the west of the monitoring site. Moderate vehicle traffic was observed during the morning and afternoon hours in the parking areas when school personnel are parking and leaving and during time periods when children are being released and picked-up at the Wilmington Childcare Center.

RES equipped each site with PM_{10} particulate monitoring samplers, and conducted a calibration regimen as follows[3]:

> A total of three (3) PM-10 particulate samplers were used for the SCAQMD PM-10 monitoring program. All samples were collected from Anderson/General Metal Works, Inc., Model G1200, SSI HV PM-10 samplers, RFPS-1287-063. The Model G1200, PM-10 samplers meets all EPA performance specifications, using a combined flow controller, mechanical/electronic timer, and model 305-105 pressure transducer flow recorders.
>
> A Sierra Anderson Model G28, variable resistance high volume calibrator was used to perform two 5-point calibrations on the three PM-10 particulate samplers. These calibrations determined a set point flow that were used to maintain a flow rate of 40 (PM-10) standard cubic foot per minute (SCFM) at standard conditions of temperature and pressure. The G28 calibrator adjusts airflows from 15-50 SCFM, permitting calibration of the flow indicator at various points on the manometer. The calibrator is composed of a variable resistance orifice assembly, NBS traceable calibration curve and manometer. A 5-point calibration was performed on all samplers at the site prior to and after the monitoring study was completed. The second calibration was performed to insure that the calibration set point has (*sic*) not changed during the monitoring program.

The study period was initially slated for six non-consecutive sampling events, and was subsequently increased to seven so that each day of the week was represented by a sample. All collection events produced valid samples. The resulting 21 samples comprise the current study.

The sampling dates were May 24 and 30, June 5, 11, 17, 23 and 29, 2000. During the monitoring cycle, filters and accompanying reports were released to and received from RES. At all times, strict sample custody procedures were followed. Each sample was

[3] Ibid.

identified using a unique filter identification number, and was accompanied by a chain of custody document recording sample event information, consultant and AQMD staff custody signatures, and sample ID number.

5.0 ANALYTICAL METHODS

The PM_{10} sample filters were conditioned and weighed before distribution to the consultant for field sampling. After sampling, the filters were returned with their custody reports reflecting sampling time, conditions, and flow measurements to the AQMD laboratory for analysis. Using the recorded flow information, total sampled air volumes were calculated.

Once at the AQMD, the filters were conditioned, weighed to obtain the total mass of PM_{10} collected, and were used to perform carbon analysis. To determine the carbon content of the samples, a thermal-optical carbon analyzer was utilized. Using this technique, total carbon contributions to PM_{10} can be speciated as organic carbon and elemental carbon.

6.0 DATA ANALYSIS

Data from the current study was compared with data obtained in the 1997 study.

6.1 PM_{10} AMBIENT CONCENTRATION ANALYSIS

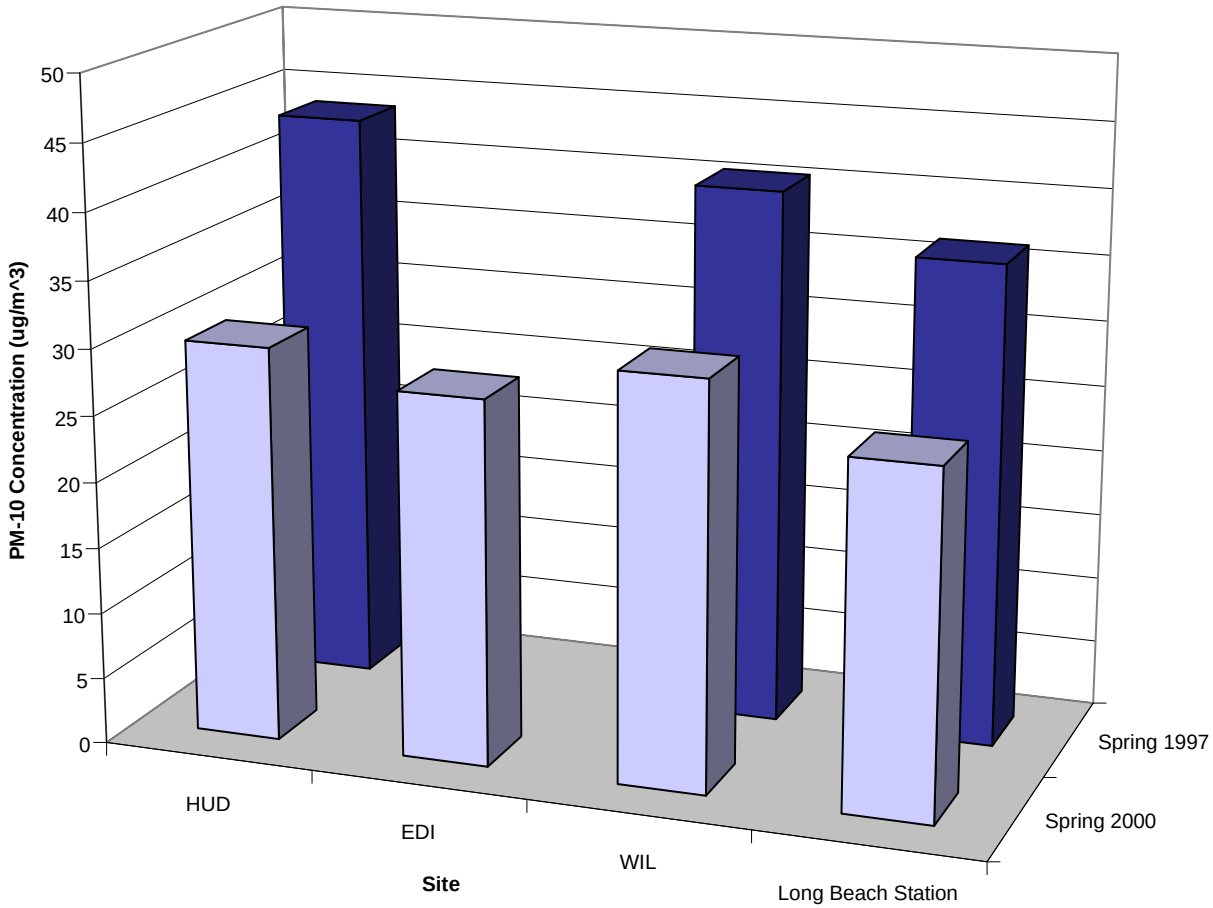
Table 1
PM_{10} Concentrations at Sampling Sites

	Date						
Site	**5/24/00**	**5/30/00**	**6/5/00**	**6/11/00**	**6/17/00**	**6/23/00**	**6/29/00**
HUD	27	31	40	32	18	19	42
EDI	20	28	37	31	25	17	35
WIL	22	38	41	33	19	24	37
Max/Day	27	38	41	33	25	24	42

Concentrations in $\mu g/m^3$
Note: State PM_{10} standard = 50 $\mu g/m^3$; Federal standard = 150 $\mu g/m^3$

Twenty-four hour ambient PM_{10} concentrations during the study period ranged from a maximum of 42 $\mu g/m^3$ at HUD on June 29, to a minimum of 17 $\mu g/m^3$ obtained at the EDI site on June 23. The average concentration for the study was 29 $\mu g/m^3$. Ambient concentration data is summarized in Figures 2 and 3.

Fig 3
Average PM10 Concentrations Spring 1997 and Spring 2000



Note: No sampling conducted at EDI during Spring 1997

As Fig 3 above illustrates, the 2000 average total ambient PM_{10} concentrations were observed to be 24%-31% lower than the values obtained during the 1997 study.

The State of California has established 50 $\mu g/m^3$ as the PM_{10} 24-hour standard. All samples collected during the course of the study complied with this standard. The highest site average (30.6 $\mu g/m^3$) over the course of the study occurred at the WIL site. This diverges from the trend observed in the 1997, 1998 and 1999 studies, where HUD was the site ranked with the highest average PM_{10} concentration.

6.2 CARBON ANALYSIS

Elemental carbon is of particular interest in this study, as it arises in part from coke and coal storage as well as transportation including diesel emissions from trucks, trains and ships. In areas of residential/industrial mix, as the sites studied, typical ratios of elemental carbon to organic carbon are 0.5**:**1 to 0.3**:**1. Calculated ratios for this study ranged from

0.3:1 to 0.7:1 and averaged 0.4:1, values consistent with the norm for similar areas in the District.

Table 2
Carbon Analysis Summary

Site	Average Mass ($\mu g/m^3$)	Organic Carbon Average ($\mu g/m^3$)	Elemental Carbon Average ($\mu g/m^3$)	Average % PM_{10} as Elemental Carbon
HUD	29.9	2.9	1.6	5.0
EDI	27.6	2.8	1.3	4.3
WIL	30.6	3.0	1.2	4.3

As in earlier studies, the total carbon content on the filters was compared to the total mass of PM_{10} collected on those filters. Carbonaceous materials accounted for 11%-17% by weight of the total PM_{10} collected, while in 1999 carbon comprised 15%-36% of PM_{10} mass. Here, the HUD site exhibited the highest total carbon and elemental carbon concentrations. A comparison of elemental carbon levels is shown in Table 3.

6.3 DISCUSSION OF SITE-SPECIFIC RESULTS

Table 3
Comparison of Elemental Carbon Results

Site	Spring 1997 Average % PM_{10} as Elemental Carbon	Fall/Winter 1998 Average % PM_{10} as Elemental Carbon	Fall/Winter 1999 Average % PM_{10} as Elemental Carbon	Spring 2000 Average % PM_{10} as Elemental Carbon
HUD	7.6	14.5	10.4	5.0
EDI	Not sampled	10.7	7.9	4.3
WIL	5.1	9.8	8.4	4.3

The above results indicate that over time, the contribution of elemental carbon to ambient PM_{10} has decreased. Between Spring 1997 and Spring 2000 at the HUD site, the percentage of elemental carbon in PM_{10} decreased from 7.6% to 5.0%, a 34% relative reduction in elemental carbon. Likewise, for the same time period at the WIL site a 16% relative reduction was observed.

For the period between Fall/Winter 1999 and Fall/Winter 2000, the HUD site experienced a decrease from 14.5% elemental carbon in PM_{10} to 10.4%, a 28% relative reduction; meanwhile the WIL site saw a relative decrease of 14%. The EDI site mirrored the HUD site with a 26% relative decrease of elemental carbon in PM_{10}.

Therefore, the two studies conducted since the implementation of Rule 1158 both show significant reductions in elemental carbon.

6.4 BASIN-WIDE RESULTS COMPARISON

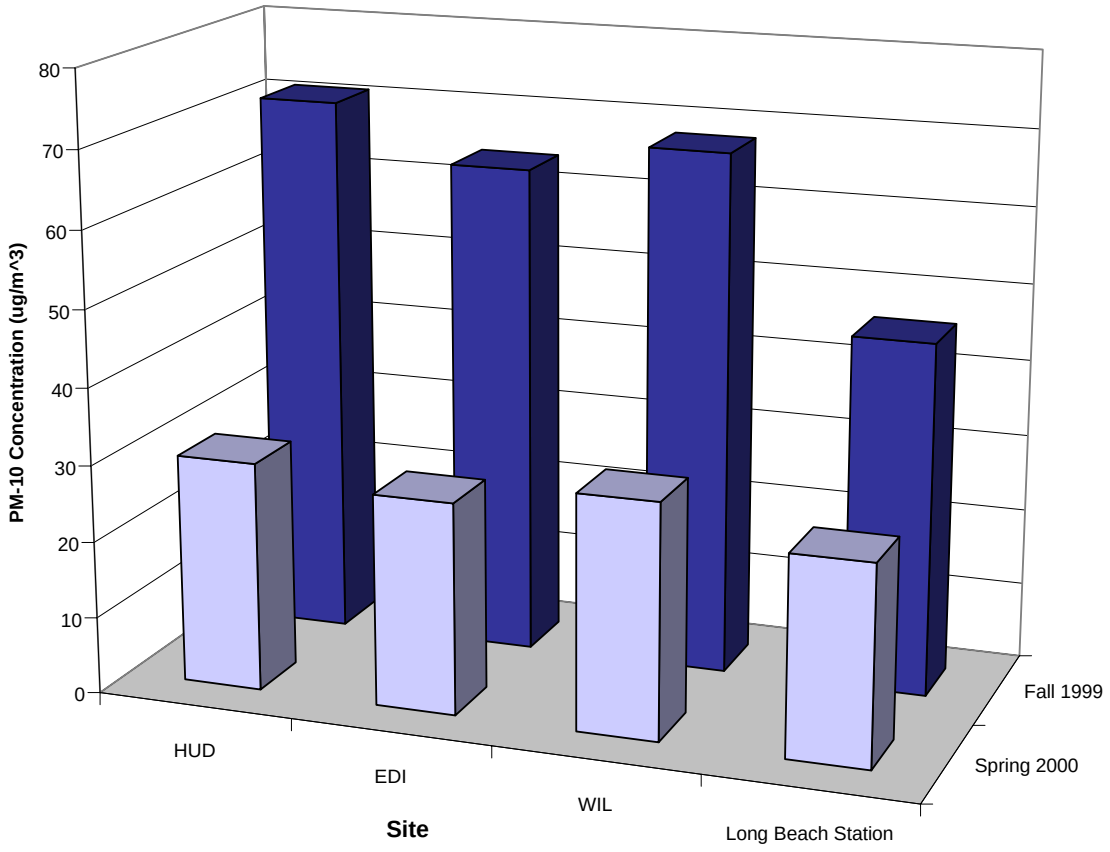
Like the 1998 and 1999 studies, the current study was conducted coincident with District-wide PM_{10} monitoring, in accordance with the EPA 1-in-6 day sampling schedule. Rubidoux is consistently the site with the highest measured PM_{10} concentration in the District. Figure 4 illustrates that Rubidoux had higher PM_{10} levels than the maximum project PM_{10} measurement for each day during the current study. This result contrasts the 1998 and 1999 Fall/Winter studies, in which the project average frequently exceeded the Rubidoux measurement. This is because the fall/winter period has more offshore flow, which carries pollutants toward the coast. By contrast, in the spring/summer months, winds carry pollutants inland. (The Spring 1997 study measurements were not taken coincident with the PM_{10} network.) In further contrast to earlier studies, Figure 4 also illustrates that the study maximum value does not significantly differ from measurements taken throughout the Basin.

One trend that has continued from the 1998 and 1999 studies is the relationship between the Long Beach PM_{10} network station and the study sites. Figure 5 shows that for all sampling days where data was available for both study sites and the Long Beach station, the average PM_{10} concentration measured at the Long Beach station is lower. Though the difference is less marked than that seen in Winter/Fall 1999, it appears that meteorological and local source conditions in the study area cause consistently higher PM_{10} levels to be observed elsewhere in the greater Long Beach/Wilmington area than at the Long Beach network station.

6.5 SEASONAL TRENDS

As is observed throughout the Basin, fall/winter PM_{10} levels in the study area are considerably higher than springtime concentrations (Figure 6). These findings are consistent with all previous particulate studies in the Basin, and are attributed to much greater stagnation during the fall/winter months than occurs during the spring/summer months.

Figure 6
Comparison of Fall/Winter 1999 and Spring 2000 Average PM_{10} Concentrations



7.0 CONCLUSIONS

In contrast to the 1997, 1998, and 1999 studies, the greater Long Beach/Wilmington area now exhibits ambient PM_{10} concentrations typical of similar commercial/residential areas in other parts of the Basin. The daily PM_{10} concentration data generated during the current study did not differ significantly from the data obtained at PM_{10} network monitoring stations elsewhere in the District during the same period. This arises from a 24% - 31% decrease in PM_{10} from the Spring 1997 study to the Spring 2000 study, which was observed both at the contractor-run study sites and the District-maintained Long Beach monitoring station.

The Long Beach monitoring station did continue to produce PM_{10} results lower than those measured at the study sites. This again reinforces the Fall 1998 and Fall 1999 conclusion that relocation of the station to a more southwesterly location may better characterize local air quality.

Examination of the elemental carbon data provides the most striking results of the study: the contribution to PM_{10} concentration by elemental carbon has dropped between 16% and 34%. This reinforces the findings of the Fall/Winter 1999 study, which together show significant reductions in elemental carbon levels since the implementation of Rule 1158.

In conjunction with the Fall/Winter 1998 and 1999 studies, the current study provides a baseline for future examination of seasonal PM_{10} variation in the area. Initial results indicate that springtime PM_{10} concentrations are considerably lower than those observed in the fall/winter.

It should be recognized that Fall/Winter 1999 and Spring 2000 studies represent a limited amount of data. Subsequent Fall/Winter and Spring studies will be vital in determining if the evident downward trends are valid. If these results hold up over time, future reductions in particulate and elemental carbon levels would be affected by reductions from other sources of ambient elemental carbon such as diesel trains, trucks and ships.

APPENDIX A-1

TOTAL CARBON ANALYSIS BY SAMPLE DATE

(CONCENTRATIONS in $\mu g/m^3$)

Date	Site	Total Mass	Total Carbon	Total % Carbon
5/24/00	HUD	27	4.6	17%
	ED	20	3.7	19%
	WIL	22	3.8	17%
5/30/00	HUD	31	3.7	12%
	ED	28	3.8	14%
	WIL	38	4.1	11%
6/5/00	HUD	40	6.4	16%
	ED	37	5.3	14%
	WIL	41	5.5	13%
6/11/00	HUD	32	4.4	16%
	ED	31	4.2	14%
	WIL	33	4.1	12%
6/17/00	HUD	18	3.0	17%
	ED	25	3.4	14%
	WIL	19	3.3	17%
6/23/00	HUD	19	2.8	15%
	ED	17	2.7	16%
	WIL	24	3.9	16%
6/29/00	HUD	42	6.2	15%
	ED	35	4.4	13%
	WIL	37	4.9	13%

APPENDIX A-2

ELEMENTAL CARBON ANALYSIS BY SAMPLE DATE

(CONCENTRATIONS in $\mu g/m^3$)

Date	Site	Total Mass	Elemental Carbon	% Elemental Carbon
5/24/00	HUD	27	1.7	6%
	ED	20	1.2	6%
	WIL	22	1.3	6%
5/30/00	HUD	31	1.2	4%
	ED	28	1.2	4%
	WIL	38	1.2	3%
6/5/00	HUD	40	2.6	7%
	ED	37	1.7	5%
	WIL	41	1.8	4%
6/11/00	HUD	32	1.4	4%
	ED	31	1.4	5%
	WIL	33	1.1	3%
6/17/00	HUD	18	0.7	4%
	ED	25	0.8	3%
	WIL	19	0.9	5%
6/23/00	HUD	19	0.8	4%
	ED	17	0.6	4%
	WIL	24	1.0	4%
6/29/00	HUD	42	2.5	6%
	ED	35	1.3	4%
	WIL	37	1.6	4%

APPENDIX A-3

ORGANIC TO ELEMENTAL CARBON ANALYSIS BY SAMPLE DATE

(CONCENTRATIONS in $\mu g/m^3$)

Date	Site	Elemental Carbon	Organic Carbon	Ratio EC/OC
5/24/00	HUD	1.7	2.9	0.6
	ED	1.2	2.5	0.5
	WIL	1.3	2.5	0.5
5/30/00	HUD	1.2	2.6	0.5
	ED	1.2	2.6	0.5
	WIL	1.2	2.9	0.4
6/5/00	HUD	2.6	3.8	0.7
	ED	1.7	3.6	0.5
	WIL	1.8	3.7	0.5
6/11/00	HUD	1.4	3.0	0.5
	ED	1.4	2.8	0.5
	WIL	1.1	3.0	0.4
6/17/00	HUD	0.7	2.3	0.3
	ED	0.8	2.6	0.3
	WIL	0.9	2.4	0.4
6/23/00	HUD	0.8	2.0	0.4
	ED	0.6	2.1	0.3
	WIL	1.0	2.9	0.3
6/29/00	HUD	2.5	3.7	0.7
	ED	1.3	3.1	0.4
	WIL	1.6	3.3	0.5

APPENDIX A-4

WIND ROSES GENERATED DURING SPRING 2000 STUDY

Provided by RES Environmental, Inc.