



***Assessment of Hydrogen Sulfide Levels
In London Grove Township,
Chester County, Pennsylvania***

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Bureau of Air Quality**

**And
Department of Health
Bureau of Epidemiology**

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September 1999



Preface

This report represents the collaborative efforts of the Pennsylvania Department of Environmental Protection (DEP) and the Pennsylvania Department of Health (Health Department). DEP's air quality staff monitored ambient and indoor air concentrations of hydrogen sulfide (H₂S) at selected sites near mushroom composting operations in London Grove Township, Chester County, Pennsylvania from April 1998 to June 1999. DEP also monitored H₂S concentrations at a control site in Franklin Township, Chester County. The Health Department's Bureau of Epidemiology conducted health surveys at the two DEP-monitored school sites. In addition, a community health survey was conducted by the Health Department to examine possible adverse health effects of H₂S concentrations in the atmosphere.

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EXECUTIVE SUMMARY

Since early 1997, residents living near mushroom composting operations in London Grove Township, Chester County (study area) have complained to the Pennsylvania Department of Environmental Protection (DEP) about hydrogen sulfide (H₂S) odors. In addition to “quality of life” issues, residents were concerned about the adverse health implications of H₂S exposure.

In order to better understand the air quality and health aspects of H₂S in the study area, DEP and the Pennsylvania Department of Health (Health Department) collaborated on a study to monitor ambient H₂S concentrations in the area to determine whether elevated H₂S levels were causing any adverse health impacts. DEP conducted ambient H₂S monitoring at five sites (including sites at two elementary schools and two private residences) in the study area from the spring of 1998 to early summer of 1999. The monitoring data revealed H₂S levels that exceeded both the one-hour and 24-hour H₂S standards established by the Commonwealth 30 years ago. The majority of the high H₂S concentrations were detected at the site located immediately adjacent to a composting operation.

During the period from April 1998 to October 1998, the Health Department conducted three health surveys in the study area. A major goal of these surveys was to determine if there was a correlation between exposure to H₂S measured at the schools or in the community and observed physical symptoms and/or medical conditions. Based on its analysis of the H₂S data and reported health impacts, the Health Department indicated that “the results do not support a consistent association between exposure to low levels of hydrogen sulfide and the appearance of symptoms.”

Although the monitored H₂S levels in the study area have not been shown to be associated with adverse health impacts, the odors do impact the “quality of life” of residents living in areas near composting operations. However, DEP has limited authority under the Pennsylvania Air Pollution Control Act to initiate any action to address odors or other emissions arising from the production of agricultural commodities, including the production, processing or storage of compost. Compost used predominantly in the production of agricultural commodities is not subject to Pennsylvania air quality regulations. When composting operations include activities that are subject to regulation, it is difficult to separate odors from exempted and regulated composting activities at certain sites. Consequently, finding ways to reduce odors from all composting operations is the best approach.

Therefore, DEP will provide financial support for Penn State University’s (Penn State’s) research efforts to reduce odors and H₂S emissions from mushroom composting activities. While the research to minimize odors from composting operations holds promise, DEP recognizes that the ultimate resolution of issues related to mushroom composting activities requires the composting industry and the affected community to develop a partnership to address air pollution in the community.

INTRODUCTION

During the past two and a half years, DEP's Southeast Regional Office has received numerous odor complaints from residents living near mushroom-compost processing facilities in the West Grove/Avondale area of Chester County. Residents in the study area were concerned that H₂S emissions, and possibly other chemicals, from the mushroom composting operations could be impacting their health. A matter of particular concern was the health of the students attending the Avon Grove Elementary School, located on State Road to the east of West Grove.

To address the concerns of the West Grove/Avondale community, DEP and the Health Department developed an H₂S sampling plan. In accordance with the plan, DEP personnel conducted the air monitoring activities and made decisions relative to H₂S monitoring in the study area. The H₂S monitoring data were recorded during one-hour and 24-hour intervals at the following locations in London Grove Township: Avon Grove Elementary School, West Grove Borough Garage and private residences on Meadow Wood Lane and Holly Drive. The Kemblesville Elementary School in Franklin Township was monitored to provide background H₂S data. The H₂S data obtained by DEP were compiled for the school and community health surveys.

The Health Department conducted a school health survey of children at the Avon Grove and Kemblesville Elementary Schools and a community health survey in several areas in close proximity to the school. The school health surveys were conducted during April 20 - June 5, 1998 and August 31 - October 30, 1998. The Community Health Survey was conducted during May 18 - June 30, 1998. The health surveys were designed to evaluate the air quality in the two elementary schools and the community and to determine any possible health concerns related to the H₂S levels. The H₂S concentrations recorded during DEP's monitoring program were compared with reported health symptoms to determine whether there was an association between exposure to H₂S levels and the appearance of health symptoms. The Kemblesville Elementary School in Franklin Township, Chester County, was the control group for the school health surveys.

This H₂S report consists of two chapters and appendices. Chapter One describes the ambient and indoor H₂S monitoring program conducted by DEP, and its findings. The pollutant wind roses shown in Figures 1 through 3 depict the hourly H₂S results when winds are from the direction indicated at an average speed greater than one mile per hour (mph). The hourly H₂S values recorded by DEP for each monitoring site, hourly wind speed and direction data are included in appendices to this report.

Chapter Two of the report pertains to the "Hydrogen Sulfide Exposure Studies" conducted by the Health Department. This chapter, prepared by the Health Department, contains an Executive Summary in Section 2.1 and three separate health survey reports in Sections 2.2-2.4. The School

Health Survey conducted at the Avon Grove and Kemblesville Elementary Schools from April 20 - June 5, 1998 is described in Section 2.2 of this report. Sections 2.3 and 2.4 pertain to the Community Health Survey conducted in London Grove Township from May 18 - June 30, 1998 and the School Health Survey conducted for a two-month period, August 31 - October 30, 1998, respectively.



Chapter 1

Monitoring Hydrogen Sulfide Levels In London Grove Township, Chester County, Pennsylvania

1.1. BACKGROUND

In December 1997, DEP dispatched a sophisticated Mobile Analytical Unit (MAU) to London Grove Township, Chester County to conduct air quality monitoring in response to complaints of odors and adverse health effects made by people living near a mushroom composting operation. During the week of December 15, 1997, the MAU analyzed ambient air at various locations in the area for volatile organic compounds (VOCs). The air quality staff from the Southeast Regional Office supported this effort by conducting occasional testing for H₂S levels. Based on the air sampling results, the Health Department concluded that no adverse health effects should result from the pollutant levels measured by DEP personnel. On March 19, 1998, the Health Department's findings were reported to the public during a meeting held at the Avon Grove High School. At that meeting, DEP indicated that the sampling program for H₂S would be expanded since the compound was identified as a source of odors during the sampling period and might be present at certain times of the day in concentrations higher than those measured in December 1997. The Health Department agreed to review the H₂S data collected from continuous monitoring conducted by DEP and to use the data in its evaluation of health surveys conducted in the London Grove study area.

DEP and the Health Department developed an H₂S sampling plan in consultation with the Agency for Toxic Substances and Disease Registry of the U.S. Public Health Service (ATSDR) and the U.S. Environmental Protection Agency's, Emergency Response Team, Edison, New Jersey. Pursuant to the H₂S sampling plan, DEP installed and operated H₂S monitors at the Avon Grove Elementary School, the West Grove Borough Garage, private residences on Holly Drive and Meadow Wood Lane, and at a control site, the Kemblesville Elementary School in Franklin

Township. DEP personnel conducted air monitoring in the study area from April 8, 1998 to June 16, 1999. This H₂S monitoring program was not initiated for enforcement purposes.¹

The objective of the H₂S monitoring program was to provide the Health Department with the necessary data to assess the health impact of ambient H₂S concentrations in areas near mushroom composting operations. Health questionnaires distributed to people living in the London Grove area were designed to determine whether there is a connection between measured H₂S concentrations and complaints of adverse health effects. The Health Department conducted seasonal health-survey studies at the Avon Grove and Kemblesville Elementary Schools, and within the London Grove community at the health survey locations and survey dates shown below in Table 1. The Kemblesville Elementary School, Franklin Township, served as a background site for the H₂S health surveys.

Table 1. Health Department survey periods.

Survey	Dates
Health Survey – Avon Grove and Kemblesville Elem. School – Spring, 1998	April 20 through June 5, 1998
Community Health Survey in London Grove Township	May 18 through June 30, 1998
Health Survey – Avon Grove and Kemblesville Elem. School – Autumn, 1998	August 31 through October 30, 1998

¹ The one-hour and 24-hour ambient air H₂S standards, 100 ppb and 5 ppb, respectively, were adopted on October 20, 1969, by the now defunct Air Pollution Commission. These standards were adopted following H₂S sampling and the investigation of darkened lead-based paint on the exterior of houses located near burning coal refuse piles. The ambient air standards were designed to: (1) evaluate the results of community air pollution studies conducted by the Department of Health; (2) determine the need for air pollution control regulations in regions of the Commonwealth; and (3) develop rules and regulations in accordance with Section 5(f)(2) of the Air Pollution Control Act, Act of January 8, 1960 (P.L. 2119). See original record in the Pennsylvania State Archives (Pennsylvania Historical & Museum Commission) pertaining to “Pennsylvania Ambient Air Quality Standards,” (Adopted October 20, 1969).

Table 2 provides a timeline of the activities that occurred during the assessment of H₂S concentrations in London Grove Township.

Table 2. Timeline of the H₂S sampling study conducted in London Grove Township.

Date	Event
3/19/98	Public meeting at Avon Grove High School regarding air sampling in December 1997.
4/8/98	H ₂ S samplers set up at Avon Grove Elementary School, Meadow Wood Lane and Holly Drive.
4/10/98	H ₂ S sampler set up at Kemblesville Elementary School.
4/20/98	Health study initiated at Avon Grove Elementary School and Kemblesville Elementary School.
4/27/98	Range of sampler on Meadow Wood Lane changed from 0-1000 ppb to 0-5000 ppb.
5/18/98	Community health study begun within 1/2 mile of Avon Grove Elementary School.
6/5/98	Sampler set up at West Grove Borough Garage.
6/5/98	Last day of school.
6/12/98	Sampler moved from Kemblesville Elementary School to inside the residence on Meadow Wood Lane.
6/30/98	Community health study ends.
8/27/98	Sampler moved from West Grove Borough Garage to Kemblesville Elementary School.
8/31/98	First day of school. School health study resumes.
10/29/98	Samplers removed from Holly Drive and inside the residence on Meadow Wood Lane.
10/30/98	Health study ends at Kemblesville and Avon Grove Elementary Schools.
11/4/98	Sampler removed from Kemblesville Elementary School.
12/2/98	Inside H ₂ S monitor at Avon Grove Elementary School converted into an outside SO ₂ monitor.
2/8/99	Outside SO ₂ monitor at Avon Grove Elementary School converted back to an inside H ₂ S monitor.
5/26/99	Removed H ₂ S monitor on Meadow Wood Lane and installed it at the Avon Grove Elementary School to monitor outdoor air.
6/16/99	Last day of sampling at the Avon Grove Elementary School.

1.2. MONITORING METHODS

Ambient monitoring of H₂S was the primary focus of the DEP sampling activities conducted in London Grove Township, Chester County, Pennsylvania. The Department also conducted indoor H₂S monitoring at the Avon Grove Elementary School because of its proximity to composting operations in the West Grove/Avondale area and concerns for students attending the school. To support the interpretation of the H₂S results, meteorological measurements of wind speed, wind direction, temperature, relative humidity and rainfall were made during the study. During the course of the study, the DEP used as many as six samplers at five different locations to obtain H₂S data. The specific monitoring site locations, dates of operation and parameters measured during the study are listed in Table 3 of this report.

Monitoring Equipment

The following types of equipment were used to monitor both ambient and indoor H₂S concentrations in the study area:

SPM Tape Sampler

Manufactured by Zellweger Analytics, Inc., the SPM can sample at either a 53-1500 parts per billion (ppb) range or a 2-90 ppb range. The unit has an internal sample pump which draws air at a constant flow rate through a chemically treated paper tape. The tape darkens on exposure to H₂S. A light emitting diode and optical sensor measure the rate of color change. At the end of each sample period the concentration is output to a digital display and a 1 to 5 volt analog output. The output is a “latch and hold” type that displays the concentration until the end of the next sample period. Periodically, the tape responds to other hydrides such as arsine and phosphine. However, these compounds are very unlikely to be present in ambient or indoor air. The tape does not respond to other sulfides.

Campbell Scientific, Inc. Model CR10 Datalogger

The CR10 datalogger recorded the output of the SPM tape sampler and other connected equipment. The data recorded included the time, date, 5-minute H₂S averages, one-hour H₂S averages, maximum H₂S concentrations and SPM fault status. The H₂S data were manually downloaded on site and stored on a networked computer in the Harrisburg Central Office.

Thermo Environmental Inc. (TEI) Continuous SO₂/H₂S Monitor

With the TEI, ambient air was continuously pumped through a scrubber to remove sulfur dioxide (SO₂) then through a heated catalyst to convert H₂S into SO₂. The SO₂ was then measured out of the converter as H₂S. The TEI analyzer used pulsed UV fluorescence detection and had a range of 0-1000 ppb or 0-5000 ppb.

Datalogger: SumX 4000

The datalogger measured the TEI outputs once per second and stored the time and date, 1-minute averages, 5-minute averages, one-hour averages, and analyzer fault status. The data were transmitted via dial-up telephone line to the central computer in Harrisburg.

Meteorological Equipment

A 10-meter weather tower, with Qualimetrics wind speed and direction sensors, was erected at the Avon Grove Elementary School to obtain meteorological information. In addition, a Vaisala HMP-35C sensor provided temperature and relative humidity data, and a TE525 6” tipping bucket rain gage measured rainfall amounts.

Equipment Calibration

SPM Tape Sampler

The responses of the SPM tape samplers were checked before the samplers were placed in the field. These monitors have a fixed factory calibration and cannot be adjusted. The percent accuracy relative to the standard was measured at three concentrations covering the operating range. These measurements were accomplished by taking H₂S from a certified gas standard cylinder blended with humidified ultra-pure air. For every two weeks the monitor was deployed in the field, an optical response test and electrical output test were performed. Based on information provided by the EPA Emergency Response Team, an accuracy of +/-25% is expected with the tape sampler.

TEI SO₂/H₂S Monitor

A multi-point calibration was performed after each monitor was first deployed in the field and had run continuously for at least 24 hours until the monitor was stabilized. The DEP ran a zero-check once every 24 hours. At two-week intervals, a 3-point check was performed to verify instrument calibration and linearity in accordance with the calibration procedure specified in the Commonwealth of Pennsylvania's Air Monitoring Systems Quality Assurance Manual. Accuracy limits are +/- 15%.

1.3. MONITORING SITE LOCATIONS

The specific H₂S monitoring sites, dates of operation and parameters measured are shown below in Table 3. During the course of the study, the DEP used as many as six samplers at five different locations to obtain H₂S data. (see map in Appendix A of this report).

Table 3. H₂S monitoring site locations.

Site Name	Location	Measures	Monitor Type	Operating Dates	Parameter(s)
Avon Grove Elem. School (AVO2) H ₂ S1	Northwest corner	Outdoor	TEI 0-1000 ppb	4/8/98-6/16/99	H ₂ S, WS, WD
Avon Grove Elem. School (AVO2) H ₂ S	Classroom 21	Indoor	TEI 0-1000 ppb	4/8/98-12/2/98 12/2/98-2/8/99 2/8/99-6/16/99	H ₂ S SO ₂ H ₂ S
West Grove Borough	West Grove Borough Garage	Outdoor	SPM 53-1500 ppb	6/5/98-8/27/98	H ₂ S
Kemblesville Elem. School	Front of building	Outdoor	SPM 2-90 ppb	4/10/98-4/22/98 5/18/98-6/12/98 8/27/98-11/4/98	H ₂ S
Holly Drive	Private home	Outdoor	SPM 53-1500 ppb	4/8/98-10/29/98	H ₂ S, Rain, Temp, R.H.
Meadow Wood Lane (AVO1) H ₂ S	Private home	Outdoor	TEI 0-5000 ppb	4/8/98-5/26/99	H ₂ S
Meadow Wood Lane	Private home	Indoor	SPM 53-1500 ppb	6/12/98-10/29/98	H ₂ S, Temp, R.H.

Avon Grove Elementary School

Two TEI SO₂/H₂S monitors were operated at the Avon Grove Elementary School. One monitor analyzed classroom air, while the other monitored ambient air outside of the school. Data from both monitors were polled hourly by a central computer in Harrisburg. The meteorological tower was also located at the Avon Grove Elementary School to measure wind speed and direction.

Kemblesville Elementary School

An SPM sampler was located outside of the Kemblesville Elementary School, south of West Grove on Rt. 896 in Franklin Township. The Health Department used this school as its control group for the health assessment portion of the H₂S study.

Meadow Wood Lane

A TEI SO₂/H₂S monitor was installed to monitor outside air at a residence on Meadow Wood Lane, which is west of the Avon Grove Elementary School. H₂S data were polled twice per week over the resident's phone. During the summer months, an SPM tape sampler measured indoor H₂S concentrations, and the data were collected on a bi-weekly basis.

Holly Drive

A residential site on Holly Drive, which is farther west of the Avon Grove Elementary School and south of potential H₂S air contamination sources, was chosen as a monitoring site. An SPM tape sampler was installed, along with temperature, relative humidity and rainfall measuring devices.

West Grove Borough

DEP installed an SPM tape sampler at the Borough Garage on the western side of West Grove, in an area where malodors have historically been reported. The sampler provided data for comparison with other sampling locations.

1.4. H₂S DATA ANALYSIS

After each hourly data poll during school hours (7:00 a.m. to 4:00 p.m.), the data obtained from the two TEI continuous monitors at the Avon Grove Elementary School were automatically reviewed. This review was undertaken to identify any 5-minute data above 90 ppb. Data from the SPM samplers were retrieved manually and reviewed once per week.

All TEI H₂S concentration measurements were averaged to provide short (5-minute), medium (one-hour) and long-term (24-hour) intervals for health-effect assessments, as requested by the Southeast Regional Office. One-minute values were not archived on the central computer system. However, one-minute H₂S concentrations over 200 ppb were manually retrieved, archived on a

personal computer and periodically transferred to a shared Microsoft Excel™ spreadsheet. The H₂S concentrations obtained from SPM measurements were averaged only in 5-minute and one-hour intervals.

1.5. RESULTS

All SPM samplers used in the study, except at the background site, operated at a range of 53 to 1500 ppb. Because any actual concentration between 0 and 52 ppb is represented in the calculated average as a zero, the hourly averages produced by these SPM samplers are probably below the true values. Nevertheless, one-hour averages exceeding 100 ppb were recorded at the Meadow Wood Lane, Holly Drive and West Grove SPM monitoring sites. All one-hour averages exceeding the 100 ppb standard at SPM sampler sites are shown in Table 4.

Table 4. Exceedances of the one-hour (100 ppb) H₂S standard for SPM tape samplers.

Location	Date	Hour Beginning (EST)	H ₂ S 1-Hour Avg. (ppb)	H ₂ S Max During Hour (ppb)	1-Hour Avg. Wind speed (mph)	Avg. Wind Direction Degrees
Meadow Wood Lane (Indoor) ^a	7/1/98	11:00	122	509	11.6	291
Meadow Wood Lane (Indoor)	8/19/98	7:00	417 ^b	1493 ^b	n/a	n/a
Meadow Wood Lane (Indoor)	9/10/98	11:00	148	514	8.0	315
Meadow Wood Lane (Indoor)	9/10/98	12:00	226	784	7.3	319
Meadow Wood Lane (Indoor)	9/10/98	13:00	153	439	8.6	314
Meadow Wood Lane (Indoor)	10/21/98	11:00	152	310	9.0	296
Meadow Wood Lane (Indoor)	10/21/98	12:00	110	181	8.5	296
West Grove Borough	6/17/98	5:00	120	283	2.7	247
West Grove Borough	6/17/98	6:00	122	359	3.3	283
West Grove Borough	6/24/98	19:00	378	1035	0.8	194
West Grove Borough	6/24/98	20:00	136	335	1.4	182
West Grove Borough	6/25/98	0:00	150	783	0.2	194 ^c
West Grove Borough	6/25/98	23:00	189	1040	3.0	220
West Grove Borough	6/26/98	0:00	208	411	4.6	225
West Grove Borough	6/27/98	5:00	150	231	4.9	283
West Grove Borough	7/9/98	19:00	136	493	0.4	170 ^c
West Grove Borough	7/14/98	4:00	120	196	0.3	167 ^c
West Grove Borough	7/15/98	20:00	123	359	1.2	152
Holly Drive	7/18/98	6:00	408	1207	4.3	321
Holly Drive	7/18/98	7:00	368	1307	3.2	325
Holly Drive	8/29/98	7:00	175	605	1.5	74

^a The SPM at Meadow Wood Lane monitored air inside the residence.

^b The one-hour average may be inaccurate due to the upper range of sampler being exceeded.

^c The wind direction may be inaccurate because wind speed during period was less than 0.5 mph.

The SPM tape sampler used at the Meadow Wood Lane residence monitored indoor air in the first floor living area of the home. The SPM tape samplers at all other locations monitored ambient (outdoor) air. The SPM at the background site, Kemblesville Elementary School, did not exceed, or even approach, the one-hour standard. Because of the range of the SPM samplers, the DEP could not obtain 24-hour averages accurate enough to be compared to the 5 ppb, 24-hour H₂S standard.

A TEI continuous SO₂/H₂S monitor sampled outdoor air at the same home on Meadow Wood Lane. The TEI monitor was initially set to a 0 to 1000 ppb range, but was changed to 0 to 5000 ppb after an episode occurred with readings approaching full scale. Table 5 provides a list of all the exceedances of the 100 ppb, one-hour H₂S standard recorded by the TEI monitors.

Table 5. Exceedances of the one-hour (100 ppb) H₂S standard for TEI continuous monitors.

Site	Date	Hour Beginning (EST)	H ₂ S 1-Hour Avg. (ppb)	1-Hour Avg. Wind speed (mph)	Avg. Wind Direction Degrees
Avon Grove Elem. School (Outdoor)	10/21/98	11	129	9.0	296
Meadow Wood Lane*	4/25/98	7	126	9.2	310
Meadow Wood Lane	4/25/98	9	122	11.9	312
Meadow Wood Lane	4/25/98	10	161	10.6	311
Meadow Wood Lane	5/26/98	10	162	5.8	317
Meadow Wood Lane	5/26/98	14	121	5.3	317
Meadow Wood Lane	6/8/98	13	242	10.4	318
Meadow Wood Lane	6/18/98	7	109	7.0	307
Meadow Wood Lane	6/18/98	8	150	7.8	302
Meadow Wood Lane	7/1/98	11	168	10.4	294
Meadow Wood Lane	7/11/98	12	133	11.6	291
Meadow Wood Lane	8/19/98	6	607	n/a	n/a
Meadow Wood Lane	8/19/98	7	120	n/a	n/a
Meadow Wood Lane	8/26/98	14	120	n/a	n/a
Meadow Wood Lane	9/10/98	10	215	6.1	316
Meadow Wood Lane	9/10/98	11	216	8.0	315
Meadow Wood Lane	9/10/98	12	364	7.3	319
Meadow Wood Lane	9/10/98	13	224	8.6	314
Meadow Wood Lane	9/16/98	11	140	5.1	287
Meadow Wood Lane	10/16/98	13	115	3.2	303
Meadow Wood Lane	10/21/98	10	221	6.9	289
Meadow Wood Lane	10/21/98	11	224	9.0	296
Meadow Wood Lane	10/21/98	12	147	8.5	296
Meadow Wood Lane	11/7/98	12	154	10.6	294
Meadow Wood Lane	11/7/98	13	239	9.0	300
Meadow Wood Lane	11/17/98	13	102	10.6	308
Meadow Wood Lane	11/28/98	12	106	9.1	272
Meadow Wood Lane	12/4/98	15	355	6.9	290
Meadow Wood Lane	12/4/98	16	146	6.2	291
Meadow Wood Lane	3/13/99	13	281	6.8	330
Meadow Wood Lane	3/13/99	14	258	6.7	317
Meadow Wood Lane	4/19/99	6	142	0.5	168

* The continuous analyzer at Meadow Wood Lane monitored ambient outdoor air.

The data collected from the TEI Continuous SO₂/H₂S Monitors at the Avon Grove Elementary School outdoor site revealed a single one-hour average above 100 ppb. The monitor operating in a classroom at the school had no levels exceeding the one-hour standard. The TEI monitor at the Meadow Wood Lane site, however, had 31 one-hour averages exceeding 100 ppb between April 9, 1998 and May 26, 1999. All but one of the elevated H₂S episodes at the Meadow Wood Lane site occurred when the hourly average wind direction was between 272 and 330 degrees (from the Northwest) with the hourly average wind speed mainly above five miles per hour.

Table 6 shows the H₂S concentrations for each day between April 9, 1998 and June 16, 1999 when the data recorded by TEI monitors at the Meadow Wood Lane and Avon Grove Elementary School sites indicated exceedances of the 5 ppb, 24-hour average standard.

Table 6. Exceedances of the 24-hour (5 ppb) H₂S standard for TEI continuous monitors.

Site	Date	H ₂ S (ppb) 24-Hour Average
Avon Grove Elem. School (Indoor)	6/18/98	6
Avon Grove Elem. School (Indoor)	7/1/98	6
Avon Grove Elem. School (Indoor)	9/10/98	10
Avon Grove Elem. School (Indoor)	10/21/98	11
Avon Grove Elem. School (Indoor)	2/12/99	8
Avon Grove Elem. School (Indoor)	5/19/99	6
Avon Grove Elem. School	4/25/98	9
Avon Grove Elem. School	6/18/98	8
Avon Grove Elem. School	7/3/98	6
Avon Grove Elem. School	7/11/98	6
Avon Grove Elem. School	9/5/98	10
Avon Grove Elem. School	9/10/98	11
Avon Grove Elem. School	10/16/98	8
Avon Grove Elem. School	10/21/98	10
Avon Grove Elem. School	11/7/98	7
Avon Grove Elem. School	11/17/98	6
Avon Grove Elem. School	2/12/99	20
Avon Grove Elem. School	2/28/99	6
Avon Grove Elem. School	3/3/99	6
Avon Grove Elem. School	3/13/99	7
Avon Grove Elem. School	4/22/99	9
Avon Grove Elem. School	5/3/99	7
Avon Grove Elem. School	5/5/99	11
Avon Grove Elem. School	5/17/99	7
Meadow Wood Lane	4/25/98	24
Meadow Wood Lane	5/18/98	9
Meadow Wood Lane	5/26/98	17
Meadow Wood Lane	5/28/98	7
Meadow Wood Lane	5/30/98	9
Meadow Wood Lane	6/5/98	6
Meadow Wood Lane	6/18/98	18
Meadow Wood Lane	6/25/98	8
Meadow Wood Lane	7/3/98	7
Meadow Wood Lane	7/4/98	6
Meadow Wood Lane	7/11/98	13
Meadow Wood Lane	7/27/98	7

Table 6 (continued). Exceedances of the 24-hour (5 ppb) H₂S standard for TEI continuous monitors.

Site	Date	H ₂ S (ppb) 24-Hour Average
Meadow Wood Lane	8/3/98	6
Meadow Wood Lane	8/4/98	6
Meadow Wood Lane	8/5/98	7
Meadow Wood Lane	8/19/98	32
Meadow Wood Lane	8/26/98	8
Meadow Wood Lane	8/29/98	9
Meadow Wood Lane	9/10/98	51
Meadow Wood Lane	9/16/98	14
Meadow Wood Lane	9/24/98	8
Meadow Wood Lane	9/29/98	7
Meadow Wood Lane	10/3/98	7
Meadow Wood Lane	10/10/98	6
Meadow Wood Lane	10/16/98	11
Meadow Wood Lane	10/17/98	7
Meadow Wood Lane	10/21/98	31
Meadow Wood Lane	11/3/98	7
Meadow Wood Lane	11/7/98	23
Meadow Wood Lane	11/9/98	7
Meadow Wood Lane	11/10/98	6
Meadow Wood Lane	11/13/98	8
Meadow Wood Lane	11/14/98	7
Meadow Wood Lane	11/16/98	8
Meadow Wood Lane	11/17/98	15
Meadow Wood Lane	12/4/98	22
Meadow Wood Lane	12/6/98	6
Meadow Wood Lane	12/16/98	7
Meadow Wood Lane	1/28/99	8
Meadow Wood Lane	2/3/99	8
Meadow Wood Lane	2/11/99	8
Meadow Wood Lane	2/16/99	6
Meadow Wood Lane	3/13/99	28
Meadow Wood Lane	4/6/99	6
Meadow Wood Lane	4/19/99	8

During the assessment of H₂S levels, the 24-hour ambient air standard was exceeded 45 days at the outdoor Meadow Wood site and 18 days at the Avon Grove Elementary School outdoor site. Data from the monitor located inside the school indicated that the 24-hour H₂S standard was exceeded 6 days during the sampling period. The indoor TEI monitor at the Avon Grove Elementary School was later switched to monitor outside SO₂ levels from December 2, 1998 to February 8, 1999. There were no exceedances of the 3-hour SO₂ standard (500 ppb) or the 140 ppb, 24-hour SO₂ standard (See Appendix B-3 of this report).

The monitor located at the control site (Kemblesville Elementary School) to obtain background H₂S data did not operate between April 22 and May 18, 1998 due to an equipment failure. A replacement monitor was not available because all of the SPM samplers were being used at the time. A portable H₂S sampler, the Jerome 621 Gold Film H₂S Analyzer, was temporarily installed at the Kemblesville Elementary School to collect data from April 28 to May 18, 1998. These data are presented in Appendix E.2. The weather tower wind sensors were damaged by lightning on July 21, 1998 and were replaced on August 6, 1998. Therefore, local wind data for that time period could not be obtained. In addition, there are no wind data for the 10-day period, August 18 to August 27, 1998.

Tables 7 and 8 show the highest 1-minute and 5-minute H₂S averages, respectively, for each monitoring site.

Table 7. Highest 1-minute average at each monitoring site.

Site	Date	Time	H ₂ S (ppb)	
			Highest	1-Min. Avg.
Meadow Wood Lane (Outdoor)	8/19/98	6:53	4888	
Meadow Wood Lane (Indoor) ^a	8/19/98	7:00	1493 ^b	
Avon Grove Elem. School (Outdoor)	6/18/98	8:51	828	
Avon Grove Elem. School (Indoor)	6/4/98	13:23	243	
Holly Drive ^a	7/18/98	7:00	1307	
West Grove Borough ^a	6/25/98	23:00	1040	
Kemblesville Elem. School ^a	4/20/98	22:00	15	

^a SPM Tape Samplers. Maximum is an instantaneous maximum and not a 1-minute average.

^b Upper limit of SPM. Actual concentration may have been higher.

Table 8. Highest 5-minute average at each monitoring site.

Site	Date	Time	H ₂ S (ppb)	
			Highest	5-Min Avg.
Meadow Wood Lane (Outdoor)	8/19/98	6:55	3667	
Meadow Wood Lane (Indoor) ^a	8/19/98	7:00	1456 ^b	
Avon Grove Elem. School (Outdoor)	10/21/98	11:25	512	
Avon Grove Elem. School (Indoor)	6/4/98	13:25	227	
Holly Drive ^a	7/18/98	6:25	1102	
West Grove Borough ^a	6/24/98	19:45	947	
Kemblesville Elem. School ^a	4/20/98	22:00	15	

^a SPM Tape Samplers.

^b Actual average may be higher. Range of SPM exceeded during this 5-minute period.

Figures 1 through 3 illustrate the hourly H₂S results at the TEI monitoring sites, when winds were from the direction indicated at an average speed greater than one mph.

Figure 1. Hourly H₂S results at the Meadow Wood Lane TEI site, when winds were from the direction indicated in the graphs (hourly wind speed greater than one mph).

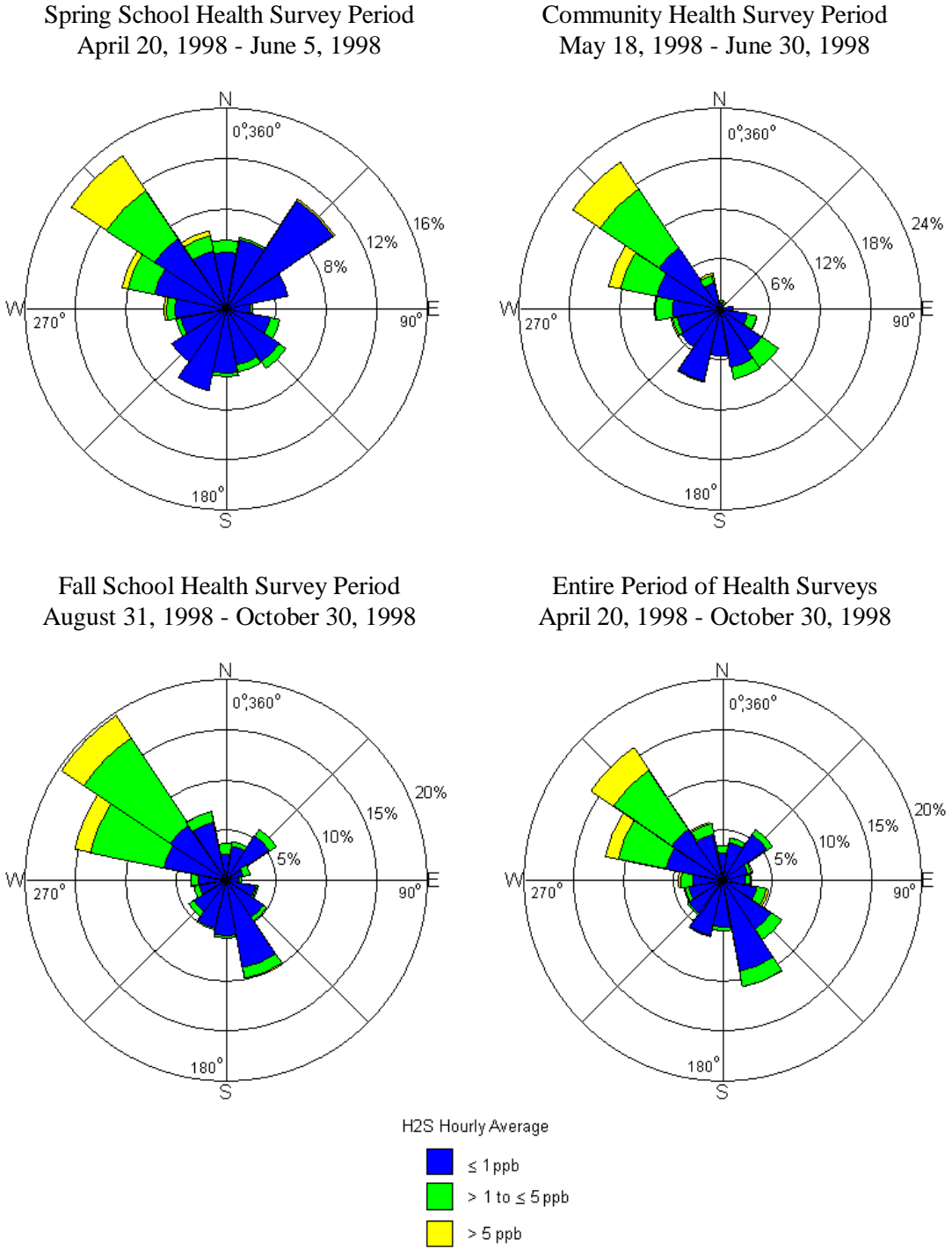


Figure 2. Hourly H₂S results at the Avon Grove Elementary School Outdoor TEI site, when winds were from the direction indicated in the graphs (hourly wind speed greater than one mph).

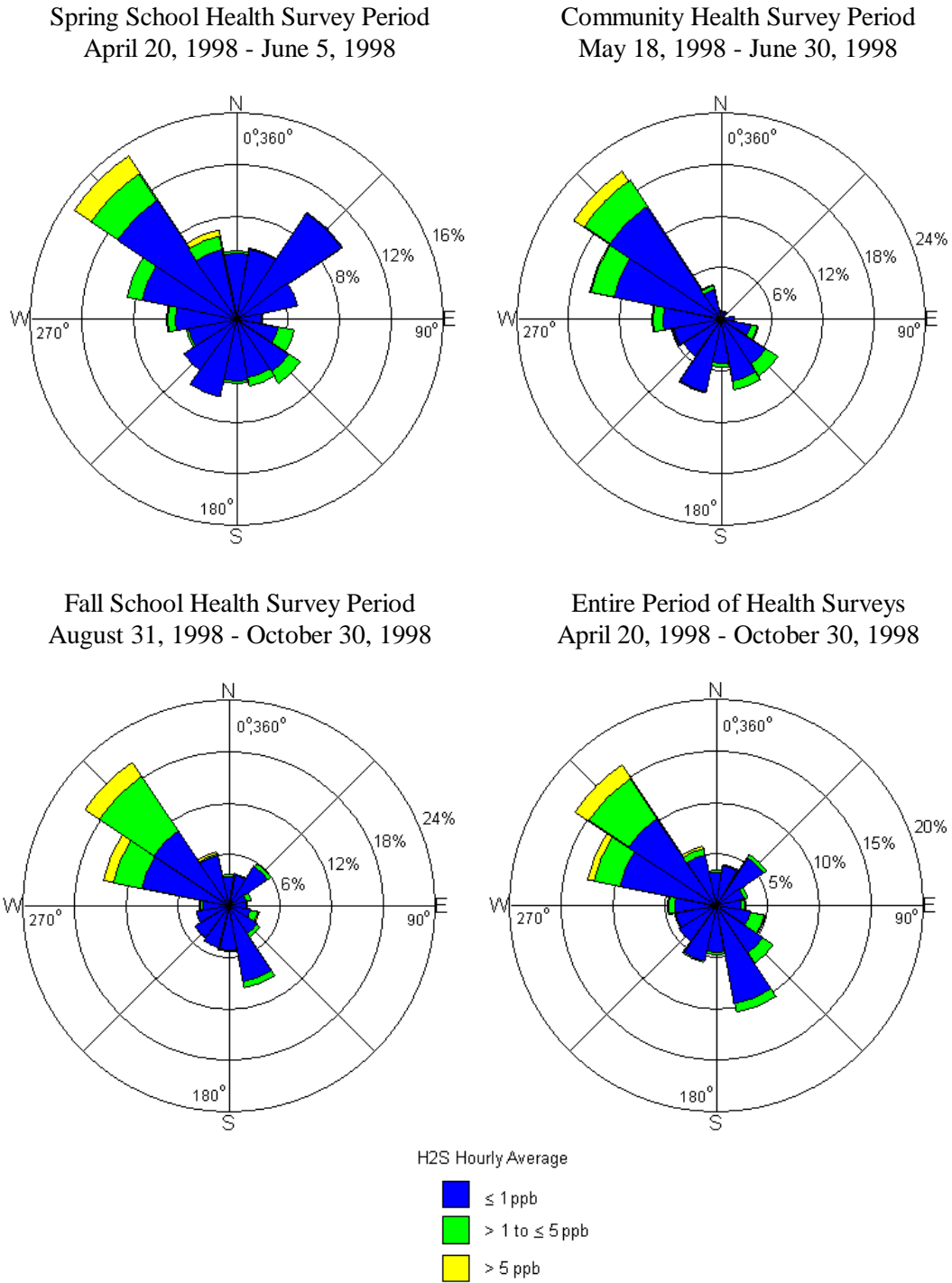
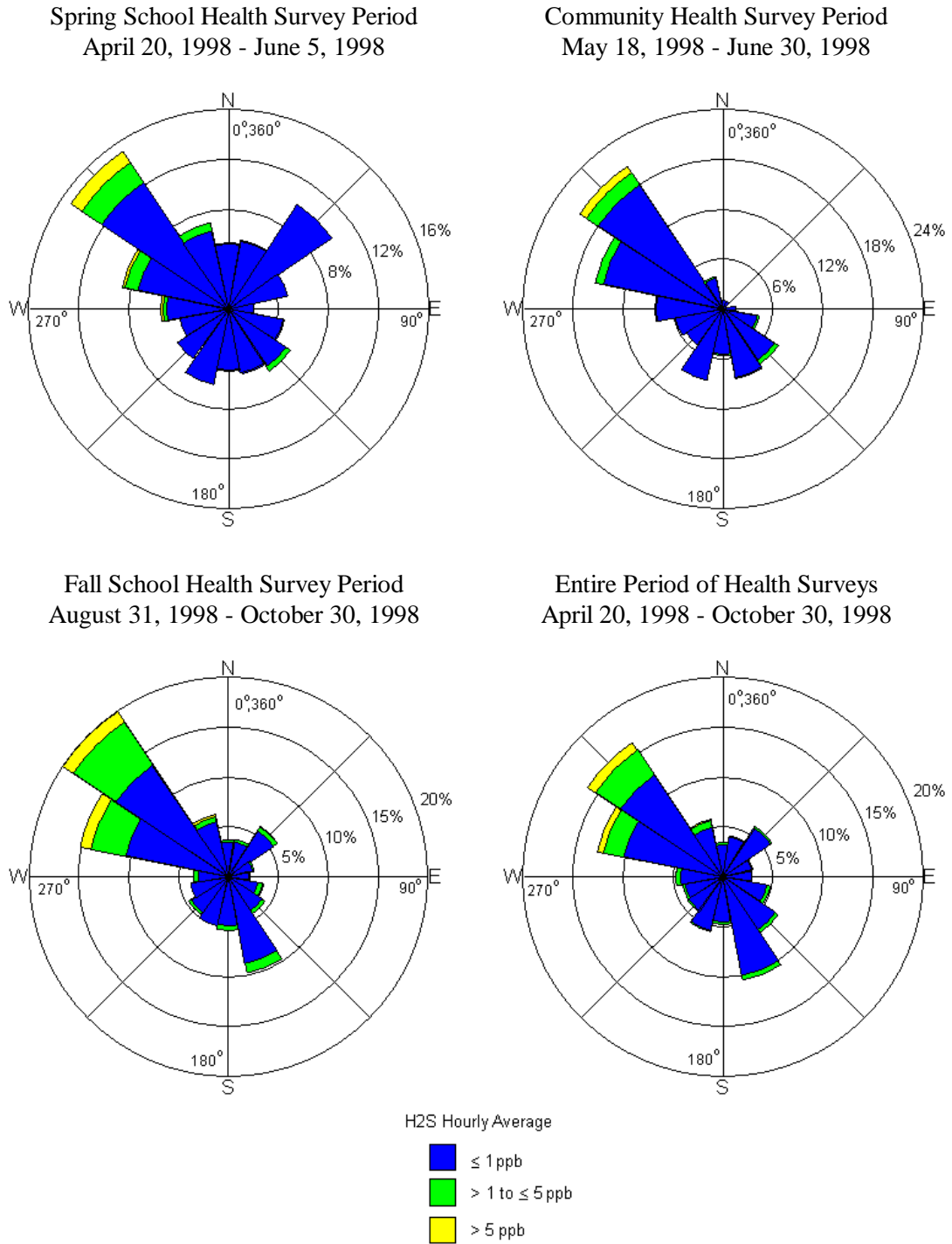


Figure 3. Hourly H₂S results at the Avon Grove Elementary School Indoor TEI site, when winds were from the direction indicated in the graphs (hourly wind speed greater than one mph).



The total number of exceedances of the one-hour H₂S standard at TEI monitoring sites, on a monthly basis, are set forth below in Table 9.

Table 9. Monthly number of exceedances of the one-hour H₂S standard at TEI monitoring sites.

Month	Meadow Wood Lane Outdoor	Avon Grove Elementary Outdoor	Avon Grove Elementary Indoor
April 1998	3	0	0
May 1998	2	0	0
June 1998	3	0	0
July 1998	2	0	0
August 1998	3	0	0
September 1998	5	0	0
October 1998	4	1	0
November 1998	4	0	0
December 1998	2	0	0
January 1999	0	0	0
February 1999	0	0	0
March 1999	2	0	0
April 1999	1	0	0
May 1999	0 *	0	0
June 1999	--	0 **	0 **

* Sampling ended 5/26/99 ** Sampling ended 6/16/99

Finally, the Appendices to Chapter 1 contain a compilation of hourly H₂S values for each monitoring site, and hourly wind speed and direction data.

1.6. DISCUSSION

The results of the ambient air quality monitoring in London Grove Township, Chester County, indicated a number of exceedances of the Commonwealth's one-hour and 24-hour H₂S ambient air quality standards. These 30-year old ambient air quality standards were adopted initially as air quality criteria set at a level to prevent damage to paints and to prevent malodors². The ambient H₂S standards were not based on health studies that indicate adverse health impacts occur at these

² See Footnote 1, *supra* at Page 5. See original record in the Pennsylvania State Archives (Pennsylvania Historical & Museum Commission) pertaining to "Pennsylvania Ambient Air Quality Standards," (Adopted October 20, 1969).

levels³. The Health Department's recent findings also indicate that ambient H₂S concentrations at the levels detected in the study area did not result in adverse health impacts (see Chapter 2 of this report).

Nonetheless, the H₂S levels detected can cause complaints of objectionable odors. These objectionable odors constitute "quality of life" concerns for residents in the areas impacted by the H₂S odors. The highest concentrations of H₂S detected at the Meadow Wood Lane monitoring site are not representative of the H₂S levels in the general study area. The Meadow Wood Lane monitoring site is adjacent to and downwind of a suspected source of H₂S and the levels detected are reflective of the influence of this source on the immediate area.

Because the composting facility near Meadow Wood Lane is producing an agricultural commodity, DEP has limited authority under the Air Pollution Control Act (APCA) to initiate enforcement action for elevated H₂S emissions from the facility. Section 4.1 (a) of the APCA provides that "[e]xcept as required under the Clean Air Act or the regulations promulgated under the Clean Air Act, this act [APCA] does not apply to the production of agricultural commodities." Subsection (a) further specifies that "... the Environmental Quality Board shall not have the authority to adopt rules or regulations relating to air contaminants and air pollution arising from the production of agricultural commodities." See 35 P.S. § 4004.1 (a). Therefore, the provisions of the APCA and regulations adopted under the act do not apply to the production of an agricultural commodity unless required by the federal Clean Air Act and its implementing regulations.

Subsection (b)(3) of the APCA⁴ exempts "[t]he commercial production, processing or storage of compost ... regardless of whether the compost is being produced, processed, or stored on a different premises than the premises in which the compost is being used" so long as the compost does not contain any biosolids originating from a municipal waste treatment facility. Whenever odors, malodors or fugitive emissions arising from the production, processing or storing of compost are covered by the agricultural exemption, any odors, malodors or fugitive emissions resulting from the composting operations are also exempt from state air quality requirements. Therefore, the production, processing and storage of compost near the Meadow Wood Lane site and at similar sites used primarily to produce agricultural commodities are no longer subject to any state regulatory air quality requirements, including control of the odors which might arise from those composting activities. In November 1998, the DEP issued Policy Document 254-5401-001, "Compliance Strategy for Mushroom Composting Operations," which implements the appropriate Air Quality and Waste Management requirements dealing with the mushroom composting industry. This policy addresses how the DEP will deal with odors associated with mushroom composting operations.

³ "The values are not precise and some deviation from the values is not evidence of injury or adverse effects." See original record in the Pennsylvania State Archives (Pennsylvania Historical & Museum Commission) pertaining to "Pennsylvania Ambient Air Quality Standards," (Adopted October 20, 1969).

⁴ See 35 P.S. §4004.1(b)(3).

The processing of spent mushroom substrate (SMS) near the Meadow Wood Lane site could be subject to regulation under the APCA and Pennsylvania's air quality regulations, depending on how the final product is used. However, when both spent and raw composting are being done at the same facility, it is difficult to distinguish odors produced by potentially regulated sources from those produced by exempted sources. At sites that process only SMS, it may also be difficult to identify the specific source of the odor because of the large number of composting operations in the general area.

Given the difficulty in determining the origin of the odors, the most appropriate long-term course of action is to develop measures to reduce odors from the composting operations. To this end, Penn State has developed a proposal to study the use of aerated floor bunkers to reduce odors from SMS processing. These bunkers have already been used successfully to reduce odors from Phase I (raw) composting by eliminating anaerobic zones within the pile. Usually, SMS is spread either on fields and allowed to weather for two to three years or actively composted in static piles before being used as a soil amendment. Both of these methods have the potential to contaminate surface and ground water and to produce odors. Penn State's research would involve the construction of an aerated floor bunker at its Mushroom Test Demonstration Facility, where SMS would be tested under different conditions (e.g. various air blowing rates and aeration frequencies) to determine optimum performance of the system and optimum product quality. Air samples would be taken and analyzed by the Monell Chemical Senses Center (Monell) in Philadelphia for volatile sulfur compounds (VSC) which are indicators for malodors from SMS processing activities. Laboratory-scale experiments utilizing SMS would also be performed by Monell to determine the types and amounts of VSC emitted under different, controlled conditions. The results of the research conducted by Penn State and Monell would be made available to the general public and mushroom industry. The DEP would encourage the mushroom composting industry to use aerated floor bunkers for composting SMS on a large-scale basis if its environmental and product quality benefits are demonstrated. The Monell Chemical Senses Center already has funding from the Pennsylvania Agriculture Department for a 2-year study to develop other ways to reduce odors from the processing of spent compost. Monell's research is focusing on the possible use of additives in SMS to control odors. This research effort should be completed by the end of the year 2000.

DEP will provide financial support for Penn State's research efforts to reduce odors and H₂S emissions from mushroom composting operations. The DEP will assess this research effort on an ongoing basis and evaluate the feasibility of cost-effective odor reduction techniques. While the research to minimize odors holds promise, the ultimate resolution of these odor issues requires that the affected community and the composting industry develop a partnership to address air pollution in the affected community.

In this regard, a group of citizens, mushroom growers and government representatives provided both DEP and the Health Department with valuable assistance in evaluating odor and health issues impacting the study area. Their contributions to the project were invaluable. This dialogue should continue in order to ensure that measures developed to reduce odors from composting operations in the study area address both public and private sector concerns.