Sonoma Technology, Inc.
Air Quality Research and Innovative Solutions

Seventh Annual Report of Ambient Air Quality Monitoring at Sunshine Canyon Landfill and Van Gogh Elementary School: A Seven-Year Summary





November 22, 2007–November 21, 2014

Prepared for
Planning Department, City of Los Angeles
and
Los Angeles County Department of Regional Planning
Los Angeles, California

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Seventh Annual Report of Ambient Air Quality Monitoring at Sunshine Canyon Landfill and Van Gogh Elementary School: A Seven-Year Summary November 22, 2007–November 21, 2014

Annual Report
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On the cover (clockwise from upper left): monitoring trailer and meteorological tower at Van Gogh School, DeltaCal NIST-traceable reference meter for auditing flow and temperature, aethalometer with Beta Attenuation Monitor and data acquisition system, monitoring trailer and meteorological tower at South Berm, and Sunshine Canyon Landfill.

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Executive Summary

Continuous monitoring of meteorological and air quality parameters began at the Sunshine Canyon Landfill (Landfill) and at Van Gogh Elementary School (Community) in the nearby community of Granada Hills in fall 2007. Ambient concentrations of particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) are determined by integrated hourly measurements employing a beta attenuation monitor (BAM). Wind speed and wind direction are measured as 1-minute averages, and black carbon (BC)—a surrogate for diesel particulate matter (DPM)—is measured as 5-minute averages. All data are reported as hourly averages. The collected data undergo quarterly validation and are evaluated for completeness. BC values are compensated for saturation effects, which bias instrument measurements low when BC concentrations are high. PM_{10} concentrations are compared with federal and state PM_{10} standards and with the historical, regional, and annual ambient PM_{10} concentrations. BC concentrations are compared with regional concentrations. The PM_{10} and BC data undergo further analysis to characterize the impact of landfill operations on ambient air quality on a neighborhood scale. The validated hourly data and a summary of the analytical results and field operations are reported to the Planning Department of the City of Los Angeles, and to the Los Angeles County Department of Regional Planning, quarterly and annually.

This Seventh Annual Report includes data summaries, accompanied by analysis and interpretation, drawn from seven complete years of continuous monitoring of PM_{10}, BC, and meteorological data at the Landfill and Community monitoring sites. This represents an extensive repository of data with high temporal resolution. These annual data sets, characterized by high data quality, increase the level of confidence for inferences made from comparisons with standards, from comparisons between the two sites, from observed seasonal or annual trends, and from comparisons with regional observations reported by South Coast Air Quality Management District (SCAQMD) monitoring sites in the South Coast Air Basin (SoCAB). Baseline-year data, collected between November 22, 2001, and November 21, 2002, at the Landfill and Community monitoring sites, can provide additional historical perspective. This annual report uses the available data to characterize ambient PM_{10} and BC concentrations on a neighborhood scale and in the context of the SoCAB, and to continue to evaluate the impact of landfill operations on air quality in the community.

This report is parallel in format to previous years' Annual Reports, with analysis and discussion based on multiple years of sampling, but updated with results from the seventh year. Some sections, such as those covering methodology, are repeated from previous years for clarity and to keep discussion of results within the framework of the ongoing monitoring program. The specific analytical approaches include evaluation of PM_{10} exceedances, regional comparisons of PM_{10}, regional comparisons of BC, effects of meteorology and work activity level on ambient concentrations of PM_{10} and BC, and quantitative estimates of the contributions of landfill operations to ambient concentrations of PM_{10} and BC.

The seven years of monitoring results reinforce the following general conclusions, by category:

- PM_{10} exceedances
  - The Landfill site is more prone to exceeding the federal 24-hr PM_{10} standard than is the Community site (eighteen exceedances versus two exceedances over the seven years spanning November 22, 2007, through November 21, 2014).
  - PM_{10} exceedances at the Landfill site are accompanied by high average wind speeds within a narrow wind direction sector from the northwest over the landfill.
  - PM_{10} exceedances at the Community site are accompanied by exceedances at the Landfill site and by elevated regional PM_{10} concentrations, suggesting a synergy between regional concentrations and landfill impacts.
  - PM_{10} exceedances at the Landfill site and Community site cannot be attributed to regional PM_{10} concentrations alone, since there were no exceedances recorded at the nearby regional sites on days with exceedances at the Landfill site.
  - Year 3 (November 22, 2009 – November 21, 2010) was the only November–to-November monitoring year in which there were no exceedances of the federal 24-hr PM_{10} standard at the Landfill site.
  - At the Landfill site, 7 of the 18 PM_{10} exceedances to date occurred in the fall quarter (September–November), while 6 of the 18 occurred in the spring quarter (March–May). Five exceedances occurred in the winter quarter (December–February). No exceedances occurred in the summer quarter (June–August), although monthly median concentrations are highest during the summer.
- Regional comparisons of PM_{10}
  - For 2008, 2009, and 2010, monthly average PM_{10} concentrations at the Landfill site and at the Community site were lower than those measured in downtown Los Angeles (North Main Street, continuous monitor). During 2011, six monthly averages from the Landfill monitor and three monthly averages from the Community monitor exceeded the Los Angeles average, with a majority occurring typically during summer months of onshore wind flow. During 2012, five monthly averages from the Landfill monitor exceeded the Los Angeles average; however, three months (July, August, and December) could not be compared because of incomplete data at one or both sites. During 2013, five monthly averages from the Landfill monitor exceeded the Los Angeles average, most during warm weather. During 2015, five monthly averages from the Landfill monitor exceeded the Los Angeles average; again, most were during warmer weather.
  - Annual average PM_{10} concentrations at the Landfill site and the Community site are higher than those measured in Santa Clarita (one-in-six day Federal Reference Method [FRM]).
  - On average, regional influences remain large compared to landfill impacts. The observed patterns in seasonal or monthly average PM_{10} concentrations, within years, are similar among the Landfill site, the Community site, downtown Los Angeles

(North Main Street), Burbank (West Palm), and Santa Clarita. However, the neighborhood-scale impacts of the landfill are apparent during discrete time periods, which are typically characterized by high wind speeds from the northwest.

- Regional comparisons of BC
  - SCAQMD conducted the Multiple Air Toxics Exposure Study (MATES IV) from July 2012 to June 2013, and STI obtained the hourly, validated data from this study to help provide regional context as part of this Annual Report. As part of MATES IV, BC measurements were made at Burbank, Los Angeles, Pico Rivera, and Huntington Park.
  - BC concentrations at the Landfill and Community sites were shown to be significantly lower than those measured at the four MATES IV sites during the one-year MATES IV monitoring period. Moreover, 75th percentile and upper percentile concentrations were also significantly lower at the Landfill and Community sites than at the MATES IV sites in the Los Angeles Basin.
- Wind direction and work activity level can impact the ambient concentrations of PM_{10} and BC. According to the seven-year averages,
  - During the highest activity levels (working hours on working days)
    - When the wind is from the SoCAB, the Landfill and Community monitors measure about the same median PM_{10} and BC concentrations.
    - When the wind is from the SoCAB, the Community monitor measures almost three times the median concentration of PM_{10} and about four times the median concentration of BC as when the wind is from the landfill.
    - When wind is from the landfill, the Community PM_{10} and BC concentrations are about one-half of those measured at the landfill.
  - During the lowest activity levels (non-working days),
    - Ambient concentrations of PM_{10} and BC are lower on non-working days, but the extent of the decrease is influenced by wind direction:
      - For PM_{10}, daytime (working hours) ambient concentrations were approximately 70% lower on non-working days than on working days when wind direction was from the landfill. When winds came from the SoCAB, the difference between non-working days and working days was smaller (about 16% lower on non-working days), reflecting the larger regional PM_{10} influence of the SoCAB under these wind conditions.
      - For BC, the proportional decrease in daytime (working hours) concentrations between working and non-working days was larger than for PM_{10}. Compared to working hours, BC concentrations during non-working hours decreased by a factor of 2 to 4 when winds were from the landfill, and by a factor of 1 when winds were from the SoCAB.

- Quantitative estimates of landfill impacts on ambient concentrations of PM_{10} and BC during working days when wind direction is from the landfill suggest the following. **Tables ES-1 and ES-2** summarize the landfill's estimated contribution to PM_{10} and BC at both sites (Landfill and Community) by year:
  - For PM_{10}
    - The landfill contributes small amounts of PM_{10} to concentrations monitored at the Community site, except during Year 3, when the contribution was more substantial. This additional contribution is estimated to be 4, 6, 9, 5, 6, 2 and 0.4 µg/m^3, in consecutive order for the last seven years. The 61% decrease from Year 5 to Year 6 (from 6 µg/m^3 to 2 µg/m^3) reversed the former trend of increasing contributions observed from Year 1 to Year 3 and again from Year 4 to Year 5. A similar decrease was measured between Year 3 and Year 4, while a further decrease was observed between Year 6 and Year 7.
    - The estimated landfill PM_{10} contribution as measured at the Landfill site is, depending on the year, up to 37 times greater than the estimated contribution to PM_{10} concentrations at the Community site. As measured at the Landfill monitor only, the landfill's contribution to hourly average PM_{10} concentrations increased from 7.2 µg/m^3 in Year 1 to 26.3 µg/m^3 in Year 4, but decreased in Year 5. In Year 6, it increased again, and it decreased again in Year 7. For Years 3, 4, 5, and 6, the landfill accounts for the majority of the PM_{10} recorded by the monitor there. This trend is not seen in the Community monitor's data.
    - The substantial increases in PM_{10} attributed to the landfill from Year 1 through Year 4, the decreases in Year 5 and Year 7, and the increase in Year 6 at the Landfill site are not duplicated at the Community monitor; this suggests that the landfill is a local source that minimally impacts neighborhood- or regional-scale measurements.
  - For BC
    - Annual landfill contributions account for one-third to two-thirds of the total ambient BC concentrations measured at the Landfill monitor. Annual landfill contributions are lower at the Community site, ranging from near zero to about one-third of the measured total. As measured at the Landfill BC monitor, the landfill contribution to ambient BC concentrations declined by 69% from Year 1 to Year 2, but then increased from Year 2 through Year 5. These increases in measured BC concentrations at the Landfill site are assumed to be associated with a general increase in landfill activities or scope of operations. The landfill contribution to ambient BC concentrations dropped significantly from Year 5 to Year 6 at both the Landfill monitor and Community monitor. This may be due to changes in landfill activities and/or diesel equipment modifications, though no activity data or statistics on diesel equipment is presented in this report.
    - The estimated landfill contribution to BC concentrations as measured at the Landfill site, depending on the year, ranges from 3 to 22 times greater than the estimated contribution at the Community site.

Table ES-1. Contribution of hourly average PM_{10} by the landfill at the Landfill and Community sites.

Year	Landfill Site		Community Site	
	Amount ($\mu g/m^{-3}$)	% of Total	Amount ($\mu g/m^{-3}$)	% of Total
Year 1 11/22/07–11/21/08	7.2	15%	4.1	19%
Year 2 11/22/08–11/21/09	12.6	26%	5.7	24%
Year 3 11/22/09–11/21/10	26.3	69%	8.5	66%
Year 4 11/22/10–11/21/11	32.4	62%	4.8	37%
Year 5 11/22/11–11/21/12	23.2	50%	5.9	31%
Year 6 11/22/12–11/21/13	27.8	56%	2.3	13%
Year 7 11/22/13–11/21/14	15.7	26%	0.4	2%

Table ES-2. Contribution of hourly average BC by the landfill at the Landfill and Community sites.

Year	Landfill Site		Community Site	
	Amount ($\mu g/m^{-3}$)	% of Total	Amount ($\mu g/m^{-3}$)	% of Total
Year 1 11/22/07–11/21/08	0.61	61%	0.05	13%
Year 2 11/22/08–11/21/09	0.19	19%	0.04	9%
Year 3 11/22/09–11/21/10	0.34	43%	0.05	14%
Year 4 11/22/10–11/21/11	0.40	47%	-0.03	0%
Year 5 11/22/11–11/21/12	0.56	62%	0.14	32%
Year 6 11/22/12–11/21/13	0.23	33%	0.01	2%
Year 7 11/22/13–11/21/14	0.26	41%	0.11	36%

1. Introduction

Two air quality monitoring sites were established by operators of the Sunshine Canyon Landfill in 2001. One monitoring site is on a high-elevation ridge on the southern edge of the Sunshine Canyon Landfill (Landfill site). The second site is at Van Gogh Elementary School in the nearby community of Granada Hills (Community site). These sites were established to monitor particulate matter less than 10 microns in aerodynamic diameter (PM_{10}), black carbon (BC) as a surrogate for diesel particulate matter (DPM), wind direction, and wind speed, in fulfillment of the stipulations set forth in the City of Los Angeles' Conditions of Approval for the expansion of the Sunshine Canyon Landfill in the City of Los Angeles (Section C.10.a of Ordinance No. 172,933). In 2009, the County of Los Angeles Department of Regional Planning and Public Works adopted conditions (County Condition 81) very similar to the City's conditions, governing ambient air quality monitoring for the County portion of the landfill. The original Conditions of Approval also required sampling of landfill gas (LFG) on four occasions throughout each year at each of the locations. The LFG sampling requirement was subsequently eliminated as part of the routine monitoring contract. From April 2010 through December 2012, BFI/Republic operated the Sunshine Canyon Landfill under a Stipulated Order for Abatement (SOA) issued by the South Coast Air Quality Management District (SCAQMD) Hearing Board (a quasi-judicial body separate from SCAQMD). The SOA included many operational provisions, and one of the subsequent amendments to the SOA required BFI/Republic to move to one-in-six day sampling of volatile organic compounds (VOCs) for a minimum of one year. As a result of this required higher frequency sampling of VOCs, the four LFG samples are no longer required as part of the City and County Conditions of Approval. Although the formal SOA has been lifted, the landfill operator may still adhere to some of the stipulations, such as those limiting landfill activities under certain wind conditions.

1.1 Baseline Year and Continuous Monitoring

A baseline year of continuous monitoring of PM_{10}, BC, and meteorology occurred between November 22, 2001, and November 21, 2002, and a report of the baseline year results was produced by ENVIRON International Corporation.[1] A baseline study of LFG was conducted in 2003 and served as the basis for the establishment of an LFG monitoring protocol.[2] Between the time that the baseline studies were completed and November 2007, when continuous monitoring began, ambient sampling for PM_{10}, BC, and LFG was planned to be conducted at a nominal frequency of four times each year by ENVIRON International Corporation. Data from those years are not included in this report.

Beginning in 2007, ambient monitoring of particulate matter (and LFGs in some years) at the Landfill and Community sites became the responsibility of Sonoma Technology, Inc. (STI). STI's technical approach to monitor PM_{10} and BC was based on continuous monitoring (hourly,

[1] ENVIRON International Corporation (2003) Results of the baseline ambient air monitoring program for the Sunshine Canyon Landfill. Final report prepared for Browning-Ferris Industries of California, Inc., by ENVIRON International Corporation, Contract No. 03-9660A, June 6.
[2] ENVIRON International Corporation (2003) Proposed landfill gas baseline ambient air monitoring protocol for the Sunshine Canyon Landfill. Report prepared for Browning-Ferris Industries of California, Inc., by ENVIRON International Corporation, Contract No. 03-9660A, March 27.

year-round), whereas previous monitoring was limited to four events per year. Continuous all-year monitoring of PM_{10} and BC allows greater potential for evaluation of times when air flows from the landfill to the Community receptor site at Van Gogh Elementary School, as well as for evaluation of diurnal trends, day-of-week differences, seasonal differences, and annual trends in pollutant concentrations in comparison with regional monitors operated by the SCAQMD and the California Air Resources Board (CARB).

November 22, 2014, marked the completion of seven full years of continuous monitoring of PM_{10}, BC, and meteorology at the two monitoring locations. Data capture rates and the quality of the captured data have generally been very high. A few discrete events have interrupted data capture at one or both sites; for example, the Sayre Fire in late 2008 took out power at the Landfill monitoring site for several weeks. In addition, equipment upgrades in 2010 caused some loss of data because instruments were temporarily removed. Even with these interruptions, however, data completeness statistics for the seven years indicate average data capture rates of approximately 94% at the Landfill site and approximately 97% at the Community site (see Section 2). On average, less than 3% of all captured data were judged as invalid.

1.2 Report Overview

In this report, the high-quality, high-time-resolution data captured over the seven years between November 2007 and November 2014 are analyzed and summarized to offer a realistic characterization of ambient air quality concentrations at the two monitoring locations, and to provide perspective on air quality at the landfill and the local community in the context of the greater South Coast Air Basin (SoCAB). Some additional analyses are provided in **Appendix A**.

Regulatory standards for pollutants are commonly used to judge the compliance status of air districts and air basins. Currently, the only federal health-based standard for PM_{10} is the daily (24-hr) average concentration of 150 $\mu g/m^3$. The State of California's PM_{10} 24-hr standard (50 $\mu g/m^3$) is more stringent than the federal standard. (The previously existing federal annual standard of 50 $\mu g/m^3$ was revoked because of the lack of substantial evidence of health effects attributable to long-term exposures.) In this report, the 24-hr federal standard of 150 $\mu g/m^3$ is used as a benchmark metric for evaluating the specific monitoring locations in relation to each other and to the federal standard.

Regional comparisons of ambient PM_{10} concentrations are used to place the Landfill and Community monitors within the larger context of regional concentrations. For these comparisons, three of the closest regional monitoring sites, operated by the SCAQMD, were chosen: downtown Los Angeles (North Main Street); Burbank (West Palm), and Santa Clarita. **Figure 1-1** shows the relative locations of the sites.

Ambient concentrations of BC as a surrogate for DPM continue to receive increased interest statewide, nationally, and globally. SCAQMD has shown that DPM is one of the primary toxics of concern in the SoCAB. Regional comparisons of ambient BC concentrations are used to place the Landfill and Community monitors within the larger context of regional concentrations. For these comparisons, four of the closest regional monitoring sites from the Multiple Air Toxics Exposure Study (MATES IV) air toxics study (summer 2012 – summer

2013),[3] also operated by the SCAQMD, were selected: Burbank (approximately the same location as the Burbank PM_{10} site), Central LA (approximately the same location as the Los Angeles PM_{10} site), Huntington Park, and Pico Rivera. This is the first Sunshine annual report for which this data has been available to Sonoma Technology. Note that this regional comparison spans only the one-year study period of the MATES IV study. Our evaluation includes Sunshine monitoring site data which are time-coincident with the MATES IV study. Currently, MATES IV data are the best BC data available for placing the Landfill and Community sites in a regional context.

Figure 1-1. Locations of the Landfill and Community monitors in relation to the three SCAQMD PM_{10} sites and four MATES IV BC sites used for regional comparisons. Note that in MATES IV documentation, Los Angeles is referred to as “Central LA.”

[3] Information at http://www.aqmd.gov/home/library/air-quality-data-studies/health-studies/mates-iv.

Black carbon aethalometers are subject to what is known as a tape saturation effect, where the buildup of BC on the tape causes an artifact affecting the accuracy of the measured concentration.[4,5] To effectively compare BC measured at the Landfill and Community sites to BC measured at the regional MATES IV study sites, BC values from the Landfill and Community site were compensated for this tape saturation effect, which was not done in previous annual or quarterly reports. Instrument response is dampened with heavier loading (i.e., heavier concentrations) of black carbon aerosol. This artifact can bias BC concentrations low. However, mathematical methods to correct the BC concentrations are available and are widely used.

For this annual report, we reprocessed all seven years (November 22, 2007 – November 21, 2014) of BC data. Compensated BC values are used for all figures and tables in this report. In the past, BC compensation was not conducted because uncompensated BC values were directly comparable to the baseline year of this study (2001-2002). However, at this point in the study, it is more important to effectively compare Landfill and Community site BC values to regional values, and thus values must be properly compensated. Values were compensated using an open source BC data masher. Compensation methods (including the "gap" method used here) are described in a presentation for the 2012 National Ambient Air Monitoring Conference.[6] As is illustrated in **Figure 1-2**, the difference between values is small, with BC compensated values slightly exceeding uncompensated values. Based on the regression equations in the figure, compensated BC is about 13% higher than uncompensated BC. As illustrated in **Figure 1-3**, the median of BC values between BC and BC compensated methods (shown by the notches in the box plots) is similar.

Figure 1-3 is a notched box-whisker plot. Each box indicates the interquartile range (IQR), where 50% of the data lie, with the notch at the median. If notches do not overlap, this indicates the data are statistically different at the 95% confidence level. The whiskers go to 1.5 times the IQR; points beyond this are shown individually as diamonds. Note that this data set is quite large, and the notches in these graphs are quite small.

Meteorological factors and work activity levels are known to have an impact on local and regional pollutant concentrations. An analysis based on wind direction and landfill working versus non-working days and hours is used to quantify the relationship of these factors to PM_{10} and BC concentrations. This analysis also provides quantitative estimates of landfill contributions to ambient concentrations of PM_{10} and BC. A summary of the analytical method is presented in Section 6, with additional analyses in Appendix A.

One area of concern to the residents of nearby communities is the occurrence of offensive odors. An abatement hearing in March 2010 (SCAQMD Case 3448-13) resulted in

[4] Drinovec L.et al. (2014) The "dual-spot" Aethalometer: an improved measurement of aerosol black carbon with real-time loading compensation. *Atmos. Meas. Tech. Discuss.*, 7(9), 10179-10220, doi: 10.5194/amtd-7-10179-2014. Available at http://www.atmos-meas-tech-discuss.net/7/10179/2014/.

[5] Allen G. (2014) Analysis of spatial and temporal trends of black carbon in Boston. Report prepared by Northeast States for Coordinated Air Use Management (NESCAUM), Boston, MA, January. Available at nescaum.org/documents/analysis-of-spatial-and-temporal-trends-of-black-carbon-in-boston/nescaum-boston-bc-final-rept-2014.pdf/.

[6] Allen G. and Turner J. (2012) Aethalometer Data Post Processor ("Masher") Update: Spot Loading Correction. Presented at the *National Ambient Air Monitoring Conference, Denver, CO, May 16*. Available at http://www.epa.gov/ttnamti1/files/2012conference/3C01Allen.pdf.

several stipulated requirements placed on landfill operations to help address the odor problems. However, the frequency of odor complaints continued to increase, and the original Order for Abatement was amended in November 2011 to add several additional conditions. One of the November 2011 abatement amendments directly affected STI's monitoring protocols. The landfill was required to conduct one-in-six day sampling of VOCs for a minimum of one year, following established U.S. Environmental Protection Agency (EPA) schedules and the protocols of SCAQMD's MATES IV. This program, conducted separately from STI's monitoring, effectively made the LFG sampling required under City Conditions of Approval C.10.a redundant. Since June 2012, STI has not conducted any LFG sampling as previously required in fulfillment of City Condition C.10.a and County Condition 81.

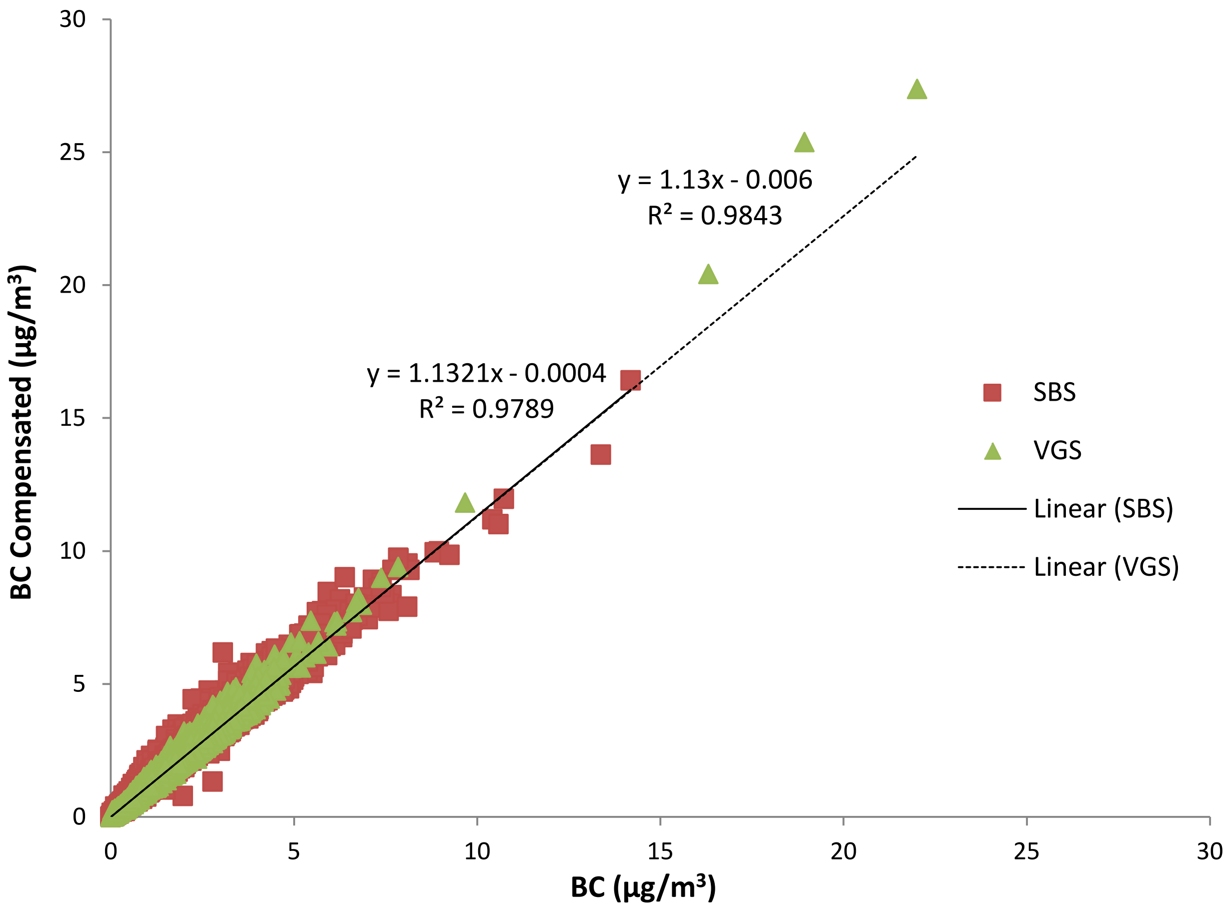


Figure 1-2. Linear regression, and R-squared values for BC vs. compensated BC-Gap at the Sunshine Berm Site (SBS) and the Van Gogh Site (VGS). Regression was performed using all valid and suspect data for the full seven years of the study period (November 22, 2007–November 21, 2014). Slope values of approximately 1.13 show that the compensated BC values are, on average, about 13% greater than the uncompensated BC values. The solid and dotted linear regression lines overlap each other in the figure.

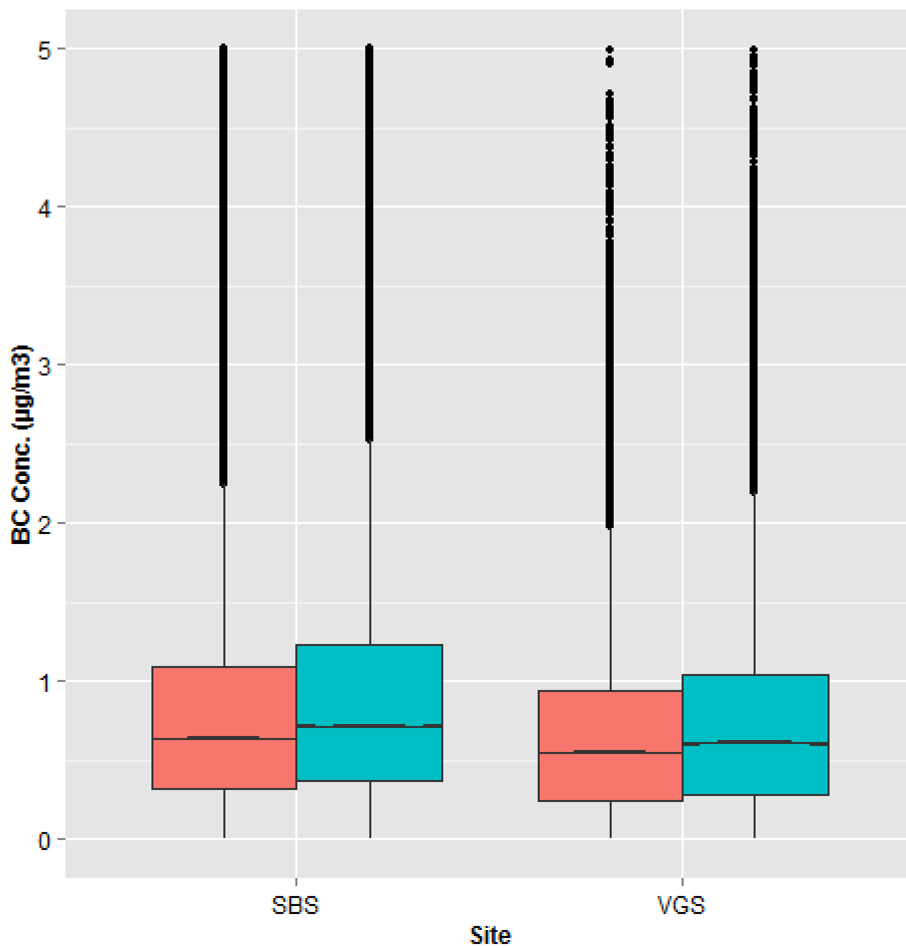


Figure 1-3. Box plot showing comparison of BC (pink) and BC Compensated (turquoise) values at the Sunshine Berm Site (SBS) and the Van Gogh Site (VGS). Median BC values between the two methods are very similar. All valid and suspect data for the full seven years of the study period (November 22, 2007–November 21, 2014) were used.

2. Data Completeness

Table 2-1 shows completeness statistics for all measured variables for the seven years considered in this analysis. Except for Year 2 at the Landfill monitoring site, the percent data capture exceeded 90% in each site-year for PM_{10} and averaged more than 97% over all years. Because the Sayre Fire shut down the Landfill monitoring site's data collection effort from November 15, 2008, through January 8, 2009, data capture rates were lower for Year 2. Note that the values in this table are based on valid hourly averages and may differ slightly from percentages presented in the quarterly reports, which are based on 1-minute or 5-minute data.

Table 2-1. Data completeness statistics for hourly data during Years 1–7 of continuous monitoring and overall seven-year averages.[a] The begin and end dates for each year are chosen to allow comparison with data collected from the baseline year (November 22, 2001–November 21, 2002).

Years	Monitoring Location	Percent Data Capture (%)[b]			Percent Data Valid or Suspect (%)[c]			Percent Data Suspect (%)[d]		
		PM_{10}	BC	WS/WD[e]	PM_{10}	BC	WS/WD	PM_{10}	BC	WS/WD
Year 1 November 22, 2007–November 21, 2008	Sunshine Canyon Landfill Site	94.2%	90.7%	88.3%	98.0%	99.9%	93.3%	0.0%	0.0%	0.0%
	Van Gogh Elementary School Site	95.8%	92.3%	95.4%	96.0%	100.0%	94.7%	0.0%	0.0%	0.0%
Year 2 November 22, 2008–November 21, 2009	Sunshine Canyon Landfill Site	86.6%	81.3%	86.8%	97.9%	100.0%	98.3%	0.0%	0.0%	0.0%
	Van Gogh Elementary School Site	98.7%	98.5%	99.9%	96.3%	100.0%	99.9%	0.0%	0.0%	0.0%
Year 3 November 22, 2009–November 21, 2010	Sunshine Canyon Landfill Site	99.7%	87.8%	98.4%	98.2%	100.0%	99.2%	0.0%	0.0%	4.3%
	Van Gogh Elementary School Site	98.4%	87.9%	98.3%	97.0%	100.0%	100.0%	0.3%	23.3%[f]	0.0%
Year 4 November 22, 2010–November 21, 2011	Sunshine Canyon Landfill Site	90.8%	99.6%	99.9%	96.9%	100.0%	97.5%	0.0%	0.0%	1.6%
	Van Gogh Elementary School Site	100.0%	99.8%	100.0%	99.2%	99.9%	96.3%	0.0%	0.0%	0.0%
Year 5 November 22, 2011–November 21, 2012	Sunshine Canyon Landfill Site	99.1%	99.6%	99.4%	95.4%	99.9%	96.7%	5.0%	0.0%	1.0%
	Van Gogh Elementary School Site	94.1%	99.9%	98.7%	98.1%	99.9%	96.1%	0.0%	0.0%	0.0%
Year 6 November 22, 2012–November 21, 2013	Sunshine Canyon Landfill Site	99.9%	99.7%	98.7%	98.6%	99.9%	100.0%	0.5%	0.0%	0.0%
	Van Gogh Elementary School Site	100.0%	99.8%	99.4%	97.7%	100.0%	100.0%	0.4%	0.1%	0.0%
Year 7 November 22, 2013–November 21, 2014	Sunshine Canyon Landfill Site	100.0%	87.9%	98.1%	99.3%	100.0%	100.0%	0.2%	0.0%	0.0%
	Van Gogh Elementary School Site	100.0%	99.1%	98.5%	98.0%	100.0%	100.0%	0.1%	0.6%	0.0%
Seven-Year Average	Sunshine Canyon Landfill Site	95.7%	92.4%	95.7%	97.8%	100.0%	97.9%	0.8%	0.0%	1.0%
	Van Gogh Elementary School Site	98.1%	96.8%	98.6%	97.5%	100.0%	98.1%	0.1%	3.4%[g]	0.3%

[a] Slightly different methods were used to calculate these values over the years, and previous annual reports contained some errors in this table. All percent completeness statistics have been recalculated by the methods detailed in the following table notes, and numbers in the table have been updated accordingly. Numbers have also been updated to reflect compensated BC data completeness (comparable in completeness to uncompensated BC data).

[b] Percent Data Capture is the percent of hourly data values that were collected divided by the total number of expected data intervals in the date range (e.g., 24 hourly data values are expected per day, and 8,760 hourly data values are expected per year—8,784 during the 2008 leap year).

[c] Percent Data Valid or Suspect is the percent of data values that are either valid or suspect divided by the number of captured data values.

[d] Percent Data Suspect is the percent of data values that are labeled as suspect divided by the number of captured data values.

[e] Wind speed/wind direction.

[f,g] Three-fourths of the data from the June 2010 – August 2010 quarter were suspect because flow rates as measured by the reference flow meter were outside of tolerance levels. This was due to a leak in the push-to-connect fitting at the back of the aethalometer. Further details can be found in the 11th Quarterly report. This quarter negatively affects the seven-year average for percent suspect. Without this quarter, the seven-year average would be 0.1% instead of 3.4%.

3. PM$_{10}$ Exceedances

Table 3-1 lists all the days during the past seven years of continuous monitoring on which the federal 24-hr PM$_{10}$ standard was exceeded at one or both monitoring sites, along with 24-hr average concentrations from those days at the three comparative SCAQMD sites (Burbank, Santa Clarita, and downtown Los Angeles). The federal standard was exceeded on 18 occasions at the Landfill site; on two of those 18 days, the Community monitor also registered an exceedance. Note that the first exceedance reported in Table 3-1 occurred in October 2007, after the equipment at the sites was refurbished and continuous monitoring began, but before the period covered by this report. These early concentration data are valid and thus included here for completeness. The SCAQMD sites in Burbank, Santa Clarita, and Los Angeles did not report exceedances on any of those days. However, the SCAQMD sites did report high 24-hr PM$_{10}$ concentrations on the two days when the Community monitor recorded PM$_{10}$ exceedances. The downtown Los Angeles monitor was only 3 µg/m^3 below the PM$_{10}$ exceedance threshold on October 27, 2009, and the concentrations measured at Burbank were also elevated. The elevated concentrations at other sites suggest that, when regional concentrations are high, a synergistic effect exists between landfill contributions and regional contributions that push the Community site's PM$_{10}$ concentrations over the federal standard. Note that when regional concentrations are low, high 24-hr concentrations at the Landfill monitor, such as those seen during three days in 2011, had no significant effect on Community PM$_{10}$ concentrations.

The Burbank and Los Angeles sites have continuous PM$_{10}$ monitors, like those at the Landfill and Community sites, which report hourly concentrations; the Santa Clarita site, however, employs Federal Reference Method (FRM) sampling (integrated 24-hr samples on filters) on a one-in-six day schedule. Only one of the days listed in Table 3-1 happened to fall on the one-in-six day Santa Clarita sample schedule. This serves as a reminder of the utility of continuous monitoring: on October 22, 2007, there was a PM$_{10}$ exceedance at the Landfill site, and the PM$_{10}$ concentration at the downtown Los Angeles site was elevated, but there was no filter sample collected at the Santa Clarita station. It is also of interest to note that on the previous day, October 21, an FRM filter sample at Santa Clarita measured an exceedance of 167 µg/m^3. At the Landfill site on October 21, 12 of the 24-hourly PM$_{10}$ values were invalid, because the measurements exceeded the maximum of the PM$_{10}$ monitor (1,000 µg/m^3), causing the output to default to error values. These were consecutive hourly samples between 2:00 a.m. and 1:00 p.m. Because this proportion (50%) of valid samples is below the 75% criteria for valid daily averages, the average for that day was reported as invalid. The 24-hr average PM$_{10}$ concentration at the Community site on October 21 was 115 µg/m^3, with hourly average values ranging from 150 to 294 µg/m^3 between the hours of 3:00 a.m. and noon.

The three exceedances at the Landfill site in 2011 and the exceedance on October 26, 2012, are notable because they exceeded the federal PM$_{10}$ standard by a substantial amount, while concentrations at the Community site and available regional monitoring sites were low on all of those days. After seven years of continuous data collection, it is clear that PM$_{10}$ exceedances at the Landfill site are more common than they are in the Community or at regional monitoring sites, suggesting that surface material is being entrained at high wind speeds and subsequently detected by the Landfill monitor. By the time these air parcels reach the Community or regional monitors, they have been diluted, and some of the larger particles may have been removed by deposition.

Table 3-1. Summary of 24-hr PM$_{10}$ concentrations at the two monitoring sites and at the Burbank, Santa Clarita, and Los Angeles regional sites operated by SCAQMD on days when a federal PM$_{10}$ exceedance (more than 150 μg/m^3) occurred at the Landfill site.

Date	Landfill Site PM$_{10}$ (μg/m^3)	Community Site PM$_{10}$ (μg/m^3)	Burbank West Palm PM$_{10}$ (μg/m^3)	Los Angeles Main Street PM$_{10}$ (μg/m^3)	Santa Clarita PM$_{10}$ (μg/m^3)
10/22/2007	183	41	93	108	-- [b,c]
2/14/2008	167	48	19	30	-- [b]
5/21/2008	290	152	119	140	-- [b]
10/9/2008	158	104	-- [b]	59	91
11/15/2008	269 [a]	136	-- [b]	85	-- [b]
1/9/2009	185	71	-- [b]	68	-- [b]
5/6/2009	257	91	-- [b]	49	-- [b]
10/27/2009	239	165	130	147	-- [b]
1/20/2011	207	28	26	46	-- [b]
4/30/2011	221	32	25	40	-- [b]
11/2/2011	263	43	37	56	-- [b]
5/22/2012	186	61	34	76 [d]	-- [b]
10/26/2012	227	49	31	40	-- [b]
3/21/2013	181	34	32	37	-- [b]
4/8/2013	174	64	53	-- [b]	-- [b]
10/4/2013	200	64	28	58	-- [b]
12/4/2013	155	18	21	25 [e]	-- [b]
12/9/2013	181	31	24	34	-- [b]

[a] Only 6 hours of data available.
[b] No data available.
[c] The previous day at Santa Clarita, 10/21/07, an exceedance of 167 μg/m^3 was recorded.
[d] Only 12 hours of data available.
[e] Only 17 hours of data available.

The PM$_{10}$ exceedances listed in Table 3-1 were generally accompanied by high wind speeds, with wind direction falling within a narrow sector that encompasses the active portion of the landfill. Wind data from the Landfill site for all exceedance days are plotted as a wind rose overlay in **Figure 3-1**, which is an aerial image of the Landfill. The majority of the winds were from the northwest, passing directly over working areas of the landfill. A smaller, but still significant, proportion of the winds were from the north sector. Wind speeds were highest when the wind direction was from the northwest and from the north. In Figure 3-1, the center point of the wind rose diagram is directly over the location of the monitoring trailer on the south berm site.

Figure 3-1. Wind rose from exceedance days during seven continuous monitoring years at the Landfill monitoring site, illustrating the fetch that encompasses working portions of the landfill. Wind speed units are mph. The wind rose center point is directly over the location of the landfill monitoring site.

4. Regional Comparisons of PM_{10}

Comparing the PM_{10} concentrations measured at the Landfill and Community monitoring sites with those measured at nearby regional monitoring sites places the locally collected data in a larger, more regional, context. The Landfill and Community sites are not isolated; they are directly affected by the large SoCAB and the nearby highly trafficked freeway system. The sites chosen for comparison, depicted earlier in Figure 1-1, are the closest regulatory sites that conduct routine PM_{10} monitoring.

Figure 4-1 shows the monthly average PM_{10} concentrations for the Landfill and Community monitoring sites, and for the three regional locations, for 2008 through 2014. For the first three years of continuous monitoring, the SCAQMD monitor at the downtown Los Angeles location recorded, on average, the highest PM_{10} concentrations, with exceptions noted in May 2009 and June/July 2010. These exceptions were discussed in the *Third Annual Report of Ambient Air Quality Monitoring at Sunshine Canyon Landfill and Van Gogh Elementary School (June 1, 2009–May 31, 2010)*, delivered to the Los Angeles City Planning Department in March 2011. The regional monitor in Burbank followed a month-to-month pattern similar to the Los Angeles pattern, but at a lower average PM_{10} concentration. The FRM monitor at Santa Clarita, on the very northern edge of the air basin, recorded, on average, the lowest PM_{10} concentrations of the regional sites. From 2008 to 2010, the Landfill and Community measurements tended to track between the Los Angeles and Santa Clarita data.

The 2011 through 2013 monitoring years exhibited a deviation from this pattern, with the Landfill monitor exhibiting the highest average monthly concentrations during the late spring to early fall. To help explain this atypical pattern and to emphasize the importance of the effect of meteorology on measured pollutant levels, the June through September meteorological data are presented in **Figure 4-2** for the years 2010, 2011, 2012, and 2013; these data demonstrate that measurements at the two monitoring sites are dominated by wind flow from the southeast and thus by regional PM_{10} concentrations originating in the SoCAB.

As shown in Figure 4-1, PM_{10} concentrations in June and July of both 2010 and 2011 at the Landfill and Community sites were higher than those recorded in Los Angeles. PM_{10} concentrations in June 2012 and in August and September 2011 were also higher at the Landfill site than at the Los Angeles site, and the Community monitor recorded concentrations similar to, or slightly higher than, those in downtown Los Angeles. (The July and August data for 2012 for the Landfill site are not shown. The landfill PM_{10} monitor recorded suspect data 18.5% of the time during the June through August quarter of 2012 due to a worn flow controller valve that led to erratic sample flow rates. The monthly percent valid PM_{10} data for July did not meet the 75% completeness criteria.) Wind roses in Figure 4-2 show clearly that the mid-summer elevation in PM_{10} detected at the Landfill and Community monitors is driven by the onshore wind flow prevalent in those months, bringing pollutants from the SoCAB northward. During June through September 2010, nearly 60% of the winds were from the due south sector. Note that during these months in 2011, 2012, and 2013, a notable wind direction shift to the south-southeast sector occurred. More than 87% of the associated hourly wind speeds during the June to September time period, in all four years, were less than 5 mph, implying that entrainment of crustal material from the landfill was not a major contributor to PM_{10} concentrations.

The dominance of low speed, south-southeasterly winds from June 2011 through September 2011 was coupled with PM_{10} concentrations at the Landfill monitor that consistently exceeded those of the downtown Los Angeles monitor. This might suggest that the shift in direction in 2011 could account for the higher PM_{10} concentrations. Missing PM_{10} concentrations for July and August 2012 limit the comparison between the two years. However, wind roses for June through September for 2008 and 2009 indicate that the prevailing winds in 2008 were nearly identical to 2011 and 2012, exhibiting the greater proportion of south-southeasterly winds, while 2009 was similar to 2010, with a larger proportion of the winds from due south (data not shown). During those earlier two years, the downtown Los Angeles monitor consistently exhibited the highest PM_{10} concentrations during the June through to September period. The main conclusion drawn from these periods of low-speed, southerly winds is that summertime elevations in PM_{10} concentrations measured at the Landfill and Community sites are not attributable to Landfill activities. The cause for the shift in site rankings between years is not discernible from available data, but hypotheses include additional generation of PM_{10} by activities occurring north of downtown Los Angeles, but south of the Landfill monitor. Alternatively, lower concentrations of PM_{10} might exist at ground level during certain periods in downtown Los Angeles, compared to what was entrained at higher altitudes and carried to the higher elevation sites.

The 2014 monitoring year followed the general pattern as the 2011 through 2013 period: the Landfill and Community monitors exhibited higher monthly average concentrations than the regional sites. This is expected as the wind rose for 2014 in Figure 4-2 suggests consistent predominant wind for the time period. However, there is one exception: in June and July 2014 the highest monthly average concentrations were observed at the Community monitor rather than Landfill monitor. A similar pattern was observed in June and July 2010. **Figure 4-3** shows the daily average concentrations during June and July in 2010 and 2014, where we found the Community monitor recorded the highest daily average concentrations almost every day in June. The reason for the exceptions is unknown. One possibility is that when the onshore wind flow prevalent in those months bringing pollutants from the SoCAB northward, the PM concentrations drops gradually due to particle deposition, or there was some construction with significant disturbed dirt going on to the south of the Community site.

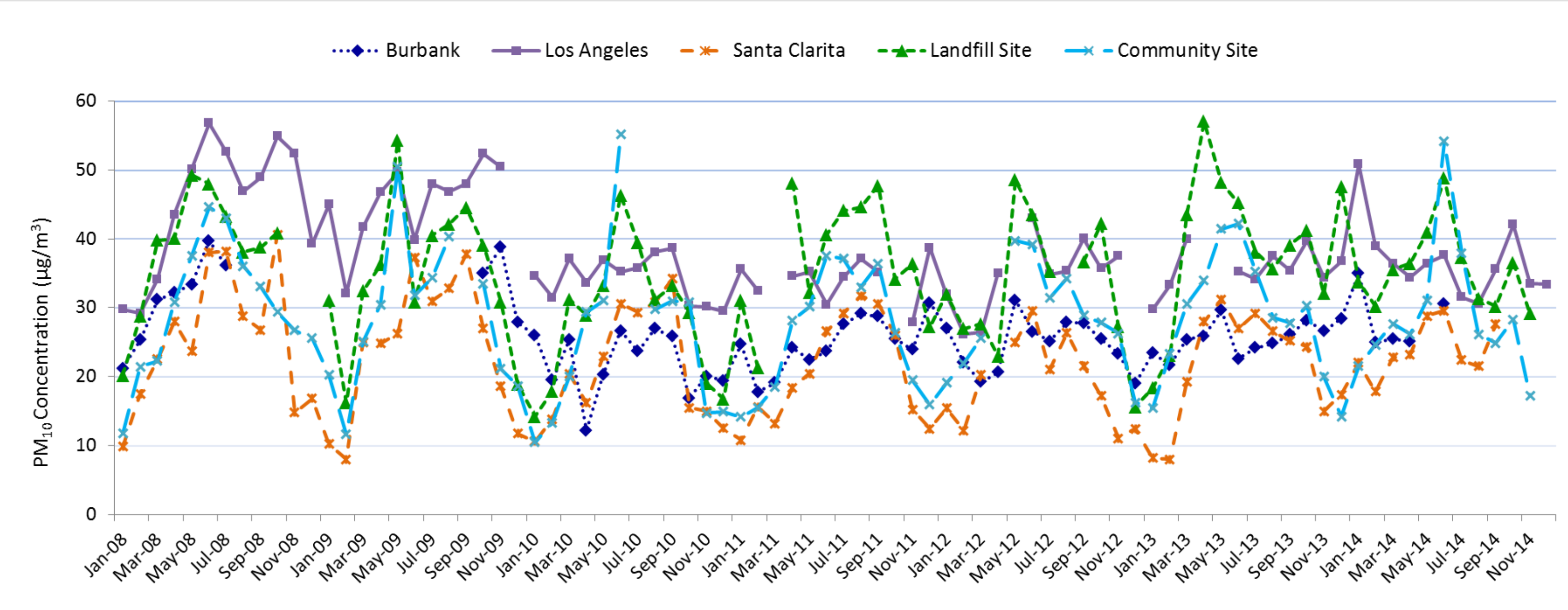


Figure 4-1. Monthly average PM_{10} concentrations for the Landfill and Community sites and three regional monitoring sites for 2008–2014 (Note: Like the Landfill and Community sites, Burbank and Los Angeles sites report hourly concentrations, while the Santa Clarita site reports integrated 24-hr samples on filters on a one-in-six day schedule).

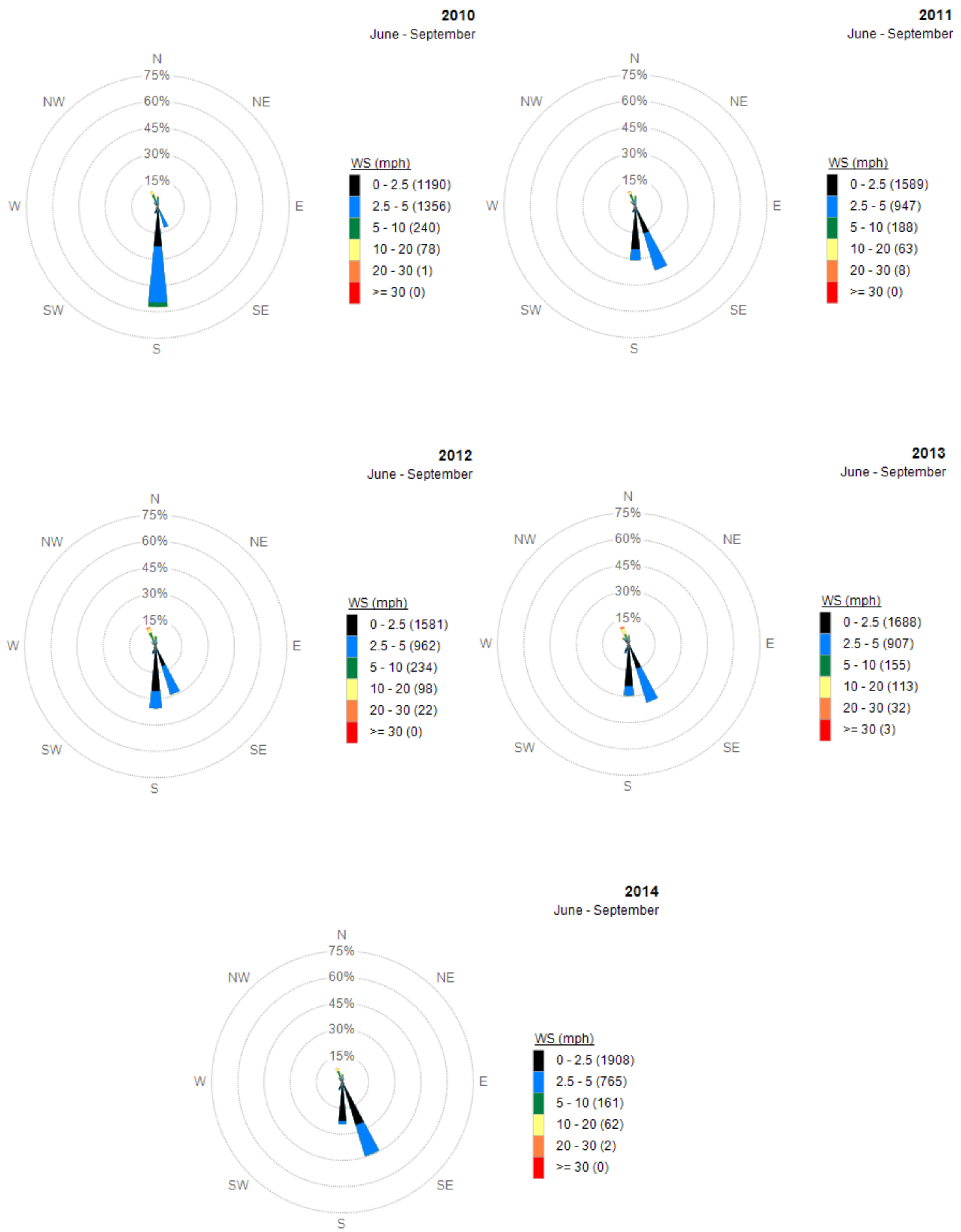


Figure 4-2. Wind roses of hourly data from the Landfill monitor for the months of June through September for 2010, 2011, 2012, 2013, and 2014. The wind roses show the dominance of onshore wind flows in the summer, coupled with relatively low hourly averaged wind speeds, and illustrate the shift to SSE winds during 2011, 2012, 2013, and 2014 compared to 2010.

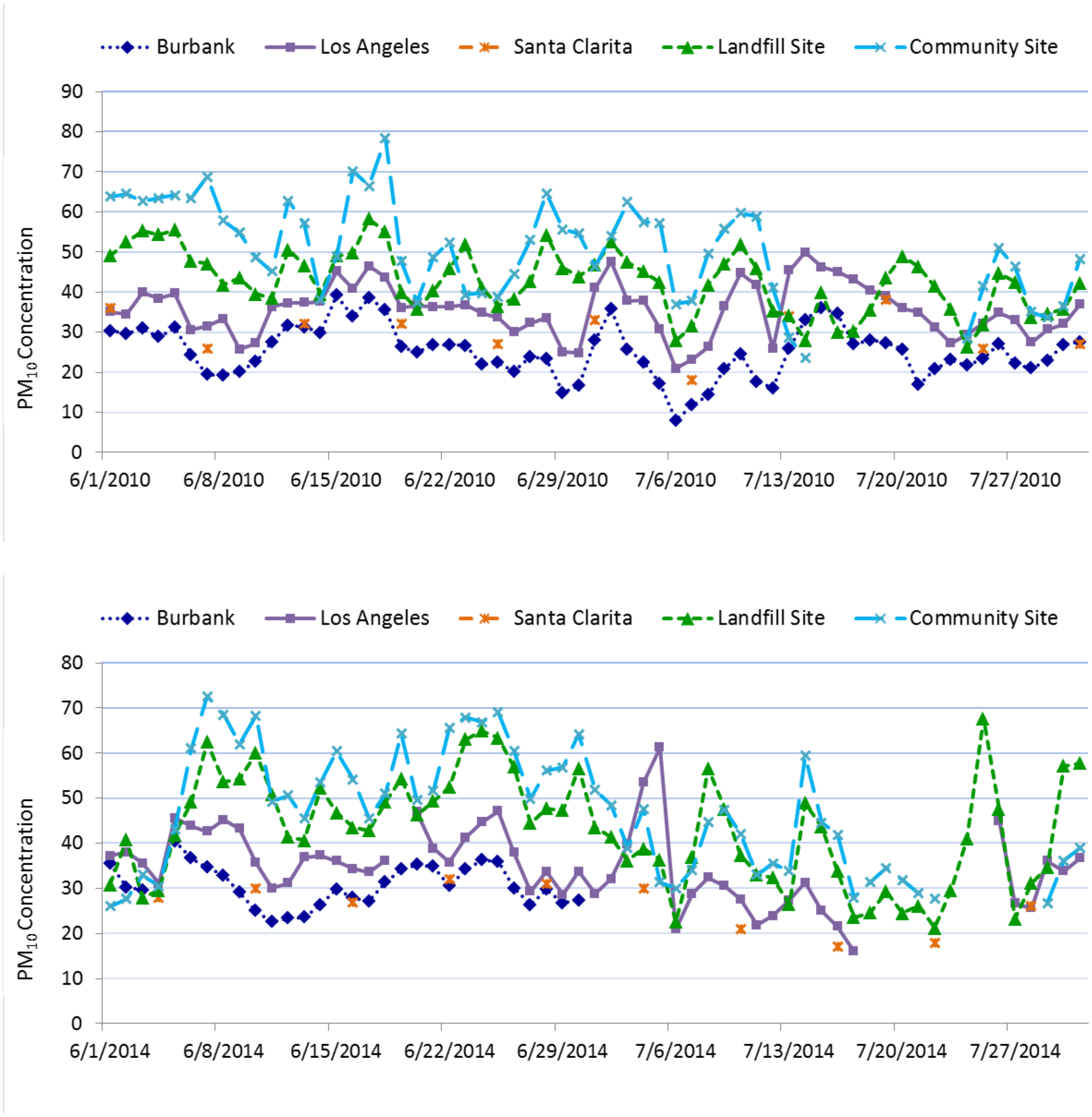


Figure 4-3. Daily average PM_{10} concentrations for the Landfill and Community sites and three regional monitoring sites for June and July in 2010 (upper) and 2014 (lower).

5. Regional Concentrations of BC

Concentrations of black carbon by month and time of day, and a differential between the Landfill and Community sites, are shown in **Figure 5-1**. These data are from the time period of the MATES IV study in 2012-2013. Concentrations of BC are highest in the summer, with a maximum median concentration occurring at both sites in August. While Figure 5-1 represents only one year of data, this seasonal trend is consistent across all seven years of monitoring data with one exception: the very high variability in February concentrations is a one-year issue that was not seen in the other seven years of monitoring data. Concentrations of BC are highest in the early morning hours (Figure 5-1, bottom). The big diurnal differential dip in the early morning hours at 6:00 a.m. LST is consistent across years. This indicates a clear pattern of higher local concentrations at the berm station in the early morning hours.

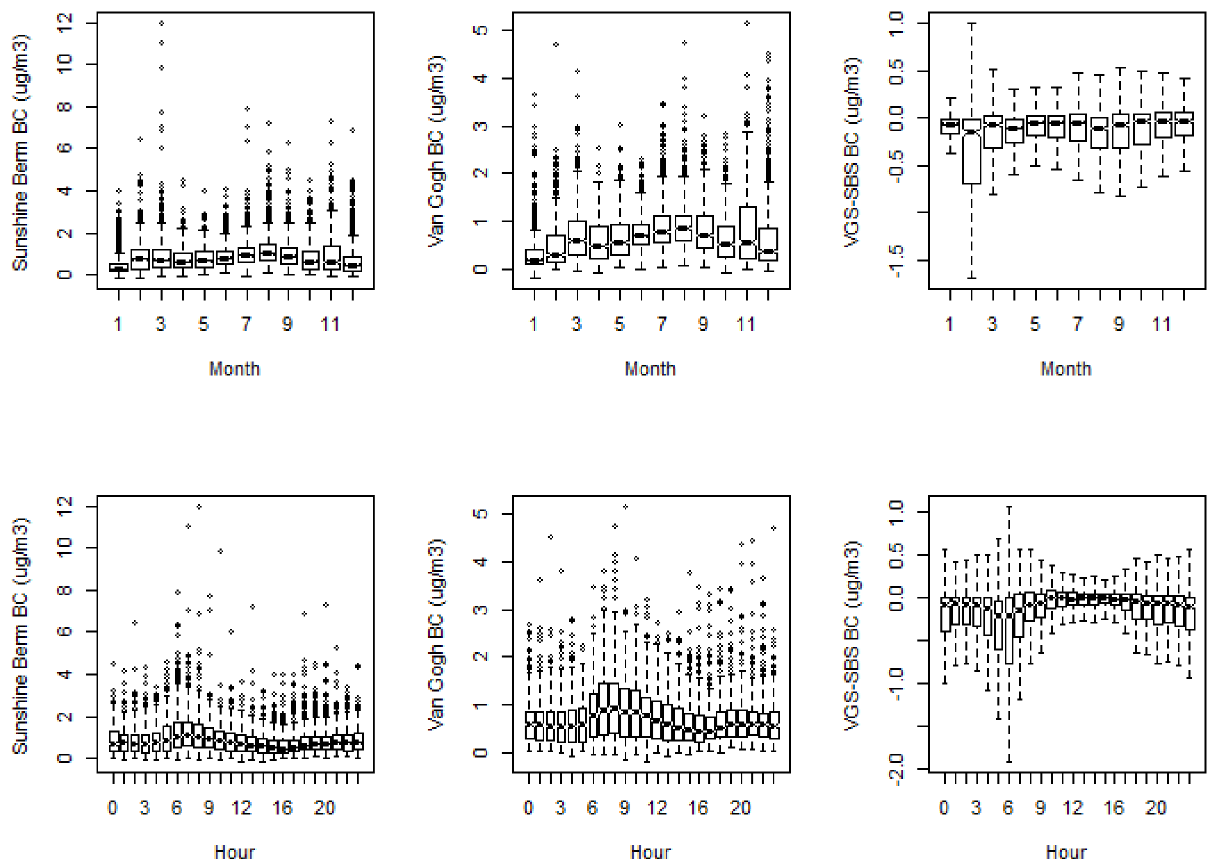


Figure 5-1. Concentrations of black carbon at the two landfill stations by month (top three figures) and time of day (bottom three figures) for the time period of the MATES IV study. Differentials are shown on the far right; concentrations below zero indicate that the Sunshine Berm station had higher concentrations than did the Van Gogh station.

To place the data in a regional context, Landfill and Community black carbon concentrations during the MATES IV period (covering July 2012 to June 2013) are shown in comparison to MATES IV black carbon measurements that were made at Burbank, Los Angeles, Pico Rivera, and Huntington Park. **Figure 5-2** shows a comparison of concentrations for the days and hours when each of the sites had valid BC data available during this time period. Concentrations at the Sunshine Berm site (SBS) and Van Gogh site (VGS) are shown in blue, while other nearby Los Angeles sites are shown in gray. Median concentrations at the Landfill and Community sites are significantly lower than those measured at the other four sites during the same time period. Moreover, 75th percentile (top of the box) and upper percentile concentrations (indicated by error bars) are also significantly lower at the Landfill and Community sites than at other sites in the Los Angeles Basin. Diurnal differences in concentrations are greatest during early morning rush hours, and concentrations across the basin are most similar during afternoon and early evening hours.

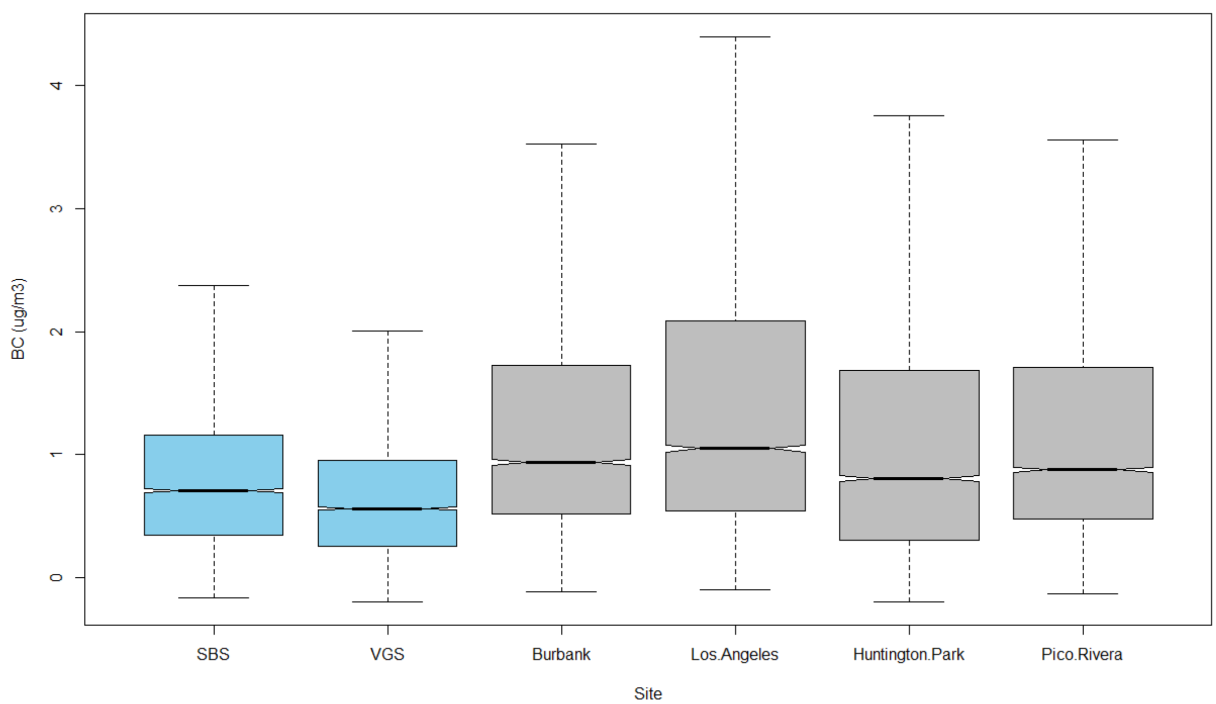


Figure 5-2. A comparison of regional BC concentrations from July 2012 through June 2013 at landfill sites (blue) and MATES IV monitoring stations (gray). Note that in MATES IV documentation, Los Angeles is referred to as "Central LA."

6. PM_{10} and BC: Effects of Wind Direction and Work Activity Levels

Wind direction and landfill work activity levels affect PM_{10} and BC concentrations measured at the Landfill and Community monitoring sites. As demonstrated in Section 4, winds coming from the south, for example, transport pollutants from densely populated areas of the SoCAB and have a major effect on local pollutant concentrations. Similarly, observations of landfill contributions to neighborhood-scale PM_{10} and BC concentrations are expected under northerly wind flow or under calm conditions, such as early morning, when downslope flows or airflow through canyons and around elevated landforms can have an effect. PM_{10} and BC concentrations would also be expected to vary diurnally, and from day to day, as source strengths increase and decrease with changing activity levels. These activity levels vary with different times of day (e.g., daytime versus nighttime) or between working days and holidays, both regionally and at the local (landfill operations) scale.

The seven-year data archive is used here to compare, with long-term averaging, the concentrations of PM_{10} and BC that characterize the Landfill and Community monitoring sites under northerly and southerly wind flows and under differing activity levels. Activity levels are binned according to landfill working and non-working days and working and non-working hours. The seven-year averaged results presented in this report concerning the effect of work activity levels on concentrations of PM_{10} and BC are, overall, consistent with those presented in STI's third, fourth, fifth, and sixth annual reports.

6.1 General Wind Roses for the Sunshine Sites

Figures 6-1 and **6-2** show two-year groups of annual wind roses at the Landfill site and Community site from 2007 through 2014. Winds at the Landfill site are strongest when they are from the north and north-northwest; conversely, southerly winds are lighter. Community site winds are also strongest from the north-northwest; winds from all other directions are generally lighter. Wind directions at the Community site are more variable than at the Landfill site. The landfill site is located on the top of a ridge with no visible obstructions. The Community site is in a hollow, and nearby trees have grown over the years and contribute to disruption of wind flow.

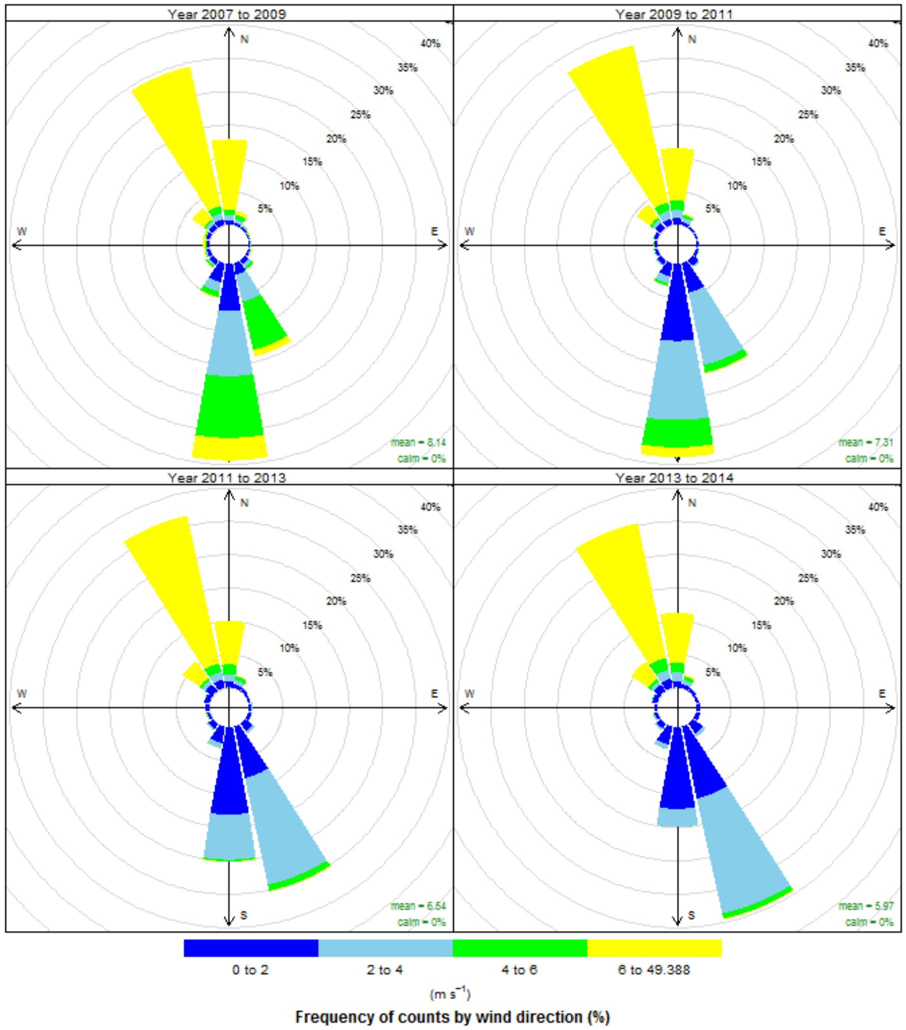


Figure 6-1. Sunshine Berm station wind roses over the seven years of monitoring data. Winds are highly directional at the Sunshine Berm site.

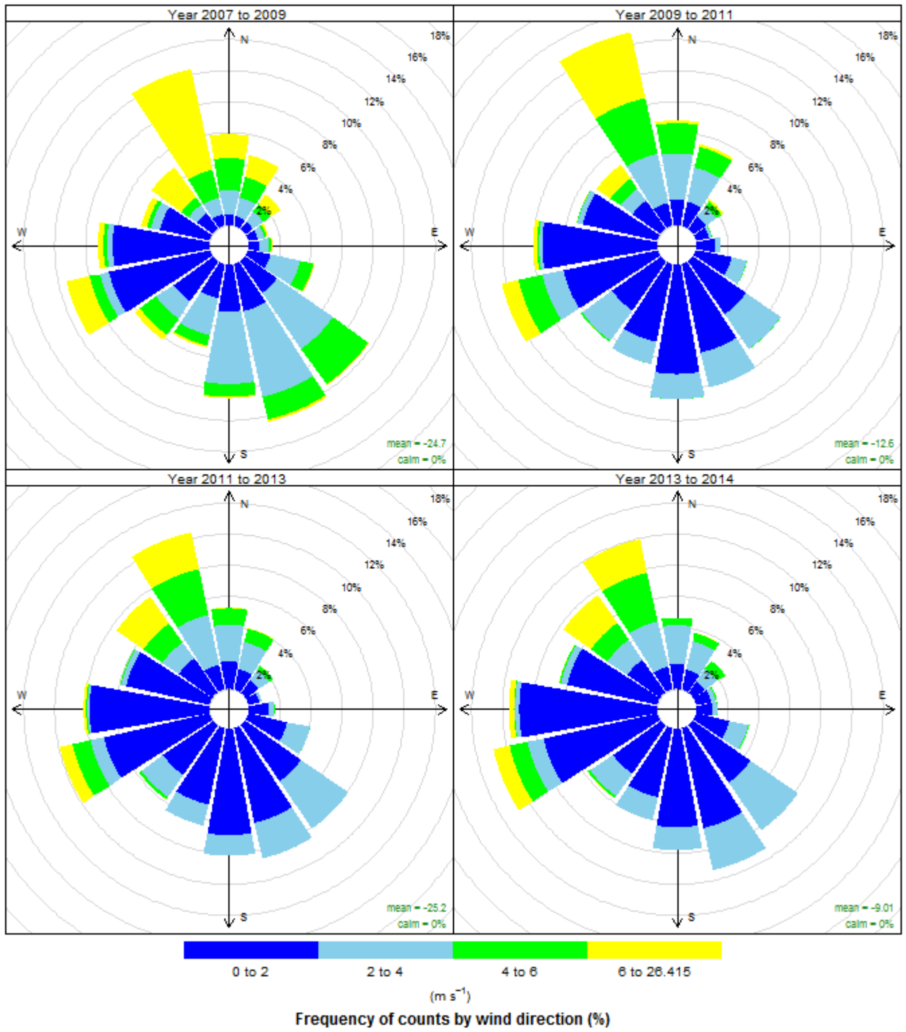


Figure 6-2. Community site wind roses over the seven years of monitoring data. Winds are more variable at the Community site than at the Landfill site.

Figure 6-3 shows a pollution rose and a pollution differential rose for the Community site. A pollution rose is akin to a histogram of concentrations associated with the direction from which the winds originated.

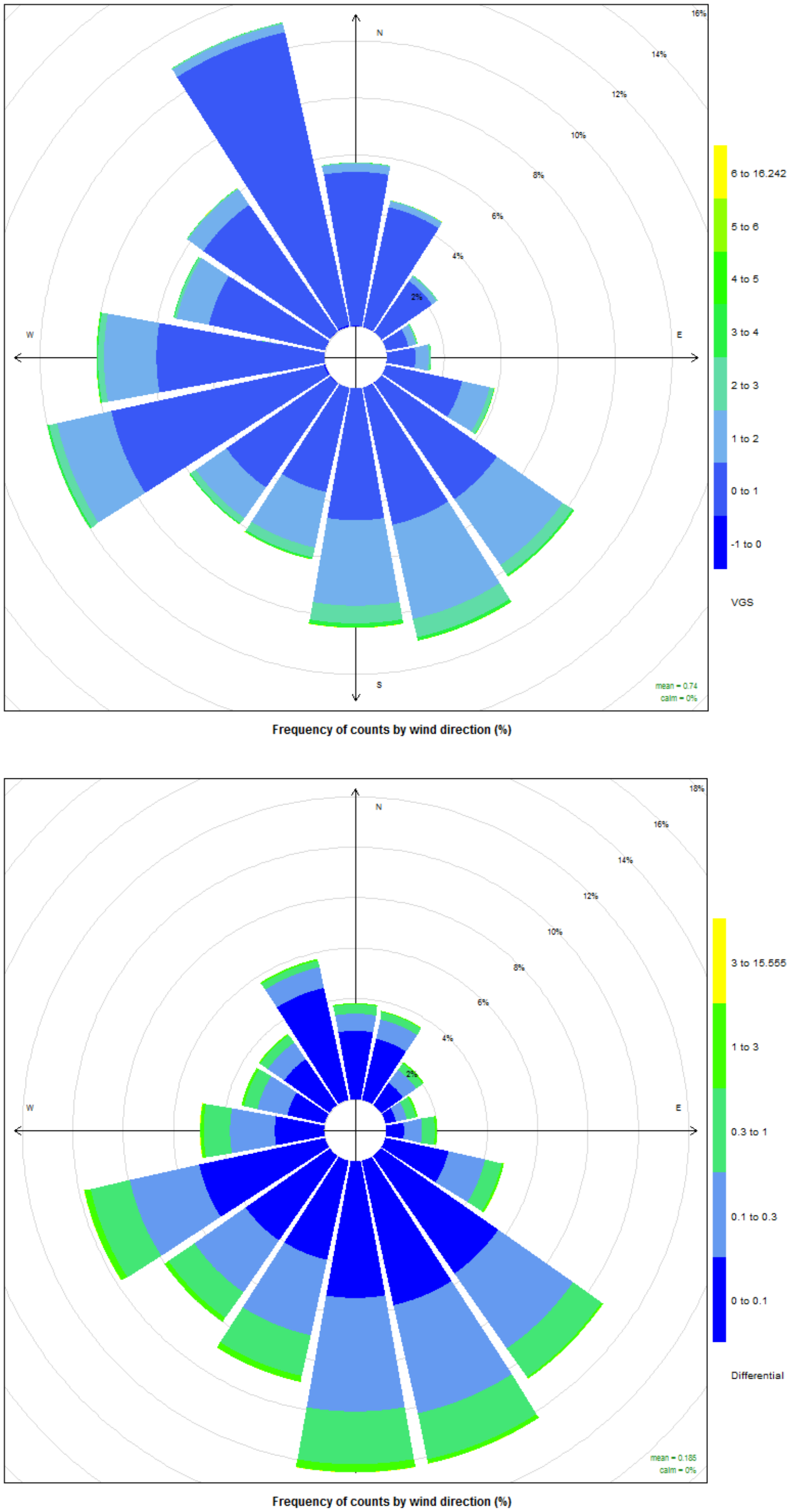


Figure 6-3. Black carbon pollution roses for the Community site showing (top) the directions associated with highest BC concentrations and (bottom) the directions associated with BC concentrations that are higher than those at the Landfill site.

The wind data above show that the winds at the Landfill site are highly directional, and winds at the Community sites are more variable. The highest BC concentrations at the Community site are associated with winds from the south, rather than winds from the direction of the Landfill site.

6.2 Wind Direction Sectors for Categorizing Data

In light of the information about highly directional winds, data for this analysis were selected by using one wind sector to represent the landfill source and areas to the north and another wind sector to represent the area from which pollutants travel from the SoCAB. **Figure 6-4** is an aerial image of the area showing the wind sectors representing the landfill source in black for the Landfill monitor and in green for the Community monitor. Hourly pollution data corresponding to hourly wind direction data that fall within the boundaries of these sectors are used to compute the pollution metrics for working and non-working days (or hours). Note that the Landfill monitor's wind sector (greater than or equal to 303 degrees and less than or equal to 360 degrees from true north) is broader than the Community monitor's (greater than or equal to 325 degrees and less than or equal to 355 degrees from true north). The analysis is based only on direction, not on matching times between records. The underlying premise is that long-term averages calculated in this manner more accurately represent true average landfill-derived contributions than do those calculated from matched hourly records, because of the frequent poor wind direction correlation between the two sites. The wind direction correlation between sites is poor because of problems with the siting of the meteorological tower at the Van Gogh School, elevation differences between the sites, and the geographic distance of about one mile. At Van Gogh School, nearby obstructions (e.g., tall trees) deflect the wind, causing localized turbulence and eddies that preclude accurate wind measurements. As a rule of thumb, wind measurements should be made at a minimum horizontal distance of three times the height of any obstruction. There are no obstructions at the Landfill monitoring site. The Landfill site is at 1,722 feet above sea level (ASL), 440 feet higher than the Community site (1,282 feet ASL). Thus, some hourly records included in an individual monitor's averages do not appear in the other monitor's averages. For average concentrations calculated from the wind sector targeting the SoCAB, both monitors are in the same sector (greater than or equal to 150 degrees and less than or equal to 210 degrees from true north; see **Figure 6-5**).

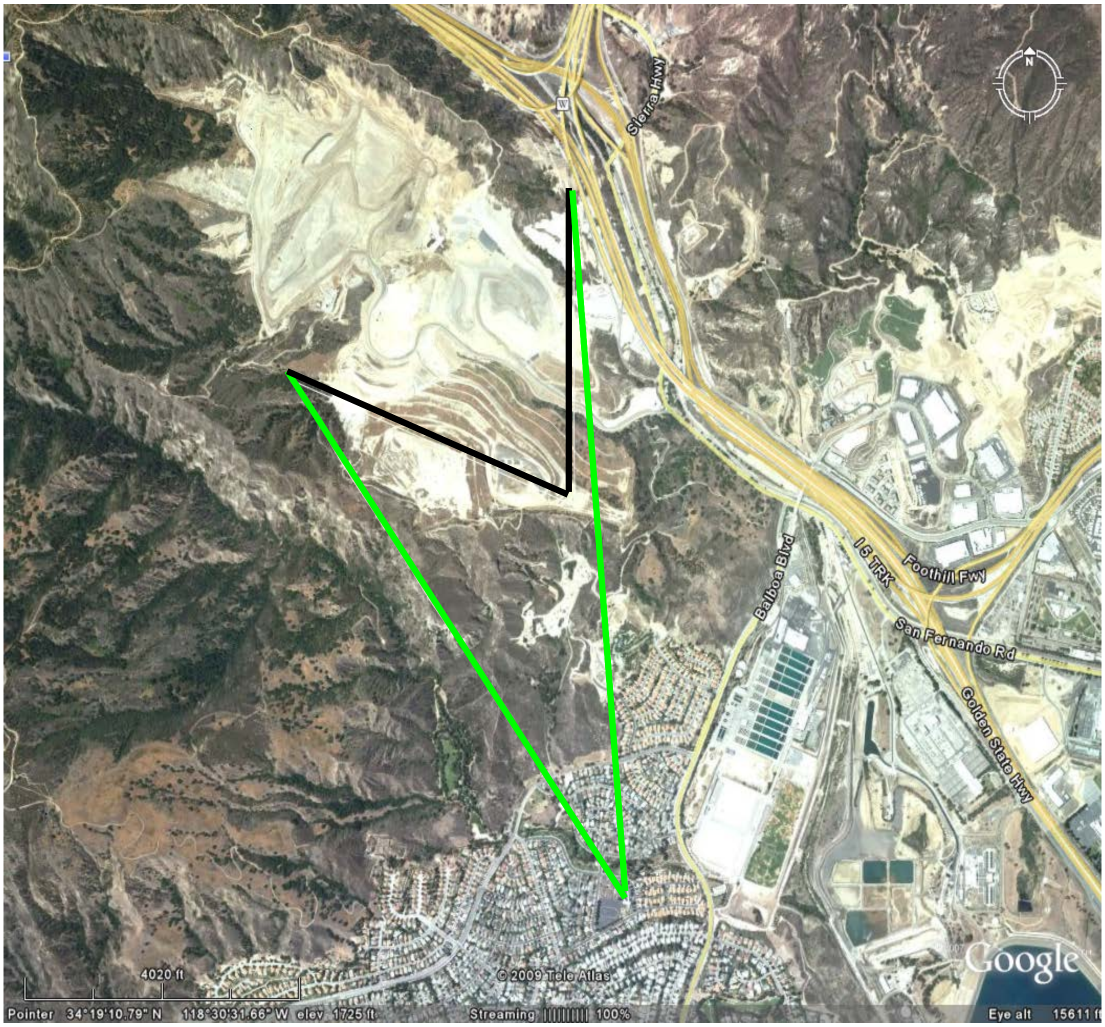


Figure 6-4. Aerial image of the Sunshine Canyon Landfill and the surrounding area, showing the wind direction sectors representing the landfill source used for selecting data for analysis from the Landfill monitor (in black) and the Community monitor (in green).

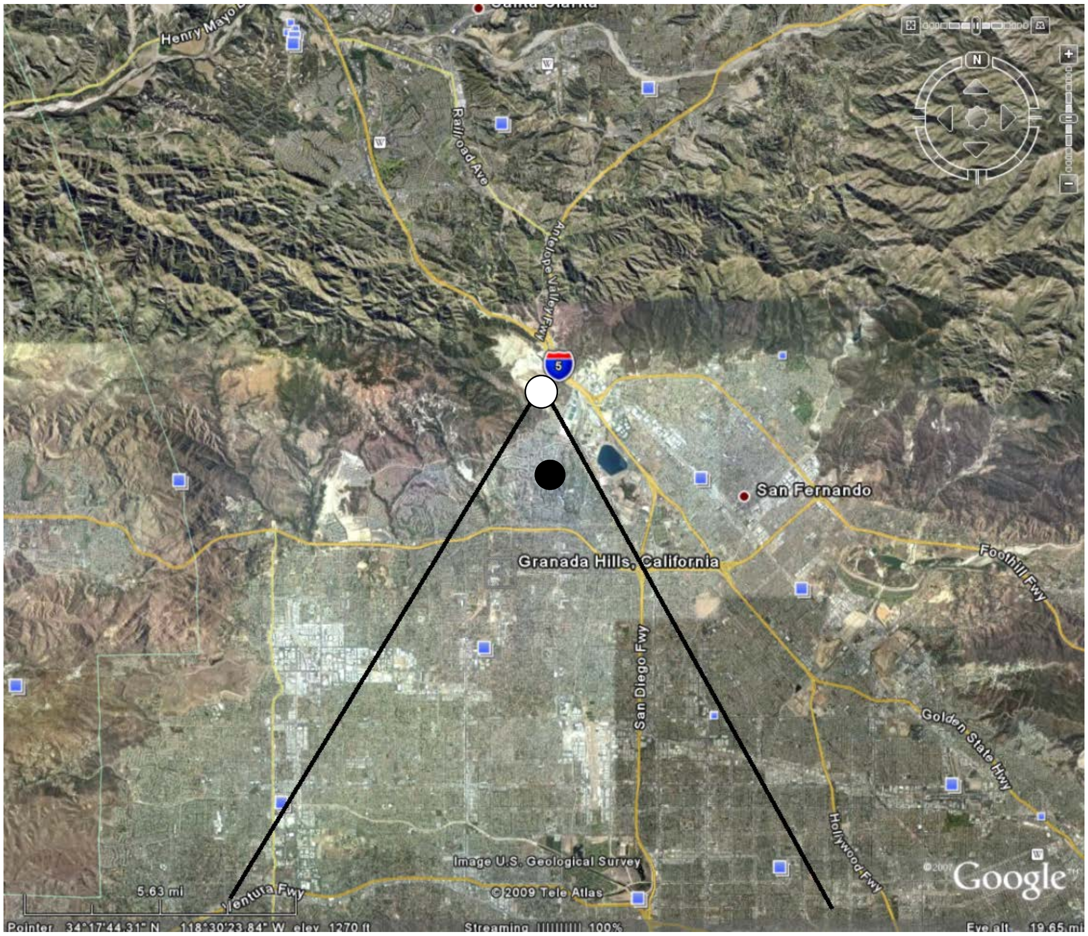


Figure 6-5. Aerial image of the Sunshine Canyon Landfill and the northern portion of the SoCAB, showing the wind direction sector representing the SoCAB source used for selecting data for analysis to compare with the landfill wind direction sectors depicted in Figure 6-4. The white dot represents the Landfill monitor, and the black dot represents the Community monitor.

6.3 Working and Non-Working Days and Hours for Categorizing Data

After the hourly data have been initially binned by the wind direction sectors described above, hourly PM_{10} and BC concentrations are categorized into the landfill's working and non-working days, and working and non-working hours within those days (based on landfill operations). Working days at the landfill are defined as Monday through Friday, excluding federal holidays. Non-working days are considered Sundays and federal holidays, including New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day; operations occurring on those days would confound the averages to an unknown degree. Additional non-Sunday holidays during which the landfill is closed, but operating, would similarly be incorrectly binned and thus slightly skew the resulting estimated concentration for that category. Saturdays are categorized "mixed use" at the landfill; thus, they do not fit easily into either category. The non-Sunday holidays and Saturdays are excluded from the analysis.

6.4 PM_{10} Concentrations

Figure 6-6 summarizes the seven-year hourly average PM_{10} concentrations for the northerly and southerly wind sectors for working and non-working days and for working and non-working hours within those days in a notched box-whisker plot.[7] The following general conclusions are based on the median values presented in Figure 6-6. Note that these conclusions are nearly identical to those reached in the Sixth Annual Report (delivered in 2013), as are the proportions cited in the following bullets:

- During the highest activity levels (working hours on working days, panel (a)):
  - When the wind is from the SoCAB, the Landfill and Community monitors measure about the same median concentrations of PM_{10}.
  - When the wind is from the SoCAB, the median concentration of PM_{10} at the Community site is about three times as high as when the wind is from the landfill.
  - When wind is from the landfill, median PM_{10} concentrations at the Community site are less than one-half of those measured at the landfill itself, suggesting that although the landfill-derived PM_{10} concentrations are significant, they remain mostly localized to the landfill.
- During non-working hours on working days (panel (b)):
  - When the wind is from the SoCAB, the Community monitor measures higher PM_{10} concentrations than when wind is from the landfill. When the wind is from the landfill, PM_{10} concentrations are lower at both monitoring sites than when the wind is from the SoCAB, and the Community monitor is characterized by lower concentrations than the Landfill monitor, illustrating a localized landfill contribution during times of low activity (nighttime).
- During the lowest activity levels (non-working days, panels (c) and (d)):
  - Median ambient concentrations of PM_{10} are lower on non-working days, but the extent of the decrease is influenced by wind direction. At the Landfill site, median ambient PM_{10} concentrations in daytime (working hours) showed a greater proportional decrease on non-working days when wind direction was from the landfill (approximately 70% lower) than on non-working days when wind came from the SoCAB (approximately 16% lower), reflecting the larger regional PM_{10} influence of the SoCAB on non-working days.

[7] A notched box-whisker plot shows the entire distribution of concentrations for each year. In box-whisker plots, each box shows the 25th, 50th (median), and 75th percentiles. The boxes are notched (narrowed) at the median and return to full width at the 95% lower and upper confidence interval values. These plots indicate that we are 95% confident that the median falls within the notch. If the 95% confidence interval is beyond the 25th or 75th percentile, then the notches extend beyond the box (hence a “folded” appearance).

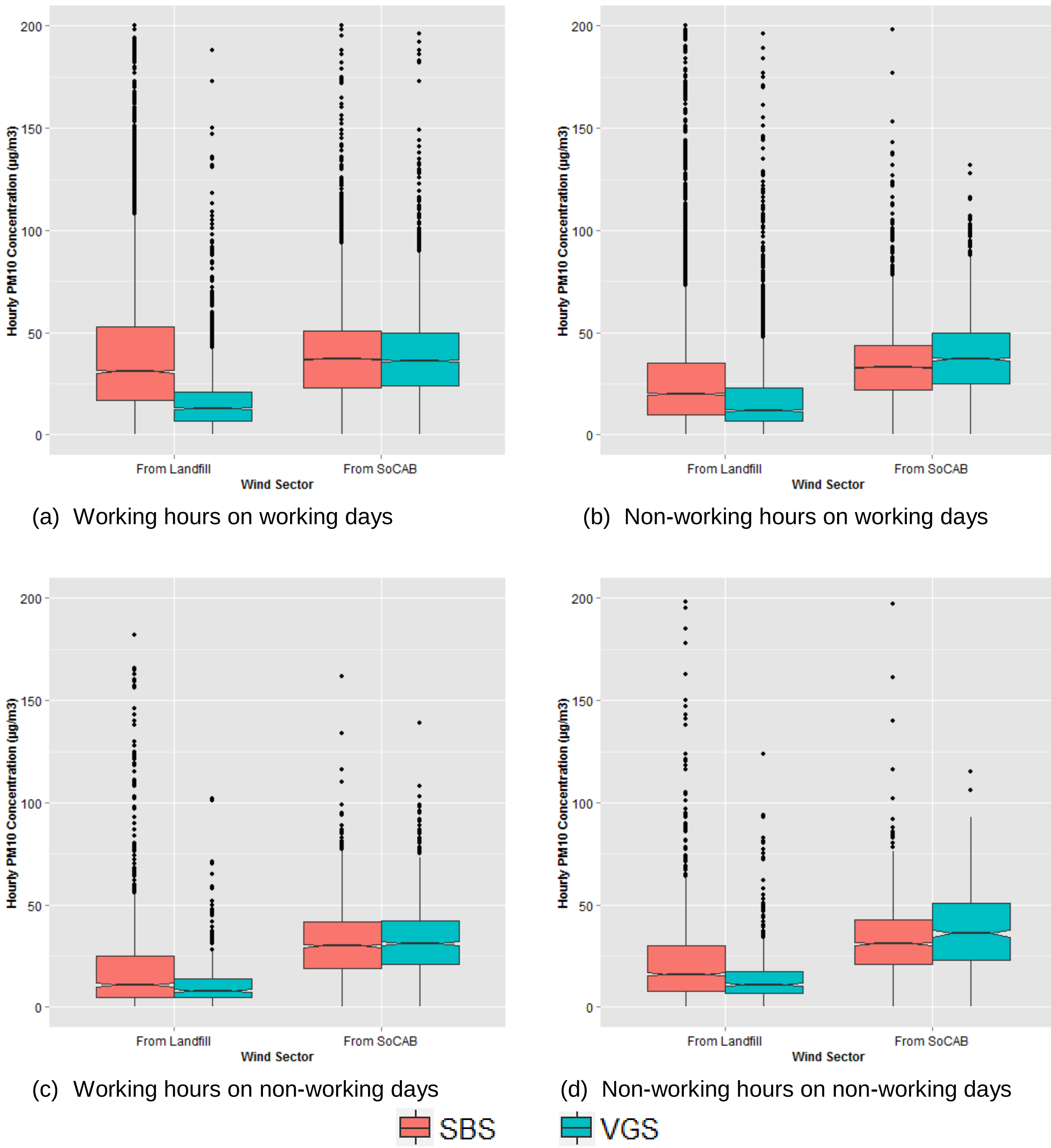


Figure 6-6. Notched box plot of seven-year hourly average PM_{10} concentrations for northerly ("From Landfill") and southerly ("From SoCAB") wind sectors for working and non-working days and for working and non-working hours within those days for the Landfill (Sunshine Berm Site [SBS], pink box) and Community (Van Gogh School [VGS], turquoise box) monitor sites. Outliers over 200 μg/m^3 are not displayed.

6.5 BC Concentrations

Figure 6-7 summarizes the seven-year hourly average BC concentrations for the northerly and southerly wind sectors during working and non-working days and during working and non-working hours within those days in a notched box-whisker plot.

The following general conclusions are based on the median values presented in Figure 6-7. These conclusions are similar to those reached in the Sixth Annual Report, as are the proportions cited in the following bullets:

- During the highest activity levels (working hours on working days, panel (a)):
  - When the wind is from the SoCAB, the Landfill and Community monitors measure similar median BC concentrations.
  - When the wind is from the SoCAB, the Community monitor measures roughly five times the median concentration of BC as when the wind is from the landfill.
  - When wind is from the landfill, the Community BC levels are about one-half of the BC levels measured at the landfill itself.
- During the lowest activity levels (non-working days, panels (c) and (d)):
  - Median ambient concentrations of BC are lower on non-working days in all categories, but the extent of the decrease is influenced by wind direction. The proportional decrease in concentrations on non-working days was larger for BC than for PM_{10}. Compared to working days, BC concentrations on non-working days decreased by a factor of 2 (Community site) to 4 (Landfill site) when winds were from the landfill, and were about the same when winds were from the SoCAB. On working days, diesel-powered vehicles (trucks and earth moving equipment) operating at the landfill increase the ambient concentrations of DPM, as determined by the BC measurements. However, the large metropolitan area of the SoCAB remains the dominant source of DPM.

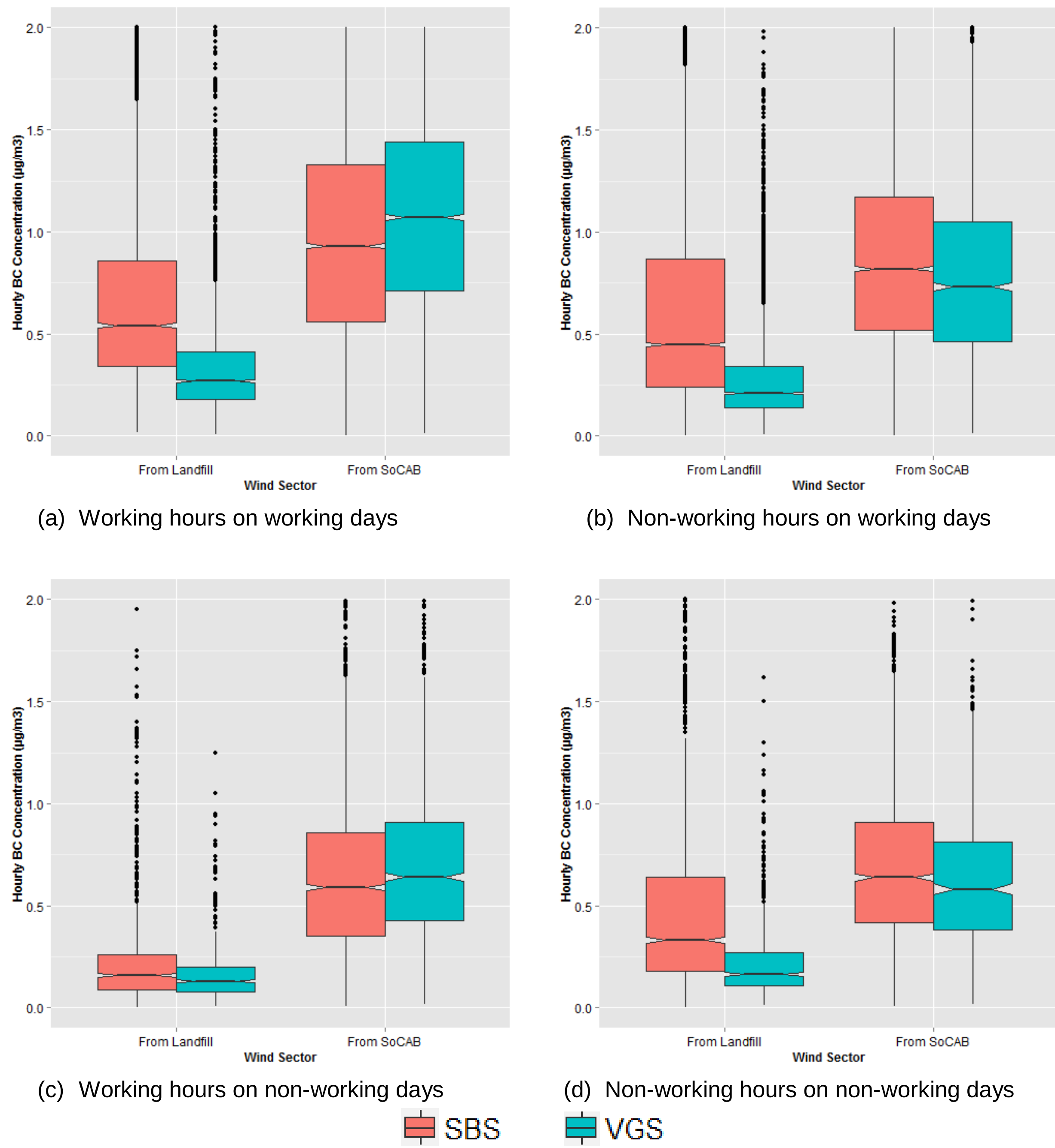


Figure 6-7. Notched box plot of seven-year hourly average BC concentrations for northerly and southerly wind sectors for working and non-working days and for working and non-working hours within those days for the Landfill (SBS, pink box) and Community (VGS, turquoise box) monitor sites. Outliers over 2 µg/m^3 are not displayed.

7. Quantitative Estimates of Landfill Impacts on Ambient Concentrations of PM_{10} and BC

Quantitatively estimating the impact of landfill operations on neighborhood-scale ambient air quality is required by the original Conditions of Approval (C.10.a) and the nearly identical County Condition 81. Specifically, the Conditions require determination of “whether air quality near the Landfill is consistent with the supporting environmental documentation for the City Project (i.e., the City’s Final Supplemental Environmental Impact Report or ‘FSEIR’).” The FSEIR reported the emissions estimates of pollutants likely to result from landfill operations, modeled by the Industrial Source Complex Short Term (ISCST3) regulatory model. Beginning with baseline year data (November 22, 2001–November 21, 2002) and continuing through 2008, no attempt was made to specifically address this requirement, probably because there is no way to *directly* calculate an appropriate metric. The primary reason is that no pollutant monitoring data are gathered immediately upwind of the landfill to enable accurate estimates of the regional concentrations north of the landfill (and thus unaffected by landfill contributions). While the SCAQMD operates a BAM-1020 monitor at the Santa Clarita station, it is configured for $PM_{2.5}$ sampling. These $PM_{2.5}$ data are not directly comparable to the PM_{10} data provided by the BAM-1020 instruments currently deployed at the Landfill and Community monitoring sites. The Santa Clarita station does employ FRM measurements of PM_{10} (integrated 24-hr samples on filters) on a one-in-six day schedule. While 24-hr averaged data from the Landfill PM_{10} monitor could be compared with the 24-integrated data from the FRM samples every sixth day, the low frequency sampling supports only minimal statistical power for calculating upwind (background) PM_{10} concentrations. Additionally, the location of the Santa Clarita station relative to the landfill and nearby freeways further minimizes the potential for direct application of that data for calculating landfill contributions of PM_{10}, and wind direction often changes during the 24-hour period, meaning the 24-hour averages from Santa Clarita likely confuse any apportionment by wind direction.

Beginning with STI’s Second Annual Report[8] in 2009, a data analysis method for approximating landfill contributions to neighborhood-scale PM_{10} and BC concentrations, intended to address City Ordinance C.10.a (and subsequently, County Condition 81), was developed. The method was used to assess regional concentrations and provide estimates of landfill contributions above the regional contributions. It uses long-term averaging to maximize the sample size (hourly values) to be sufficiently representative. In the 2009 Second Annual Report, rolling averages were used to maximize the sample size. Since the Third Annual Report, rolling averages have not been used because full years of continuous data are available for calculating the yearly averages used in the analysis. The results of the analysis have an undefined level of uncertainty because, in lieu of directly measured concentrations upwind of the landfill, regional pollutant concentrations are estimated from a southerly wind direction sector, isolating the SoCAB, to provide an estimate of regional pollutant levels during working days and non-working days.

[8] Vaughn D.L. and Roberts P.T. (2009) Second annual report of ambient air quality monitoring at Sunshine Canyon Landfill and Van Gogh Elementary School. Prepared for the Planning Department, City of Los Angeles, CA, by Sonoma Technology, Inc., Petaluma, CA, STI-907032-3671-AR, August.

The method involves using the same specific wind direction sectors and activity level bins for selecting the BC and PM_{10} data as described above for the annual average regional comparisons. Although presented in previous reports, the method is described again here for completeness.

7.1 Justification of the Method

As illustrated in Section 5, when the wind is from the south, bringing pollutants northward from the SoCAB, the long-term average pollutant concentrations measured at the Community and Landfill monitoring sites are similar. When the wind is from the north, bringing pollutants southward, the pollutant concentrations measured at the two monitoring sites are much less similar. This observation provides the framework to

- Calculate regional pollutant concentrations not affected by contributions from the landfill.
- Calculate differences in regional pollutant concentrations between regular working days and non-working days. The data from non-working days provide estimates of baseline or background pollutant levels, and the data from working days provide estimates of any additional regional contribution associated with regular work days.
- Estimate regional contributions and use this estimate to assess landfill contributions to neighborhood-scale pollutant concentrations when winds are from the north (i.e., when landfill impacts, if any, would be measurable at both monitoring sites). In the absence of a monitor north of the landfill, the application of this estimate results in an undefined degree of uncertainty, since it is unknown how well this estimate of regional concentrations truly reflects the impact of concentrations from areas north of the landfill.

7.2 Specific Steps of the Method

Implementation of this analytical approach involves the following basic steps, using only validated and quality-assured data:

- From the two monitoring sites, select the hourly pollutant concentration data for the analysis based on wind direction sectors, as described in Section 6.2.
- Categorize the data from the two sites into landfill-operating days (referred to as “working days”) and non-operating days (referred to as “non-working” days), as described in Section 6.3.
- Categorize the data from the two sites into working hours (chosen to reflect the main operating hours of the landfill) and non-working hours (non-operating periods), as described in Section 6.3.
- Calculate average pollutant concentrations for each data category.
- Using only the average concentrations derived from data attributed to the SoCAB, calculate the difference in regional concentrations between working days and non-working days.

- Compare the average concentrations measured on working days when the wind direction is from the landfill with the regional estimates and calculate an estimate of landfill contributions. Under these sampling conditions, the working day concentrations are assumed to have three components:
  1. A regional contribution, estimated using data from non-working days when winds are from the landfill
  2. An additional regional contribution, estimated by multiplying the estimate in (1) by the proportional increase in concentrations observed during times of southerly winds on working days compared to non-working days
  3. Average concentrations, measured when winds blow from the landfill on working days, in excess of the sum of (1) and (2), which are attributed to the landfill. If average concentrations measured when winds are from the landfill increase proportionally with the regional increases associated with working days, no contribution from the landfill would result from this calculation.

The hours within each of these working and non-working day categories are additionally binned into working hours (defined as beginning at 0600 PST and ending at 1700 PST) and non-working hours. While the level of activity may vary within each timeframe, reliance on long-term averaging of pollutant concentrations will help to integrate the effect of these varying activity levels.

7.3 Estimates of Landfill Contributions of BC and PM_{10}

The results of the analyses are presented in two figures and two tables: Figure 7-1 and Table 7-1 for PM_{10} and Figure 7-2 and Table 7-2 for BC. The bar charts shown for each parameter depict the measured average concentration at both monitoring sites for working days during daytime hours, apportioned among three components: a component attributable to a background regional concentration estimated from non-working days, an additional regional component attributable to working days, and a component estimated as the landfill contribution on working days. The tables show the percent contribution by the landfill to the Landfill and Community sites, for each pollutant, by year.

7.3.1 PM_{10} Impacts

Figure 7-1 shows the estimated apportionment of average PM_{10} concentrations to regional, non-working day levels; additional regional inputs on working days; and landfill contributions associated with working days (calculated by difference). **Table 7-1** shows the contribution of PM_{10} by the landfill at the Community and Landfill sites, by year.

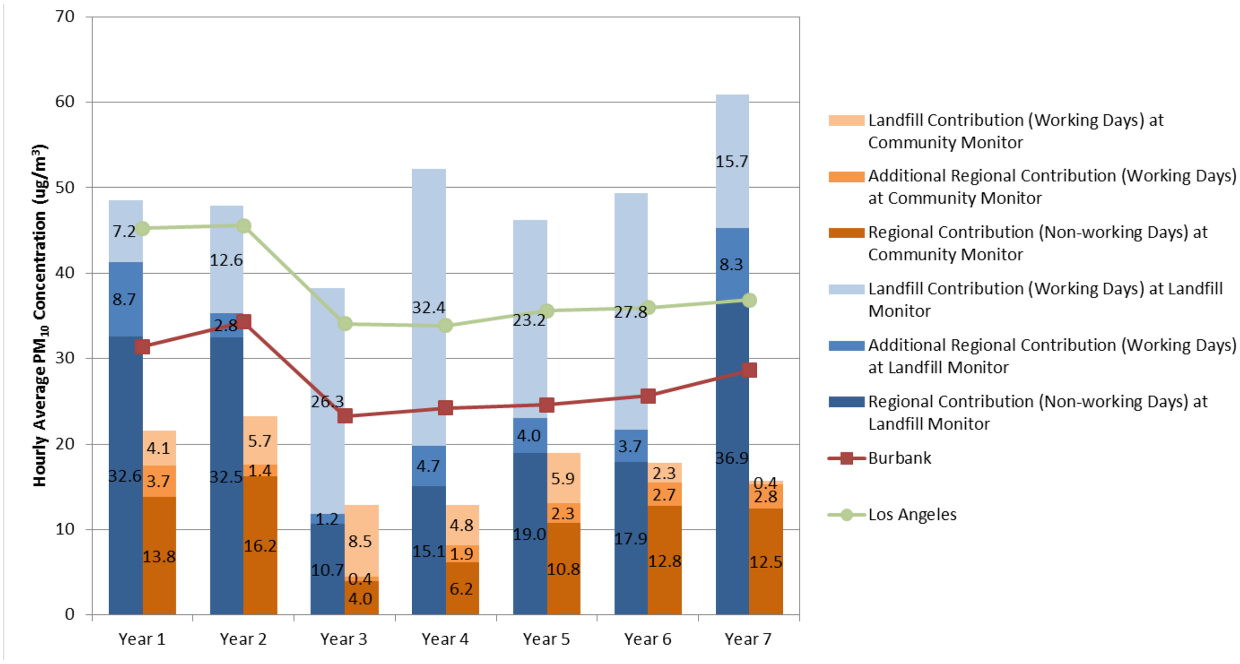


Figure 7-1. Summary of seven consecutive years of quantitative estimates of the average regional contribution to ambient PM_{10} levels on non-working days (dark blue/orange bars), the additional regional contribution associated with increased activity levels on working days (medium blue/orange bars), and the average hourly landfill contribution on working days (light blue/orange bars) for the Landfill (blue bars) and Community (orange bars) monitor sites. Line graphs show annual averages for Los Angeles and Burbank (January through December).[9]

Table 7-1. Contribution of hourly average PM_{10} by the landfill at the Landfill and Community sites.

Year	Landfill Site		Community Site	
	Amount ($\mu g/m^{-3}$)	% of Total	Amount ($\mu g/m^{-3}$)	% of Total
Year 1 11/22/07–11/21/08	7.2	15%	4.1	19%
Year 2 11/22/08–11/21/09	12.6	26%	5.7	24%
Year 3 11/22/09–11/21/10	26.3	69%	8.5	66%
Year 4 11/22/10–11/21/11	32.4	62%	4.8	37%
Year 5 11/22/11–11/21/12	23.2	50%	5.9	31%
Year 6 11/22/12–11/21/13	27.8	56%	2.3	13%
Year 7 11/22/13–11/21/14	15.7	26%	0.4	2%

[9] For Burbank in year 7 (2014), the average only covers January through June due to data availability.

The following comments are offered about the estimates of regional and landfill contributions of PM_{10} shown in Figure 7-1:

- As measured at the Landfill monitor only, the landfill's contribution (light blue bars) to hourly average PM_{10} concentrations increased until Year 4. It decreased in in Year 5 but increased again in Year 6. Though the landfill's contribution decreased in Year 5, it still accounted for the majority of the PM_{10} recorded by the monitor there, similar to other years since Year 3. In Year 7, the landfill's contribution decreased again by nearly a factor of 2, to a level similar to Year 2.
- This trend is not seen in the Community monitor's data. Estimates of landfill contributions to community levels of PM_{10} remain comparatively low, with no trend.
- Ambient PM_{10} concentrations at the Landfill and Community monitoring sites have tracked regional concentrations fairly well, except for in Year 4 at the Landfill monitor, where increased landfill contributions contributed to higher average levels, while the Community and regional sites remained about the same as Year 3. (Note: the annual averages shown by the line graphs are meant to illustrate the degree of agreement in regional trends of annual average PM_{10} concentrations between the SCAQMD sites and the two local monitoring sites. They are January-through-December averages, and thus not directly comparable to the November-to-November averages shown for the Landfill and Community monitoring sites.)
- In any given year, the "background" PM_{10} concentration, estimated from non-working days when wind direction is from the landfill (dark blue bars), is about twice that observed at the Community monitor (dark orange bars). This non-working day background value is a direct measurement, bound by the "from landfill" wind direction sector on Sundays and holidays. The confidence level in this measurement is high. This finding suggests that, even on non-working days, the landfill is contributing PM_{10} that is measured by the Landfill monitor but not detected by the Community monitor. Note, however, that the background concentration attributed to non-working days, as measured by the Community monitor, has increased since Year 3 (until Year 7, when it decreased slightly).
- The contribution of the landfill to average PM_{10} concentrations at the Community site decreased by about 61% between Year 5 and Year 6. The landfill contribution decreased dramatically again between Year 6 and 7 (~83%).
- The additional regional contribution of PM_{10} associated with working days at the Landfill site (medium blue bars) decreased by 8% between Year 5 and Year 6, while that at the Community site (medium orange bars) increased by 17%. Except for Year 7, the additional regional contribution associated with working days remained the smallest contributor compared to the background regional contribution (from non-working days) and the landfill contribution on working days.
- The trend of increases in PM_{10} attributed to the landfill from Year 1 through Year 4 at the Landfill site may be associated with increased activity at the landfill. The trend stopped in Year 5, when PM_{10} attribution to the landfill decreased by 28%, but increased again in Year 6, by 20%.

- PM_{10} measured at the landfill location in Year 7 exhibited a higher hourly average than any other year to date. This was driven largely by a twofold increase in the background regional contribution measured on non-working days. In contrast, the landfill contribution decreased by almost one-half from Year 6 to Year 7. The substantial increases in PM_{10} attributed to the landfill from Year 1 through Year 4 are not duplicated at the Community monitor; this suggests that the landfill is a local source that minimally impacts neighborhood- or regional-scale measurements. A 23% increase in PM_{10} attribution to the landfill at the Community site between Year 4 and Year 5 could be due to a change in meteorology (strong northerly winds on non-working days) or changes at the landfill facility.
- The estimated landfill contribution to PM_{10} concentrations measured at the Community monitor in Year 7 was the lowest of all measured years, at 0.4 μg/m^3.

7.3.2 Black Carbon Impacts

Figure 7-2 shows the estimated apportionment of average BC concentrations to regional non-working day levels, additional regional inputs on working days, and landfill contributions associated with working days (calculated by difference) for each of the seven monitoring years. Note that the data values shown in Figure 7-2 are different from those in the Sixth Annual Report as the compensated BC values are used (see Section 1.2). However, the general patterns and trends are consistent. **Table 7-2** shows the contribution of BC by the Landfill at the Community and Landfill sites, by year.

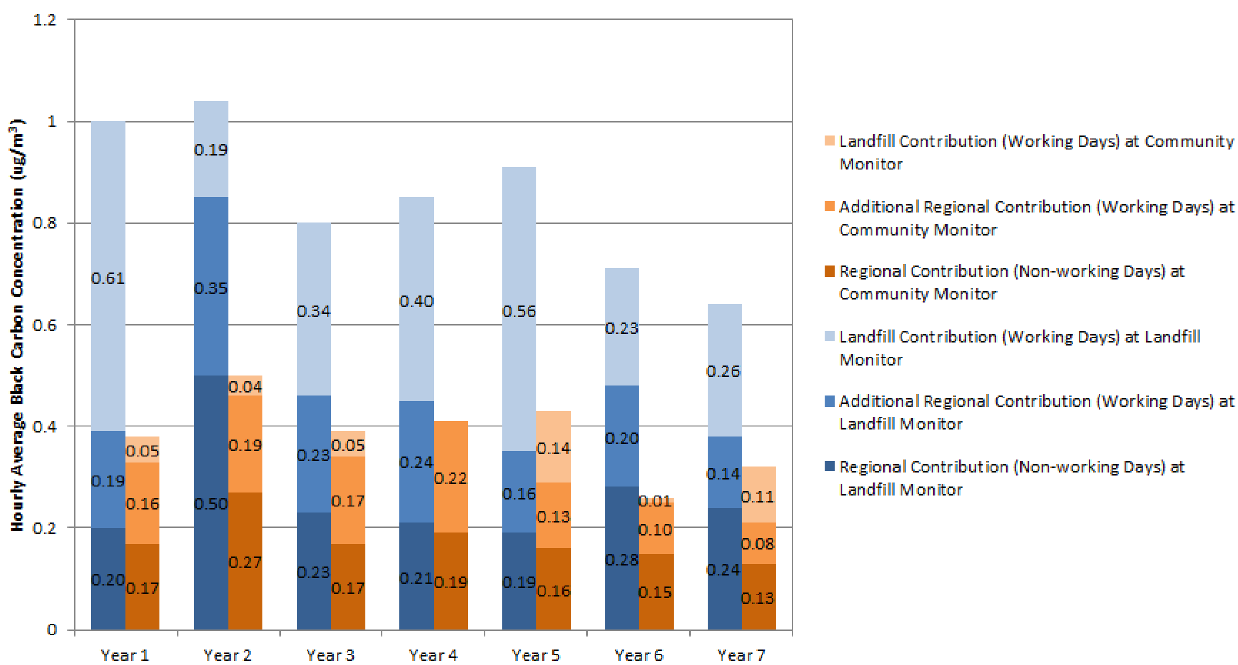


Figure 7-2. Summary of seven consecutive years of quantitative estimates of the average regional contribution to ambient BC levels on non-working days (dark blue/orange bars), the additional regional contribution associated with increased activity levels on working days (medium blue/orange bars), and the average hourly landfill contribution on working days (light blue/orange bars).

Table 7-2. Contribution of hourly average BC by the landfill at the Landfill and Community sites.

Year	Landfill Site		Community Site	
	Amount ($\mu g/m^{-3}$)	% of Total	Amount ($\mu g/m^{-3}$)	% of Total
Year 1 11/22/07–11/21/08	0.61	61%	0.05	13%
Year 2 11/22/08–11/21/09	0.19	19%	0.04	9%
Year 3 11/22/09–11/21/10	0.34	43%	0.05	14%
Year 4 11/22/10–11/21/11	0.40	47%	-0.03	0%
Year 5 11/22/11–11/21/12	0.56	62%	0.14	32%
Year 6 11/22/12–11/21/13	0.23	33%	0.01	2%
Year 7 11/22/13–11/21/14	0.26	41%	0.11	36%

The following comments are offered about Figure 7-2:

- As shown previously with PM_{10}, annual landfill contributions to ambient BC concentrations (light blue bars) are substantial at the Landfill monitor, but low and stable at the Community monitor (light orange bars). For the first three years, average landfill contributions to BC concentrations in the community were about 0.05 $\mu g/m^3$. In Year 4, these contributions were close to zero (-0.03 $\mu g/m^3$, within the monitor's measurement error), and in Year 6 averaged only 0.01 $\mu g/m^3$. Years 5 and 7 were different. In these years, during working days, average landfill contributions at the Community site were greater than the additional regional contributions.
- As measured at the Landfill BC monitor, the landfill contribution to ambient BC concentrations (light blue bar) declined by 69% from Year 1 to Year 2, but then increased during Year 2 through Year 5. These increases in measured BC concentrations at the landfill are assumed to be associated with a general increase in landfill activities or scope of operations, but no metric of that level of activity is provided. The landfill contribution to ambient BC concentrations dropped significantly from Year 5 to Year 6 at both the Landfill and Community monitors. Because tonnage has not decreased at the landfill, this decrease is probably not due to any decrease in landfill activities (no specific activity data is cited here). A portion of this decrease might reflect ongoing efforts to better control DPM emissions from the truck fleet throughout the SoCAB, as well as landfill-based trucks and equipment.

8. Field Operations

Field operations include regular visits to both monitoring sites. During the first four years of the study, these visits were scheduled at two-week intervals. We have changed this interval to monthly because the experience gained over the recent years has demonstrated that monthly visits suffice to meet the routine maintenance operations associated with the Beta Attenuation Monitor (BAM) and the Aethalometer. This protocol is in keeping with the recommended maintenance schedule recommended by Met One (manufacturer of the BAM) and Magee Scientific (manufacturer of the Aethalometer). This protocol is accompanied by daily review of data that allows problems to be detected quickly. Many times the detected problems can be addressed remotely via cellular connection to the site instruments. Occasionally, non-scheduled onsite visits by an STI technician are required and occur as soon as reasonably possible.

Each quarterly report contains tables with the dates and times of each site visit and a summary of activities that took place. Consult these reports for a summary of field activities that occurred in Years 1 through 6. **Tables 8-1 and 8-2** summarize all visits during Year 7 (December 1, 2013, through November 30, 2014), for the two monitoring sites.

In 2010, STI upgraded the site infrastructure and equipment, using funds provided by Republic Services. Since then, the continuity and reliability of the monitoring sites has improved.

Table 8-1. Sunshine Canyon Landfill monitoring site visits and field maintenance and operations from December 1, 2013, through November 30, 2014.

Date of Site Visit	Description of Work
January 3, 2014	Cleaned BAM inlet. Performed BAM flow/leak check.
January 25, 2014	Replaced BAM vacuum pump, tested new pump. Performed BAM flow/leak check.
February 5, 2014	Performed Aethalometer flow check. Replaced BAM tape, ran BAM self-test. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and cabinet. Performed BAM flow/leak check.
March 10, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data.
March 17, 2014	Restarted Aethalometer; down from 3/16/2014 0630 power outage.
April 3, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM cabinet, roller, vane; and sample inlet assembly. Changed BAM tape.
May 9, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and nozzle.
June 2, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Changed BAM tape; cleaned roller and nozzle. Calibrated wind and temperature sensors.
July 23, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned roller vane and nozzle.
August 7, 2014	Changed BAM tape.

Date of Site Visit	Description of Work
September 2, 2014	Performed flow check on BC and beta attenuation monitor (BAM) samplers. Cleaned BAM roller, vane, and nozzle. Collected PM_{10} data. Card reader failure for BC sampler; replaced failed card with temporary card and took card for data recovery.
September 4, 2014	Replaced temporary card with appropriate card.
September 22, 2014	Replaced AC unit.
September 26, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and nozzle. Changed BAM tape supply.
October 23, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and nozzle.
October 31, 2014	Cleaned BAM inlet. Performed flow check on BAM.
November 25, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and nozzle. Changed BAM tape.

Table 8-2. Van Gogh monitoring site visits and field maintenance and operations from December 1, 2013, through November 30, 2014.

Date of Site Visit	Description of Work
January 2, 2014	Cleaned BAM inlet. Performed BAM flow/leak check.
January 17, 2014	Tested BAM vacuum pump, replaced vacuum pump motor, and tested.
February 5, 2014	Performed Aethalometer flow check. Replaced BAM tape. Collected PM_{10} and BC data. Performed BAM flow/leak check. Cleaned BAM cabinet, roller, and nozzle.
February 7, 2014	Performed Aethalometer flow calibration.
March 10, 2014	Performed flow check on BC sampler. Collected PM_{10} and BC data. Cleaned BAM cabinet, roller, and vane.
March 17, 2014	Restarted Aethalometer; down from 3/16/2014 0630 power outage.
April 3, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller vane, nozzle, and inlet assembly. Changed BC tape.
April 4, 2014	Replaced sample inlet assembly fitting on Aethalometer. Checked BC flow.
April 18, 2014	Changed RMY signal cable for wind.
May 9, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Changed BC tape.
June 6, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller and vane, changed tape. Calibrated wind and temperature sensors.

Date of Site Visit	Description of Work
July 23, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller and vane.
July 28, 2014	Resolved BAM flow issue. Respooled new tape.
September 2, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and nozzle.
September 26, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and nozzle. Changed BAM tape.
October 23, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data.
October 31, 2014	Cleaned BAM inlet. Performed flow check on BAM.
November 25, 2014	Performed flow check on BC and BAM samplers. Collected PM_{10} and BC data. Cleaned BAM roller, vane, and nozzle.

Appendix A: Additional Analyses

This appendix contains discussions of the temporal variability in BC, PM_{10}, and wind direction (Section A.1), and of the effects of wind direction, wind speed and work activity on BC and PM_{10} (Section A.2).

A.1 Temporal Variability in BC, PM_{10}, and Wind Direction

As shown in **Figure A-1**, the diurnal profiles of BC and PM_{10} are characterized by a morning peak in concentrations at both monitoring locations. The peak in BC occurs between 6:00 a.m. and 8:00 a.m., while the peak in PM_{10} is broader, occurring between 6:00 a.m. and 10:00 a.m. Overall, the mean hourly concentrations of both BC and PM_{10} are lower at the Community monitor than at the Landfill monitor. The diurnal profiles in Year 7 (November 22, 2013, through November 21, 2014) are consistent with the previous six years.

As shown in the box-whisker plots[10] (**Figure A-2**), both the Community and Landfill monitors experience higher median concentrations of BC and PM_{10} during the warm season (approximately May through September).

During May through September, the predominant wind direction at the Landfill site is from the SoCAB (56% to 79% of the time), whereas during the other months of the year it is from the Landfill sector (38% to 70% of the time) (**Figure A-3**). However, at the Community site from this period, the predominant wind direction is from neither the Landfill nor the SoCAB sectors, although winds are more often from the SoCAB than from the Landfill (Figure A-3). Perturbation of winds caused by large trees near the Community site substantially increases the variability in wind direction. A calculated variable, called sigma theta (based on the standard deviation of wind direction measurements), is normally used to quantify this variability. Sigma theta values at the Community monitor are higher than at the Landfill monitor (data not shown).

Figures A-4 and A-5 show seasonal wind roses of hourly data collected at the Landfill and Community sites, respectively. At the Landfill site, winds are predominantly from the northerly and southerly directions during all seasons, with a larger proportion of winds from the north during the winter and from the south during the summer (Figure A-4). The prevailing wind direction at the Community site is variable during all seasons (Figure A-5).

[10] A notched box-whisker plot shows the entire distribution of concentrations for each year. In box-whisker plots, each box shows the 25th, 50th (median), and 75th percentiles. The boxes are notched (narrowed) at the median and return to full width at the 95% lower and upper confidence interval values. These plots indicate that we are 95% confident that the median falls within the notch. If the 95% confidence interval is beyond the 25th or 75th percentile, then the notches extend beyond the box (hence a “folded” appearance).

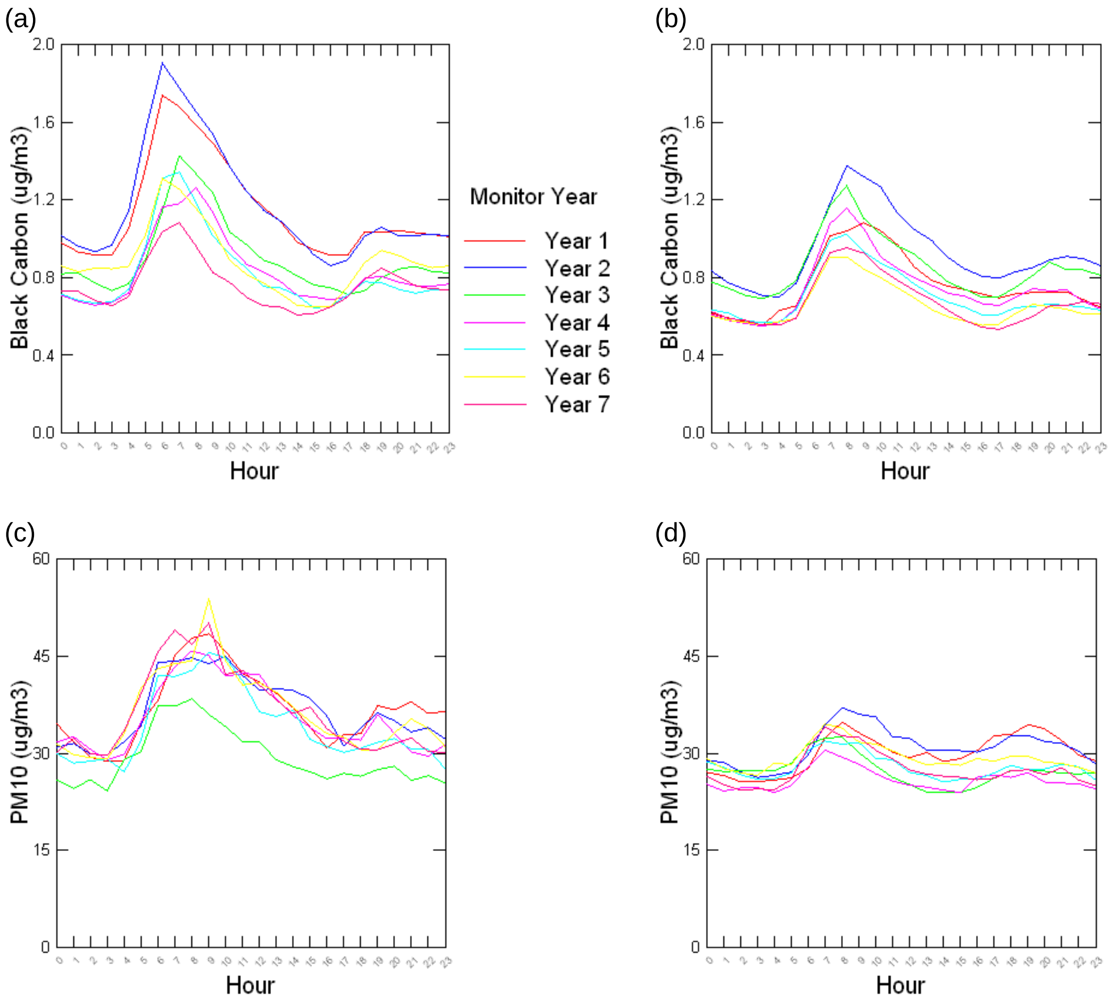


Figure A-1. Mean BC and PM_{10} concentrations by hour for the seven monitoring years at the Landfill (a, c) and Community (b, d) sites.

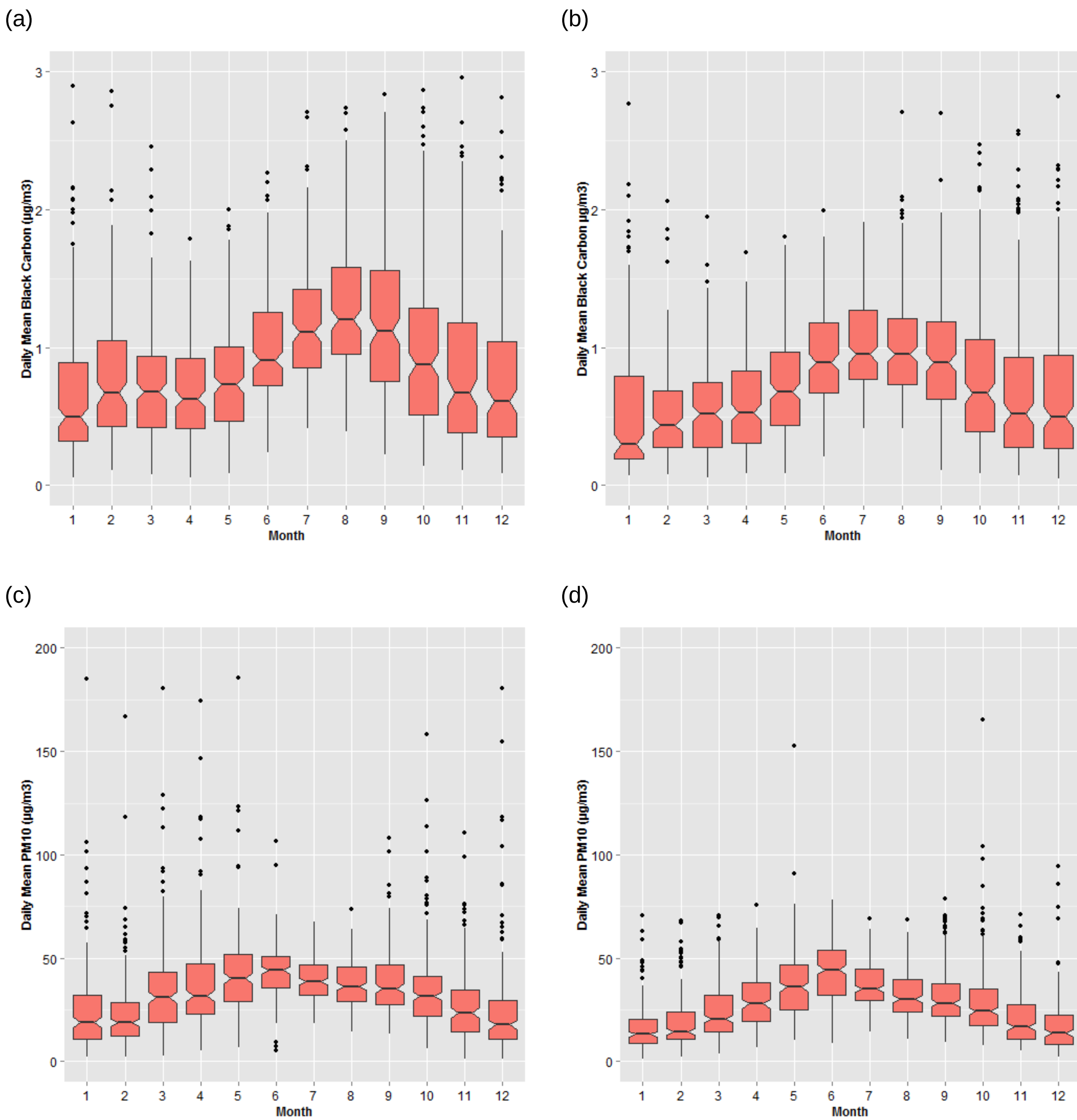
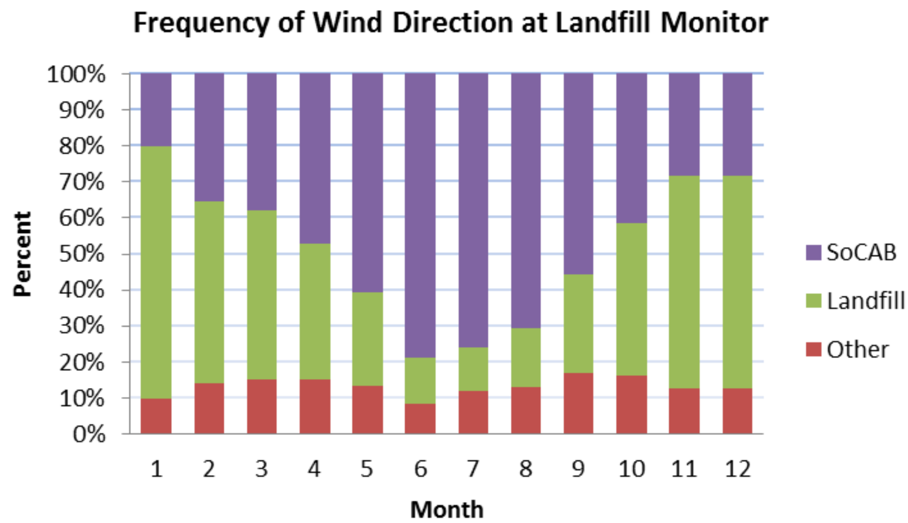
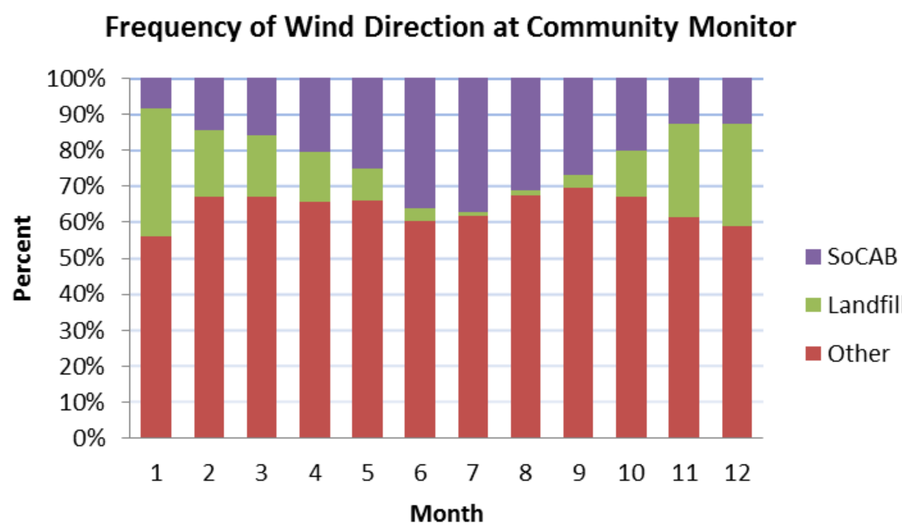


Figure A-2. Distribution of daily mean BC and PM_{10} concentrations by month at the Landfill (a, c) and Community (b, d) sites, during all seven monitor years (2007–2014). BC data greater than 3 µg/m^3 are excluded, as are PM_{10} data greater than 200 µg/m^3.



(a)



(b)

Figure A-3. Percent of time that the Landfill (a) and Community (b) monitoring sites experienced winds that originated from each wind direction sector (South Coast Air Basin, Landfill, Other) during each month from 2007–2014.

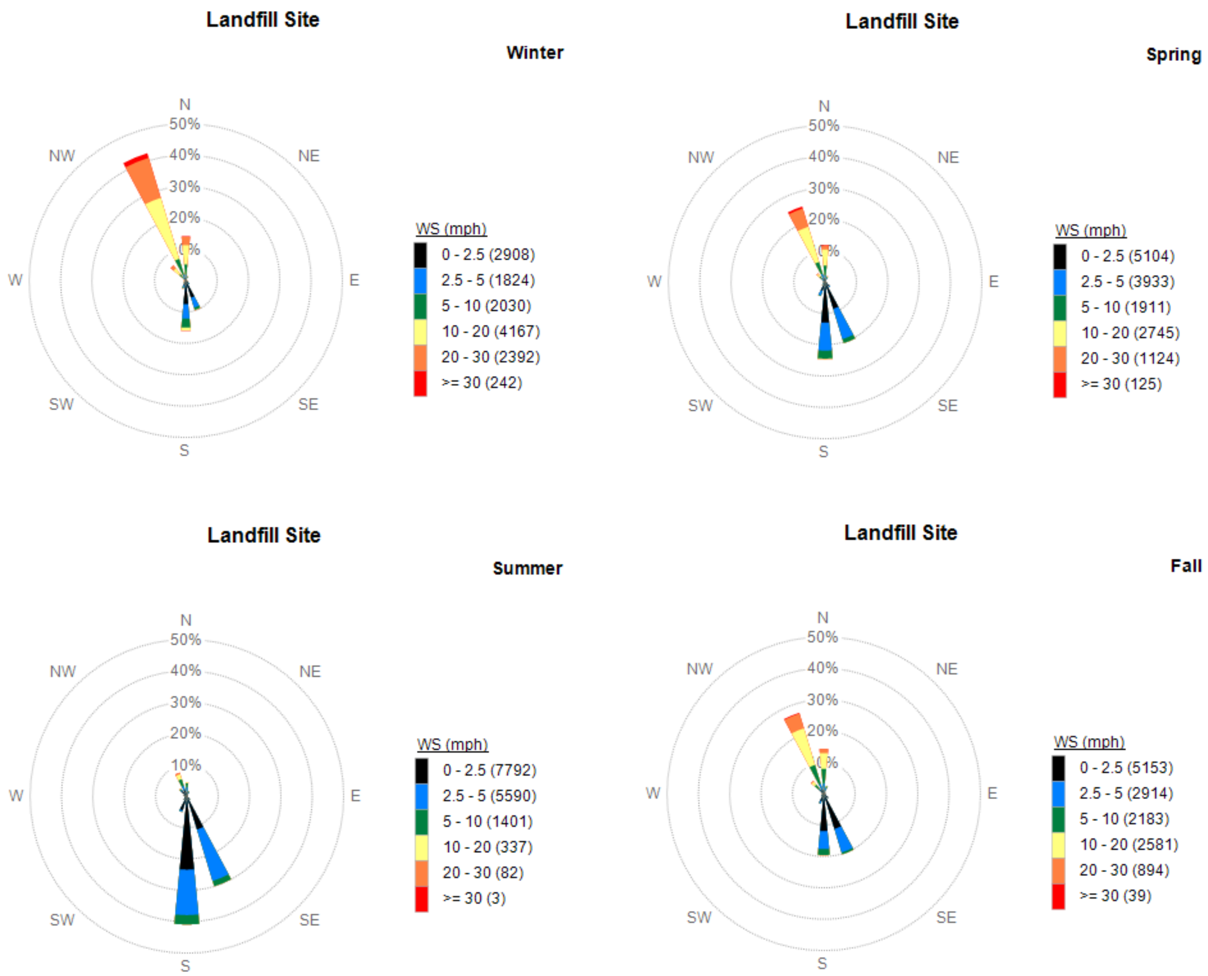


Figure A-4. Seasonal wind roses of hourly data collected at the Landfill monitor during 2007-2014.

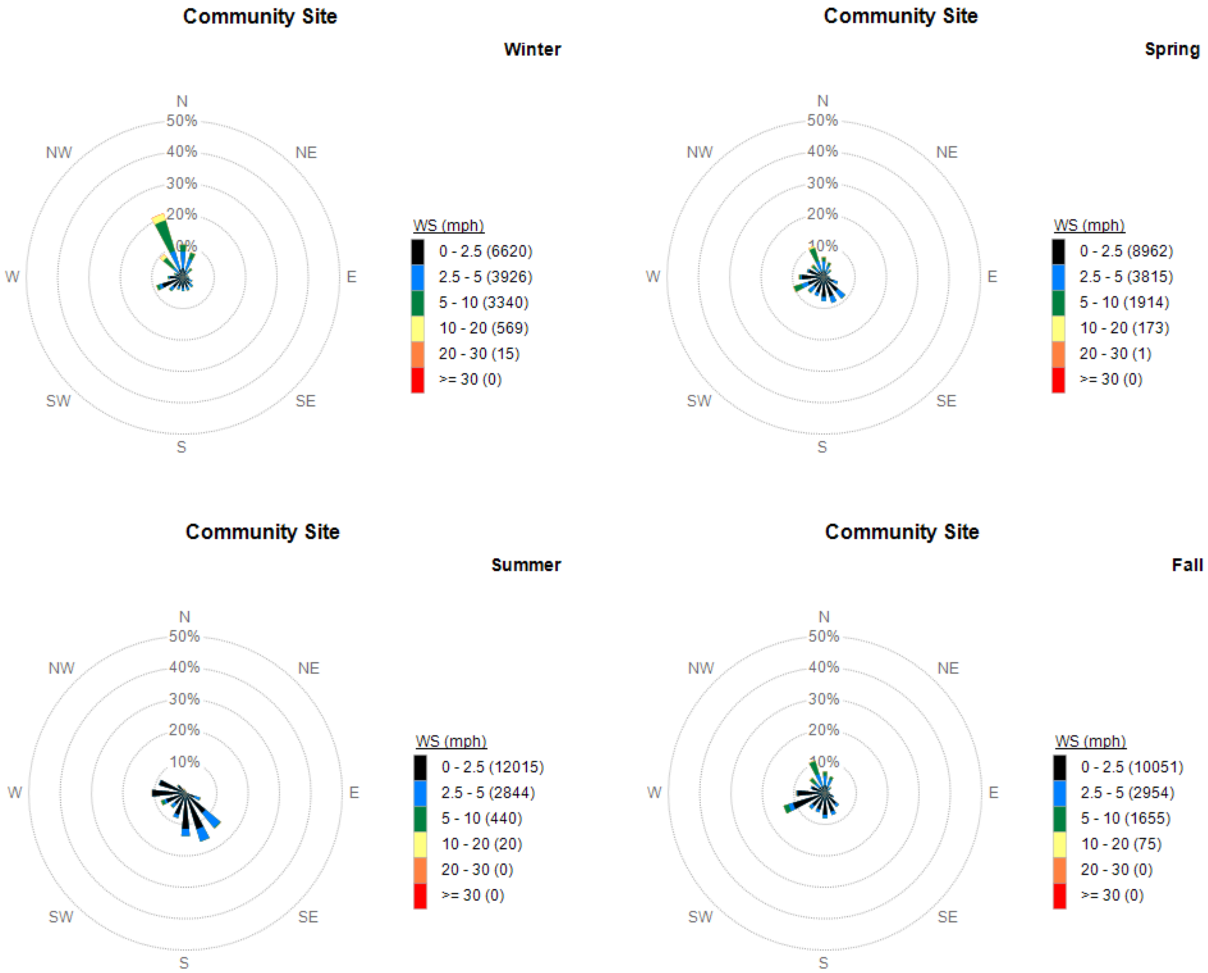


Figure A-5. Seasonal wind roses of hourly data collected at the Community monitor during 2007-2014.

A.2 BC and PM10: Effects of Wind Direction, Wind Speed, and Work Activity Levels

As shown in **Figure A-6**, concentrations of BC and PM_{10} are higher on the weekdays than the weekends. Higher concentrations are consistent with greater activity at the landfill during the week, as well as with more potential vehicles on the roads throughout the SoCAB. Concentrations of BC and PM_{10} are higher on Saturdays than Sundays at the Landfill site, though median PM_{10} is barely higher. Activity occurs at the landfill on some Saturdays, but not on Sundays.

As shown in **Figure A-7**, concentrations of BC and PM_{10} are several times greater when winds come from the south than from the north. In addition, concentrations are typically similar between the Landfill and Community sites when winds are from the SoCAB direction. Concentrations are greater at the Landfill site than the Community site when winds are from the north.

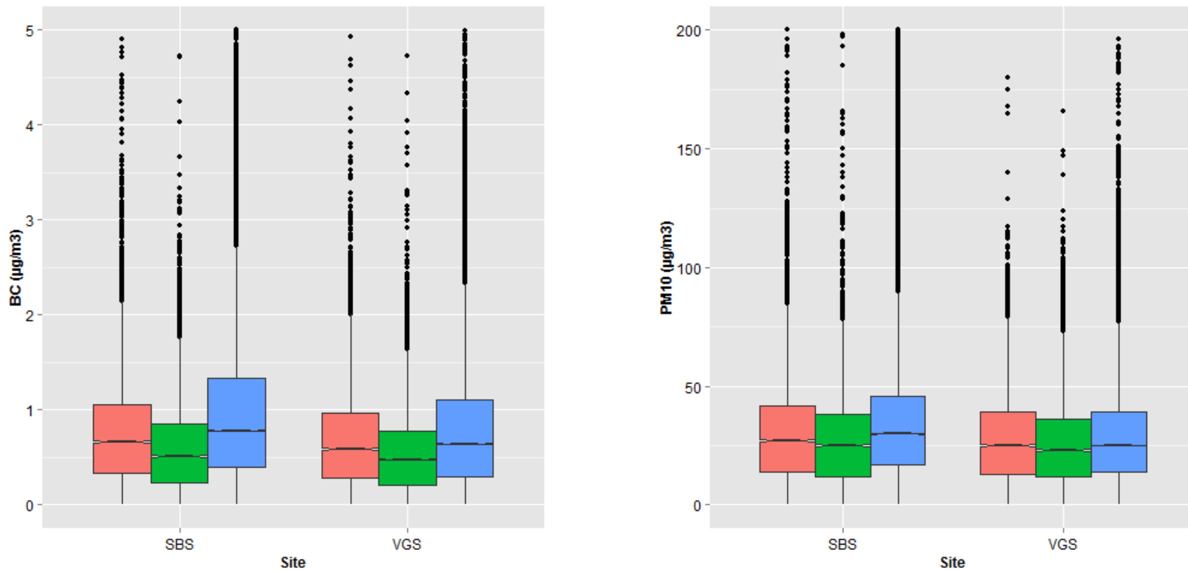


Figure A-6. Hourly BC and PM_{10} concentrations at the Landfill (SBS) and Community (VGS) monitoring sites on weekdays (blue), Saturdays (pink), and Sundays (green). Data from November 22, 2007, through November 21, 2014, are included. BC data greater than 5 µg/m^3 and PM_{10} data greater than 200 µg/m^3 are excluded.

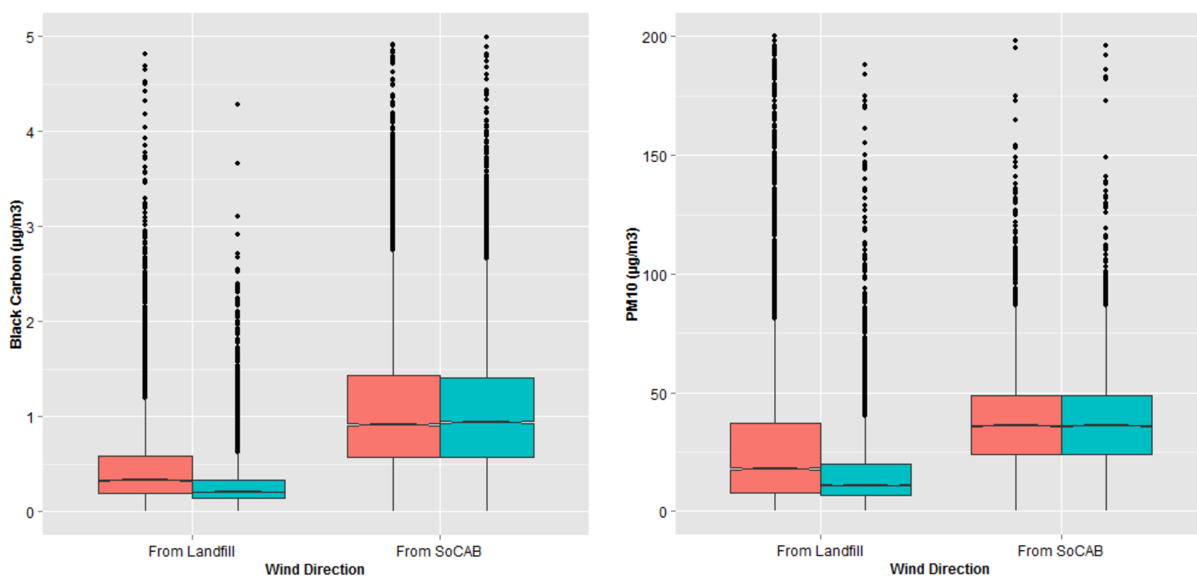


Figure A-7. BC and PM_{10} concentrations at the Landfill (pink) and Community (turquoise) monitors during November 22, 2007, through November 21, 2014, when winds originate from the Landfill versus when they originate from the SoCAB. Results are based on hourly data points where both sites experienced winds from the same sector. BC data greater than 5 µg/m^3 and PM_{10} data greater than 200 µg/m^3 are excluded.