Health Consultation

KEYSTONE SANITARY LANDFILL

DUNMORE, LACKAWANNA COUNTY, PENNSYLVANIA

Prepared by the
Pennsylvania Department of Health
Division of Environmental Health Epidemiology

April 1, 2019

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

The Pennsylvania Department of Health (PADOH) prepared this Health Consultation for the Keystone Sanitary Landfill site, located in Dunmore, Lackawanna County, Pennsylvania. This publication was made possible by Grant Number [CDC-RFA-TS17-170103CONT19] under a cooperative agreement with the Agency for Toxic Substances Disease Registry (ATSDR). The PADOH evaluated data of known quality using approved methods, policies, and procedures existing at the date of publication. ATSDR reviewed this document and concurs with its findings based on the information presented by the PADOH.

You may contact

PADOH at 717-787-3350 or Env.health.concern@pa.gov
or visit https://www.health.pa.gov/topics/envirohealth/Pages/Assessment.aspx
Or
ATSDR TOLL FREE at 1-800-CDC-INFO or visit: https://www.atsdr.cdc.gov

HEALTH CONSULTATION

KEYSTONE SANITARY LANDFILL

DUNMORE, LACKAWANNA COUNTY, PENNSYLVANIA

Prepared by the
Pennsylvania Department of Health
Division of Environmental Health Epidemiology
under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Community Heath Investigations
Atlanta, Georgia 30333

Table of Contents

Summary

The Keystone Sanitary Landfill (KSL) is an active municipal solid waste collection site located at 249 Dunham Drive, Dunmore, Pennsylvania, in Lackawanna County. The landfill was built over mines known for ground subsidence and has been in operation over 40 years and has been generating electricity from the methane gas released from the landfill for the past 20 years or so. Environmental concerns have been an issue in this community. On February 17, 2015, the Pennsylvania Department of Health (PADOH) received a request from a Pennsylvania state representative and members of Friends of Lackawanna (a local non-profit organization committed to protecting the health and safety of the community) to conduct an environmental health study/evaluation of air quality surrounding the landfill. The community was concerned about harmful environmental exposures because of the landfill's operation and its future expansion. Based on these concerns, PADOH and the Agency for Toxic Substance and Disease Registry (ATSDR) began a collaboration with Pennsylvania Department of Environmental Protection (PADEP) to evaluate community concerns about environmental exposures near the landfill, particularly focusing on evaluating air quality data near the landfill.

PADOH and ATSDR reviewed the data collected by PADEP and provided the public health evaluation in this health consultation. The main objectives of this health consultation were to (1) determine if exposure to contaminants in ambient air surrounding the landfill poses a public health risk to the community near the landfill area under the landfill's current operating conditions, (2) evaluate available environmental information for other potential community exposure pathways of concern related to the landfill; and (3) address concerns about cancer rates in the community by summarizing the most recent cancer incidence data for the population living near the landfill.

Conclusions: PADOH and ATSDR reached the following five conclusions for the site assuming the data collection period is representative of typical conditions:

Conclusion 1

Long-term chemical exposures: PADOH and ATSDR conclude that chronic (long-term) exposure to the chemicals detected in ambient air near the landfill at the monitored locations is not expected to cause harmful non-cancer health effects under the landfill's current operating conditions. However, chronic exposure to benzene and formaldehyde may cause a very low increased cancer risk.

Basis for Conclusion

- Long-term exposures to the detected contaminants' concentrations in ambient air near the landfill were below the levels known to cause non-cancer health effects.

- Benzene and formaldehyde were detected above ATSDR Cancer Risk Evaluation Guides (CREGs). Further analyses indicate the cancer risk estimates for these two contaminants were low (from 3 in 100,000 to 6 in 1,000,000) and within the U.S. Environmental Protection Agency (EPA)'s target cancer risk range of 1 in 1,000,000 to 1 in 10,000. These pollutants are commonly found in outdoor air and the cancer risk estimates based on community measurements were typical of exposure across similar suburban/urban communities in the United States.

Conclusion 2

Short-term chemical exposures: PADOH and ATSDR conclude that acute (short-term) exposure to some of the contaminants detected in ambient air near the landfill could have caused transitory health effects for sensitive populations, such as pregnant women, children, older adults and people with respiratory disease.

Basis for Conclusion

- Ammonia exceeded the acute ATSDR comparison value (CV) of 1,200 µg/m^3 once at the Mid Valley High School (MVH) location. Temporary acute health effects such as mild irritation of the eyes, nose, and throat could have occurred for some individuals, especially sensitive populations, from exposure to ammonia on February 25, 2016 at the MVH location (8,000 µg/m^3). Although there was uncertainty regarding the representativeness of the maximum detection of ammonia due to field sampling issues and weather conditions on that particular day of sampling, the laboratory analysis was valid. Therefore, ammonia was further evaluated to protect public health.

- Methylamine exceeded the National Oceanic and Atmospheric Administration (NOAA) odor threshold level of 26.7 µg/m^3 once at all three monitoring locations. Acute odor-related health effects such as, mild irritation of the eyes, nose, throat and respiratory tract could have been experienced by some individuals, especially sensitive populations from exposure to methylamine on February 1, 2016 at the Sherwood Park (SHP) location (1,100 µg/m^3), as well as on February 4, 2016 at the Keystone Sanitary Landfill (KSL) (1,200 µg/m^3) and MVH (1,200 µg/m^3) locations.

- Acetaldehyde was detected twice (on March 17, 2016 and March 29, 2016) above the odor threshold level (3 µg/m^3) at each of the three monitoring locations, with a maximum concentration of 14 µg/m^3 at KSL, 15 µg/m^3 at MVH, and 17 µg/m^3 at SHP. Acute odor-related health effects people could experience from exposure to this chemical include irritation of the eyes, skin, and respiratory tract.

- Hydrogen sulfide was detected above its odor threshold range of 0.5 – 300 ppb [ATSDR 2016]. The maximum concentrations were 13,624 µg/m^3 (9,745 ppb) at the MVH athletic field location and 134 µg/m^3 (96 ppb) at the working face of the landfill location during the mobile analytical unit (MAU) screening. Although, the detection limit for hydrogen sulfide in the community-based monitoring was much lower than that available with the MAU, no detections of hydrogen sulfide were observed in the community-based monitoring results.

- Currently, public health agencies are limited in our ability to evaluate the combined acute health effects from exposure to multiple contaminants in air. In this evaluation, contaminants were detected only once or twice exceeding the acute CV or odor level on different days. Therefore, we do not expect combined health effects from the detected levels of ammonia, methylamine, acetaldehyde and hydrogen sulfide, since these chemicals were not detected at the same time and/or at the same location.

Additional information on effects of environmental odors on health as well as resources for residents who are concerned about odors in their community is available at https://www.atsdr.cdc.gov/odors/index.html.

Conclusion 3

Particulate matter exposures: Based on the particulate matter ($PM_{2.5}$) results from the Scranton air monitoring station, PADOH and ATSDR conclude that breathing the levels of $PM_{2.5}$ detected when the results are averaged over a long term (months or a year or more) is not expected to harm people's health. However, PADOH and ATSDR conclude that there were peak short-term (daily or 24-hour) $PM_{2.5}$ exposure concentrations that could harm people's health.

Basis for Conclusion

- The annual 2015 average (10.4 $\mu g/m^3$), the 8 months of 2016 average (8.5 $\mu g/m^3$), and the combined 2015-2016 20-month average (9.7 $\mu g/m^3$) $PM_{2.5}$ results were all either essentially at or below the World Health Organization (WHO) annual health-based CV of 10 $\mu g/m^3$.

- There were few daily average $PM_{2.5}$ levels (above 12.1 $\mu g/m^3$) of health concern for unusually sensitive populations such as individuals with heart, lung, cardiopulmonary disease at this location. There were two hourly peak values (one in May 2015 and another in July 2016) that were particularly high and of health concern for all populations; note these appeared to be isolated events on a single day that were preceded and followed by days with much better air quality the rest of those months.

- All but two months (April 2015 and August 2016) over the 20-month period reviewed had at least one daily $PM_{2.5}$ average above the (EPA Air Quality Index (AQI) lower range for the moderate air quality designation of 12.1 $\mu g/m^3$. The AQI level for moderate air quality reflects a level that may cause transient effects in unusually sensitive individuals. The percentage of days monitored above this short-term level per month ranged from 0 to 68%.

- Based on polar plot assessment of particulate concentration, wind direction and wind speed, $PM_{2.5}$ levels above 12 $\mu g/m^3$ were recorded for brief (less than 24-hour) durations when winds were from the southeast and in the direction of KSL.

- Overall, higher 24-hour average $PM_{2.5}$ levels were associated with very low wind speeds indicating a $PM_{2.5}$ source very close to the sensor. Annually, stronger winds from the southeast (the direction of KSL) correspond to the lowest levels of $PM_{2.5}$.

- The regulatory limits for ambient air quality in the U.S. are EPA's National Ambient Air Quality Standards (NAAQS), and these limits consider results averaged over longer time periods. The NAAQS include an annual average concentration for $PM_{2.5}$, not to exceed 12 µg/m^3, averaged over three consecutive calendar years, as well as a 24-hour average concentration not to exceed 35 µg/m^3, averaged over three consecutive calendar years. The Scranton station was in compliance for both the annual and 24-hour NAAQS $PM_{2.5}$ standards from 2014-2016.

Conclusion 4

Subsurface vapor exposures: PADOH and ATSDR conclude that a data gap exists for assessing current and future potential exposures from subsurface vapor migration from the landfill into residences (i.e., vapor intrusion). Planned changes in landfill operations (including excavation, liner construction and landfilling in an area closer to the Swinick community) could adversely impact future subsurface vapor migration pathways.

Basis for Conclusion

- The subsurface geology beneath the Swinick neighborhood is complex due to mining and other human activities that modified the subsurface in the area.

- Elevated concentrations of carbon monoxide (CO) and volatile organic compounds (VOCs) have been detected in subsurface vapors and indoor air of Swinick homes in the past, but the cause of these contaminants is not known.

- Various agency reports have given different interpretations of the significance and potential source(s) of the contaminants detected in the subsurface and indoor air in the Swinick community in the past.

Conclusion 5

Cancer incidence: PADOH and ATSDR conclude that the age-adjusted incidence rate for all cancers (combined) and the rates for breast cancer, melanoma, non-Hodgkin's lymphoma and prostate cancer for all six zip codes (combined) surrounding the landfill were statistically significantly lower than the state rate. The laryngeal cancer rate in the combined zip code area was statistically significantly higher when compared to the state rate. Based on a review of peer-reviewed literature studies, there is inadequate (i.e. available studies are of insufficient quality, consistency or statistical power to decide the presence or absence of a causal association) evidence to suggest a causal link between laryngeal cancer and municipal solid waste disposal.

Basis for Conclusion

Cancer incidence rates in individual zip code areas and all the six zip codes combined were compared with the state rate by calculating standardized incidence ratios using U.S. Census and Pennsylvania cancer registry data from 2005-2014. However, cancer incidence rate analysis does not account for other non-environmental confounding risk factors such as heredity, occupation, diet, life style (smoking) etc., which are known to influence cancer incidence.

Recommendations

PADOH and ATSDR recommend that PADEP (1) continue to closely oversee landfill activities and enforce landfill permit regulations, including nuisance odor rules; (2) consider a fence line air monitoring program that includes publicly accessible real time results for selected limited analytes as part of the landfill's future permit requirements; (3) make publicly available the response and oversight activities that PADEP has conducted at the landfill; and (4) conduct timely responses to nuisance odor complaints and consider maintaining and posting an odor complaint log to document the frequency of odor complaints, intensity of odors, duration, odor characteristics, and weather conditions such as wind direction.

To address nuisance and general public health concerns related to seagulls drawn to landfill operation, PADOH and ATSDR suggest PADEP and landfill authorities consider best practices for minimizing gull populations near KSL, including minimizing the open working face of the landfill to the extent feasible.

PADOH and ATSDR recommend that involved state and federal agencies should continue to emphasize to local authorities and community members that property owners should install and properly maintain carbon monoxide monitors in this area.

PADOH and ATSDR recommend that PADEP should consider working with the landfill to perform vapor intrusion investigations in the Swinick community to evaluate current indoor air levels of VOCs and to ensure that conditions do not change in the future after new operations commence in the historic Dunmore landfill area.

PADOH and ATSDR recommend that residents and school officials monitor air quality alerts for the area (for example, via EPA's AirNow website for the Scranton area at https://airnow.gov/index.cfm?action=airnow.local_city&mapcenter=%200&cityid=608), consider implementing EPA's Air Quality Flag Program https://airnow.gov/index.cfm?action=flag_program.index), and take protective actions as needed. This is particularly important for sensitive populations, older adults, and children. PADOH and ATSDR recommend that residents minimize exposure to sewer gases by running water periodically through floor and sink drains, especially those used less often. This prevents the traps in the pipes from drying out. Also, it is important to maintain septic systems (if applicable) and call a licensed plumber if you have wet spots in crawlspaces under your home or in your yard that do not go away.

Next Steps

PADOH and ATSDR

- Shared the public comment version of this KSL health consultation (dated December 14, 2017) with local residents and interested stakeholders and held a public availability session on January 29, 2018 to explain the findings and address questions from the community.

- Solicited public comments and incorporated our responses into this final report.

PADOH and ATSDR will continue to assist PADEP, when requested with evaluation of additional environmental data from the landfill and surrounding communities.

Limitation of the findings

PADOH and ATSDR identified the following limitations and uncertainties in the sampling and the subsequent public health evaluation:

- The air sampling information represents ambient air quality in the community during the current operating scenario for the landfill. It does not represent air quality if the landfill expands its operations. Under the current expansion proposal, changes are anticipated that could impact the community's air quality including (1) landfill operations would move to a working face closer to residential areas; and (2) the additional weight and composition of landfilled materials might cause unknown changes in subsurface vapor conditions.

- While the agencies collaborated to be as comprehensive as feasible in the analytes included in the air monitoring, not every contaminant potentially associated with emissions from a landfill was included in the analyte list, and several contaminants had method detection limits above the ATSDR CVs and/or odor thresholds. In addition, a common odor causing landfill contaminant (hydrogen sulfide) was detected at high levels (13,624 µg/m3 or 9,745 ppb) during one of the MAU monitoring periods but was not detected during the community-based air monitoring. This observed difference in our monitoring data sets warrants further evaluation if strong sulfur odors are observed in the community in the future. Further, although acrolein was detected several times at all three monitoring locations, there are established data quality concerns with standard analyses for acrolein and the health agencies decided not to further evaluate acrolein.

- The community-based air monitoring occurred only for a three-month duration. The three months monitoring may not represent the full range of exposures that might occur throughout a full year.

- The objective of PADEP's air monitoring collaboration with the health agencies was to evaluate ambient air quality near the landfill where people are breathing the air. Hence, monitoring locations were prioritized on that basis. However, the available monitoring locations in the community were not in the direction of prevailing winds coming from the landfill. Therefore, the tradeoff in this situation was that contaminants related to landfill emissions were likely not detected at the community monitoring locations except in the less frequent times that winds were blowing opposite the prevailing direction. Lastly, sampling data were not collected at background locations for comparison to monitoring locations closest to the site.

Statement of Issues

On February 17, 2015, PADOH received a request from a Pennsylvania state representative as well as from community members to conduct an environmental health study/evaluation of air quality surrounding the landfill. PADOH and ATSDR reviewed the available environmental data collected by PADEP near the landfill and provided the public health evaluation in this health consultation.

Background

Keystone Sanitary Landfill (KSL) is located at 249 Dunham Drive, Dunmore, Pennsylvania, in Lackawanna County. The landfill is within Dunmore and Throop boroughs adjacent to Interstate 81 and the Casey Highway 6 (Appendix A, Figures A1 and A2). The KSL spans approximately 1,000 acres, and it is one of the largest active landfills in Pennsylvania. This landfill operates under permits regulated by the PADEP and receives approximately 7,000 tons of waste per day from Pennsylvania, New York, New Jersey and Connecticut (in person communication with KSL manager during site visit, March 10, 2015). At a site visit in 2015, landfill management characterized the composition of accepted waste as approximately 77% municipal solid wastes, 10% drill cuttings from unconventional natural gas drilling operations, 6% sludge and residual wastes, 4% flood wastes, and 3% construction and demolition wastes. KSL accepted 414,420.8, 507,180.5, 506,830.8, and 468,008.8 tons per quarter in 2015; 382,821.5, 453,615.8, 485,204.2, and 463,014.6 tons per quarter in 2016, and 371,075.8 and 461,523.5 tons per quarter in 2017 [Mcgurk 2017].

In April 2012, the landfill was approved to increase its maximum daily volume from 5,000 tons to 7,500 tons (KSL manager, personal communication during site visit, March 10, 2015). In 2014, the PADEP received an application for the Phase III expansion of the KSL. The expansion area is to be located on 435 acres within the current permit boundary and involves expanding over and between existing fill areas. The application originally proposed to increase the height of the landfill by 165 feet. Following KSL and PADEP's evaluation of the application, KSL responded with new proposed landfill permit parameters, including a significant reduction in the proposed final height of the expansion and a reduction in volume and design life. Most waste as proposed in this new application will be placed in the valley between the existing disposal areas. The revised proposal would increase the facility's disposal capacity by 134 million cubic yards and expand Keystone's life-span by approximately 44 years (PADEP Program Manager, email communication, May 1, 2017).

From February 2015 to the present, PADOH and ATSDR have been interacting with the community regarding their concerns over potential environmental contamination due to landfill operations and proposed expansion application. The community has environmental and health concerns related to noise, odors, dust and toxic contaminants in air due to landfill operations. Community members associate the following health concerns with the landfill: cancer, immune system disorders, nervous system disorders, birth defects, liver problems, skin problems, respiratory illnesses, muscular problems, nosebleeds, and headaches. Some community members who live near the landfill oppose the expansion of the landfill. They also have expressed concerns regarding the landfill's leachate water mixing into storm water, and odors due to activities surrounding the landfill. Additional information on community concerns is provided in Appendix B in a question and answer format.

This health consultation is principally focused on our public health evaluation of PADEP's 2016 ambient air sample results. In addition, this health consultation evaluates available data on particulate matter in ambient air in the area, subsurface investigation, as well as rates of cancer in the community. Information on PADEP's MAU air data, odor complaints in the community, surface water results, and community concerns are included in Appendices.

PADOH and ATSDR invited the public to review the public comment version of the KSL health consultation and provide comments during the public comment period (December 14, 2017 to February 14, 2018). The public comment version was revised to address the public comments. Those comments and responses are included in Appendix I. Appendix J was included to support specific responses related to comments 89 and 112.

Demographics

PADOH and ATSDR reviewed the population demographics within a 1-mile radius of the landfill (Appendix A, Figure A1) based on 2010 U.S. Census data. As of 2010, there were 6,794 people living within one mile of the landfill boundary. The population was 97% White, 1% Asian, and 2% other races, 6% were children (age 6 and younger), 22% were adults aged 65 and older, and 18% were females (ages 15 to 44 years). PADOH and ATSDR also reviewed the demographics nearby each monitoring station individually (Appendix A, Figures A3a-A3c). There were 3,457 people living within one mile of the KSL monitoring location, and 3,707 people living within one mile of the MVH monitoring location. Over 1,700 students attend the high school (7^{th}-12^{th} grade) and elementary school (kindergarten- 6^{th} grade) at this location. Also, there were 7,690 people living within one mile of the SHP monitoring location.

Environmental Data

Mobile Analytical Unit (MAU) Air Monitoring

As an initial screening procedure to identify contaminants in the air near the landfill, PADEP conducted air monitoring using an Open Path Fourier Transform Infrared (OPFTIR) spectrometer system on PADEP's MAU at the following six locations: SHP, MVH parking lot, MVH athletic field, Swinick neighborhood, the working face of the landfill where waste is actively deposited, and the leachate lagoon; see Appendix A, Figure A4. The first four of these locations were selected to represent where people live and work in the community, and the last two of these locations were selected as onsite potential contaminant source locations where emissions to the air would be expected to occur. MAU monitoring was conducted to identify contaminants near potential source locations on three dates: April 2015, June 2015, and March 2016. Air data from the OPFTIR method can only be helpful to instantly identify the pollutants emitted from the landfill/potential source location at the time of sampling only. This method has limited utility for public health exposure assessment because of its high detection limits and because the instantaneous readings cannot be converted into appropriate exposure values for the evaluation of potential health effects. In addition, this instrument's detection limits vary markedly from place to place due to factors such as instrument calibration, distance/angle that the electromagnetic beam traverses (beam path), deployment of beam transmission and reception, ambient air temperature, and relative humidity of air. Based on these data limitations, MAU results were evaluated on a limited basis.

A summary of the instantaneous contaminant concentrations reported from the PADEP MAU at both the offsite (community) and onsite (landfill) locations is provided in Appendix C, Table C5. Table C6 summarizes the maximum concentration of contaminants detected at the offsite (community) locations.

Community-Based Summa Canister Ambient Air Monitoring

Following the review of these MAU air monitoring data and literature on common landfill gas contaminants, PADOH, ATSDR, and PADEP selected certain contaminants for more rigorous community-based air monitoring using glass-lined summa canisters and sorbent tubes. The goal of this effort was to analyze the classes of pollutants identified as being present by the OPFTIR screening and those known to be emitted from landfills. Both summa canisters and sorbent tubes have been extensively validated for monitoring air toxics in indoor and outdoor air. Contaminants selected for further monitoring were 75 VOCs, analyzed by method TO-15; 20 reduced sulfur compounds (e.g., mercaptan, hydrogen sulfide, carbon disulfide) analyzed by method ASTM D 5504-12; 3 carbonyls/aldehydes compounds (acetaldehyde, formaldehyde, and acrolein) analyzed by method TO-11; ammonia, analyzed by modified National Institute for Occupational Safety and Health (NIOSH) 6015 method; methanol, analyzed by modified NIOSH 2000 method; methylamine, analyzed by Occupational Safety and Health Administration (OSHA) method 40; and triethylamine, analyzed by modified OSHA method PV2060. Each sample was collected over a 24-hour period every 3 days from January – April 2016 at two community monitoring locations (MVH and SHP) and one near the landfill monitoring location (KSL) (Appendix A, Figure 3). The two community monitoring locations (MVH and SHP) were selected based on proximity to populated areas and ability to obtain access agreements from nearby private residences. All three monitoring locations were within two miles from the active disposal area and within a mile from the permit boundary of the landfill property. A total of 90 samples were collected from all locations (30 samples from each location) and 87 valid measurements were evaluated (29 samples for each location). Photographs of the air monitoring locations and the interior of a sample box are provided in Appendix A Figures A5- A8.

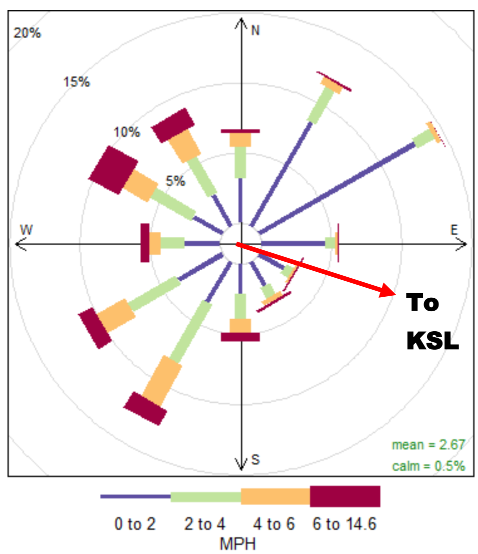
These monitoring stations were deployed and operated by PADEP officials. The goal of the three-month sampling period, with locations in three directions from the landfill, and inclusive of a broad range of contaminants potentially related to the landfill, was to try to generate a representative picture of the local air quality for nearby residents.

From PADEP's odor complaints log document (Appendix C, Table C4), there were only six odor complaints which occurred during the air sampling period (January–April 2016). All samples were validated by checking monitoring parameters, including sampling flow rates. Duplicate samples were run randomly and were in tolerance with original samples. Sample analyses were completed by PADEP’s contractor, Australian Laboratory Services, and analyzed in Cincinnati, Ohio and Simi Valley, California. PADOH and ATSDR evaluated only the validated sample results in this health consultation.

Wind Analysis

To assess the prevailing wind patterns near the landfill, PADOH and ATSDR obtained wind speed and wind direction data from the Scranton meteorological station located about 1.5 miles northwest of the landfill. ATSDR generated wind roses from the available data. A wind rose displays the statistical distribution of wind speeds and directions observed at a meteorological station. The wind rose in Figure 1 below indicates the prevailing wind direction in the area is from the northwest and southwest. Based on the prevailing wind information, the areas most likely to be affected from emissions from the current working face of the landfill are those areas located southeast and northeast of the current working face of the landfill.
As shown on Figures A3 in Appendix A, there are no residential areas and only Interstate 81 and Route 6 in the southeast and northeast direction adjacent to the landfill. The objective of PADEP's air monitoring collaboration with the health agencies was to evaluate ambient air quality near the landfill where people are breathing the air. Hence, monitoring locations were prioritized on that basis. The tradeoff in this situation was that contaminants related to landfill emissions were likely not detected at the community-based monitoring locations except in the less frequent times that winds were blowing opposite the prevailing direction. Monthly and yearly wind direction patterns and additional supporting meteorological analyses are summarized in detail in Appendix D.

Figure 1: Annual Wind Rose Depicting Prevailing Wind Direction at Keystone Sanitary Landfill Based on Scranton Meteorological Station (April 2015 – April 2016)



Particulate Matter ($PM_{2.5}$) Ambient Air Monitoring

PADEP collected $PM_{2.5}$ data from the closest PADEP's Commonwealth of Pennsylvania Air Monitoring System (COPAMS) station in Scranton (Appendix D, Table D). There are several potential sources of $PM_{2.5}$ in the site area, including automobile and truck emissions on and off of the landfill, as well as industrial operations. PADOH and ATSDR evaluated regional $PM_{2.5}$ levels from PADEP's COPAMS station in Scranton from January 2015 to August 2016 in this public health evaluation to consider whether landfill operations were impacting this aspect of air quality.

Subsurface Air Quality Monitoring

PADOH and ATSDR reviewed available historical environmental data on potential subsurface impacts to indoor air quality near the KSL (Appendix E, Table E1to E3). Groundwater, residential indoor air, and sub-surface borehole sampling was conducted from 1997–2002 in the Swinick neighborhood of Dunmore by the PADEP and other agencies to evaluate subsurface levels of CO and other gases and the impact on residences. These investigations were not specifically related to the Keystone Landfill site. After those investigations, a few residences were provided with permanent CO detectors and had their floor drain systems modified to prevent future gas migration into their homes; and venting of the affected subsurface areas was conducted to release CO to the atmosphere and decrease the potential for migration into the homes. The source of these subsurface gases in the community was not determined.

Cancer Registry Data

To address community's cancer health concern near the landfill, PADOH and ATSDR reviewed relevant cancer data near the landfill for the following six zip codes: 18434, 18447, 18509, 18510, 18512, and 18519 (Appendix F, Table F). Cancer incidence rates were compared for each six-individual zip code with the state rate and for all six zip codes combined with the state rate using U.S. Census and Pennsylvania cancer registry data from 2005-2014.

Health Effects Evaluation

Exposure Pathway Analysis

An exposure pathway is defined as the process by which people are exposed to or encounter chemical substances. An exposure pathway has five parts: (1) a source of contamination, (2) an environmental medium and transport mechanism, (3) a point of exposure, (4) a route of exposure, and (5) a receptor population. Generally, ATSDR considers three exposure categories: 1) completed exposure pathways, that is, all five parts of a pathway are present; 2) potential exposure pathways, that is, one or more of the parts may not be present, but information is insufficient to eliminate; and 3) eliminated exposure pathways, that is, a receptor population does not come into contact with contaminated media. Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future.

Completed Exposure Pathway

Inhalation of ambient air near the landfill

Landfills can impact air quality by emissions from the landfill migrating offsite. Emissions from a landfill can move through the landfill surface to the ambient air and be carried by wind to the community. A person's level of exposure to air contaminants from a landfill can vary depending on many factors that influence the direction, speed, and distance of migration of contaminants from the landfill. Some of these factors which may impact levels of exposure to some air contaminants include but are not limited to

- Landfill cover type,
- Natural and man-made pathways,
- Wind speed and direction,
- Moisture,

- Groundwater levels,
- Temperature, and
- Barometric and soil gas pressure.

A completed exposure pathway exists through inhalation of ambient air near the landfill.

Potential Exposure Pathway

Incidental inhalation of landfill contaminants in indoor air through subsurface vapor migration (i.e. vapor intrusion)

Volatile and semi volatile landfill contaminants can migrate underground, percolate upward, and impact the indoor air of nearby buildings. Landfill operators, including at the KSL, collect gases created by the landfill to reduce the potential for migration offsite. To further evaluate this potential exposure pathway, PADOH and ATSDR reviewed available historical environmental data. A conclusive connection to any source or combination of sources (including blasting operations related to highway construction, abandoned surface and deep coal mines and related waste disposal areas underlying the community, or the landfill) was never determined. However, reviewing these historic assessments showed that future changes to operating conditions, including excavation of existing waste and landfilling activities closer to the Dunmore Swinick community, have the potential to alter preferential subsurface vapor pathways. This potential subsurface vapor exposure pathway is a data gap for public health exposure assessment. Further details on our public health review of historical information available on the subsurface pathway is provided in Appendix E.

Eliminated Exposure Pathway

Ingestion and absorption of landfill contaminants through groundwater and leachate water

Residents in Dunmore and Throop Boroughs are connected to the public drinking water system. Groundwater that may be impacted by contamination from the landfill is not being accessed for the public drinking water source. Exposure from the landfill leachate water is also eliminated based on information from PADEP and from our site visits, because it appears that people do not have access to leachate on the landfill property. Contaminants detected in surface water or storm water runoff are provided in Appendix C, Table C7. More information on stormwater runoff contaminants is provided in the Community Concerns Summary in Appendix B.

Please note, biological monitoring was not conducted as part of this evaluation. As described in ATSDR's Public Health Assessment Guidance manual (https://www.atsdr.cdc.gov/hac/phamanual/pdfs/phagm_final1-27-05.pdf), ATSDR and our state health partners primarily rely on measurements of chemicals in the environment to conduct our public health evaluations. Biomarkers and biological half-lives for many of the toxins detected during the monitoring period have not been well documented in humans. Based on the exposure concentration of toxins detected, it was not necessary to conduct biological monitoring or estimate half-lives of toxins.

Data Screening and Comparison Values (CVs)

PADOH and ATSDR compared the maximum environmental concentrations detected with available CVs to screen contaminants detected near the landfill (Table C1 in Appendix C) that are likely to cause adverse health effects. CVs are chemical and media-specific concentrations in air, soil, and drinking water that are used to identify environmental contaminants for further evaluation. CVs are conservative and non-site specific. CVs are based on health guidelines with uncertainty or safety factors applied to ensure that they are adequately protective of public health.

Concentrations above a CV will not necessarily be harmful. Contaminants that exceed a CV were further evaluated using other standards and/or scientific studies, where appropriate, to determine whether adverse health effects are likely. When an ATSDR CV is not available, screening values are acquired from other environmental and health agencies. However, the basis for values obtained from other environmental and health agencies (CARB, TCEQ and NOAA) were not reviewed/approved by ATSDR. CVs are not intended to be used as environmental clean-up levels. After screening the contaminants of potential concern, PADOH calculated an exposure point concentration (EPC) that is believed to represent typical upper bound exposure averages. A conservative EPC is the 95% upper confidence limit of the arithmetic mean (95UCL). See Appendix G for detailed information on CVs and calculations on 95UCL.

Evaluation of Community-Based Ambient Air Monitoring Data

As noted above, PADOH and ATSDR screened ambient air data to select contaminants of potential concern (COPC). These COPC were then subjected to further analyses. Appendix C, Table C1 summarizes the contaminants detected during the January through April 2016 monitoring event. The maximum concentration of the following contaminants exceeded either chronic or acute CVs: 1,4-dioxane, benzene, naphthalene, ammonia, formaldehyde, acetaldehyde, acrolein and methylamine.

Of these contaminants, 1,4-dioxane, naphthalene, ammonia, methylamine, and acetaldehyde were rarely detected (less than 5 days out of 29 days of monitoring) above their respective CVs for one or two days over the entire monitoring period. These infrequent and intermittent maximum concentration exposures are not considered chronic exposures. Therefore, they were not selected for further chronic health evaluation. Maximum concentrations of acrolein, benzene, and formaldehyde frequently exceeded the ATSDR CREG values. However, acrolein is a highly reactive chemical and this complicates analysis and detection. In 2010, EPA reported a study that raised significant concerns about the reliability of acrolein monitoring results using summa canisters and the currently available methods [EPA 2010]. Therefore, due to established data quality concerns with standard analyses for acrolein, the acrolein data were not further evaluated in this health consultation.

The levels detected for all the COPC were either low or below the available acute CVs, except for methylamine and ammonia. These two contaminants were selected for acute-health effects evaluation.

General health effects information on contaminants selected (benzene, formaldehyde, ammonia, methylamine and $PM_{2.5}$) for further health effects evaluation are summarized in Appendix H.

Contaminants Selected for Chronic Public Health Analysis from Community-Based Ambient Air Monitoring Data

Using the conservative EPC of 95UCL, PADOH selected two contaminants (benzene and formaldehyde) for potential chronic health effects evaluation (Table 1, see below).

Benzene

Benzene was detected at quantifiable levels in 7 out of 29 air samples at the KSL and SHP locations and 6 out of 29 air samples at the MVH location. The 95UCL was 0.57 µg/m^3 at KSL, 0.75 µg/m^3 at MVH, and 0.71 µg/m^3 at SHP. These levels exceeded the ATSDR CREG value of 0.13 µg/m^3 for cancer health effects. However, the 95UCLs at all three locations were less than 29 µg/m^3 and 9.6 µg/m^3 – the ATSDR CV for acute and chronic exposure to benzene for non-cancer health effects.

Non-cancer Exposure Evaluation

Since the 95UCLs of benzene levels measured at all three locations were less than the ATSDR acute and chronic CV, non-cancer health effects (both acute and chronic) are not expected from exposure to benzene at any of the three locations.

Cancer Exposure Evaluation

The ATSDR CREG for benzene is 0.13 µg/m^3 and is equivalent to the risk of one additional cancer per lifetime among a population of 1,000,000 exposed individuals (or the risk is equal to 0.000001). The CREG is very low given the typical cancer risk in the United States is one in two men (0.5) or one in three women (0.33)[1].

To estimate excess lifetime cancer risk from exposure to benzene from these monitoring data, the exposure concentration was multiplied by the EPA inhalation unit risk (IUR). The EPA IUR for benzene is 0.0000078 µg/m^3. Based on national average ambient air levels in rural areas (1.5 µg/m^3), PADOH estimated that an individual continuously breathing ambient air (in remote/rural areas in USA) containing benzene with a concentration of 1.5 µg/m^3 over his or her lifetime (78 years)[2] would theoretically have about a 1.2×10^{-5} or 1 in 100,000 increased chance of developing cancer. PADOH calculated the cancer risks at the benzene levels detected at KSL (0.57 µg/m^3), MVH (0.75 µg/m^3) and SHP (0.71 µg/m^3) monitoring locations. The estimated excess lifetime cancer risk for KSL was 4.4×10^{-6} or about 4 in 1,000,000 and for MVH was 5.8×10^{-6} or about 6 in 1,000,000 and for SHP was 5.5×10^{-6} or about 6 in 1,000,000 (Table 2 below). The estimated cancer risks at all three locations were less than the estimated cancer risk associated with national average ambient remote/rural outdoor air (Note: monitoring of benzene was not conducted at background locations). Therefore, residents living near KSL, MVH and SHP do not have elevated cancer risk from exposure to ambient benzene. In summary, the cancer risk estimates from exposure to benzene at all three locations were low under current operating conditions at the landfill.

1 https://www.cancer.org/cancer/cancer-basics/lifetime-probability-of-developing-or-dying-from-cancer.html
2 https://www.epa.gov/expobox/about-exposure-factors-handbook

Table 1. Summary of Contaminants Detected (January – April 2016) Above Comparison Values near the Keystone Sanitary Landfill, Dunmore PA (µg/m^3)

Contaminants	CV	CV Source	MDL	Monitoring Locations								
				KSL location			Community Locations					
				Landfill (KSL)			Mid Valley High School (MVH)			Sherwood Park (SHP)		
				Range	Detects/ Total samples	95 UCL	Range	Detects/ Total samples	95 UCL	Range	Detects/ Total samples	95 UCL
Benzene	9.6 0.13	cMRL CREG	0.79	<0.79–1.6	7/29	0.57	<0.79–2.6	6/29	0.75	<0.79–2.1	7/29	0.71
Formaldehyde	9.8 0.077	cMRL CREG	0.15	<0.15–6.9	26/29	2.1	<0.15–2.5	23/29	1.5	<0.15–2.3	25/29	1.5

Table 2. Cancer and Non-Cancer Risk Estimates of Contaminants Detected (January – April 2016) Above Comparison Values Near the Keystone Sanitary Landfill, Dunmore, PA (µg/m^3)

Contaminants	CV	CV Source	IUR	Monitoring Locations								
				KSL location			Community Locations					
				Landfill (KSL)			Mid Valley High (MVH)			Sherwood Park (SHP)		
				95UCL	ELCR	HQ	95UCL	ELCR	HQ	95UCL	ELCR	HQ
Benzene	9.6 0.13	cMRL CREG	7.8E-06	0.57	4.4E-06	0.1	0.75	5.8E-06	0.1	0.71	5.5E-06	0.1
Formaldehyde	9.8 0.077	cMRL CREG	1.3E-05	2.1	2.7E-05	0.2	1.5	1.9E-05	0.1	1.5	1.9E-05	0.1
Total Cancer Risk and Hazard Index					3.1E-06	0.3		2.5E-06	0.2		2.4E-06	0.2

µg/m^3 = micro gram per cubic meter; RfC = Reference Concentration; CREG = Cancer Risk Evaluation Guide; a/cMRL = acute/chronic minimum risk level; ND = Not Detected; 95UCL = 95% mean Upper Confidence Limit; MDL = Method Detection Limit; For most NDs recommended censored value of MDL/2, and for a few NDs recommended censored values of MDL/square root of 2 is used for calculating 95UCL.; For formaldehyde, there were only few non-detects, hence MDL/ square root of 2 was used, and for benzene there were only few detects, hence MDL/2 was used to calculate 95UCL CV = Comparison Value; IUR = Inhalation Unit Risk; ELCR = Excess Lifetime Cancer Risk = IUR x 95% mean UCL value; HQ = Hazard Quotient = 95UCL Air/cMRL or RfC; NA = Not Available/Applicable; An example of ELCR calculation for continuous benzene exposure for a lifetime of over 78 years at MVH location: 7.8E-06 x 0.75 = 5.8E-06

Formaldehyde

Formaldehyde was detected at quantifiable levels in 26 out of 29 air samples at KSL, 23 out of 29 air samples at MVH and 25 out of 29 air samples at SHP. The 95UCL at KSL was 2.1 µg/m^3, at MVH was 1.5 µg/m^3, and at SHP was 1.5 µg/m^3. All these levels exceeded the ATSDR CREG value of 0.077 µg/m^3 for cancer health effects. However, the 95UCLs at all three locations were less than 49 µg/m^3 and 9.8 µg/m^3 — ATSDR's CV for acute and chronic exposure respectively to airborne formaldehyde for non-cancer effects.

Non-Cancer Exposure Evaluation

The formaldehyde 95UCLs calculated for each of the three locations were less than ATSDR's acute and chronic CV of 49 µg/m^3 and 9.8 µg/m^3 respectively. Therefore, non-cancer health effects (both acute as well as chronic) are not expected from ambient air formaldehyde exposures at any of the three locations.

Cancer Exposure Evaluation

The ATSDR CREG for formaldehyde is 0.077 µg/m^3 and is equivalent to the risk of one additional cancer per lifetime among a population of 1,000,000 exposed individuals (or the risk is equal to 0.000001). The CREG is very low given the typical cancer risk in the United States is one in two men (0.5) or one in three women (0.33)[3].

To estimate excess lifetime cancer risk from exposure to formaldehyde at the detected levels during this monitoring, the 95UCL was multiplied by the EPA IUR. The EPA IUR for formaldehyde is 0.000013 per µg/m^3. Based on the average concentration of formaldehyde in U.S. suburban outdoor ambient air of 7.4 µg/m^3 (Appendix H), PADOH estimated that an individual living in a suburban environment continuously breathing ambient air containing formaldehyde (7.4 µg/m^3) over his or her lifetime would theoretically have about 9.6×10^{-5} or 10 in 100,000 increased risk of developing cancer. For indoor air containing formaldehyde at 20.91 µg/m^3 (Appendix H), the estimated cancer risk was 2.7×10^{-4} or about 3 in 10,000 increased chance of developing cancer.

PADOH calculated the excess lifetime cancer risks for formaldehyde at KSL (2.7×10^{-5} or 3 in 100,000), MVH (1.9×10^{-5} or about 2 in 100,000) and SHP (1.9×10^{-5} or about 2 in 100,000) (Table 2 above). These estimated excess lifetime cancer risks are slightly below cancer risk for typical ambient air formaldehyde exposures in the U.S. Therefore, based on the excess lifetime cancer risks, the residents living near the KSL, MVH, and SHP monitoring locations have no greater cancer risk from exposure to formaldehyde when compared to the general population of U.S. residents living in a similar environment. In summary, the cancer risk estimates from exposure to formaldehyde at all three locations were low and not expected to cause harmful cancer health effects under current operating conditions at the landfill.

[3] https://www.cancer.org/cancer/cancer-basics/lifetime-probability-of-developing-or-dying-from-cancer.html

Contaminants Selected for Acute Public Health Analysis from Community-Based Ambient Air Monitoring Data

Ammonia exceeded acute the ATSDR CV on one day at one location. Methylamine exceeded NOAA odor threshold level of 26.7 µg/m^3, on one day at all locations. However, the maximum level of methylamine detected at one location (SHP) wasn't found to coincide with the other two locations (KSL and MVH) on the same day.

Ammonia

Ammonia was detected five days out of 29 days at all three locations. The levels detected at the KSL and SHP monitoring stations were below the ATSDR acute MRL; but, at the MVH monitoring station, ammonia was detected once (8,000 µg/m^3 on February 25, 2016) exceeding the ATSDR acute CV of 1,200 µg/m^3. Note, issues with sampling equipment on a foul weather day (rain, snow, thunderstorm, 40+ mile per hour winds) were observed on the day of the high ammonia detection at MVH, which may have affected the sample reading. However, to be conservative, PADOH and ATSDR assumed the data were acceptable and evaluated this result further. The highest level detected (8,000 µg/m^3) at MVH location is about four times lower than the lowest observed adverse effect level (34,760 µg/m^3) noted in a study of human volunteers [Verberk et al. 1977], and approximately seven times higher than the acute MRL ATSDR derived from this study. Hence, it is possible that people who are sensitive to ammonia might have experienced acute health effects such as mild irritation of the eyes, nose, and throat. These effects could have possibly lasted for a short period since exposures occurred just once over a three-month monitoring period.

Methylamine

Methylamine detected once at all three monitoring locations exceeded NOAA odor threshold level of 26.7 µg/m3. However, the levels detected at SHP (1,100 µg/m^3 on February 1, 2016) and at KSL and MVH (1,200 µg/m^3 on February 4, 2016), were about 21 - 23 times lower than the lowest level (25,407 µg/m^3) at which acute health effects were observed in an available study [Bingham et al. 2001] of people exposed to this chemical in air (see Appendix H). Uncertainty remains regarding the lowest level (25,407 µg/m^3) at which acute health effects could occur in the general population. Therefore, it is possible that exposure to methylamine at the highest levels detected on those days at all three locations could have resulted in odor induced acute health effects such as mild irritation of the nose, eyes, and throat, particularly for sensitive populations (such as pregnant women, children, older adults and people with respiratory disease).

Contaminants with Comparison Values Below the Method Detection Limit

A few contaminants that were not detected during the community-based monitoring have cancer CVs (CREG values) below the method detection limits. This included the following contaminants: vinyl chloride, 1,3-butadiene, acrylonitrile, chloroform, carbon tetrachloride, 1,2-dibromoethane, hexachlorobutadiene, and cis-dichloropropene (see Table 3 below). Therefore, we cannot make a quantitative cancer risk determination about potential exposure to these contaminants. However, non-cancer health effects from exposure to these chemicals is not expected, since the detection limits were below their respective non-cancer CV values.

Table 3: Contaminants with Comparison Values Below Method Detection Limits (µg /m^3)

Contaminants	MDL	Concentration	Health CV	Source
Acrylonitrile	0.781	ND	0.015	CREG
1,3-Butadiene	0.774	ND	0.033	CREG
Carbon tetrachloride	0.754	ND	0.17	CREG
Chloroform	0.781	ND	0.043	CREG
Cis-Dichloropropene	0.680	ND	0.25	CREG
1,2-Dibromoethane	0.768	ND	0.0017	CREG
Hexachlorobutadiene	0.778	ND	0.045	CREG
Vinyl chloride	0.792	ND	0.11	CREG

µg/m^3 = micro grams per cubic meter; CREG = Cancer Risk Evaluation Guide; ND = Not Detected; MDL = Method Detection Limit; CV = Comparison Value

Evaluation of Air Monitoring Data for Odor Symptoms

Per the information recorded in PADEP's odor complaint logs (Appendix C, Table C4), there were only six odor complaints which occurred during the air sampling period (January – April 2016). Appendix C, Table C2 shows the frequencies of three contaminants (acetaldehyde, ammonia and methylamine) that were detected above their odor threshold levels in the community-based air monitoring near the KSL using summa canisters and sorbent tubes. Note, odors in the environment can come from many sources. Also, not all odors are toxic. Toxicity depends on the substances, its exposure concentration, and the frequency and duration of exposure. If the right conditions exist, odorous contaminants can be toxic and cause health effects. Odors can also cause odor-related symptoms even if they are not causing toxicity. Odor-related symptoms people can experience from these chemicals include shortness of breath, headaches, nausea, and irritation of the eyes, nose and respiratory tract. These symptoms would have usually resolved when the odor goes away. A few sulfur compounds were detected in the MAU monitoring (particularly hydrogen sulfide) but were not detected in the community-based air monitoring. Appendix C, Table C3 shows the number of contaminants that may cause odor-related symptom but were not able detected in the community-based air monitoring due to the high detection limit. Hence, odor related symptoms cannot be discussed for these non-detects. Additional information on effects of environmental odors on health as well as resources for residents who are concerned about odors in their community is available at https://www.atsdr.cdc.gov/odors/index.html.

Acetaldehyde was detected twice at each location with a maximum concentration of 14 µg/m^3 at KSL, 15 µg/m^3 at MVH, and 19 µg/m^3 at SHP exceeding the odor threshold level of 3 µg/m^3 [Nagata 2003]. Acetaldehyde is common in landfill gases. Acetaldehyde has a pungent suffocating odor, but at dilute concentrations the odor is fruity and pleasant. Acute exposure to acetaldehyde results in irritation of the eyes, skin, and respiratory tract. Transient irritation of the eyes, nose, and throat could have resulted from brief exposures to these contaminants. The presence of acetaldehyde above the odor threshold on those days could have potentially affected nearby community's quality of life.

Ammonia was detected only once at MVH (8,000 µg/m^3) on February 25, 2016 exceeding the odor threshold range of 3,487 – 36,962 µg/m^3 [NRC 2008]. Ammonia is a corrosive irritant gas. It causes irritation of the eyes, nose, and throat at the levels detected in air. Since the detected ammonia concentration falls within the odor threshold range, exposure to ammonia on that day could have potentially affected the nearby community's quality of life, particularly sensitive populations (such as pregnant women, children, older adults and people with respiratory disease).

Methylamine was detected once at each location (1,200 μg/m^3 at KSL and MVH on February 4, 2016, and 1,100 μg/m^3 at SHP on February 1, 2016) above the odor threshold level of 26.7 μg/m^3 [NOAA 1999]. Methylamine is a colorless gas with a fish or ammonia like odor. Therefore, it is possible that exposure to methylamine at the highest levels detected on those days at all three locations could have potentially affected the nearby community's quality of life, particularly sensitive populations.

Hydrogen sulfide (H_2S) was detected only in the MAU monitoring but was not detected in the community-based air monitoring. H_2S is a colorless, flammable gas with a distinctive rotten egg odor and was detected above its odor threshold range of 5 – 300 ppb [ATSDR 2016]. The maximum concentrations were at 13,624 μg/m3 (9,745 ppb) at the MVH athletic field location and at 134 μg/m3 (96 ppb) at the working face of the landfill location during the mobile analytical unit (MAU) screening. Although, the detection limit for H_2S in the community-based monitoring was much lower than that available with the MAU, no detections of H_2S were observed in the community-based monitoring results. The short-term presence of high levels of H_2S on that one day could have adversely affected some individuals at the MVH athletic field location, especially sensitive populations.

Evaluation of $PM_{2.5}$ Ambient Air Monitoring Data

A summary of the $PM_{2.5}$ 24-hour daily maximum and monthly average monitoring results from PADEP's COPAMS station in Scranton from January 2015-August 2016 is given in Appendix D, Table D. This time period corresponds to the overall duration of all of the field activities evaluating air quality in the community near the KSL.

PADOH and ATSDR used the EPA AQI lower range for the moderate air quality designation of 12.1 μg/m^3 to screen the Scranton COPAMS data for short-term (daily 24-hour) exposures. The AQI level for moderate air quality reflects a level that may cause transient effects in sensitive populations. PADOH and ATSDR used the WHO Air Quality Guideline (AQG) of 10 μg/m^3 to screen for long-term (annual average 24-hour) exposures.

As shown in Table D, the annual average $PM_{2.5}$ concentrations in 2015 (10.4 μg/m^3) and the average of the 8 months of 2016 when our monitoring took place (8.5 μg/m^3), as well as the combined 2015-2016 average (9.7 μg/m^3) were all either at or below the WHO AQG annual value of 10 μg/m^3. This means that long term health impacts from $PM_{2.5}$ levels in this area are not expected. However, all but two months (April 2015 and August 2016) over the 20-month period reviewed had at least one 24-hour average above the short-term CV. The percentage of days monitored per month with $PM_{2.5}$ values above the short-term CV ranged from 0 to 68%. There were two 24-hour average peak values (one in May 2015 and another in July 2016) that were particularly high; note these appeared to be isolated events that were preceded and superseded by days with much better air quality.

Eighteen out of the 20 months evaluated had the 24-hour average $PM_{2.5}$ levels in the good to moderate AQI category range. The moderate category corresponds to $PM_{2.5}$ concentrations of 12.1-35.4 μg/m^3. In the moderate AQI range, respiratory symptoms are possible in sensitive individuals, and there is possible aggravation of heart or lung disease in people with cardiopulmonary disease and older adults. EPA recommends that sensitive people should consider reducing prolonged or heavy exertion when air quality is in the moderate AQI range[4].

Note, the particulate matter CVs (WHO and EPA AQI) that PADOH and ATSDR used for screening purposes in this report are lower than the regulatory requirements the Commonwealth follows for ambient air quality. The regulatory limits for ambient air quality in the U.S. are EPA's NAAQS, and these limits consider results averaged over longer time periods. The NAAQS include an annual average concentration for $PM_{2.5}$, not to exceed 12 μg/m^3, averaged over three consecutive calendar years, as well as a 24-hour average concentration not to exceed 35 μg/m^3, averaged over three consecutive calendar years [EPA 2012]. The Scranton COPAMS station was in compliance for both the annual and 24-hour NAAQS $PM_{2.5}$ standards from 2014-2016.

Evaluation of Subsurface Air Monitoring Data

A detailed summary of the available subsurface air monitoring information is provided in Appendix E. Various reports have given different levels of interpretation of the historical subsurface air monitoring results in the Swinick community neighboring KSL. A conclusive connection to any source or combinations of sources (including blasting operations related to highway construction, abandoned surface and deep coal mines and related waste disposal areas underlying the community, or the KSL) was never determined. Regardless, historical data show several VOCs detected in boreholes installed in the site area that could be of potential concern if similar levels were detected inside the air of homes.

Residential data from the past suggested that VOC concentrations in residential areas were not as high as in boreholes. However, the past residential sampling for VOCs only included one sampling event in four homes, and the source of the VOCs (especially toluene, which was detected widely and at high levels) was never conclusively determined. Given the incompleteness of the records available on this past VOC sampling information and the fact that these data do not represent current conditions, we did not evaluate this information formally in this document.

Since the residential community was (1) constructed above a former coal mine, (2) is adjacent to a former sedimentation pond for coal washing, and (3) the residential fill, at certain depths, is of coal fines, and could produce VOCs including toluene, this issue should be further investigated because historical contamination could be an ongoing source of exposure if contaminated subsurface vapors are entering homes in the area. Although groundwater is not present in significant quantities in the upper aquifer system containing the former mine workings, it is conceivable that a previous spill could remain in pockets/fractures and that resulting volatiles could travel relatively long distances through the mine workings/fractures in the area.

[4] https://www.airnow.gov/index.cfm?action=aqibasics.aqi

Cancer Registry Data Review

PADOH and ATDSR have reviewed cancer statistics for Lackawanna County and local communities near KSL since the 1990s. Specific colorectal cancer types have been observed to be elevated in Lackawanna County and Northeast Pennsylvania overall in the past [ATSDR 1992, PADOH/ATSDR 1993, PADOH/ATSDR 1999].

Based on current community resident requests, PADOH reviewed cancer data from the Pennsylvania Cancer Registry from 2005-2014 for residents living near the landfill. Residents who were diagnosed with cancer over the period 2005-2014 while living at an address located in zip codes 18434, 18447, 18509, 18510, 18512, and 18519 were included. The following types of cancer were reviewed: bladder, brain, breast, cervix, colon, esophagus, Hodgkin's lymphoma, kidney, larynx, leukemia, liver, lung, melanoma, non-Hodgkin's lymphoma, oral cavity, ovary, pancreas, prostate, stomach, testis, thyroid, uterus and other cancer types. Age-adjusted cancer incidence rates were compared for each of the six individual zip codes with the state rate, and all six zip codes combined with the state rate. In summary, the majority of cancer subtypes were not statistically significantly different from the state rate, all the zip codes combined incidence rates were statistically significantly lower for breast cancer, melanoma, non-Hodgkin's lymphoma and prostate cancer and significantly higher for cancer of the larynx (Appendix F, Table F). Based on the American Cancer Society the common environmental risk factors for laryngeal cancer are, long and intense exposures to wood dust, paint fumes, and certain chemicals used in the metalworking, petroleum, plastics, and textile industries [ACS 2014]. Based on a review of peer-reviewed literature published between 1983-2008, Porta *et al* (2009) a study concluded that there is inadequate (i.e. available studies are of insufficient quality, consistency or statistical power to decide the presence or absence of a causal association) evidence to suggest a causal link between laryngeal cancer and municipal solid waste disposal. A detailed summary of the health outcome review of cancer in the community is provided in Appendix F.

Child Health Considerations

PADOH and ATSDR recognize that developing fetuses, infants, and children have unique vulnerabilities. PADOH and ATSDR considered potential health effects for children as part of this public health evaluation. A child's exposure can differ from an adult's in many ways. A child drinks more liquid, eats more food, and breathes more air per unit of body weight than an adult and has a larger skin surface area in proportion to body volume. A child's behavior and lifestyle also influence exposure levels. Children crawl on the floor, put things in their mouths, play closer to the ground, and spend more time outdoors. These behaviors can result in longer exposure durations and higher intake rates. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, access to medical care, and risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

Conclusions

PADOH and ATSDR reached the following five conclusions for the site assuming the data collection period is representative of typical conditions:

Conclusion 1

Long-term chemical exposures: PADOH and ATSDR conclude that chronic (long- term) exposure to the chemicals detected in ambient air near the landfill at the monitored locations is not expected to cause harmful non-cancer health effects under the landfill's current operating conditions. However, chronic exposure to benzene and formaldehyde may cause a very low increased cancer risk.

Basis for Conclusion

- Long-term exposures to the detected contaminants concentration in ambient air near the landfill were below the levels known to cause non-cancer health effects.

- Benzene and formaldehyde were detected above ATSDR Cancer Risk Evaluation Guides (CREGs). Further analyses indicate the cancer risk estimates for these two contaminants were low ((from 3 in 100,000 to 6 in 1,000,000) and within EPA's target cancer risk range of 1 in 1,000,000 to 1 in 10,000. These pollutants are commonly found in outdoor air and the cancer risk estimates based on community measurements were typical of exposure across similar suburban/urban communities in the United States.

Conclusion 2

Short-term chemical exposures: PADOH and ATSDR conclude that acute (short- term) exposure to some of the contaminants detected in ambient air near the landfill could have caused transitory health effects for sensitive populations, such as pregnant women, children, older adults and people with respiratory disease.

Basis for Conclusion

- Ammonia exceeded the acute ATSDR comparison value (CV) of 1,200 $\mu g/m^3$ once at the MVH location. Temporary acute health effects such as mild irritation of the eyes, nose, and throat could have occurred for some individuals, especially sensitive populations from exposure to ammonia on February 25, 2016 at the MVH location (8,000 $\mu g/m^3$). Although there was uncertainty regarding the representativeness of the maximum detection of ammonia due to field sampling issues and weather conditions on that particular day of sampling, the laboratory analysis was valid. Therefore, ammonia was further evaluated to protect public health.

- Methylamine exceeded the NOAA odor threshold level of 26.7 $\mu g/m^3$ once at all three monitoring locations. Acute odor related health effects such as, mild irritation of the eyes, nose, throat and respiratory tract could have been experienced by some individuals, especially sensitive populations from exposure to methylamine on February 1, 2016 at the SHP location (1,100 $\mu g/m^3$), as well as on February 4, 2016 at KSL (1,200 $\mu g/m^3$) and MVH (1,200 $\mu g/m^3$) locations.

- Acetaldehyde was detected twice (on March 17, 2016 and March 29, 2016) above the odor threshold level (3 $\mu g/m^3$) at each of the three monitoring locations, with a maximum concentration of 14 $\mu g/m^3$ at KSL, 15 $\mu g/m^3$ at MVH, and 17 $\mu g/m^3$ at SHP. Acute odor-related health effects people could experience from exposure to this chemical include irritation of the eyes, skin, and respiratory tract.

- Hydrogen sulfide was detected above its odor threshold range of 0.5 – 300 ppb [ATSDR 2016]. The maximum concentrations were 13,624 μg/m^3 (9,745 ppb) at the MVH athletic field location and 134 μg/m^3 (96 ppb) at the working face of the landfill location during the MAU screening. Although the detection limit for hydrogen sulfide in the community-based monitoring was much lower than that available with the MAU, no detections of hydrogen sulfide were observed in the community-based monitoring results.

- Currently, public health agencies are limited in our ability to evaluate the combined acute health effects from exposure to multiple contaminants in air. In this evaluation, contaminants were detected only once or twice exceeding the acute CV or odor level on different days. Therefore, we do not expect combined health effects from the detected levels of ammonia, methylamine, acetaldehyde and hydrogen sulfide, since these chemicals were not detected at the same time and/or at the same location.

  Additional information on effects of environmental odors on health as well as resources for residents who are concerned about odors in their community is available at https://www.atsdr.cdc.gov/odors/index.html.

Conclusion 3

Particulate matter exposures: Based on the particulate matter ($PM_{2.5}$) results from the Scranton air monitoring station, PADOH and ATSDR conclude that breathing the levels of $PM_{2.5}$ detected when the results are averaged over a long term (months or a year or more) is not expected to harm people's health. However, PADOH and ATSDR conclude that there were peak short-term (daily or 24-hour) $PM_{2.5}$ exposure concentrations that could harm people's health.

Basis for Conclusion

- The annual 2015 average (10.4 μg/m^3), the 8 months of 2016 average (8.5 μg/m^3), and the combined 2015-2016 20-month average (9.7 μg/m^3) $PM_{2.5}$ results were all either essentially at or below the World Health Organization (WHO) annual health-based CV of 10 μg/m^3.

- There were few daily average $PM_{2.5}$ levels (above 12.1 μg/m^3) of health concern for unusually sensitive populations such as individuals with heart, lung, cardiopulmonary disease at this location. There were two hourly peak values (one in May 2015 and another in July 2016) that were particularly high and of health concern for all populations; note these appeared to be isolated events on a single day that were preceded and followed by days with much better air quality the rest of those months.

- All but two months (April 2015 and August 2016) over the 20-month period reviewed had at least one daily $PM_{2.5}$ average above EPA's AQI lower range for the moderate air quality designation of 12.1 μg/m^3. The AQI level for moderate air quality reflects a level that may cause transient effects in unusually sensitive individuals. The percentage of days monitored above this short-term level per month ranged from 0 to 68%.

- Based on polar plot assessment of particulate concentration, wind direction and wind speed, $PM_{2.5}$ levels above 12 μg/m^3 were recorded for brief (less than 24- hour) durations when winds were from the southeast and in the direction of KSL.

- Overall, higher 24-hour average $PM_{2.5}$ levels were associated with very low wind speeds indicating a $PM_{2.5}$ source very close to the sensor. Annually, stronger winds from the southeast (the direction of KSL) correspond to the lowest levels of $PM_{2.5}$.

- The regulatory limits for ambient air quality in the U.S. are EPA's NAAQS, and these limits consider results averaged over longer time periods. The NAAQS include an annual average concentration for $PM_{2.5}$, not to exceed 12 μg/m^3, averaged over three consecutive calendar years, as well as a 24-hour average concentration not to exceed 35 μg/m^3, averaged over three consecutive calendar years. The Scranton station was in compliance for both the annual and 24-hour NAAQS $PM_{2.5}$ standards from 2014-2016.

Conclusion 4

Subsurface vapor exposures: PADOH and ATSDR conclude that a data gap exists for assessing current and future potential exposures from subsurface vapor migration from the landfill into residences (i.e., vapor intrusion). Planned changes in landfill operations (including excavation, liner construction and landfilling in an area closer to the Swinick community) could adversely impact future subsurface vapor migration pathways.

Basis for Conclusion

- The subsurface geology beneath the Swinick neighborhood is complex due to mining and other human activities that modified the subsurface in the area.

- Elevated concentrations of carbon monoxide (CO) and volatile organic compounds (VOCs) have been detected in subsurface vapors and indoor air of Swinick homes in the past, but the cause of these contaminants is not known.

- Various agency reports have given different interpretations of the significance and potential source(s) of the contaminants detected in the subsurface and indoor air in the Swinick community in the past.

Conclusion 5

Cancer incidence: PADOH and ATSDR conclude that the age-adjusted incidence rate for all cancers (combined) and the rates for breast cancer, melanoma, non-Hodgkin's lymphoma and prostate cancer for all six zip codes (combined) surrounding the landfill were statistically significantly lower than the state rate. The laryngeal cancer rate in the combined zip code area was statistically significantly higher when compared to the state rate. Based on a review of peer-reviewed literature studies, there is inadequate (i.e. available studies are of insufficient quality, consistency or statistical power to decide the presence or absence of a causal association) evidence to suggest a causal link between laryngeal cancer and municipal solid waste disposal.

Basis for Conclusion

Cancer incidence rates in individual zip code areas and all the six zip codes combined were compared with the state rate by calculating standardized incidence ratios using U.S. Census and Pennsylvania cancer registry data from 2005-2014. However, cancer incidence rate analysis doesn't account for other non-environmental confounding risk factors such as heredity, occupation, diet, life style (smoking) etc., which are known to influence cancer incidence.

Recommendations

PADOH and ATSDR recommend that PADEP (1) continue to closely oversee landfill activities and enforce landfill permit regulations, including nuisance odor rules; (2) consider a fence line air monitoring program that includes publicly accessible real time results for selected limited analytes as part of the landfill's future permit requirements; (3) make publicly available the response and oversight activities that PADEP has conducted at the landfill; and (4) conduct timely responses to nuisance odor complaints and consider maintaining and posting an odor complaint log to document the frequency of odor complaints, intensity of odors, duration, odor characteristics, and weather conditions such as wind direction.

PADOH and ATSDR suggest PADEP and landfill authorities consider best practices for minimizing gull populations near KSL, including minimizing the open working face of the landfill to the extent feasible.

PADOH and ATSDR recommend that involved state and federal agencies should continue to emphasize to local authorities and community members that property owners should install and properly maintain carbon monoxide monitors in this area.

PADOH and ATSDR recommend that PADEP should consider working with the landfill to perform vapor intrusion investigations in the Swinick community to evaluate current indoor air levels of VOCs and to ensure that conditions do not change in the future after new operations commence in the historic Dunmore landfill area.

PADOH and ATSDR recommend that residents and school officials monitor air quality alerts for the area (for example, via EPA's AirNow website for the Scranton area at https://airnow.gov/index.cfm?action=airnow.local_city&mapcenter=%200&cityid=608), consider implementing EPA's Air Quality Flag Program https://airnow.gov/index.cfm?action=flag_program.index), and take protective actions as needed. This is particularly important for sensitive populations, older adults, and children.

PADOH and ATSDR recommend that residents minimize exposure to sewer gases by running water periodically through floor and sink drains, especially those used less often, to prevent the traps in the pipes from drying out; maintaining septic systems (if applicable) and calling a licensed plumber if you have wet spots in crawlspaces under your home or in your yard that do not go away.

Next Steps

PADOH and ATSDR

- Shared the public comment version of this KSL health consultation (dated

December 14, 2017) with local residents and interested stakeholders and held a public availability session on January 29, 2018 to explain the findings and address questions from the community.

- Solicited public comments and incorporated our responses into this final report.

PADOH and ATSDR will continue to assist PADEP, when requested with evaluation of additional environmental data from the landfill and surrounding communities.

Limitation of the findings

PADOH and ATSDR identified the following limitations and uncertainties in the sampling and the subsequent public health evaluation:

- The air sampling information represents ambient air quality in the community during the current operating scenario for the landfill. It does not represent air quality if the landfill expands its operations. Under the current expansion proposal, changes are anticipated that could impact the community's air quality including (1) landfill operations would move to a working face closer to residential areas; and (2) the additional weight and composition of landfilled materials might cause unknown changes in subsurface vapor conditions.

- While the agencies collaborated to be as comprehensive as feasible in the analytes included in the air monitoring, not every contaminant potentially associated with emissions from a landfill was included in the analyte list, and several contaminants had method detection limits above the ATSDR CVs and/or odor thresholds. In addition, a common odor causing landfill contaminant (hydrogen sulfide) was detected at high levels (13,624 $\mu g/m^3$ or 9,745 ppb) during one of the MAU monitoring periods but was not detected during the community-based air monitoring. This observed difference in our monitoring data sets warrants further evaluation if strong sulfur odors are observed in the community in the future. Further, although acrolein was detected several times at all three monitoring locations, there are established data quality concerns with standard analyses for acrolein and the health agencies decided not to further evaluate acrolein.

- The community-based air monitoring occurred only for a three-month duration. The three months monitoring may not represent the full range of exposures that might occur throughout a full year.

- The objective of PADEP's air monitoring collaboration with the health agencies was to evaluate ambient air quality near the landfill where people are breathing the air. Hence, monitoring locations were prioritized on that basis. However, the available monitoring locations in the community were not in the direction of prevailing winds coming from the landfill. Therefore, the tradeoff in this situation was that contaminants related to landfill emissions were likely not detected at the community monitoring locations except in the less frequent times that winds were blowing opposite the prevailing direction. Lastly, sampling data were not collected at background locations for comparison to monitoring locations closest to the site.

Report Preparers

Author
Sasidevi Arunachalam, MS PHS,
Health Assessment Program
Bureau of Epidemiology,
Division of Environmental Health Epidemiology
Pennsylvania Department of Health

Principal Investigator
Farhad Ahmed, MBBS, MPH,
Health Assessment Program
Bureau of Epidemiology,
Division of Environmental Health Epidemiology
Pennsylvania Department of Health

ATSDR Regional Representative
Robert H. Helverson, MS
Region Representative
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry
Centers for Disease Control and Prevention

ATSDR Region 3 Director
Lora Siegmann Werner, MPH
Regional Director
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry
Centers for Disease Control and Prevention

Technical Project Officer
Robert E. Robinson, MBA
Environmental Health Scientist
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry
Centers for Disease Control and Prevention

References

[ACS] The American Cancer Society. 2014. What Are the Risk Factors for Laryngeal and Hypopharyngeal Cancers? Available from: https://www.cancer.org/cancer/laryngeal-and-hypopharyngeal-cancer/causes-risks-prevention.html

[ATSDR] Agency for Toxic Substances and Disease Registry. 1992. Petitioned Public Health Assessment, Lackawanna County, Pennsylvania (aka Lackawanna Valley Area). Atlanta, GA. US Department of Health and Human Services, Public Health Service.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1999. ToxFAQs: Methyl Mercaptan. Atlanta, GA. US Department of Health and Human Services. [updated 1999 July; accessed 2016 June 2]. Available from: http://www.atsdr.cdc.gov/toxfaqs/tfacts139.pdf

[ATSDR] Agency for Toxic Substances and Disease Registry. 2015. Formaldehyde ToxFAQs. [Updated 2015 May; accessed 2016 February 27]. Available from: http://www.atsdr.cdc.gov/toxfaqs/tfacts111.pdf

[ATSDR] Agency for Toxic Substances and Disease Registry. 2016. Hydrogen sulfide ToxFAQs. [Updated 2016 December; accessed 2017 October 27]. Available from: https://www.atsdr.cdc.gov/toxfaqs/tfacts114.pdf

Bingham E, Cohrssen B, Powell C.H. 2001. Patty's Toxicology Volumes 1-9, 5th edition. Verberk MM., et al. 1977. Effects of ammonia in volunteers. Int Arch Occup Environ Health 39:73-81.

Daniela Porta, Simona Milani, Antonio I Lazzarino1, Carlo A Perucci1 and Francesco Forastiere. 2009. Systematic review of epidemiological studies on health effects associated with management of solid waste. Environmental Health 8:60

[EPA] U.S. Environmental Protection Agency. 2016. Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI). Available from: https://www.airnow.gov/

[EPA] U.S. Environmental Protection Agency. 2010. Daa Quality Evaluation Guidelines for Ambient Air Acrolein Measurements. [Updated 2010 December; accessed 2016 November 2]. Available from: http://www.epa.gov/ttnamti1/files/ambient/airtox/20101217acroleindataqualityeval.pdf

[EPA] U.S. Environmental Protection Agency. 2012. National Ambient Air Quality Standards. Available from: https://www.epa.gov/criteria-air-pollutants

Mcgurk, T. 2017. E-mail to L. Werner of the Agency for Toxic Substances and Disease Registry et al. August 17, 2017 2:40 pm.

Nagata Y. 2003. Measurement of Odor Threshold by Triangle Odor Bag Method. Japan Environmental Sanitation Center, Ministry of the Environment. [Accessed 2016 June 2]. Available from: http://www.env.go.jp/en/air/odor/measure/02_3_2.pdf

[NOAA] National Oceanic and Atmospheric Administration. 1999. Odor threshold level of Methylamine. Available from: https://cameochemicals.noaa.gov/chris/MTA.pdf

[NRC] National Research Council (US). 2008. Committee on Acute Exposure Guideline Levels. Acute Exposure Guideline Levels for Selected Airborne Contaminants: Volume 6. Washington (DC): National Academies Press (US); 2008.

[PADOH/ATSDR] Pennsylvania Department of Health, under cooperative agreement to the ATSDR. 1993. Taylor Borough Dump, Site Review and Update.

[PADOH/ATSDR] Pennsylvania Department of Health, under cooperative agreement to the Agency for Toxic Substances and Disease Registry. 1999. Marjol Battery Site Health Consultation.

Appendix A

Maps and Photographs

Figure A1: Site Location and Demographics

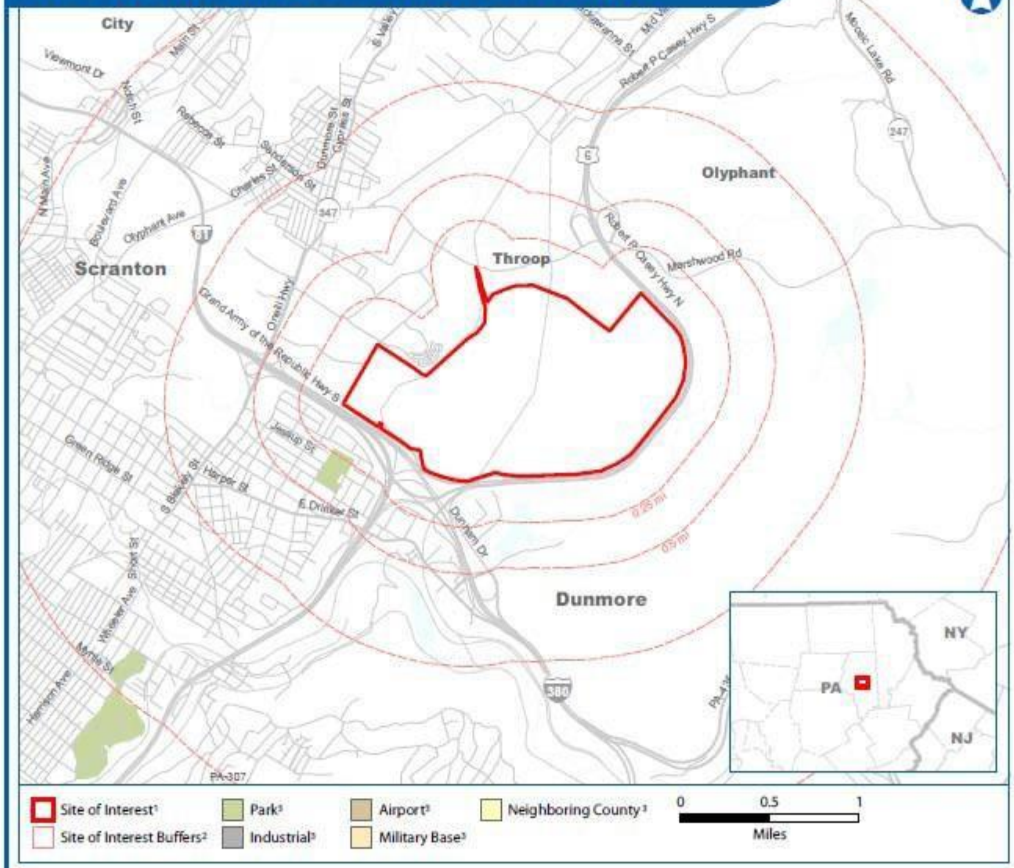
EPA FACILITY ID UNAVAILABLE

INTRODUCTORY MAP SERIES

Keystone Sanitary Landfill

Dunmore/Throop, Lackawanna County, PA

SITE AND DEMOGRAPHIC SNAPSHOT



Demographic Statistics[4,5]
Within 1 Miles buffer of site boundary

Measure	2000	2010	Change	Measure	2000	2010	Change
Total Population	7,259	6,794	-6%	Two or More Races	30	59	+96%
White Alone	7,177	6,583	-8%	Hispanic or Latino[6]	52	107	+105%
Black Alone	26	38	+46%	Children Aged 6 and Younger	510	409	-19%
Am. Indian & AK Native Alone	2	3	+50%	Adults Aged 65 and Older	1,719	1,502	-12%
Asian Alone	17	71	+317%	Females Aged 15 to 44	1,367	1,237	-9%
Native Hawaiian & Other Pacific Islander Alone	2	0	-100%	Housing Units	3,361	3,317	-1%
Some Other Race Alone	7	41	+485%	Housing Units Pre 1950	5,500	2,346	-57%

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]TomTom International BV (2012). [4]US Census 2010.
Notes: [5]Calculated using area-proportion spatial analysis method. [6]Individuals identifying origin as Hispanic or Latino may be of any race.
Projection: NAD 1983 StatePlane Pennsylvania North FIPS 3701 Feet.

PRJ 04940 JXA0 11/3/16

GRASP

Agency for Toxic Substances and Disease Registry

Division of Toxicology and Human Health Sciences

ATSDR

FINAL - FOR PUBLIC RELEASE

Figure A2: KSL and Municipal Boundaries (Dunmore and Throop Boroughs)

Figure A3: Summa Canister and Sorbent Tube Monitoring Locations (KSL, MVH, and SHP) and Scranton Meteorological Station

Figure A3a: KSL Monitoring Location Demographics

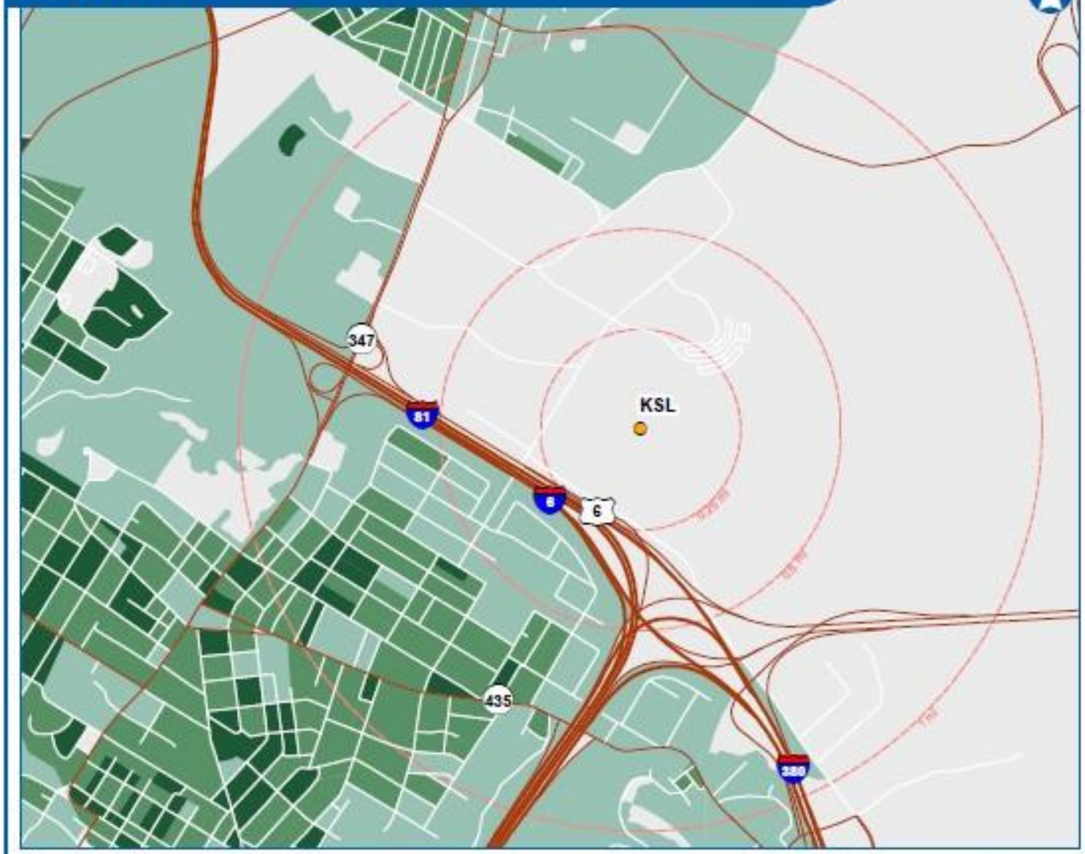
EPA FACILITY ID: UNAVAILABLE

INTRODUCTORY MAP SERIES

Keystone Sanitary Landfill

Dunmore/Throop, Lackawanna County, PA

POPULATION DENSITY



The **Population Density Map** depicts the site of interest and the distribution and number of people residing in the surrounding community. The distribution of population in and around a site is critical to understanding a community's potential for exposure to hazardous substances.

Based on US Census 2010 statistics, **119,354** individuals reside within a **5-mile buffer** of the site of interest.

Site of Interest

- Site of Interest[1]
- Site of Interest Buffers[2]

Population Density by Census Block[3] (No. per sq. mi.)

- Zero
- 0 to 5,000
- 5,000 to 10,000
- > 10,000

Healthcare Facilities

- Hospitals[4]
- Urgent Care[5]

0 0.5 1
Miles

Total Population[3,6]
Within specified distance of site boundary

Distance	2000	2010	Change
0.25 mile	0	0	+0%
0.50 mile	263	264	+0%
1 mile	3,685	3,457	-6%
3 miles[7]	59,073	58,212	-1%
5 miles[7]	119,630	119,354	+0%

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]US Census 2010. [4]Oak Ridge National Laboratory (2013). [5]TomTom International BV (2012).
Notes: [6]Calculated using area-proportion spatial analysis method. [7]Buffer not shown.
Projection: NAD 1983 StatePlane Pennsylvania North FIPS 3701 Feet.

GRASP PRJ ID 04946, 11/14/2016

GRASP

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences

ATSDR

FINAL - FOR PUBLIC RELEASE

Figure A3b: MVH Monitoring Location Demographics

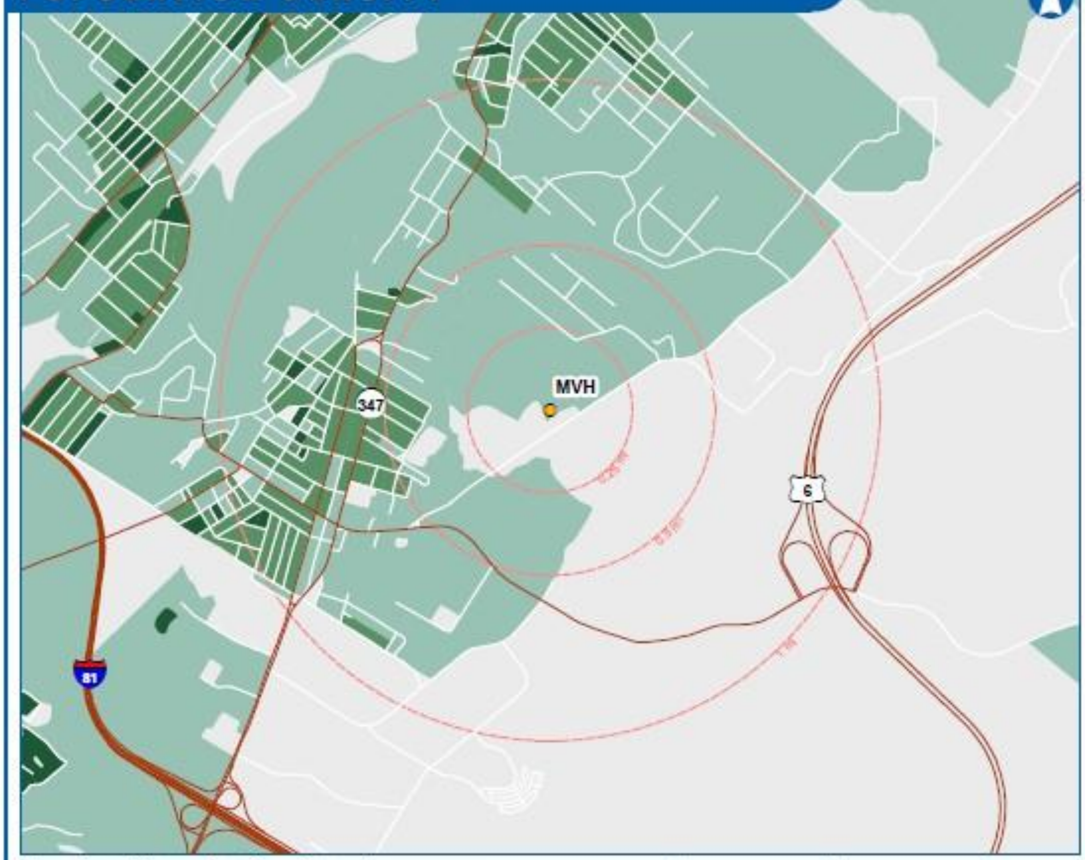
EPA FACILITY ID UNAVAILABLE

INTRODUCTORY MAP SERIES

Midvalley School

Dunmore/Throop, Lackawanna County, PA

POPULATION DENSITY



The **Population Density Map** depicts the site of interest and the distribution and number of people residing in the surrounding community. The distribution of population in and around a site is critical to understanding a community's potential for exposure to hazardous substances.

Based on US Census 2010 statistics, **106,770** individuals reside within a **5-mile buffer** of the site of interest.

Site of Interest

- Site of Interest[1]
- Site of Interest Buffers[2]

Population Density by Census Block[3] (No. per sq. mi.)

- Zero
- 0 to 5,000
- 5,000 to 10,000
- > 10,000

Healthcare Facilities

- Hospitals[4]
- Urgent Care[5]

0 0.5 1
Miles

Total Population[3,6]
Within specified distance of site boundary

Distance	2000	2010	Change
0.25 mile	2	53	+2550%
0.50 mile	398	543	+36%
1 mile	3,448	3,707	+7%
3 miles[7]	49,589	48,088	-3%
5 miles[7]	106,917	106,770	+0%

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]US Census 2010. [4]Oak Ridge National Laboratory (2013). [5]TomTom International BV (2012).
Notes: [6]Calculated using area-proportion spatial analysis method. [7]Buffer not shown.
Projection: NAD 1983 StatePlane Pennsylvania North FIPS 3701 Feet.

GRASP PRJ ID 04948, 11/14/2019

GRASP

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences

ATSDR

FINAL - FOR PUBLIC RELEASE

Figure A3c: SHP Monitoring Location Demographics

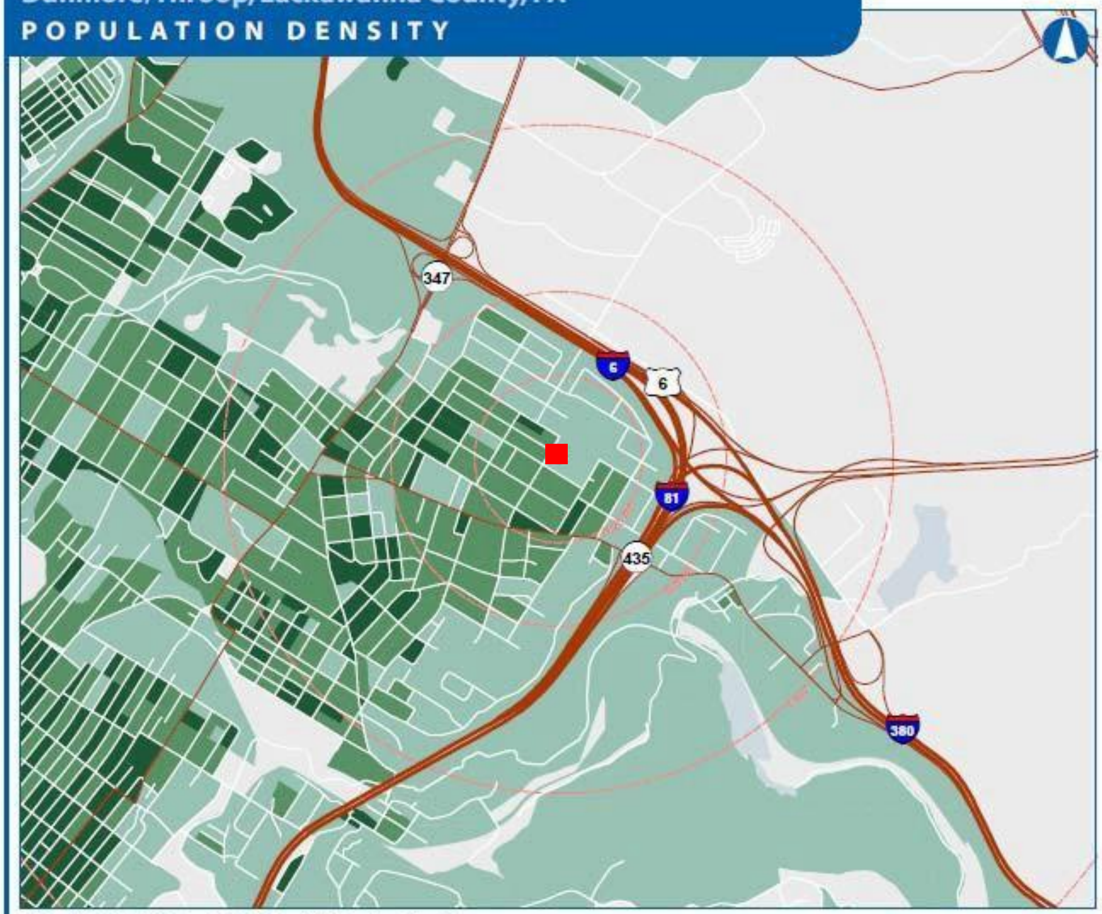
EPA FACILITY ID: UNAVAILABLE

INTRODUCTORY MAP SERIES

Sherwood Park

Dunmore/Throop, Lackawanna County, PA

POPULATION DENSITY



The **Population Density Map** depicts the site of interest and the distribution and number of people residing in the surrounding community. The distribution of population in and around a site is critical to understanding a community's potential for exposure to hazardous substances.

Based on US Census 2010 statistics, **118,944** individuals reside within a **5-mile buffer** of the site of interest.

Site of Interest

- Site of Interest[1]
- Site of Interest Buffers[2]

Population Density by Census Block[3] (No. per sq. mi.)

- Zero
- 0 to 5,000
- 5,000 to 10,000
- > 10,000

Healthcare Facilities

- Hospitals[4]
- Urgent Care[5]

Total Population[3,6]
Within specified distance of site boundary

Distance	2000	2010	Change
0.25 mile	1,185	1,099	-7%
0.50 mile	3,298	3,093	-6%
1 mile	8,181	7,690	-6%
3 miles[7]	64,032	63,657	+0%
5 miles[7]	119,249	118,944	+0%

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]US Census 2010. [4]Oak Ridge National Laboratory (2013).[5] TomTom International BV (2012).
Notes: [6]Calculated using area-proportion spatial analysis method. [7]Buffer not shown.
Projection: NAD 1983 StatePlane Pennsylvania North FIPS 3701 Feet.

GRASP PRJ ID 04948, 11/16/16

GRASP

Agency for Toxic Substances and Disease Registry
Division of Toxicology and Human Health Sciences

ATSDR

FINAL - FOR PUBLIC RELEASE

Figure A4: Mobile Analytical Unit (MAU) Sampling Locations

Figure A5: Keystone Sanitary Landfill Sampler

Figure A6: Mid Valley High School Sampler

Figure A7: Sherwood Park Sampler

Figure A8: Interior of the Sample Box

Appendix B

Community Concerns Summary

PADOH and ATSDR Region 3 (ATSDR R3) addressed the following community concerns questions we gathered during our site visits and phone calls.

Have public health agency staff visited the landfill and met with community members?

PADOH, ATSDR and PADEP made several site visits to the landfill to observe current site conditions, identify monitoring and sampling locations, meet with community members, participate in public availability sessions, and attend public meetings. On March 10, 2015, staff from each agency conducted a visit to the landfill to observe the current site conditions and activities. The landfill management provided a bus tour of the 1,000-acre landfill, including the active "open face" where waste is being dumped.

On April 27, 2015, the agency staff (PADOH, ATSDR, and PADEP) in conjunction with an odor science specialist from the Monell Chemical Senses Centre attended an open house public availability meeting to speak with residents about their concerns. On May 5, 2015, PADOH and ATSDR provided an update and answered questions via conference call with the Lackawanna County Medical Society. On June 17, 2015, the three agencies made a second site visit, near the landfill, to the Dunmore reservoir and Scranton Sewer facility. The agencies also conducted a site visit on February 25, 2016, to observe the three monitoring locations near the landfill and meet with concerned community members. On March 8, 2016 ATSDR met with concerned community members at a Green Ridge Neighbors Association meeting. On January 29, 2018, PADOH and ATSDR held a public availability session at the MVH school at Throop.

How have the health agencies and PADEP been coordinating on this evaluation?

From February 2015 through May 2016, PADOH had weekly conference calls with ATSDR and PADEP discussing various issues that include proposed time lines, past data, reports, and plans on air monitoring data collection, locations, funds, and procedures. PADEP designed and sponsored the community-based air monitoring effort after detailed discussions with the health agencies on the approach. PADEP shared additional information about the landfill and the potential for community exposures with the health agencies upon request. PADOH and ATSDR shared periodic updates on this written document with PADEP.

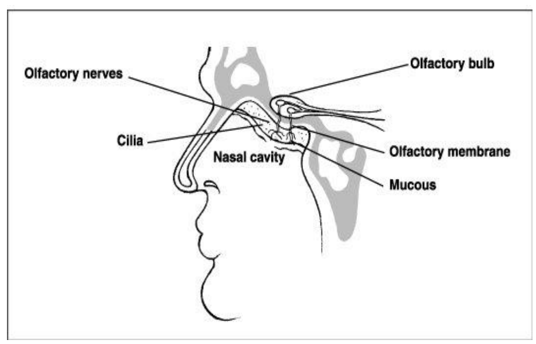
How did the health agencies incorporate information about odor complaints into this evaluation?

PADOH and ATSDR used information from community odor complaints reported to PADEP to help make decisions about the strategy for the community-based air monitoring effort at this site and used this information to qualitatively assess the potential for symptoms related to odors in the community. Per the information recorded in PADEP's odor complaint logs (Appendix C, Table C4), only six odor complaints occurred during the air sampling period (January – April 2016). During discussions with community members and PADEP, PADOH and ATSDR learned that most of the odor complaints were from drivers who use public roadways adjacent to the landfill (Highway 6 and Interstate 81). This information supported siting the KSL and Sherwood Park monitoring locations.

Is it possible to have health symptoms from environmental odors even if the concentrations measured in air do not appear high enough to cause health effects?

Yes, a substantial body of literature shows that offensive or objectionable odors themselves can cause health symptoms [ATSDR 2015; Schiffman and Williams 2005]. These symptoms may result from protective inborn or learned aversions to offensive odors, which may signal danger or threats to health [Schiffman *et al.* 2000, Schiffman and Williams 2005, Bulsing *et al.* 2009]. The presence of odors in a community can also lead to a diminished sense of well-being or quality of life for community members [Shusterman 2002]. Health complaints reported from exposure to offensive odors (such as those emanating from animal processing facilities, wastewater treatment plants, or landfills) include eye, nose, and throat irritation; headache; nausea; diarrhea; hoarseness; sore throat; cough; chest tightness; nasal congestion; palpitations; shortness of breath; stress; drowsiness; and alterations in mood [Schiffman *et al.* 2000]. Usually the symptoms occur at the same time as the odor and resolve when the odor goes away. But in sensitive people, such as those with asthma, the very young, or the very old, odors can result in symptoms that last longer and may aggravate existing medical conditions [Bulsing *et al.* 2009]. In addition, previous exposure to high levels of an irritating substance has been shown to make some people acutely sensitive to the substance in the future. If these people smell even very low levels of the substance, they might experience symptoms ranging from headaches and nausea to effects associated with panic attacks, such as lightheadedness or shortness of breath [Schiffman *et al.* 2000]. ATSDR has developed an odors web page https://www.atsdr.cdc.gov/odors/index.html that contains additional reference information on effects of environmental odors on health as well as resources for residents who are concerned about odors in their community [ATSDR 2015].

Figure B1. Human Nasal Anatomy



People can detect contaminants by smell at very low concentrations. When humans breathe in air, it travels through nasal passages which are lined with mucus membranes as shown in the Figure B1 to the right. These mucus membranes assist in filtering out unwanted particles from the inhaled air and secrete a mucus layer that lines the nasal passages [Krough 2005]. The olfactory epithelium in the specific area of mucus membrane that houses the olfactory nerve cells is located at the top of the nasal cavity [Axel 2006]. Olfactory nerve cells, also referred to as receptor cells, transmit olfactory information to the brain upon being triggered by an odorant molecule (environmental substances) in the inhaled air. The odorant may be perceived in many ways depending on the concentration.

A change in concentration will change the receptor codes and therefore a change in the perceived smell will occur [Malnic *et al.* 1999]. Furthermore, some odorants can be detected at lower concentrations than other odorants. Axel and Buck (1991) have provided understanding on how the nose can distinguish more than 10,000 distinct smells. The researchers discovered a gene pool of more than 1,000 different genes that encode olfactory receptors in the nose.

Mixtures of different contaminants that have odors have received limited investigation. It is possible a mixture of contaminants present in the air may produce additive, antagonistic, or synergistic odor effects.

The estimation of odor production and dispersion from landfill sites is a very complicated task because of the different chemical species that exist in the landfill gas emissions. The monitoring of the odor annoyance generated by a landfill area is difficult, since it is a multi-area, multi-source problem, with irregular (discontinuous) emissions of odors.

PADOH and ATSDR recommend that residents and school officials monitor air quality alerts for the area (for example, via EPA's AirNow website for the Scranton area at https://airnow.gov/index.cfm?action=airnow.local_city&mapcenter=%200&cityid=608, and consider implementing EPA's Air Quality Flag Program, https://airnow.gov/index.cfm?action=flag_program.index) and take protective actions as needed. This is particularly important for sensitive populations, older adults, and children.

Is it possible that the following health conditions could be associated with the landfill - cancer, immune system disorders, nervous system disorders, birth defects, liver problems, skin problems, respiratory illnesses, muscular problems, nosebleeds, and headaches?

Based on the community-based ambient air monitoring data for this site reviewed in this document, the public health agencies did not see contaminants detected at levels in the air that could cause health conditions such as cancer, immune system disorders, nervous system disorders, birth defects, liver problems, and/or muscular problems. However, as discussed earlier in the document, based on a few contaminants that were detected at high levels (methylamine and ammonia) on one or two days, temporary acute health effects such as mild irritation of eyes, nose, and throat and/or headaches could be possible in limited circumstances. Epidemiological studies on possible health impacts for communities who live near landfills in U.S are limited [Martine V 2000]. There are some studies for possible respiratory effects, although further study is needed to confirm this and to make determinations about the other health conditions mentioned above.

Are landfill-fed seagulls impacting the community's health near the Keystone Sanitary Landfill?

Community members have expressed concerns about possible adverse effects from the seagull population. Community members are concerned about the nuisance effect of landfill-fed seagulls polluting the nearby public water reservoir. Although this is not an exposure to a chemical exposure from the landfill, PADOH and ATSDR recognize that there is an environmental public health concern related to gull populations, landfills, and surface drinking water supplies.

As summarized in USDA 2010, gulls are attracted to landfills as a food source, and landfills may contribute to an increase in gull populations. Federal regulations mandate that landfills prevent or control potential vectors, such as gulls (40 CFR 258.22). Birds can play an important role in the transmission of diseases to people, when people come into contact with fecal droppings of those birds. Research has shown that gulls carry various species of bacteria such as Bacillus sp., Clostridium sp., Campylobacter spp., Escherichia coli, Listeria spp., and Salmonella spp. Transmission of bacteria from gulls to humans is difficult to document. Contamination of public water supplies by gull feces has been stated as the most plausible source for disease transmission. Gull feces also contribute to accelerated nutrient loading of aquatic systems, which has serious implications for municipal surface water drinking water sources, such as the one near KSL.

PADOH and ATSDR suggest PADEP and landfill authorities consider best practices for minimizing gull populations near KSL, including minimizing the open working face of the landfill to the extent feasible.

Why isn't leachate from the landfill analyzed as a pathway of concern in this health consultation document?

Community members have raised health concerns about exposure to the landfill's leachate water. PADOH and ATSDR explored this pathway using information from our visits to the site and from PADEP. Using the available information, it does not appear that people are directly exposed to leachate from the landfill. Community members do not have access to the areas onsite at the landfill where the runoff accumulates.

Concerns about this pathway were raised again after an incident on September 24, 2015. A foul-smelling discharge of black fluid was discharged into Scranton's combined sewer system which caused partial evacuation of a residential care facility for people with disabilities. PADEP investigated this incident but could not determine the source of the discharge. At the request of PADOH to further evaluate community health concerns about this incident, PADEP tested for potential odor-causing VOCs from landfill's storm water runoff. The analytical results of the sampling conducted on October 29, 2015 are presented in Appendix C, Table C7.

Although this storm water runoff is not a drinking water source, PADOH screened the detected levels of VOCs in the water samples against drinking water CVs as a point of reference. The contaminants in the sample were below those likely to cause odor or health effects after incidental contact with this water. Among the metals, arsenic was detected at a concentration of 4.4 μg/L which is above the ATSDR CREG of 0.016 μg/L, and below EPA's MCL of 10 μg/L for drinking water. Incidental dermal contact or ingestion of water containing small amounts of arsenic is not expected to cause any non-cancer or cancer health effects. Lead was detected in the water at a concentration of 20.9 μg/L which is above the EPA's action level of 15 μg/L for drinking water. Incidental dermal contact or ingestion of lead contaminated water is not likely to increase the blood lead level to a level that could cause any health effects.

Have you analyzed or addressed the pre-existing Environmental Justice (EJ) related health challenges that this community members face?

PADOH and ATSDR acknowledge that environmentally-burdened communities have additional factors that can impact health including but not limited to environmental contaminant exposures (e.g., access to healthy foods, open space, and health care). Each of these factors can affect community health outcomes. In response to concerns raised during the public comment period, PADOH and ATSDR reviewed available environmental justice indicators for this community. Based on EPA's EJ Screen Report 2017 (See Appendix C Table C8), in Dunmore the EJ indexes for $PM_{2.5}$, ozone, air toxic cancer risk, respiratory hazard index, superfund proximity, and hazardous waste proximity are greater than 50th percentile (ranking) in PA state. The ranking in Throop is similar to Dunmore with an additional parameter (Diesel PM) greater than 50th percentile. EJ indexes are calculated by combining the environmental and demographic information of Dunmore and Throop. These EJ indexes of Dunmore and Throop were ranked (as percentile) with the state of Pennsylvania, the EPA region (Pennsylvania, Virginia, West Virginia, District of Columbia, Maryland and Delaware) and the U.S.

Note, under the guidance of the state's Environmental Justice Advisory Work Group, PADEP developed an Environmental Justice Enhanced Public Participation Policy (https://www.dep.pa.gov/PublicParticipation/OfficeofEnvironmentalJustice/Pages/DEP-Enhanced-Public-Participation-Policy.aspx.

References for Appendix B

[ATSDR] Agency for Toxic Substances and Disease Registry. 2015. Environmental odors and the physiology of the sense of olfaction. Atlanta, GA. US Department of Health and Human Services. [Updated 2015 December 2; accessed 2016 November 2]. Available from: https://www.atsdr.cdc.gov/odors/docs/Environmental%20Odors%20and%20The%20Physiology%20of%20the%20Sense%20of%20Olfaction.pdf

Axel R and Buck L. 1991. A novel multigene family may encode odorant receptors: A molecular basis for odor recognition. Cell 65:175–87.
Martin V. 2000. Environ Health Perspect 108(suppl 1); 101-112. Available from: https://www.cell.com/cell/pdf/0092-8674(91)90418-X.pdf?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2F009286749190418X%3Fshowall%3Dtrue

Axel R. 2006. The molecular logic of smell. Sci Am 16(3s):68–75.

Bulsing PJ, Smeets MAM, and Van Den Hout MA. 2009. The implicit association between odors and illness. Chem Senses 34:111–119.

Krough D. 2005. Biology: A guide to the Natural world. Upper Saddle River, NJ: Pearson/Prentice Hall.

Malnic B, Hirona J, Sala S, Buck L. 1999. Combinatorial Receptor Codes for odors. Cell 96(5):7113–23.

Nagata Y. 2003. Measurement of Odor Threshold by Triangle Odor Bag Method. Japan Environmental Sanitation Center, Ministry of the Environment. [Accessed 2016 June 2]. Available from: http://www.env.go.jp/en/air/odor/measure/02_3_2.pdf

Schiffman SS, Walker JM, Dalton P, Lorig TS, Raymer JH, Shusterman D, Williams CM. 2000. Potential health effects of odor from animal operations, wastewater treatment, and recycling of byproducts. J Agromedicine 7(1):397–403.

Schiffman SS and Williams CM. 2005. Science of odor as a potential health issue. J Env Quality 34(1):129–36.

Shusterman D. 2002. Review of the upper airway, including olfaction, as mediator of symptoms. Env Health Perspect 110(S4):649–54.

[USDA] U.S. Department of Agriculture, Animal and Plant Health Inspection Service Wildlife Services, in cooperation with the U.S. Department of Interior, Fish and Wildlife Service. 2010. Environmental Assessment: Reducing Gull Damage in the Commonwealth of Massachusetts. Available from: https://www.aphis.usda.gov/regulations/pdfs/nepa/MA_Gull_EA_FINAL.pdf

Appendix C

Sampling Data Summary Information

Table C1: Summary of Contaminants Detected (January – April 2016) Using Summa Canisters and Sorbent Tubes Near the Keystone Sanitary Landfill, Dunmore, PA

Contaminants	**CV** (in **ppb** for **TO15** and in ***µg/m³*** for ***TO11***)	**CV Source**	**MDL**	**Monitoring locations**					
				KSL location		**Community Locations**			
				Landfill		**Mid Valley High**		**Sherwood Park**	
				Detects/ Total samples	**Concen. range**	**Detects/ Total samples**	**Concen. range**	**Detects/ Total samples**	**Concen. range**
TO15 COMPOUNDS (ppb)									
1,2,4-Trimethyl benzene	900 12	TCEQsESL(H) EPA RfC	0.16	**2/29**	**ND–10**	1/29	ND–0.47	1/29	ND–0.56
1,3,5-Trimethyl benzene	900 12	TCEQsESL(H) EPA RfC	0.16	1/29	ND–2.4	ND	ND	ND	ND
1,3-Butadiene	2	EPA RfC	0.35	ND	ND	1/29	ND–0.75	ND	ND
1,4-Dioxane	30 2,000 **0.055**	cMRL aMRL **CREG**	0.14	ND	ND	ND	ND	**1/29**	**ND–0.41**
4-Ethyltoluene	25 250	TCEQlESL TCEQsESL(H)	0.10	1/29	ND–1.3	ND	ND	ND	ND
4-Methyl-2-pentanone	20 200	TCEQlESL TCEQsESL(H)	0.19	ND	ND	1/29	ND–1.7	1/29	ND–0.98
Acetone	13,000 26,000	cMRL aMRL	2.1	3/29	ND–10	3/29	ND–26	4/29	ND–8.3
Acetonitrile	20 200 37.5	TCEQlESL TCEQsESL(H) RSL	0.30	1/29	ND	ND	ND–0.69	ND	ND
alpha-Pinene	63	TCEQlESL	0.090	ND	ND	1/29	ND–0.17	1/29	ND–0.13

Contaminants	**CV** (in **ppb** for **TO15** and in ***µg/m³*** for ***TO11***)	**CV Source**	**MDL**	**Monitoring locations**					
				KSL location		**Community Locations**			
				Landfill		**Mid Valley High**		**Sherwood Park**	
				Detects/ Total samples	**Concen. range**	**Detects/ Total samples**	**Concen. range**	**Detects/ Total samples**	**Concen. range**
	630	TCEQsESL(H)							
Benzene	3 9 **0.04**	cMRL aMRL **CREG**	**0.24**	**7/29**	**ND–-0.49**	**6/29**	**ND–0.82**	**7/29**	**ND–0.65**
Chloro methane	50 500	cMRL aMRL	0.24	1/29	ND–0.31	1/29	ND–0.47	1/29	ND–0.3
cis-1,2-Dichloro ethene	200 2,000	TCEQlESL TCEQsESL(H)	0.13	ND	ND	ND	ND	1/29	ND–1.7
Cyclohexane	1,700	EPA RfC	0.29	1/29	ND–1.7	1/29	ND–5	ND	ND
Dichloro difluoro methane (CFC)	1,000 10,000 19.9	TCEQlESL TCEQsESL(H) RSL	0.16	29/29	0.39–1.9	28/29	ND–0.58	29/29	0.32–2.6
d-Limonene	20 200	TCEQlESL TCEQsESL(H)	0.14	1/29	ND–0.19	1/29	ND–0.35	2/29	ND–0.29
Ethanol	1,000 10,000	TCEQlESL TCEQsESL(H)	2.7	2/29	ND–17	3/29	ND–19	2/29	ND–19
Ethyl Acetate	400 870 19.9	TCEQlESL TCEQsESL(O) RSL	0.28	11/29	ND–5.8	7/29	ND–17	8/29	ND–7.5
Ethyl benzene	60 5,000	cMRL aMRL	0.12	1/29	ND–0.59	1/29	ND–0.22	ND	ND
m, p-Xylenes	50 2,000	cMRL aMRL	0.23	1/29	ND–2.4	2/29	ND–0.79	2/29	ND–0.48
Methyl Methacrylate	2 17 175	TCEQlESL TCEQsESL(O) RSL	0.24	ND	ND	ND	ND	1/29	ND–0.56

Contaminants	CV (in **ppb** for **TO15** and in ***µg/m³*** for ***TO11***)	CV Source	MDL	Monitoring locations: KSL location: Landfill: Detects/ Total samples	Landfill: Concen. range	Community Locations: Mid Valley High: Detects/ Total samples	Mid Valley High: Concen. range	Sherwood Park: Detects/ Total samples	Sherwood Park: Concen. range
Naphthalene	**0.7** **85**	**cMRL** TCEQsESL(O)	**0.095**	**2/29**	**ND–2.2**	ND	ND	ND	ND
Methylene Chloride	300 600 29	cMRL aMRL CREG	0.22	2/29	ND–0.35	3/29	ND–2.1	1/29	ND–1.2
n-Heptane	85 850	TCEQlESL TCEQsESL(H)	0.19	2/29	ND–1.4	2/29	ND–0.70	3/29	ND–0.79
n-Hexane	600 1,800	MRL TCEQsESL(H)	0.22	2/29	ND–0.76	2/29	ND–1.7	2/29	ND–0.89
n-Nonane	200 2,000 3.9	TCEQlESL TCEQsESL(H) RSL	0.15	2/29	ND–1.5	1/29	ND–0.21	1/29	ND–0.18
n-Octane	75 750	TCEQlESL TCEQsESL(H)	0.17	2/29	ND–0.92	1/29	ND–0.29	2/29	ND–0.18
n-Propyl benzene	50 500	TCEQlESL TCEQsESL(H)	0.16	1/29	ND–0.64	ND	ND	ND	ND
o-Xylene	50 2,000	cMRL aMRL	0.18	1/29	ND–0.94	2/29	ND–0.28	1/29	ND–0.18
Propene	2,000	cCARB REL	0.29	16/29	ND–4.2	15/29	ND–2.1	13/29	ND–2
Styrene	200 5,000	cMRL aMRL	0.12	ND	ND	4/29	ND–1.4	ND	ND
Tetrahydro Furan (THF)	50 500	TCEQlESL TCEQsESL(H)	0.26	ND	ND	1/29	ND–0.61	ND	ND
Toluene	1,000 2,000	cMRL aMRL	0.21	15/29	ND–3.1	12/29	ND–6.5	7/29	ND–4.5

Contaminants	CV (in **ppb** for **TO15** and in ***µg/m³*** for ***TO11***)	CV Source	MDL	Monitoring locations					
				KSL location		Community Locations			
				Landfill		Mid Valley High		Sherwood Park	
				Detects/ Total samples	Concen. range	Detects/ Total samples	Concen. range	Detects/ Total samples	Concen. range
Trichloro fluoro methane	1,000 10,000 130	TCEQlESL TCEQsESL(H) RSL	0.089	27/29	ND–0.27	28/29	ND–0.25	29/29	0.2–1.4
Trichloro trifluoro ethane	500 5,000	TCEQlESL TCEQsESL(H)	0.065	ND	ND	1/29	ND–2.5	1/29	ND–1.4
TO11 COMPOUNDS (µg/m³)									
Ammonia	70 1,200	cMRL **aMRL**	1.2	5/29	ND–59	4/29	<12–**8000**	4/29	<12–600
Formaldehyde	9.8 49 0.077	cMRL aMRL **CREG**	0.15	26/29	<0.93–**6.9**	23/29	<0.93–**2.5**	25/29	<0.93–**2.3**
Acetaldehyde	9 470 0.45 9.4	**RfC** aCARBREL **CREG** **RSL**	0.15	2/29	<0.93–**14**	2/29	<0.93–**15**	2/29	<0.93–**19**
Acrolein	0.02 6.9	**RfC** **aMRL**	0.15	5/29	<0.46–**13**	5/29	<0.46–**15**	6/29	<0.46–**17**
Methylamine	6.4 26.1	TCEQlESL NOAA	10	1/29	<470–**1200**	1/29	<470–**1200**	1/29	<470–**1100**

Contaminants in bold exceeded Comparison Values (CVs); ppb = parts per billion; Concen. = Concentration; µg/m³ = micro gram per cubic meter; MDL = Minimum Detection Limit; RfC = Reference Concentration; CREG= Cancer Risk Evaluation Guide; a/cMRL= acute/chronic minimum risk level; NIOSH- REL = National Institute for Occupational Safety and Health- Reference Exposure Levels; NAAQS = 8-hour National Ambient Air Quality Standards; a/c CARB-REL = acute/chronic California Air Resources Board Reference Exposure Levels; ACGIH = American Conference of Governmental Industrial Hygienists; TCEQlESL = Texas Commission on Environmental Quality long-term Effects Screening Level; TCEQsESL(O) = TCEQ short-term ESL based on odor effects; TCEQsESL (H) = TCEQ short-term ESL based on health effects; NOAA = National Oceanic and Atmospheric Administration; The basis for CVs obtained from CARB, NOAA, and TCEQ were not reviewed/approved by ATSDR

Table C2: Air Contaminants Detected Above Odor Threshold Values (µg/m^3) Using Summa Canisters and Sorbent Tubes Near the Keystone Sanitary Landfill, Dunmore, PA

Contaminants	Maximum Concentration µg/m^3	Location/frequency	Odor threshold values µg/m^3
Acetaldehyde	14 15 19	KSL/2 MVH/2 SHP/2	3 (1.5 ppb) Nagata Y. 2003
Ammonia	8,000	MVH/1	3,487–36,962 (5,000 ppb – 53,000 ppb) NRC 2008
Methylamine	1,200 1,200 1,100	KSL/1 MVH/1 SHP/1	26.7 (21 ppb) NOAA 1999

KSL = Keystone Sanitary Landfill; MVH = Mid Valley High School; SHP = Sherwood Park; ppb = parts per billion; µg/m^3 = micro gram per cubic meter; NRC = National Research Council (US) Committee on Acute Exposure Guideline Levels.

Table C3: Air Contaminants with Odor Threshold Levels Below Method Detection Limits Using Summa Canister and Sorbent Tubes near Keystone Sanitary Landfill, Dunmore, PA

Contaminants	MDL	Odor threshold levels
Reduced sulfur compounds (µg/m^3)		
Hydrogen Sulfide	11	0.7 (0.5 ppb)
Methyl mercaptan	16	4
Ethyl mercaptan	20	0.02
Dimethyl sulfide	20	8
Isopropyl mercaptan	25	0.02
Tert-butyl mercaptan	30	0.11
n-propyl mercaptan	25	0.04
Thiophene	28	1.9
Isobutyl mercaptan	30	0.03
Diethyl sulfide	30	0.12
n-butyl mercaptan	30	0.01
Dimethyl disulfide	15	8
Tetra hydro thiophene	24	1.8
Diethyl disulfide	15	8
TO11 compounds (µg/m^3)		
Triethylamine	<450	22

µg/m^3 = micro gram per cubic meter; MDL = Method Detection Limit

Table C4: Community Odor Complaints Summary (2011 - 2016)

Months	**Years**							
	2011	2012	2013	2014	2015	2016	Total	Percentage
January	6	20	13	0	0	2	41	12%
February	6	14	7	5	1	0	33	9%
March	0	2	9	0	2	4	17	5%
April	2	0	2	1	6	0	11	3%
May	0	12	0	0	1	0	13	4%
June	1	11	2	0	0	0	14	4%
July	0	9	2	0	2	4	17	5%
August	1	20	0	0	3	16	40	11%
September	7	9	1	0	5	1	23	6%
October	17	23	0	0	10	5	55	15%
November	9	19	0	0	12	4	44	12%
December	26	18	1	0	5	2	52	14%
Total	75	157	37	6	47	38	360	100%
Winter (December-February)								35%
Spring (March-May)								12%
Summer (June-August)								20%
Fall (September-November)								33%

Source: PADEP Northeast office odor complaint log

Table C5: Maximum Instantaneous Concentrations Reported from PADEP MAU for April 2015, June 2015 and March 2016 near the Keystone Sanitary Landfill, Dunmore, PA (ppb) (All Locations)

	Monitoring Locations														
	Community Locations									**Non-Community Locations**					
	Sherwood Park			**Mid Valley High School Athletic Field/Parking Lot**			**Swinick Neighborhood**			**Keystone Landfill Leachate Lagoon**			**Keystone Landfill Working Face**		
Contaminants	**April, 2015**	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**
1,2,4-Trimethyl benzene	<172	<56	<199	<175/ <171	226/ <309	<233/ <307	<217	<315	<162	<275	<1027	515	<440	99	357
2-Methyl butane	<17	<12	45	<30/ <18	<19/ <50	<23/ <37	<30	<68	<19	<37	<53	<92	<150	267	90
2-Methyl pentane	<31	<12	<43	<30/ <32	<37/ <64	<47/ <60	<40	<68	<32	<49	<63	<105	<135	605	149
3-Methyl pentane	<21	<12	<43	23/ <23	<26/ <65	<30/ <46	<34	<68	<22	<48	<64	<110	<141	114	<61
Acetaldehyde	*167*	<45	<207	*74/ 86*	<121/ <142	<97/ *178*	<102	<393	<107	<113	<200	<666	<337	<56	<246
Ammonia	<5	<2	<7	<4/<4	<6/<8	<6/<8	<5	<13	6	341	**2783**	596	43	52	11
Benzene	**212**	**48**	<146	<148/ 144	<143/ <138	<191/ <249	<154	<141	<141	<845	<5163	<1762	<315	<87	<198
Carbon disulfide	*211*	<45	<156	*250*/ 112	<81/ <183	<89/ <160	<129	<234	<85	194	<168	<475	<540	50	<205
Carbon monoxide	54	26	205	50/ 232	86/ 80	28/ <29	150	210	99	66	94	733	336	51	127
Chloroform	6	<5	<28	<4/5	<11/ <11	6/14	7	<44	<8	<5	<20	<104	<37	<4	<24
Dimethyl sulfide	<64	<32	<87	<58/ <67	<63/ <144	*115*/ <136	<95	<146	<64	<131	<168	<241	<320	<71	<157
Ethane	<64	<31	<97	<60/ <68	80/ <165	<94/ <131	<93	<179	<64	<125	206	<261	<358	80	442
Ethanol	<18	<13	<34	<17/ <17	<27/ <40	<23/ 41	<19	<56	<23	<97	<550	<300	215	368	169
Ethyl benzene	<67	<36	179	<62/ <69	73/ <174	125/ <138	<109	<166	<71	<135	<827	<319	<498	339	429
Ethylene	<10	<7	<24	10/ <10	<16/ <19	<14/ <17	<11	<47	<12	<99	<579	<225	<32	<9	<26
Formaldehyde	11	<4	<15	<13/ 13	<15/ <18	<18/ <24	<15	<20	<14	19	<20	<29	<36	<6	<24
Hydrogen sulfide	<4974	<2156	<6863	<5049/ <4974	<6432/ <10777	***9745/<*** 10157	<7205	<11992	<4708	<9117	<10703	<17333	<17015	<2177	96

Contaminants	Monitoring Locations														
	Community Locations									Non-Community Locations					
	Sherwood Park			Mid Valley High School Athletic Field/Parking Lot			Swinick Neighborhood			Keystone Landfill Leachate Lagoon			Keystone Landfill Working Face		
	April, 2015	June, 2015	Mar. 2016	April, 2015	June, 2015	Mar. 2016	April, 2015	June, 2015	Mar. 2016	April, 2015	June, 2015	Mar. 2016	April, 2015	June, 2015	Mar. 2016
Iso-butane	<17	<9	<26	<16/ <18	<19/ <39	29/ <37	<27	<39	<18	<36	53	<73	<133	<37	96
Methane	60	138	<89	58/ <49	155/ 448	111/ <99	<65	374	153	<81	651	592	1669	1024	1592
Methanol	13	<3	<11	<11/ 13	12/ <12	<14/ 23	<12	<11	14	1590	842	219	87	46	33
Methyl mercaptan	<128	*68*	*281*	<119/ <130	<139/ <311	<172/ <265	<198	<304	<134	*118*	*455*	<565	***1881***	<157	***934***
Methyl tert-butyl ether	<10	<3	<12	11/15	13/ <15	<14/ <18	<12	<14	13	141	<46	<68	<25	<5	<15
Naphthalene	27	10	<26	<16/ 20	<20/ <27	<21/ 63	<19	<32	30	<22	<53	<75	<48	<5	<27
n-butane	<22	<11	39	<20/ <23	<26/ <52	<34/ <45	<33	<55	<22	<43	61	<86	498	565	441
n-hexane	<43	<24	148	<39/ <45	55/ <121	<57 /<92	<75	<118	<46	<91	<131	<227	<343	683	309
Nitric acid	27	<4	<18	14/19	<14/ <20	29/ <25	18	<20	14	<50	<271	<106	33	22	23
Nitrogen dioxide	<78	<41	<117	**100/** <79	<86/ <202	385/ <159	<117	<195	<81	<143	<196	<356	<552	<89	***609***
Nitrous oxide	<6	15	<23	<6/ <7	<12/ 54	<8/ <13	<9	<40	<10	<13	57	<70	<36	<5	<24
Nitrous acid	6	<5	<5	<4/ <4	<4/ <6	<6/12	8	7	<4	<10	<29	<23	13	1	<6
n-octane	338	<67	<198	<129/ 322	363/ <280	<188/ 668	610	<279	776	459	<306	817	1901	638	934
n-pentane	<26	<16	82	<24/ <28	<32/ <87	<39/ <57	<48	<87	<29	<61	<95	<170	1552	343	574
Ozone	<23	<5	<23	<23/ *28*	<27/ <21	<29/ <39	<24	<22	<21	<121	<735	<257	<48	<14	<30
Propane	<24	<14	107	<22/ <25	37/ <69	35/ <52	<42	<66	<26	<52	103	<129	<217	126	203
Styrene	<24	<6	<27	<24/ 25	<25/ <32	<32/ 64	<25	<31	<23	<97	<333	<224	63	18	<33
Sulfur dioxide	<93	<44	<125	<92/ <92	<121/ <203	<128/ <176	<118	<209	<92	<267	<257	<353	<297	<35	**264**

Contaminants	Monitoring Locations														
	Community Locations									**Non-Community Locations**					
	Sherwood Park			**Mid Valley High School Athletic Field/Parking Lot**			**Swinick Neighborhood**			**Keystone Landfill Leachate Lagoon**			**Keystone Landfill Working Face**		
	April, 2015	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**	**April, 2015**	**June, 2015**	**Mar. 2016**
Toluene	<84	<51	<139	<80/ <79	<80/ <199	<103/ <166	<138	<201	<84	<201	<281	<511	973	36	402
Triethylamine	15	<5	<25	<11/ 12	<16/ <17	<16/ <21	<13	<45	<15	14	<585	<75	<39	<9	<30
m-xylene	51	<17	<70	<47/ <12	<55/ <75	<63/ 118	<55	<82	53	<66	<128	<189	<141	<13	<77
o-xylene	<30	45	<58	32/30	<33/ <73	<39/ <59	<48	107	<32	<81	<116	<218	<283	<11	<80
p-xylene	<76	<36	<149	<80/ <80	<108/ <160	<106/ 243	<108	<178	92	<111	<326	<419	<308	<25	<141

ppb = parts per billion; Contaminants in bold exceeded acute comparison values (CVs)/ National Ambient Air Quality Standard values; Contaminants in bold italics exceeded acute CVs and odor threshold levels; Contaminants in italics exceeded odor threshold levels

Table C6: Maximum Instantaneous Concentrations Reported from PADEP MAU for April 2015, June 2015 and March 2016 at near the Keystone Sanitary Landfill, Dunmore, PA (Community Locations Only) (ppb)

Contaminants	Acute CV/Source Odor Threshold /Source	Community Locations								
		Sherwood Park			Mid Valley High School Athletic Field/Parking Lot			Swinick Neighborhood		
		April 2015	June 2015	March 2016	April 2015	June 2015	March 2016	April 2015	June 2015	March 2016
1,2,4-Trimethyl benzene	900/TCEQsESL	<172	<56	<199	<175/<171	226/<309	<233/<307	<217	<315	<162
2-Methyl butane	**NA**	<17	<12	45	<30/<18	<19/<50	<23/<37	<30	<68	<19
3-Methyl pentane	**NA**	<21	<12	<43	23/<23	<26/<65	<30/<46	<34	<68	<22
Acetaldehyde	256/aCARB *1.5/Nag.2003*	*167*	<45	<207	*74/86*	<121/<142	<97/*78*	<102	<393	<107
Ammonia	1,700/aMRL	<5	<2	<7	<4/<4	<6/<8	<6/<8	<5	<13	6
Benzene	**9/aMRL**	**212**	**48**	<146	**<148/144**	<143/<138	<191/<249	<154	<141	<141
Carbon disulfide	2,4001TCEQsESL *210/Nag.3003*	*211*	<45	<156	*250*/112	<81/<183	<89/<160	<129	<234	<85
Carbon monoxide	35,000/NAAQS	54	26	205	50/232	86/ 80	28/<29	150	210	99
Chloroform	100/aMRL	6	<5	<28	<4/5	<11/<11	6/14	7	<44	<8
Dimethyl sulfide	500/ACGIH *3/Nag.2003*	<64	<32	<87	<58/<67	<63/<144	115/<136	<95	<146	<64
Ethane	**NA**	<64	<31	<97	<60/<68	80/<165	<94/< l3l	<93	<179	<64
Ethanol	l 0,000/TCEQsESL	<18	<13	<34	<17/<l 7	<27/<40	<23/41	<19	<56	<23
Ethyl benzene	5,000/aMRL	<67	<36	179	<62/<69	73/<l74	125/<138	<109	<166	<71
Ethylene	**NA**	<10	<7	<24	10/<10	<16/< l 9	<14/<l 7	<11	<47	<12
Formaldehyde	40/aMRL	11	<4	<15	<13/13	<15/<18	<18/<24	<15	<20	<14
Hydrogen sulfide	***70/aMRL 0.5/ATSDR 2001***	<4,974	<2,156	<6,863	<5,049/ <4,974	<6,432/ <10,777	***9,745/*** <10,157	<7,205	<11,992	<4,708

Contaminants	Acute CV/Source Odor Threshold /Source	Community Locations								
		Sherwood Park			Mid Valley High School Athletic Field/Parking Lot			Swinick Neighborhood		
		April 2015	June 2015	March 2016	April 2015	June 2015	March 2016	April 2015	June 2015	March 2016
Iso- butane	NA	<17	<9	<26	<16/<18	<19/<39	29/<37	<27	<39	<18
Methane	NA	60	138	<89	58/<49	155/448	111/<99	<65	374	153
Methanol	3,000/TCEQsESL	13	<3	<11	<11/13	12/<12	<14/23	<12	<11	14
Methyl mercaptan	500/NIOSH-REL 15 min *0.07/Nag.2003*	<128	*68*	*281*	<119/ <130	<139/<311	<172/<265	<198	<304	<134
Methyl tert-butyl ether	2000/aMRL	<10	<3	<12	11/15	13/<15	<14/<18	<12	<14	13
Naphthalene	85/TCEQsESL (O)	27	10	<26	<16/20	<20/<27	<21/63	<19	<32	30
n-hexane	1,800/TCEQsESL	<43	<24	148	<39/<45	55/<121	<57/<92	<75	<118	<46
n-butane	NA	<22	<11	39	<20/<23	<26/<52	<34/<45	<33	<55	<22
Nitric acid	86/CARB REL	27	<4	<18	14/19	<14/<20	29/<25	18	<20	14
Nitrogen dioxide	**100/NAAQS** ***120/Nag.2003***	<78	<41	<117	**100/**<79	<86/<202	***385***/<159	<117	<195	<81
Nitrous oxide	2,500/TCEQsESL	<6	15	<23	<6/<7	<12/54	<8/<13	<9	<40	<10
Nitrous acid	NA	6	<5	<5	<4/<4	<4/<6	<6/12	8	7	<4
n-octane	NA	338	<67	<198	<129/322	363/<280	<188/668	610	<279	776
n-pentane	NA	<26	<16	82	<24/<28	<32/<87	<39/<57	<48	<87	<29
Ozone	70/NAAQS	<23	<5	<23	<23/28	<27/<21	<29/<39	<24	<22	<21
Propane	NA	<24	<14	107	<22/<25	37/<69	35/<52	<42	<66	<26
Styrene	5,000/aMRL	<24	<6	<27	<24/25	<25/<32	<32/64	<25	<31	<23
Triethylamine	NA	15	<5	<25	<11/12	<16/<17	<16/<21	<13	<45	<15
m-xylene	2,000/aMRL	51	<17	<70	<47/<12	<55/<75	<63/118	<55	<82	53
o-xylene	2,000/aMRL	<30	45	<58	32/30	<33/<73	<39/<59	<48	107	<32

Contaminants	Acute CV/Source Odor Threshold /Source	Community Locations								
		Sherwood Park			Mid Valley High School Athletic Field/Parking Lot			Swinick Neighborhood		
		April 2015	June 2015	March 2016	April 2015	June 2015	March 2016	April 2015	June 2015	March 2016
p-xylene	2,000/aMRL	<76	<36	<149	<80/<80	<108/<160	<106/243	<108	<178	92

Contaminants in bold exceeded acute comparison values (CVs); Contaminants in italics exceeded odor threshold; Nag. = Nagata; ppb = parts per billion, RfC = Reference Concentration; CREG = Cancer Risk Evaluation Guide; a/cMRL = acute/chronic minimum risk level; NIOSH – REL = National Institute for Occupational Safety and Health-Reference Exposure Levels; NAAQS = 8-hour National Ambient Air Quality Standards; aCARB REL = acute California Air Resources Board Reference Exposure Levels; ACGIH = American Conference of Governmental Industrial Hygienists; TCEQsESL = Texas Commission on Environmental Quality short-term Effects Screening Levels; TCEQsESL(O) = TCEQ short-term ESLs based on Odor effects.

Table C7: Contaminants Detected in Surface Water Storm Water Runoff (Sample from Onsite Storm Water Drain, October 29, 2015), Keystone Sanitary Landfill, Dunmore, PA

Contaminants detected (Metals and Volatile Organic Compounds)	**Maximum Concentration (µg/L)**	**Drinking water health CVs (µg/L)**
Arsenic	**4.4**	**2.1 Child cEMEG** **0.016 CREG** 10 EPA MCL
Barium	305.0	1,400 Child cEMEG
Cadmium	<2.0	0.7 Child cEMEG 5 EPA MCL
Calcium	9,100	NA
Chromium	6.94	100 EPA MCL
Copper	18.0	1,300 EPA MCLG
Iron	7,994.0	300 EPA SDWR
Lead	**20.9**	**15 EPA action level**
Manganese	275.0	300 EPA LTHA 350 Child cRMEG
Magnesium	6,028	NA
Mercury	<1.0	2 EPA MCL
Selenium	<7.0	35 Child cEMEG 50 EPA MCL/LTHA
Silver	<10	35 Child cRMEG 100 EPA LTHA
Zinc	120.0	2,100 Child cEMEG
Sodium	7,082	20,000 EPA Drinking Water Advisory
Potassium	7,373	NA
Fluoride	<200	4,000 EPA MCL
Phenols	61.1	2,100 Child cRMEG
Methyl Ethyl Ketone (MEK)**@**	16.6	4,200 Child cEMEG
Tertiary Butyl alcohol (TBA)*****	31.1	NA
Tetrahydrofuran (THF)**#**	4.1	6,300 Child cRMEG

Contaminants in bold exceeded comparison values; µg/L = micro gram per liter; CV = Comparison Value; cEMEG = child Environmental Media Evaluation Guideline; CREG = Cancer Risk Evaluation Guide; EPA = Environmental Protection Agency; MCL = EPA Maximum Contaminant Level; EPA MCLG = EPA Maximum Contaminant Level Goal; EPA SDWR = EPA Secondary Drinking Water Regulations; EPA LTHA = EPA Life Time Health Advisory; cRMEG = Chronic Reference dose Media Evaluation Guideline; @ MEK identified in blank 2.5 µg/L; * TBA identified in blank 25.8 µg/L; # THF identified in blank 2 µg/L

Table C8: EPA's Dunmore and Throop Environmental Justice Screen Report 2017

Selected Variables	Dunmore				Throop			
Environmental Indicators	PA state Percentile	EPA Region Percentile		USA Percentile	PA state Percentile	EPA Region Percentile		USA Percentile
EJ Index for $PM_{2.5}$	58	47		36	66	55		43
EJ Index for Ozone	54	45		35	63	53		42
EJ Index for NATA# Diesel PM	47	40		30	65	55		43
EJ Index for NATA# Air Toxics Cancer Risk	55	47		36	65	56		44
EJ Index for NATA# Respiratory Hazard Index	53	45		35	65	56		44
EJ Index for Traffic Proximity and Volume	9	9		8	30	26		22
EJ Index for Lead Paint Indicator	24	14		7	44	26		15
EJ Index for Superfund Proximity	54	44		31	63	52		37
EJ Index for Hazardous Waste Proximity	61	49		36	66	55		41
EJ Index for Wastewater Discharge Indicator	42	29		20	52	36		25
Demographic Indicators*	Dunmore	PA state	EPA Region	USA	Throop	PA state	EPA Region	USA
Minority Population	9%	22%	31%	38%	9%	22%	31%	38%
Low-income	31%	31%	29%	34%	33%	31%	29%	34%
Linguistically Isolated Population	1%	2%	2%	5%	0%	2%	2%	5%
Population with less than high school education	6%	11%	11%	13%	8%	11%	11%	13%
Population Under 5 years of age	5%	6%	6%	6%	5%	6%	6%	6%
Population over 64 years of age	17%	16%	15%	14%	21%	16%	15%	14%

#Based on EPA 2011 National Air Toxics Assessments; *Based on American Community Survey 2011-2015; EJ = Environmental Justice indexes are calculated by combining environmental and demographic information for a place.

Appendix D
Meteorological Analyses Supporting Information
Climate and Prevailing Winds

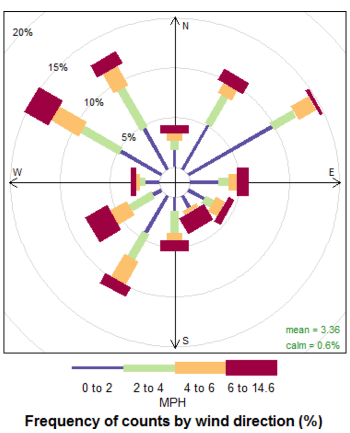
PADOH and ATSDR reviewed meteorological conditions near the KSL, because the climate and prevailing wind patterns of a given location affect how contaminants move through the air. Wind speed information was available from the Scranton air monitoring station approximately 1.5 miles NW from KSL, and temperature information was available from the Wilkes-Barre airport weather monitoring station (about 10 miles from KSL).

The average monthly temperatures recorded at the nearby Wilkes-Barre airport during the 2016 sampling had a range between 28.2^{0}F and 47.7^0 F from January 2016 to April 2016 (https://w2.weather.gov/climate/locations.php?wfo=bgm).

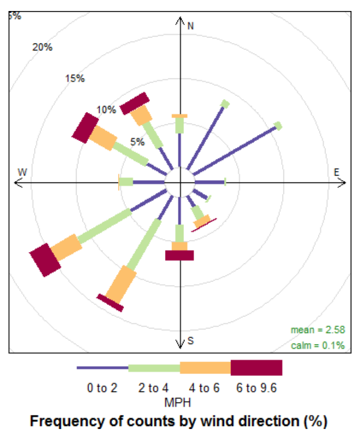
Figure 1 in the main body of the document depicts wind speed and direction in the community on an annual basis in a format know as a wind rose, using data from the Scranton air monitoring station over the time period April 2015-April 2016. Figure D1 below breaks out this wind speed and direction information monthly and seasonally, to support analysis of any seasonal changes in this information. Based on the one year of data summarized in Figure D1, there is some slight variability in wind direction and wind speed seasonally in this area.

Figure D1: Monthly and Seasonal Wind Roses Depicting Prevailing Wind Direction at Keystone Landfill Based on Scranton Meteorological Information (April 2015-April 2016)

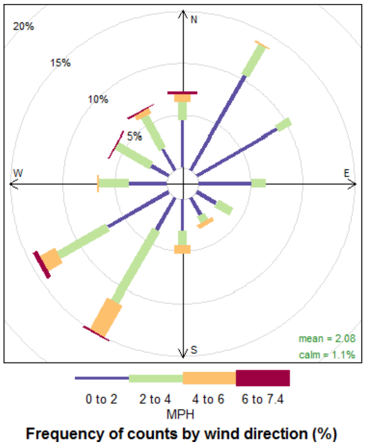
April 2015



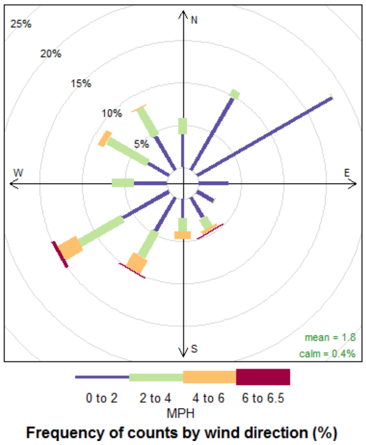
May 2015



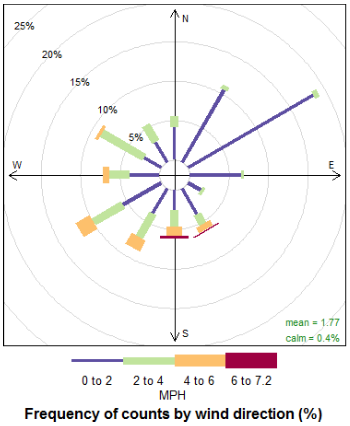
June 2015



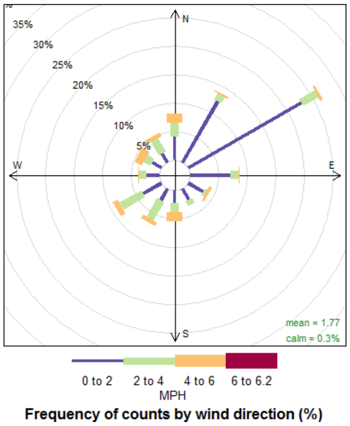
July 2015



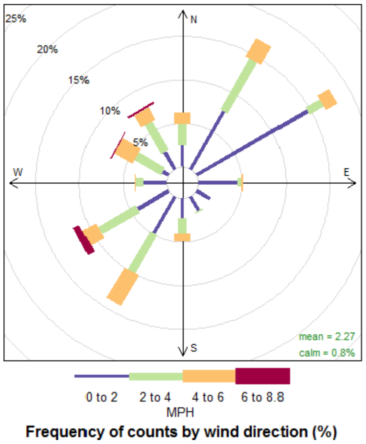
August 2015



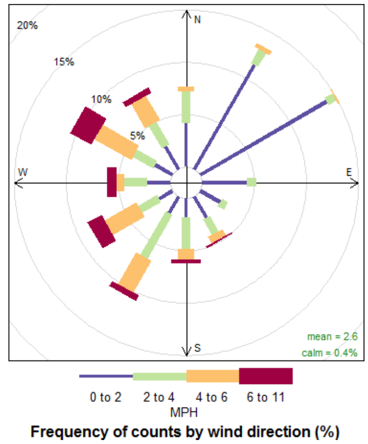
September 2015



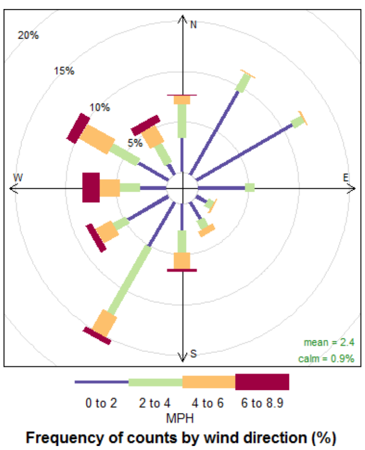
October 2015



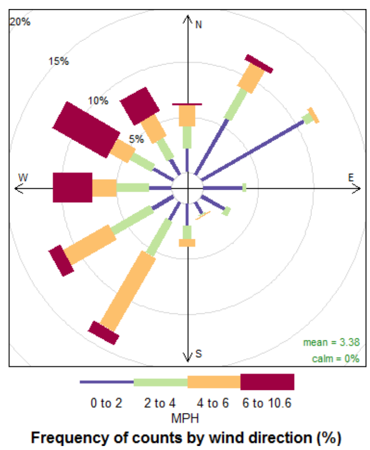
November 2015



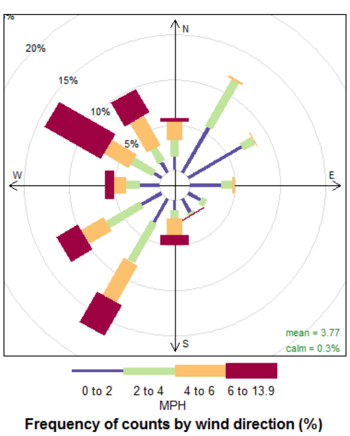
December 2015



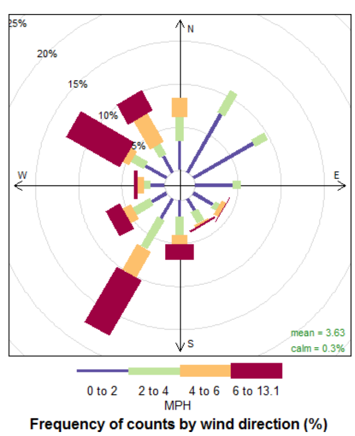
January 2016



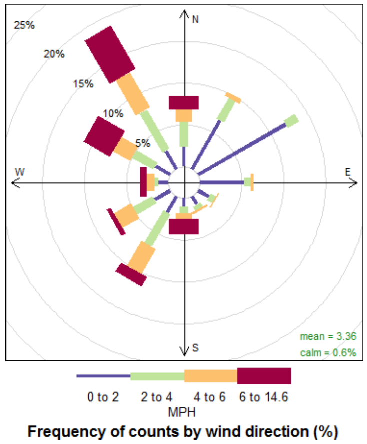
February 2016



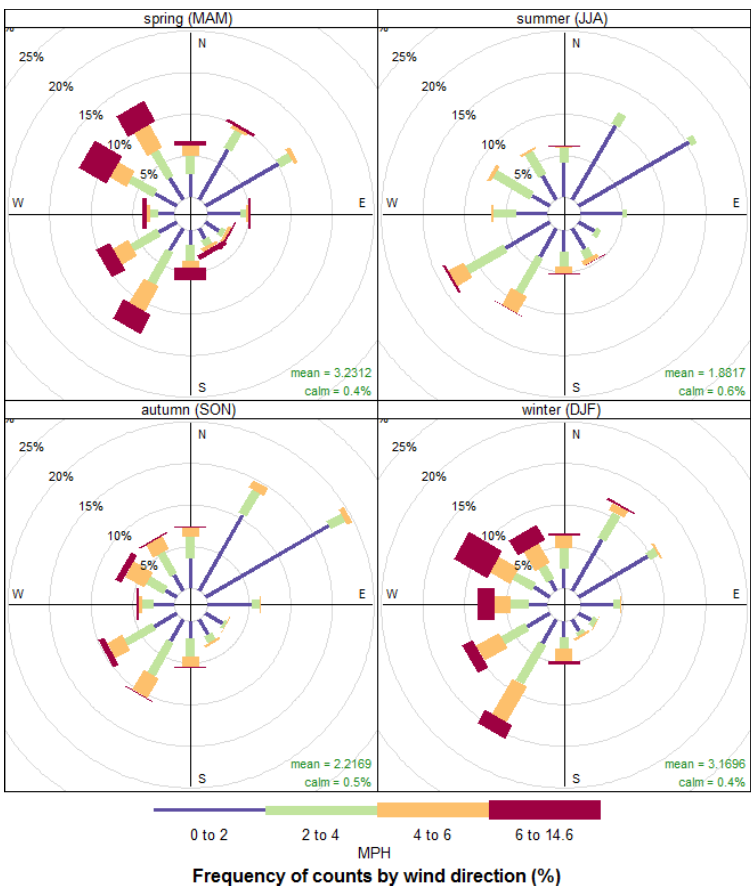
March 2016



April 2016



Seasonal Wind Roses



Hourly wind data were abstracted for each month from April 2015 to April 2016 from the Scranton air monitoring station. Hourly wind data were cleaned and analyzed in R, a statistical computing program, to determine wind patterns during the period of interest.

Note, however, that more years of weather data are needed to determine monthly/seasonal trends in wind speed and wind directions with more accuracy. Average monthly wind roses with several years of data would be less prone to variability from short term weather conditions. Comparing monthly wind roses, created using several years of data, to the long-term average would give a better picture of typical and/or unusual winds. This review focused only on the period of time monitored.

The yearly wind pattern (see Figure 1 in the main document) indicates the area usually experiences slower winds [0-4 miles per hour (mph)] from the northeast, as well as stronger winds (2-14.6 mph) from the northwest and southwest. Very little wind comes from the southeast, which is the direction of the KSL towards residential areas (there are hardly any homes southeast of KSL). Seasonally, wind direction appears similar between spring and winter (more frequent winds from the northwest), and summer and autumn (more winds form the northeast and southeast). Wind speed seems to vary seasonally as well.

The seasonal wind roses indicate wind speed increases during the spring and winter (mean wind speed of 3.23 mph and 3.17 mph respectively) and decreases in the summer and autumn (mean wind speed of 1.88 mph and 2.22 mph respectively). The highest mean monthly wind speeds were recorded during the three- month sampling period (January 29th 2016 to April 29th 2016), and the prevailing winds during this time were from the southwest and northwest. The months with the highest maximum wind speed were April 2015 and April 2016 (maximum wind speed of 14.6 mph). The month with lowest maximum wind speed was September (maximum wind speed of 6.2 mph). The month with the greatest percentage of calm wind speeds (wind speed of 0) was June 2015 (1.1%). This summary wind pattern information is specific to the year of data reviewed. Analysis of more years of weather data would be needed to determine long term monthly/seasonal trends in wind speed and wind directions.

Polar Plot Analysis of Particulate Matter 2.5 ($PM_{2.5}$) Data

Polar plots are a tool that provide a graphical method for showing the influence of wind speed and wind direction on air pollutant concentrations. By using polar coordinates, the plots provide a useful graphical technique which can provide directional information on sources of air pollution in an area [Carslaw and Beevers 2012]. Polar plots are calculated using statistical smoothing techniques to show a continuous surface. The monitoring station is represented at the center of the plot. The angles show the wind direction (e.g. the upper quadrants show concentrations with winds coming from the north), and the distance from the origin indicates the wind speed (e.g. the further out the high concentrations appear the higher the wind speeds when they were monitored, calm conditions appearing closer to the origin). To conduct polar plotting, a sufficient time series data set of pollutant concentrations is needed. Usually continuous monitoring for a pollutant is optimal, although limited polar plotting can be conducted using 24-hour data. Of the pollutant concentration data available for this KSL air quality evaluation, only the $PM_{2.5}$ data set contained enough data points for polar plot analysis.

Table D: Summary of January 2015-August 2016 $PM_{2.5}$ Results from Scranton COPAMS Station (µg/m^3)

Month	Year	Hourly Range	24-hour Avg. Range†	24-hour Avg. Per Month	# of Days Daily 24-hour Avg. > CV (%)*	AQI Category Range**	# of Days that Daily 24-hour Avg. = Good	# of Days that Daily 24-hour Avg. = Moderate	# of Days
January	2015	0-**40.2**	6.9-27.5	13.4	16 (52%)	Good-Moderate	15	16	31
February	2015	0-**41.8**	8.2-25.8	15.6	19 (68%)	Good-Moderate	9	19	28
March	2015	1.2-**36.5**	4.9-22.2	12.4	15 (48%)	Good-Moderate	16	15	31
April	2015	0-19.7	2.5-11.9	6.6	0 (0%)	Good	25	0	25
May	2015	0.5-**147.3**	5.3-16.5	10.5	11 (35%)	Good-Moderate	20	11	31
June	2015	0-**46.7**	0.8-30.5	8.6	3 (10%)	Good-Moderate	27	3	30
July	2015	0-**97.2**	4-20.7	10.6	9 (29%)	Good-Moderate	22	9	31
August	2015	0-27.4	4.2-19	9.1	6 (19%)	Good-Moderate	25	6	31
September	2015	0-**36**	0-25.8	9.1	7 (26%)	Good-Moderate	21	7	28
October	2015	0-23.1	3.2-14.9	7.6	3 (12%)	Good-Moderate	23	3	26
November	2015	0-24.7	5.4-14.2	9.3	6 (20%)	Good-Moderate	24	6	30
December	2015	0-33.9	4.5-27.8	12.1	12 (39%)	Good-Moderate	19	12	31
	2015 Annual Average: 10.4 µg /m^3								
January	2016	0-**37.3**	3.5-25.5	11.5	11 (35%)	Good-Moderate	20	11	31
February	2016	0-30.2	3.1-12.5	7.9	3 (10%)	Good-Moderate	26	3	29
March	2016	0-29.9	4.5-19.1	9.2	5 (16%)	Good-Moderate	26	5	31
April	2016	0-31.1	4.4-18.4	7.8	1 (4%)	Good-Moderate	26	1	27
May	2016	0-**85.2**	3.8-17.3	8.1	5 (16%)	Good-Moderate	26	5	31
June	2016	0-22.9	2.2-12.3	7.1	1 (3%)	Good-Moderate	29	1	30
July	2016	0-**159.7**	1.7-13.6	8.9	1 (3%)	Good-Moderate	20	1	21
August	2016	0-**64.7**	2.5-11.4	7.1	0 (0%)	Good	22	0	22
	2016 January-August Average: 8.5 µg /m^3; January 2015-August 2016 Average: 9.7 µg /m^3								

* Short Term CV: EPA Air Quality Index (AQI) lower range for the moderate air quality designation of 12.1 µg /m^3; **EPA Particulate Matter AQI Health Effect Statements, adapted from: https://www.airnow.gov/; † 24 hour $PM_{2.5}$ readings were taken each day. While some individual hourly results were classified as "Unhealthy for Sensitive Groups," "Unhealthy," and "Very Unhealthy," the daily averages for all days were within the "Good" or "Moderate" AQI categories for $PM_{2.5}$. Bold results indicate a month with at least one individual hourly result exceeding the maximum limit of the moderate AQI range of 35.4 µg /m^3, representing a health concern for unusually sensitive individuals and/or the general population. Good Range: 0-12.0; Moderate Range: 12.1-35.4; Unhealthy for Sensitive Group Range: 35.5-55.4; Unhealthy Range: 55.5-150.4; Very Unhealthy Range: 150.5-250.4.

The data abstraction and cleaning methods used for the wind data described above were also applied to the $PM_{2.5}$ data. Polar plots were created with the cleaned $PM_{2.5}$ data to determine if wind patterns may have influenced the dispersion of $PM_{2.5}$ during the period of interest. Figures D2 (annual) and D3 (monthly) are polar plots analyzing the influence of wind speed and direction on $PM_{2.5}$ levels monitored at PADEP's Scranton air monitoring station (Appendix A, Figure A3).

Figure D2: Annual polar plot of $PM_{2.5}$ air monitoring and meteorological data from the Scranton station (April 2015-April 2016)

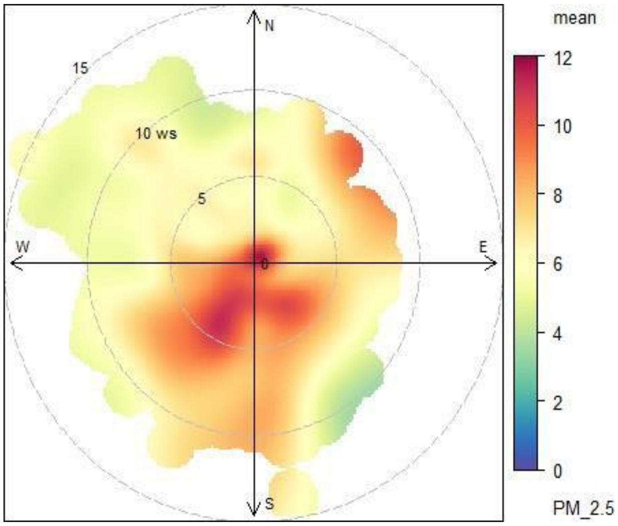
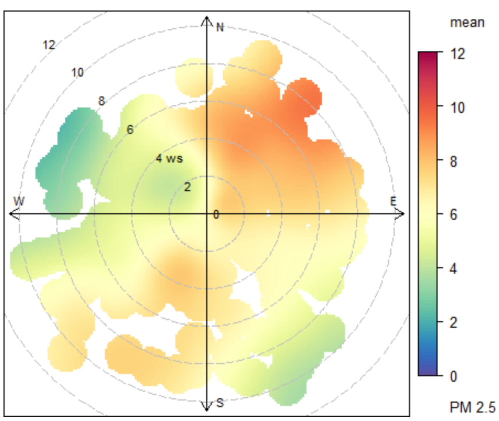
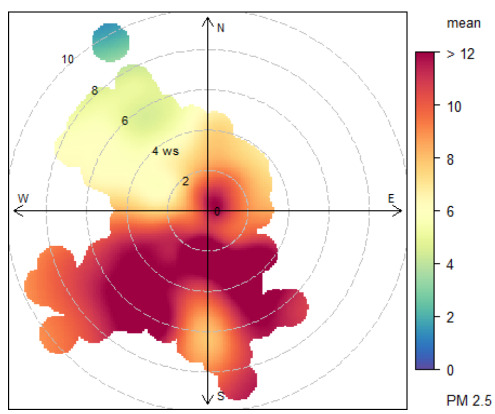


Figure D3: Monthly polar plots of $PM_{2.5}$ air monitoring and meteorological data from the Scranton station (April 2015-April 2016)

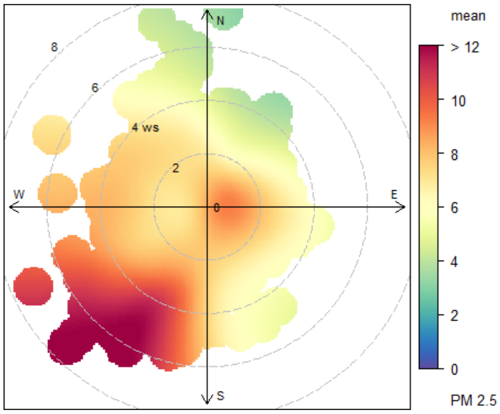
April 2015



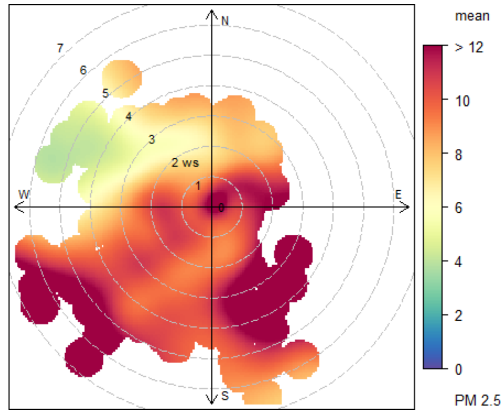
May 2015



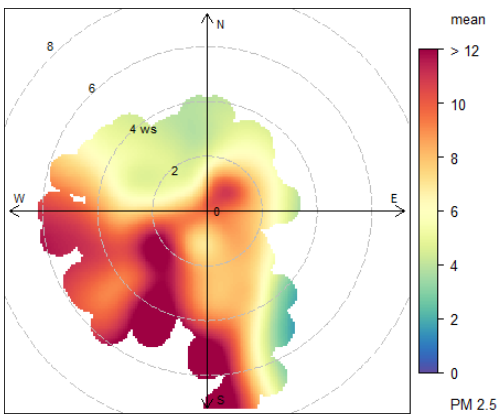
June 2015



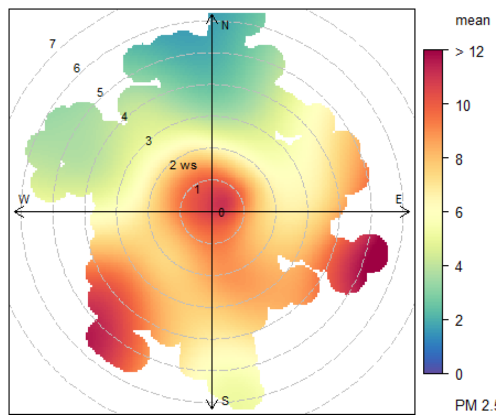
July 2015



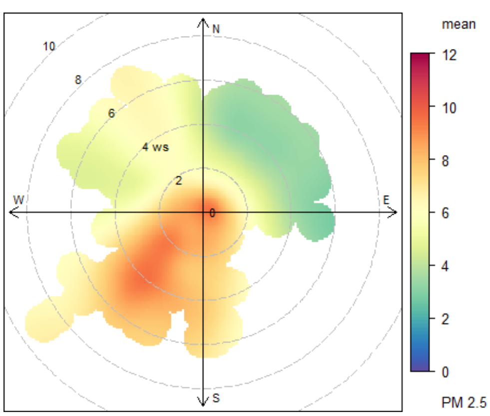
August 2015



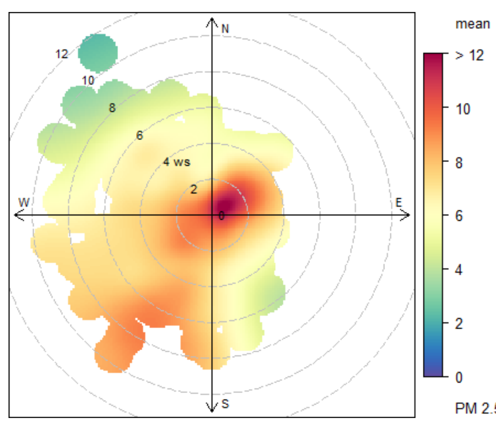
September 2015



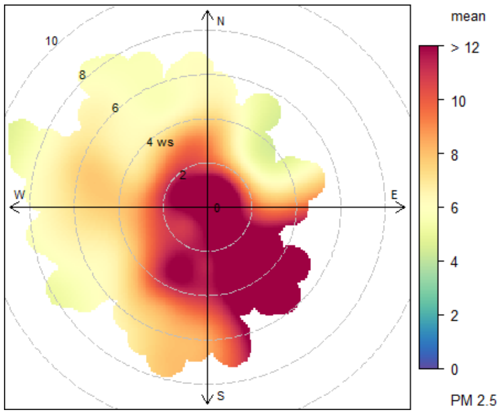
October 2015



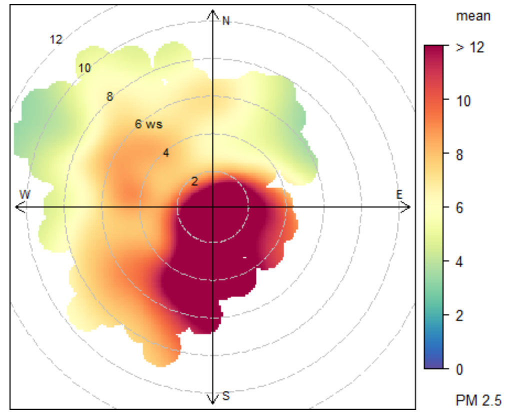
November 2015



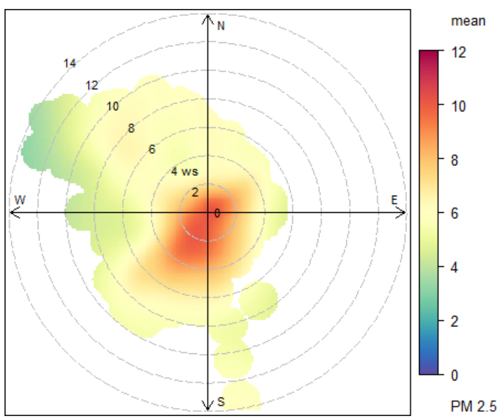
December 2015



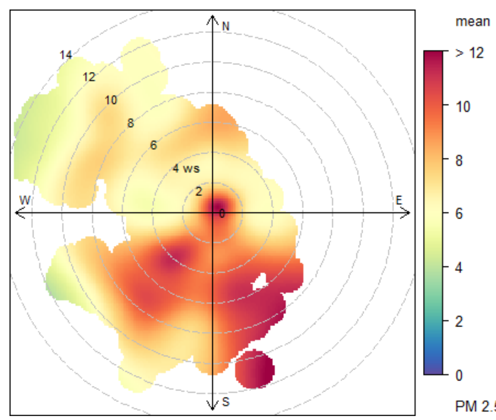
January 2016



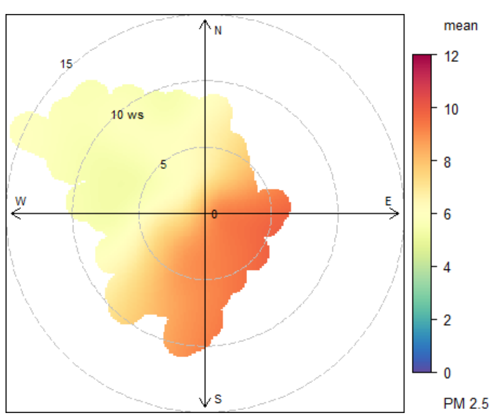
February 2016



March 2016



April 2016



The yearly polar plot indicates higher $PM_{2.5}$ levels are associated for the most part with very low wind speeds. Maximum $PM_{2.5}$ concentrations are present with little to no wind from the northeast. Higher concentrations are also present when winds less than 5 mph blow from the southwest and southeast. Light winds from the southeast correspond to elevated levels of $PM_{2.5}$. These higher $PM_{2.5}$ concentrations associated with little to no wind indicates a source very close to the sensor (e.g., not likely KSL but potentially the nearby Interstate 81 highway, agricultural or construction activity, or other nearby sources of particulate matter). Annually, stronger winds (7-10 mph) from the southeast correspond to the lowest levels of $PM_{2.5}$. However, based on the polar plot assessment of particulate concentration, wind direction, and speed, $PM_{2.5}$ levels above 12 $\mu g/m^3$ were recorded for brief (less than 24-hour) durations from the southeast and in the direction of KSL during 6 months of the monitoring period (e.g., May 2015, July 2015, September 2015, December 2015, January 2016, and March 2016). Higher levels of $PM_{2.5}$ recorded in these instances may indicate a source to the southeast (potentially the landfill).

Reference for Appendix D

Carslaw, DC and Beevers SD. 2012. Characterizing and understanding emission sources using bivariate polar plots and k-means clustering. Environmental Modeling and Software. August 22, 2012. Available at http://www.openair-project.org/PDF/OpenAir_clusterFinal.pdf.

Appendix E

Subsurface Exposure Pathway Analysis

A detailed summary of the available subsurface air monitoring information for this community is provided in this Appendix. The goal of this effort was to summarize historical environmental investigations including groundwater, residential indoor air, and sub-surface borehole sampling conducted from 1997 – 2002 in the Swinick neighborhood of Dunmore by the PADEP and other agencies. This information may be used to determine the potential for adverse health effects, identify data gaps, and make recommendations to protect the public health as part of the PADOH/ATSDR public health review of environmental exposures near the KSL site in Dunmore, PA.

Note on Site Data and Organization

Several reports exist describing actions at the Dunmore Gas Site; however, many of the reports are older and the file is not complete. ATSDR Region 3 performed a file review of the available EPA records and documents for the site. The file review was complicated by the fact that several investigations/sampling events were performed by different agencies, including the EPA, PADEP, Pennsylvania Department of Transportation (Penn DOT), and the U.S. Office of Surface Mining (OSM) Reclamation, and the local fire department. While many of the reports and sampling details were found during the file review, some information is incomplete and or missing. The statements and timeline in this summary are reconstructed from interpreting multiple reports, not all of which were released publicly.

Figure E1 shows locations of the boreholes for CO sampling (installed to measure gases present in abandoned mine workings underground) in the neighborhood and nearby areas, and homes monitored. In the rest of this appendix, these variables will be collectively referred to as "mine related gases" because they can be associated with old mine workings.

Background and Timeline of Activities

Initial Event and Response Activities

On February 6, 1997, construction activities occurred included the blasting of bedrock during the I-81 interchange construction. On February 7, 1997, an 18-year old resident living 130 feet from the blast trench was diagnosed with CO poisoning, and very high CO levels (between 300-500 ppm throughout the residence and up to 2,400 ppm at a basement drain) were measured in the home [PADEP 1997]. The fire department responded to the incident in 1997 and field monitoring showed CO levels in the basement of the home at 840 ppm and PG Energy confirmed elevated levels at 2,400 ppm in a basement drain. The following table summarizes (Table E1 – see below) CO monitoring by the PADEP on February 7, 1997, in the affected home.

No faulty appliance or other source of CO was found in the home. Other agencies were called in to identify the source of CO. During February 7-8, 1997, five homes nearest the blast site were voluntarily evacuated as a precautionary measure.

Following the initial incident, on February 8, 1997, PADEP conducted emergency response for CO, carbon dioxide (CO_2), low oxygen (O_2), and detections of percent lower explosive limit (%LEL). This monitoring after the incident established that CO levels in the home were not an immediate threat to public health. The levels of CO were measured up to 14 ppm in the homes. These readings were not thought to be associated with the highway blasting, and further investigation was undertaken. The following table summarizes the residential CO monitoring (Table E1- see below).

The residential area is part of the Swinick development in Dunmore, which consists of approximately 200 homes located across I-81 from the KSL site. Most the development is constructed on abandoned strip or deep mine areas. Historical aerial photographs showed that the area adjacent to the development was once a sedimentation pond for coal washing operations and that the fill, at certain depths, is of coal fines. Topsoil was used as cover in the residential homes. The area along the current I-81 interchange near the KSL and Swinick development, has undergone major construction activities beginning in 1995 [EPA 1998].

Table E1: Residential Carbon Monoxide Monitoring

Address	Location in the Home	CO (ppm)
Shirley Ln*	1st floor	320
	Basement	840
	Furnace Room	230
	Floor Drain, near furnace	260
	Outside cleanout of sewer	500
Swinick Dr.*	1st floor	2
	Basement	7
	Foundation	72
	Floor Drain Joint	14
	Floor Drain	7
Swinick Dr.*	Garage	14
	Kitchen	2.0
Shirley Ln*	Garage	0
	1st floor	2
	Basement	5
Shirley Ln	1st floor	0
	Basement	0
Shirley Ln	1st floor	0
	Basement	0
Shirley Ln	1st floor	0
	Basement	0
Shirley Ln	1st floor	0
	Basement	0
Shirley Ln	1st floor	0
	Basement	0
Shirley Ln	1st floor	0
	Basement	0
Shirley Ln*	1st floor	0

* In addition to most impacted residence on Shirley Ln, these homes were voluntarily evacuated after the incident

In winter-spring 1997, a multi-agency task force including OSM, PADEP, EPA, and Penn DOT performed initial response activities. Activities included installing boreholes to measure underground gas levels and temperature and conducting residential monitoring to determine gas levels in homes throughout the neighborhood. One of the original test boreholes, located at Throop and Ward Streets, was drilled to determine the outer boundaries of the site. This borehole had CO levels over 1,000 ppm, 100% LEL, O_2 at 12.7% and hydrogen sulfide levels at 645 ppm. Subsequent monitoring of this borehole showed consistent levels of CO from 300 ppm to 1,000 ppm. According to residents, this area was previously used as a trash disposal in the 1950's prior to the construction of the homes [EPA 1997a]. OSM drilled 36 boreholes, and EPA and Penn DOT sampled gases in over 100 Geoprobe soil borings in the area.

According to a 1998 EPA report, these initial studies ruled out an underground mine fire and pointed to February 1997 underground blasting conducted for highway construction as the likely source of harmful CO levels in the home. Gases were postulated to have entered the home through an abandoned water pipe and French drain system. EPA stated that the drain system would be modified so that gases could not enter again. The residents of the five evacuated homes returned, except for the home with resident diagnosed with CO poisoning [PADEP 1997].

Further Investigation of O_2/CO/CO_2 Issues

Further investigations into the cause and extent of the CO levels were performed by OSM, EPA, PADEP, and Penn DOT. Soil gas and mine gas samples were collected at the 92 boreholes (CO levels: 2- 90 ppm) throughout the site [EPA 1997c]. In March 1997, EPA Region 3 investigated, at the request of Congressman McDade, of the CO in the subsurface to identify the source including potential mine fires. In June 1997, EPA installed 7 boreholes throughout the area for monitoring of underground gases (labeled "Site Assessment Technical Assistance-SATA boreholes"), and in October 1997, weekly monitoring began at more than 40 homes in the neighborhood. Homes were monitored weekly and the SATA boreholes were monitored continuously for mine related gases until spring 1998.

The borehole data shows about half of the homes had detections of CO, elevated CO_2 and low O_2. In some of these homes the levels appeared to be associated with human activities, such as the use of unvented open flame heaters or automobile use in attached garage [Tetratech, undated]. In other homes, no explanation for the levels was identified. EPA, in coordination with Penn DOT and PADEP, also placed CO monitors in homes, based on proximity to the blasting and levels of CO during blasting. Some homes were identified for ongoing, continuous monitoring based on the level and frequency of detected gases [Tetratech, undated]. The continuous CO monitoring was conducted by PADEP at Station 19 and by Penn DOT at stations 2, 30 and an unknown home (by Penn DOT). Up to 16 homes had CO detections and about 13 had CO_2 detections; the CO/CO_2/O_2 levels did not always correlate with each other. The results showed levels were not a public health threat, with the continuous residential data for CO between 1 and 5 ppm. Subsequent residential monitoring showed low levels of CO and it was determined that CO was no longer in the homes at levels that would be a public health concern.

EPA and PADEP took steps to address the potential for future CO elevations including venting the boreholes and the installation of CO monitors in the affected homes [EPA 1997c]. Household sources were not identified or described in the information available; it does not appear that vapor intrusion systems were installed in any homes by any agencies as part of the response activities described.

In April 1997, confirmation sampling was performed at four residential basements using summa canisters. ATSDR was not able to locate address data for these four homes in the reports available to us. Field monitoring for CO before summa canister collected showed CO levels were 0 to 3.9 ppm. The summa canister sampling data showed CO was non-detect for three samples and 71 ppm in another. Methane levels ranged from 200 ppm to 960 ppm and CO2 levels in the homes ranged from 1,000 to 30,000 ppm [EPA 1997a].

In February 1999, PADEP installed 8 boreholes labeled Exposure Concentration Point ECP-1 through 8. The ECP and SATA boreholes were monitored for gases continuously, and samples were collected for 4 quarters of the year from various depths using summa canisters for VOC analysis. The four residences selected for ongoing sampling also had continuous gas monitoring. In February 2000, one sample for VOC analysis was collected from each home [Tetra Tech EMI 2000].

In 1997, NIOSH performed an investigation, due to the blasting operations in the area and concern for occupational exposures. The NIOSH investigation identified the most probable causes for CO generation in the area, including:

1. CO generation in the blast trenches which took one to two days to migrate to the homes (which corresponds with the time line of events);

2. A sealed underground pocket of CO from coal operations that was released by blasting or other operations;

3. Oxidation of carbonaceous materials is occurring to produce CO; and,

4. Historical fire underground generating CO that was released during blasting [EPA 1997a].

During the CO investigation, EPA evaluated other potential sources of CO in the area. The potential for sewage leakage was investigated, based on a sulfur dioxide (SO_2) level of 40 ppm in borehole at Throop and Ward Street. The area was wet, and the sewer line was nearby but fecal coliform tests were negative. EPA also visited the KSL and evaluated five gas monitoring wells surrounding the facility. The CO levels near the KSL ranged from 0.26 to 13 ppm, CO_2 from 450 to 56,000 ppm and methane was 1 to 3.1 ppm. Based on this, the landfill was not considered the source of CO entering the affected home [EPA 1997a].

In April 2001, gas samples were collected from selected ECP and SATA boreholes and analyzed for VOCs [Weston 2002].

Major Findings and Various Interpretations of Findings

Gas samples from boreholes indicated that low O_2, high CO, and high CO_2 conditions are prevalent in the subsurface. Methane was not frequently detected and was not present at high levels. Several VOCs were also detected in boreholes, including toluene at high levels (often greater than 1,000 ppb) and widespread throughout the sampled area.

At the end of the investigation, EPA concluded that the residents of Dunmore are no longer being exposed to harmful levels of CO in their homes, based on six months of monitoring efforts by PADEP and EPA [EPA 1997a]. EPA also concluded that CO levels were not a result of mine fire but was likely due to a French drain or a roof drain (which are used to remove water from properties) at the home that allowed CO to enter the home where the young man was exposed to high levels of CO. Based on the investigations, EPA believed blasting operations by Penn DOT as well as CO present in abandoned mines in the area could have caused elevated CO and migration to the homes via preferential pathways and basements. The data shows that EPA and PADEP found high level of CO in the subsurface, especially at the deeper locations [PADEP 1997].

The four homes sampled for VOCs had lower levels of toluene than the boreholes (up to 40 ppb in homes versus up to 13,600 ppb in boreholes). However, some contaminants were detected at higher levels. See screening evaluation for additional analytical information.

Various reports have given different levels of interpretation of the results, summarized below:

- Tetra Tech EMI [2000] reported results from continuous gas, temperature, and VOC monitoring in boreholes and 4 homes. Toluene and other VOCs were detected in most of the boreholes and at trace levels in the homes. No spatial pattern could be determined. CO and CO_2 were detected at elevated levels, and O_2 was low; specific homes had significant elevations of CO, CO_2, or both CO and CO_2. The results varied over time, and no spatial pattern could be determined.
- PADEP [2000] analyzed continuous gas data, temperature, and VOC data from boreholes as well as geological information. The 2000 DEP Final Project Report [4] concluded that KSL could be a source of CO, CO_2, and VOCs in the subsurface. The conclusion was based on temperature analysis and presence of a thrust fault which could allow gas flow.
- Weston [2002] compared Dunmore data with 2 other sites (a mine fire site and a landfill in a former coal mine) and concluded that the subsurface gases at Dunmore do not appear to be emanating from the KSL. The conclusion was based on correlation analysis and on composition of the Dunmore gases, which did not match expected typical landfill gas composition with high percent of methane.

The file indicated that the following actions were taken by PADEP and EPA:

1. A few residents were provided with permanent CO detectors for their homes (addresses and current operation unknown);

2. Modification of the floor drain systems of affected residences (addresses unknown**)** to ensure future highway blasting does not cause CO to enter the homes; and,

3. Venting the affected subsurface areas to release CO to the atmosphere and decrease the potential for migration into the homes [EPA 1997b].

Other Information

- Groundwater in the Dunmore area is primarily in a lower aquifer below the formerly mined coal seams [Gadinski et al 2000, PADEP undated]. The groundwater is found primarily at approximately 500 feet below ground and corresponds to the elevation of the local mine pool that drains the mines within the area. The upper aquifer system is reported to be mainly dry, with surface water infiltrating through and running along low permeability zones towards surface water discharge further away [PADEP undated]. Limited trapped groundwater may remain in some areas of the upper aquifer/former mine workings [Gadinski et al 2000].

- Additional information obtained from PADEP officials includes the following:
  - The Keystone landfill has not had many VOC problems in groundwater monitoring [Hannigan 2015].
  - The landfill has a gas extraction system which has operated for years, so the landfill is under negative pressure (personal communication, PADEP conference call with ATSDR, May 21, 2015). PADEP has stated that odor complaints near the landfill were significantly reduced after the collection system at the landfill was improved in 2013. We do not have information on the effectiveness of the collection system prior to 2013.
  - Numerous underground storage tank releases have apparently occurred in this area (personal communication, PADEP NE conference call with ATSDR, May 21, 2015). No online listing of releases is available and ATSDR is not able to review the potential significance of this information related to possible subsurface exposure pathways at this time.
  - The landfill operator sampled and analyzed raw landfill gas; preliminary results were shared with ATSDR and other agencies on July 15, 2015 [Bellas 2015].

Screening Level Evaluation of VOC Detections

ATSDR screened the maximum VOC detections in the borehole and residence air samples from 1999 and 2000. In the four homes that were only sampled once each in February 2000, 3 substances (benzene, chloroform, and 1,2,4-trimethylbenzene) exceeded cancer or non-cancer CVs; toluene was detected in each of these homes as well but below CVs (Table E2 – see below). Given the incompleteness of the records available on this past VOC sampling information and the fact that these data do not represent current conditions, we did not formally evaluate this information in this document.

2015 PADEP Memorandum

As a result of PADOH and ATSDR's current Keystone evaluation and interagency discussions with PADEP, PADEP asked a hydrogeologist staff to conduct a peer review of the Weston [2002] and Tetra Tech TMI [2000] reports [Hartnett 2015]. In this memorandum, Hartnett states that "although the data generated within these two reports is extensive, a definitive source(s) of the CO cannot be determined" and that "it may be possible that more in-depth study on the air/gas movements within these measures and other known geologic features may identify the source(s). This would entail the installation of multiple nested pairs of wells and years' worth of subsurface and atmospheric data; however, due to the complexities of the mine workings in this area, additional studies may still yield inconclusive results." Given this situation, and because "no one has made an IAQ [Indoor Air Quality] complaint in the area of concern since this was first reported," Harnett concludes that "additional investigations are not warranted at this time."

Table E2: Screening Level Evaluation – Residential VOC Results (ppb)

Contaminants	Maximum Conc. in Homes A-D	Non-Cancer CV and Source	Cancer CV	# of Homes with Substance Detected > CV / Cancer CV
Benzene	7	3 cMRL 9 aMRL	0.04	2/4
Chloroform	1	20 cMRL 100 aMRL	0.0089	0/4
Toluene	39.5	1000 cMRL 2000 aMRL	none	0/N/A
1,2,4-Trimethylbenzene	18	12 RfC	none	2/N/A

ppb = parts per billion
CV = comparison value
cMRL = chronic ATSDR Minimal Risk Level
RfC = EPA Reference Concentration
aMRL = acute ATSDR Minimal Risk Level

In the boreholes, which were sampled from various depths of 14 boreholes during 4 quarterly sampling events, 10 substances exceeded cancer or non-cancer CVs (Table E3 – see below).

Table E3: Screening Level Evaluation – Borehole VOC Results (ppb)

Contaminants	Maximum Conc. in Any Borehole Sample	Non-Cancer CV and Source	Cancer CV	% of Samples with Detections / Detections > Lowest CV
Benzene	5	3 cMRL 9 aMRL	0.04	19%/19%
Chloroform	24	20 cMRL 100 aMRL	0.0089	28%/28%
Dichlorodifluoromethane	154	20 - RSL	none	35%/9%
1,2-Dichloroethane	1	600 cMRL	0.009	0.4%/0.4%
Methylene Chloride	57	300 cMRL 600 aMRL	18	30%/1%
Tetrachloroethylene	15	6 cMRL 6 aMRL	0.57	17%/14%
Toluene	13,600	1000 cMRL 2000 aMRL	none	98%/18%
Trichloroethylene	7	0.4 cMRL	0.041	6%/6%
1,2,4-Trimethylbenzene	25	12 RfC	none	23%/1%
Xylene	125	23 RfC 2000 aMRL	none	48%/4%

ppb = parts per billion
CV = comparison value
cMRL = chronic ATSDR Minimal Risk Level
RfC = EPA Reference Concentration
aMRL = acute ATSDR Minimal Risk Level
Note: Results included 250 samples total for all boreholes, depths, and sampling events. Data from 4 sampling events in 1999-2000; additional sampling in selected boreholes in 2001 showed similar VOC/toluene concentrations in boreholes.

References for Appendix E

Bellas R. E-mail to J. Dyken of the Agency for Toxic Substances and Disease Registry et al. RE: Keystone Landfill Agency Update Discussion - recap from today's short call: Pennsylvania Department of Environmental Protection, received Thursday, July 15, 2015 9:33 am.

[EPA] U.S. Environmental Protection Agency. 1998. Dunmore Gas Site, Lackawanna County, Pennsylvania, OSC Assessment Report 3/17/97-9/11/97. June 9.

[EPA] U.S. Environmental Protection Agency. 1997a. Memorandum from OSC Fetzer to Abraham Ferdas, Associate Director Office of Superfund. Recommendations for Determination of Imminent and Subsurface Endangerment at the Dunmore Gas Site located in Lackawanna County, Dunmore, PA.

[EPA] U.S. Environmental Protection Agency. 1997b. OSC Assessment Report: Dunmore Gas Site- Strategies for Investigation of Carbon Monoxide Related to Trench Blasting Located a Coal Mine Area. Lackawanna County, Pennsylvania.

[EPA] U.S. Environmental Protection Agency. 1997c. Subsurface Investigation Report for Dunmore Gas Site. Dunmore, Lackawanna County, PA. December 19, 1997.

Gadinski R, Mellow J, Baughman SH, Laraway J. Modified Packer Pump for Site Characterization. Fifth International Conference of Contamination in Eastern Europe. Prague, Czech Republic. September 2000.

Hannigan L. email to L. Werner of the Agency for Toxic Substances and Disease Registry RE: Keystone DEP Results 2007-2015: Pennsylvania Department of Environmental Protection, sent Thursday, May 28, 2015 11:10 am.

Hartnett, TR. 2015. Memorandum to HSCA File, Dunmore Carbon Monoxicde Site, Dunmore Borough, Lackawanna County, August 17, 2015.

[PADEP] Pennsylvania Department of Environmental Protection. Keystone Landfill Permit Information. Available at: http://files.dep.state.pa.us/RegionalResources/NERO/NEROPortalFiles/Volume%205.pdf

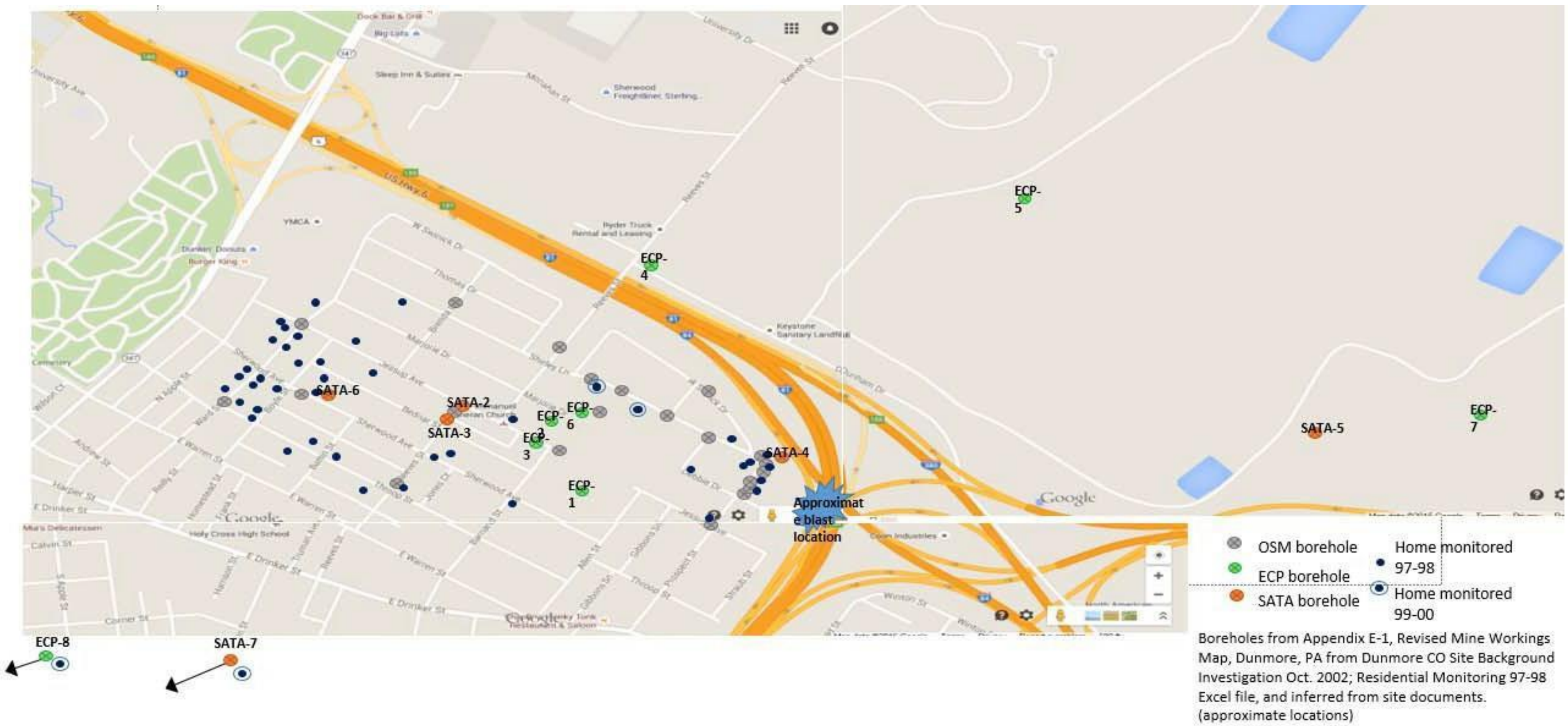
[PADEP] Pennsylvania Department of Environmental Protection. 1997. PADEP Emergency Response Memo on Carbon Monoxide monitoring in the Swinick Development, Dunmore, PA.

[PADEP] Pennsylvania Department of Environmental Protection. 2000. Dunmore Gas Site, Dunmore Borough, Lackawanna County, Final Project Report, John S. Mellow, Regional Project Officer. August 10.

Tetra Tech EMI. 2000. Final Site Investigation Report, Dunmore Co Site, Lackawanna County, Pennsylvania. Prepared for Pennsylvania DEP. June 8.

Weston Solutions, Inc. 2002. Dunmore Carbon Monoxide Site, Background Investigation, Dunmore, Lackawanna County, Pennsylvania. Prepared for Pennsylvania DEP. October.

Figure E1. Approximate Locations of the Boreholes for Carbon Monoxide Sampling, Dunmore PA



Appendix F

Health Outcome Data (Cancer Registry Data Review)

To address community resident requests, PADOH reviewed relevant cancer data near the landfill. PADOH reviewed cancer data (2005 - 2014) for the six zip codes (18434, 18447, 18509, 18510, 18512, and 18519) surrounding the KSL for the following types of cancer: bladder, brain, breast, cervix, colon, esophagus, Hodgkin lymphoma, kidney, larynx, leukemia, liver, lung, melanoma, non-Hodgkin's lymphoma, oral cavity, ovary, pancreas, prostate, stomach, testis, thyroid, uterus and other cancer types. Cancer incidence rate comparisons were made with the rest of the state.

Cancer incidence rates were compared for each of the six individual zip codes with the state rate, and all six zip codes combined with the state (whole state excluding the six zip codes area) using Pennsylvania cancer registry data from 2005 - 2014. The expected number of cancer cases were calculated for each of the six individual zip codes, and all six zip codes combined using the state rate (minus the comparison area) and then compared with the observed number of cancer cases for the 23 different types of cancers (see Table F below). Age-adjusted standardized incidence ratio (SIR) were calculated by dividing the observed number of cases by the expected number of cancer cases.

Age-adjusted SIR calculation involves comparing the observed number of cancer cases to a number that would be expected if the community were experiencing the same rate of cancer as a larger comparison area (in this case the state of Pennsylvania). Specifically, this is done by calculating rates for the comparison area and multiplying by the population in the zip code. The final number is the expected number of cases in the zip code. The observed number of cases is then divided by the expected number of cases in the zip code. This ratio of observed over expected is called an SIR. A ratio greater than 1.0 indicates that more cases occurred than expected; and a ratio less than 1.0 indicates that fewer cases occurred than expected. As an example, a ratio of 1.5 is interpreted as one-and-a-half times as many cases as the expected number, and a ratio of 0.9 indicates nine-tenths as many cases as the expected number. The SIR is considered statistically significant if the 95% confidence interval (CI) between the lower and higher confidence limits does not include 1.0. The CI helps to determine the precision of the SIR estimate. The narrower the CI, the more confidence one has in the precision of the SIR estimate.

In the interest of brevity, we are discussing only those results which are statistically significant. For all cancers combined, the combined area zip codes and the zip code 18510 had lower cancer incidence rates than the rest of the state. The incidence rate for zip code 18510 was 15% lower than the rest of the state (SIR: 0.85, 95% CI: 0.79 – 0.92). The combined zip codes incidence rate was 7% lower than the rest of the state (SIR: 0.93, 95% CI: 0.90 – 0.96).

The incidence rate for breast cancer was lower for the six zip codes combined area when compared to the rest of the state and was 12% lower than the rest of the state (SIR: 0.88, 95% CI: 0.81 – 0.96). The incidence rate for liver cancer in zip code 18512 was 60% lower than the rest of the state (SIR: 0.40, 95% CI: 0.13 – 0.93). The incidence rates for melanoma were 62% to 30% lower than the rest of the state in each of the six zip codes. For the combined zip codes, the melanoma incidence rate was 43% lower when compared with the rest of the state at SIR 0.57, 95% CI: 0.48 – 0.68. For all six zip codes combined, the non-Hodgkin's lymphoma incidence rate was 19% lower than the rest of the state with an SIR of 0.81 (95% CI: 0.69 – 0.95). The incidence rate for prostate cancer was 28% lower than the rest of the state in zip code 18447 with an SIR of 0.72 (95% CI: 0.56 – 0.91). The incidence rate for prostate cancer was also 28% lower than the rest of the state in zip code 18510 with an SIR of 0.72 (95% CI: 0.56 – 0.92). The incidence rate for prostate cancer for combined zip codes was 17% lower with an SIR of 0.83 (95% CI: 0.74 – 0.91). The incidence rate for stomach cancer was 71% higher than the rest of the state in zip code 18512 with an SIR of 1.71 (95% CI: 1.07 – 2.59). The incidence rate for laryngeal cancer in zip code 18509 and for all the zip code combined area was 122% and 39% higher respectively, than the rest of the state {SIR for zip code 18509 was 2.22 (95% CI: 1.24 – 3.66) and SIR for all zips combined was 1.39 95% CI: 1.02 – 1.86)}. The incidence rate for leukemia in zip code 18512 was 59% higher than the rest of the state with an SIR of 1.59, (95% CI: 1.02 – 2.37).

In summary, when examining the six zip codes combined area, the incidence rate for all cancers (combined) and the rates for breast cancer, melanoma, non-Hodgkin's lymphoma and prostate cancer were significantly lower than the state rate. The laryngeal cancer rate in the combined zip code area was significantly higher than the state rate (Table F). Based on the American Cancer Society the common environmental risk factors for laryngeal cancer are, long and intense exposures to wood dust, paint fumes, and certain chemicals used in the metalworking, petroleum, plastics, and textile industries [ACS 2014]. Based on a review of peer-reviewed literature published between 1983-2008, Porta *et al* (2009) the study concluded that there is inadequate (i.e. available studies are of insufficient quality, consistency or statistical power to decide the presence or absence of a causal association) evidence to suggest a causal link between laryngeal cancer and municipal solid waste disposal.

One limitation of an SIR analysis is that the population under evaluation in a small community (such as in a few zip codes) usually results in fewer cancer cases. A small number of cancer cases typically yield wide CI, meaning that the SIR is not as precise as desired.

Cancer is a common disease with a multitude of risk factors (genetic, environmental, and behavioral). The Pennsylvania cancer registry does not collect information on these risk factors. Therefore, the current analysis was not able to consider the prevalence of these risk factors in the population studied. In most cancer cases, it is difficult to find a direct cause-and-effect relationship between one exposure or risk factor and the cancer type. One of the reasons for this is the long latency period (time gap between initial exposure time and diagnosis or appearance of signs and symptoms**)**. For many cancer types, it may take decades for a cancer to develop and be diagnosed. People also migrate from one location to another, and therefore it becomes difficult to find the source of exposure that may have caused a particular cancer. Cancers diagnosed in PA residents are only reported to the PA cancer registry. Diagnoses made after the individual moved out of state may not be included in the PA cancer registry. Likewise, diagnoses made in people who have recently moved into the Commonwealth (with exposures happening elsewhere) will be included in the PA cancer registry, regardless of where exposure occurred.

Even when a statistically significant increase in cancer incidence is detected, determining the validity of an association between an environmental agent and the development of cancer is difficult, as behavioral (e.g. nutrition, physical activity, and substance use), genetic (e.g. inherited mutations, hormones, and immune conditions), and environmental (e.g. chemicals, radiation, pathogens and other contaminants) factors interact and affect cancer growth. These factors may act together or in sequence to initiate or promote cancer. Ten or more years often pass between exposures or mutations and detectable cancer, and the latency of some cancers may be closer to 20 to 30 years. Furthermore, difficulties in identifying the mode of transmission or a biological pathway, the level of exposure, and amount of exposure time all contribute to the complexities of cancer inquiry investigations.

References for Appendix F

[ACS] The American Cancer Society. 2014. What Are the Risk Factors for Laryngeal and Hypopharyngeal Cancers? Available from: https://www.cancer.org/cancer/laryngeal-and-hypopharyngeal-cancer/causes-risks-prevention.html

Daniela Porta, Simona Milani, Antonio I Lazzarino1, Carlo A Perucci1 and Francesco Forastiere. 2009. Systematic review of epidemiological studies on health effects associated with management of solid waste. Environmental Health 8:60.

Table F: Age-Adjusted Standardized Incidence Ratios (2005-2014) for Cancers by Type for Residents near the Keystone Landfill (6 – zip codes and all zip codes combined) Compared to All Pennsylvania Residents

Cancer type	Statistics	Zip codes						
		18434	18447	18509	18510	18512	18519	All zip codes (combined)
All cancers (combined)	Observed	292	790	845	716	946	358	3947
	Expected SIR	316.8 0.92	849.6 0.93	886.8 0.95	837.7 **0.85**	973.5 0.97	365.1 0.98	4229.5 **0.93**
	95%CI	0.82 - 1.03	0.87 - 1	0.89 - 1.02	0.79 – 0.92	0.91 - 1.04	0.88 - 1.09	0.9 – 0.96
Bladder	Observed	23	49	43	29	61	26	231
	Expected SIR	15.7 1.47	42.0 1.17	42.6 1.01	41.0 0.71	48.4 1.26	17.6 1.48	207.3 1.11
	95%CI	0.93 - 2.2	0.86 - 1.54	0.73 - 1.36	0.47 - 1.02	0.96 - 1.62	0.97 - 2.17	0.98 - 1.27
Brain	Observed	8	29	22	26	27	17	129
	Expected SIR	10.4 0.77	27.5 1.05	29.9 0.74	28.7 0.91	31.5 0.86	12.1 1.41	140.0 0.92
	95%CI	0.33 - 1.52	0.71 - 1.51	0.46 - 1.11	0.59 - 1.33	0.57 - 1.25	0.82 - 2.26	0.77 - 1.09
Breast	Observed	36	111	130	115	125	46	563
	Expected SIR	48.1 0.75	128.0 0.87	135.8 0.96	123.5 0.93	147.7 0.85	55.8 0.82	638.9 **0.88**
	95%CI	0.52 - 1.04	0.71 - 1.04	0.8-1.14	0.77 - 1.12	0.7 - 1.01	0.6 - 1.1	0.81 – 0.96
Cervix	Observed	2	6	2	4	6	0	20
	Expected SIR	1.9 1.06	4.8 1.25	5.3 0.38	4.8 0.83	5.5 1.08	2.2 0.00	24.6 0.81
	95%CI	0.13-3.85	0.46 - 2.72	0.05 - 1.36	0.23 - 2.13	0.4 - 2.36	-	0.5 - 1.26
Colon	Observed	36	84	86	88	109	41	444
	Expected SIR	31.6 1.14	84.8 0.99	86.7 0.99	83.1 1.06	97.3 1.12	35.6 1.15	419.2 1.06
	95%CI	0.8 - 1.57	0.79 - 1.23	0.79 - 1.22	0.85 - 1.3	0.92 - 1.35	0.83 - 1.56	0.96 - 1.16
Esophagus	Observed	2	11	10	10	10	2	45
	Expected	3.2	8.8	9.0	8.5	10.1	3.7	43.3

Cancer type	Statistics	Zip codes						
		18434	18447	18509	18510	18512	18519	All zip codes (combined)
Esophagus	SIR	0.62	1.25	1.11	1.17	0.99	0.54	1.04
	95% CI	0.07 - 2.23	0.63 - 2.24	0.53 - 2.05	0.56 - 2.16	0.48 - 1.83	0.07 - 1.94	0.76 - 1.39
Hodgkin	Observed	0	7	3	3	5	2	20
	Expected	1.4	3.6	4.8	5.2	4.2	1.8	21.1
	SIR	0.00	1.94	0.62	0.58	1.18	1.14	0.95
	95% CI	-	0.78 - 3.99	0.13 - 1.81	0.12 - 1.69	0.38 - 2.75	0.14 - 4.1	0.58 - 1.47
Kidney	Observed	7	22	21	21	27	7	105
	Expected	9.5	25.5	26.6	24.7	29.2	11.1	126.6
	SIR	0.74	0.86	0.79	0.85	0.92	0.63	0.83
	95% CI	0.3 - 1.52	0.54 - 1.31	0.49 - 1.21	0.53 - 1.3	0.61 - 1.34	0.25 - 1.3	0.68 - 1
Larynx	Observed	4	8	15	4	9	5	45
	Expected	2.4	6.6	6.8	6.3	7.5	2.8	32.3
	SIR	1.66	1.22	**2.22**	0.63	1.20	1.78	**1.39**
	95% CI	0.45 - 4.25	0.53 - 2.41	1.24 - 3.66	0.17 - 1.62	0.55 - 2.29	0.58 - 4.15	1.02 - 1.86
Leukemia	Observed	9	16	14	13	24	7	83
	Expected	5.0	13.1	14.3	13.9	15.1	5.7	67.1
	SIR	1.81	1.22	0.98	0.93	**1.59**	1.22	1.24
	95% CI	0.83 - 3.43	0.7 - 1.98	0.54 - 1.65	0.5 - 1.6	1.02 - 2.37	0.49 - 2.51	0.98 - 1.53
Liver	Observed	7	6	16	8	5	4	46
	Expected	4.1	11.1	11.4	10.7	12.5	4.7	54.6
	SIR	1.72	0.54	1.40	0.74	**0.40**	0.85	0.84
	95% CI	0.69 - 3.54	0.2 - 1.17	0.8 - 2.27	0.32 - 1.47	0.13 - 0.93	0.23 - 2.18	0.62 - 1.12
Lung	Observed	33	102	126	93	138	50	542
	Expected	40.6	109.1	111.4	105.0	126.3	46.5	538.9
	SIR	0.81	0.93	1.13	0.89	1.09	1.08	1.01
	95% CI	0.56 - 1.14	0.76 - 1.14	0.94 - 1.35	0.72 - 1.09	0.92 - 1.29	0.8 - 1.42	0.92 - 1.09
Melanoma	Observed	9	30	32	22	39	8	140

Cancer type	Statistics	Zip codes						
		18434	18447	18509	18510	18512	18519	All zip codes (combined)
Melanoma	Expected SIR	18.3 **0.49**	48.7 **0.62**	51.8 **0.62**	48.6 **0.45**	55.8 **0.70**	21.3 **0.38**	244.4 **0.57**
	95% CI	0.23 - 0.94	0.42 - 0.88	0.42 - 0.87	0.28 - 0.69	0.5 - 0.96	0.16 - 0.74	0.48 - 0.68
Myeloma	Observed	3	10	8	7	8	2	38
	Expected SIR	3.7 0.80	10.0 1.00	10.2 0.78	9.7 0.72	11.5 0.69	4.2 0.47	49.4 0.77
	95% CI	0.17 - 2.35	0.48 - 1.84	0.34 - 1.54	0.29 - 1.49	0.3 - 1.37	0.06 - 1.7	0.54 - 1.06
NHL	Observed	11	38	33	28	41	12	163
	Expected SIR	15.1 0.73	40.3 0.94	41.9 0.79	40.0 0.70	46.4 0.88	17.2 0.70	200.8 **0.81**
	95% CI	0.36 - 1.3	0.67 - 1.29	0.54 - 1.11	0.46 - 1.01	0.63 - 1.2	0.36 - 1.22	0.69 - 0.95
Oral	Observed	4	22	24	22	23	6	101
	Expected SIR	6.5 0.62	17.5 1.26	18.3 1.31	17.1 1.29	19.8 1.16	7.5 0.80	86.6 1.17
	95% CI	0.17 - 1.59	0.79 - 1.9	0.84 - 1.96	0.81 - 1.95	0.74 - 1.74	0.29 - 1.74	0.95 - 1.42
Ovary	Observed	5	14	11	8	13	3	54
	Expected SIR	4.1 1.23	10.9 1.29	11.6 0.95	10.9 0.73	12.5 1.04	4.6 0.65	54.5 0.99
	95% CI	0.4 - 2.87	0.7 - 2.16	0.47 - 1.7	0.32 - 1.45	0.56 - 1.79	0.13 - 1.89	0.74 - 1.29
Pancreas	Observed	11	19	21	14	22	6	93
	Expected SIR	8.1 1.36	21.8 0.87	22.2 0.94	21.4 0.65	25.1 0.88	9.1 0.66	107.8 0.86
	95% CI	0.68 - 2.43	0.52 - 1.36	0.58 - 1.44	0.36 - 1.1	0.55 - 1.33	0.24 - 1.43	0.7 - 1.06
Prostate	Observed	33	67	73	64	97	38	372
	Expected SIR	34.0 0.97	93.2 **0.72**	91.1 0.80	88.8 **0.72**	104.4 0.93	39.3 0.97	450.7 **0.83**
	95% CI	0.67 - 1.36	0.56 - 0.91	0.63 - 1.01	0.56 - 0.92	0.75 - 1.13	0.69 - 1.33	0.74 - 0.91

Cancer type	Statistics	Zip codes						
		18434	18447	18509	18510	18512	18519	All zip codes (combined)
Stomach	Observed	4	13	11	11	22	7	68
	Expected SIR	4.2 0.96	11.2 1.16	11.5 0.96	11.1 1.00	12.9 **1.71**	4.7 1.49	55.5 1.22
	95% CI	0.26 - 2.45	0.62 - 1.98	0.48 - 1.71	0.5 - 1.78	1.07 - 2.59	0.6 - 3.07	0.95 - 1.55
Testis	Observed	2	3	6	4	5	0	20
	Expected SIR	1.2 1.65	3.0 0.99	4.5 1.34	4.3 0.93	3.5 1.41	1.6 0.00	18.2 1.10
	95% CI	0.2 - 5.97	0.21 - 2.91	0.49 - 2.91	0.25 - 2.39	0.46 - 3.29	-	0.67 - 1.7
Thyroid	Observed	6	28	26	24	26	11	121
	Expected SIR	8.7 0.69	22.6 1.24	26.1 1.00	24.0 1.00	25.8 1.01	10.5 1.04	117.7 1.03
	95% CI	0.25 - 1.51	0.82 - 1.79	0.65 - 1.46	0.64 - 1.49	0.66 - 1.48	0.52 - 1.87	0.85 - 1.23
Uterus	Observed	9	24	24	18	29	10	114
	Expected SIR	9.6 0.93	26.1 0.92	27.7 0.87	25.1 0.72	30.0 0.97	11.4 0.88	129.8 0.88
	95% CI	0.43 - 1.77	0.59 - 1.37	0.56 - 1.29	0.43 - 1.14	0.65 - 1.39	0.42 - 1.62	0.72 - 1.06
Other Cancers	Observed	28	71	88	80	75	48	390
	Expected SIR	30.0 0.93	79.9 0.89	83.8 1.05	81.3 0.98	91.5 0.82	33.9 **1.41**	400.3 0.97
	95% CI	0.62 - 1.35	0.69 - 1.12	0.84 - 1.29	0.78 - 1.23	0.64 - 1.03	1.04 - 1.87	0.88 - 1.08

SIR = Standardized Incidence Ratio for significant difference is bolded; 95% CI = 95% Confidence Interval; Numbers highlighted in green are significantly lower than the state and numbers highlighted in red are significantly higher than the state

Appendix G

Detailed information on Comparison Values (CVs) and 95UCL calculations

CVs can be based on either carcinogenic or non-carcinogenic effects. There are several CVs available for screening environmental contaminants to identify contaminants of potential concern. These include ATSDR Environmental Media Evaluation Guides (EMEGs) and Reference Media Evaluation Guides (RMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse noncarcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) values were used for further evaluation of the substances. Concentrations greater than CREGs do not necessarily mean that people will develop cancer from exposures, but further evaluation is necessary to assess the risk of cancer.

Cancer-based CVs are calculated from the EPA oral Cancer Slope Factor (CSF) or Inhalation Unit Risk (IUR). CVs based on cancerous effects account for a lifetime exposure (78 years) with a theoretical excess lifetime cancer risk of one extra case per one million exposed people. Non-cancer values are calculated from ATSDR's Minimal Risk Levels (MRLs), EPA's Reference Doses (RfDs), or EPA's Reference Concentrations (RfCs) [ATSDR 2005].

Cancer Risk Evaluation Guides (CREGs) are media-specific CVs that are used to identify concentrations of cancer-causing substances that are likely to result in an increase of cancer rates in an exposed population. ATSDR develops CREGs using EPA's CSF or IUR, a target risk level (10^{-6}), and default exposure assumptions. The EPA target risk level of 10^{-6} represents an estimated risk of one excess cancer cases in a population of one million.

MRLs are developed by ATSDR and are an estimate of the daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects during a specified duration of exposure. MRLs are based only on non-carcinogenic effects. If sufficient data are available, MRLs are derived for acute (1-14 days), intermediate (15-365 days), and chronic (365 days and longer) durations for the oral and inhalation routes of exposure [ATSDR 2005].

Screening levels developed by the EPA were also used in this public health assessment. The EPA has developed chronic RfCs for inhalation. RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non-cancer health effects during a lifetime. RfCs are derived assuming exposure to a single substance in a single media. In this document, if there was no MRL for a given contaminant, the EPA RfC was used.

PADOH also used EPA's screening level/preliminary remediation goal website, entitled "Regional Screening Levels for Chemical Contaminants at Superfund Sites. The Regional Screening Levels (RSLs) table provides CVs for residential and commercial-industrial exposures to soil, air and tap water [EPA 2016].

Finally, if a contaminant did not have an ATSDR MRL or CREG, or EPA RfC or RSL air value, PADOH used screening levels developed by other environmental and health agencies such as the

Texas Commission on Environmental Quality (TCEQ); National Ambient Air Quality Standards (NAAQS); California Air Resources Board Reference Exposure Levels (CARB-REL); American Conference of Governmental Industrial Hygienists (ACGIH); National Institute for Occupational Safety and Health Reference Exposure Levels (NIOSH-REL); and National Oceanic and Atmospheric Administration (NOAA). However, the basis for values obtained from other environmental and health agencies haven't been reviewed/approved by ATSDR.

PADOH calculated an exposure point concentration (EPC) of the contaminants detected for further evaluation. EPC is believed to represent typical upper bound exposure averages. A conservative EPC is the 95% upper confidence limit (95UCL) of the arithmetic mean concentration. For a given number of discrete environmental samples in an exposure unit, the calculated arithmetic mean may be lower or higher than the actual arithmetic mean. However, it is highly unlikely (i.e., no more than 5 percent probability) that the 95UCL will be lower than the exposure unit's actual arithmetic mean. Usually the number of environmental samples in an exposure unit increases, the difference between the 95UCL and the sample arithmetic mean decreases. To calculate the 95UCL for contaminants that had mostly non-detects (i.e., benzene), we used the recommended censored value of the method detection limit (MDL)/2 and for contaminants with a few non-detects (formaldehyde), we used the recommended censored value of the MDL/square root of 2.

Reference for Appendix G

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005. Public Health Assessment Guidance Manual. Atlanta, GA: Department of Health and Human Services; January 2005. Available from: http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html

[EPA] U.S. Environmental Protection Agency. 2016. Risk-based Screening Levels. [Updated 2016 May; accessed 2016 November 2]. Available from: http://www2.epa.gov/risk/risk-based-screening-table-generic-tables

[TCEQ] Texas Commission on Environmental Quality. 2015. About Effects Screening Levels (ESLs). [Updated 2016 February 22; accessed 2016 November 2]. Available from: https://www.tceq.texas.gov/toxicology/esl/list_main.html/

[NOAA] National Oceanic and Atmospheric Administration. 1999. Odor threshold level of Methylamine. Available from: https://cameochemicals.noaa.gov/chris/MTA.pdf

Appendix H

General Health Effects Information on Selected Contaminants

Ammonia

Ammonia is a corrosive irritant gas. It causes irritation of the eyes, nose, and throat. ATSDR used the study of Verberk et al. (1977) to drive an acute MRL of 1,700 ppb (1,200 µg/m^3) [ATSDR 2004]. The study examined the effects of ammonia in a group of 16 volunteers. Exposure to ammonia at 50,000 ppb (34,760 µg/m^3) for 2 hours resulted in mild irritation to the eyes, nose, and throat. This level was considered as the Lowest Observed Adverse Effect Level (LOAEL). ATSDR used an uncertainty factor of 30 (3 for use of a LOAEL and 10 for human variability) which resulted in an acute MRL of 1,200 µg/m^3. Uncertainty remains regarding the lowest level at which no health effects would occur particularly for sensitive populations (such as pregnant women, children, older adults and people with respiratory disease).

Benzene

Benzene is a highly flammable, colorless liquid with a sweet odor. Benzene evaporates into air very quickly and dissolves only slightly in water. Benzene is used primarily to make other contaminants that are in turn used to make products such as Styrofoam, plastics, resins, synthetic fibers, rubbers, lubricants, dyes, detergents, drugs, and pesticides [ATSDR 2007]. Benzene is present in crude oil, gasoline, and smoke from forest fires and cigarettes [Rinsky et al. 1987]. It has been identified in outdoor air samples of both rural and urban environments and in indoor air. The following daily median benzene air concentrations were reported in the Volatile Organic Compound National Ambient Database (1975-1985): remote (0.47 ppb or 1.5 µg/m^3), rural (0.47 ppb or 1.5 µg/m^3), suburban (1.8 ppb or 5.7 µg/m^3), urban (1.8 ppb or 5.7 µg/m^3), indoor air (1.8 ppb or 5.7 µg/m^3), and work place air (2.1 ppb or 6.7 µg/m^3) [Roberts et al. 1985].

Benzene also has been shown to pass from the mother's blood to the fetus [Rinsky et al. 1987]. Long-term exposure to benzene can affect the immune system and cause cancer of the blood-forming organs. Exposure to benzene has been associated with a leukemia called acute myeloid leukemia [Yin SN *et al*. 1987; EPA 2003; HSDB 1994]. The Department of Health and Human Services has determined that benzene is a human carcinogen [DHHS 2014]. The IARC and the EPA have also determined that benzene is carcinogenic to humans.

Formaldehyde

Formaldehyde is an organic compound that is emitted from many sources, and small amounts of formaldehyde are naturally produced by plants, animals, and humans. Formaldehyde is used in the production of fertilizer, paper, plywood, and it is also used as a preservative in some foods and many household products. Releases of formaldehyde into the air occur from industries using or manufacturing formaldehyde, wood products (such as particle-board, plywood, and furniture), automobile exhaust, cigarette smoke, paints and varnishes, and carpets and permanent-press fabrics. Indoor air typically contains higher levels of formaldehyde than outdoor air [ATSDR 2015]. A study of 184 single family homes in different cities [RIOPA 2005] found a mean concentration of formaldehyde in outdoor ambient air of 3.69 µg/m^3 (3 ppb) and in housing of 20.91 µg/m^3 (17 ppb). In addition, the U.S. Consumer Product Safety Commission report stated that formaldehyde is normally present at low levels, usually less than 36.9 µg/m^3 (30 ppb), in both outdoor and indoor air. The outdoor air in rural areas has lower formaldehyde concentrations than urban areas (due to sources such as automobile exhaust). Residences or offices that contain products that release formaldehyde into air can have levels greater than 36.9 µg/m^3. In general, formaldehyde levels in outdoor air range from 0.25 to 7.4 µg/m^3 in rural and suburban areas and 1.2 to 25 µg/m^3 in urban areas [ATSDR 2015].

Acute and chronic inhalation exposure to formaldehyde in humans can result in respiratory symptoms, and eye, nose, and throat irritation. Exposure to high levels of formaldehyde in occupational settings can result in the development of leukemia, a cancer of the blood or blood forming tissue in the body. Formaldehyde is widely recognized as carcinogenic to humans [U.S. EPA 1989; NTP 2011].

Hydrogen Sulfide

Hydrogen sulfide (H_2S) is a colorless, flammable gas with a distinctive rotten egg odor with typical odor threshold range of 0.5 – 30 ppb [ATSDR 2016]. H_2S is formed by anaerobic (oxygen-free) degradation of sulfur-containing compounds and is a major concern for odors and exposures from landfills, wastewater treatment facilities, and animal production operations. It is used in the production of sulfur and sulfuric acid. Studies in humans suggest that the respiratory tract and nervous system are the most sensitive targets of H_2S toxicity. Exposure to low concentrations of H_2S may cause irritation to the eyes, nose, or throat. It may also cause difficulty in breathing for some asthmatics. Respiratory distress or arrest has been observed in people exposed to very high concentrations of H_2S [ATSDR 2016].

Methylamine

Methylamine is colorless gas with a pungent fish like odor. The contaminant is alkaline and causes severe irritation or necrosis of mucous membranes and skin. Methylamine was detected once at each location (1,200 µg/m^3 at KSL and MVH on February 4, 2016, and 1,100 µg/m^3 at SHP on February 1, 2016). Information regarding acute toxicity of methylamine in humans is very limited. It has been reported in one study [Bingham *et al*, 2001] that irritation of eyes, nose and throat has resulted from exposure to methylamine concentrations of 20,000 ppb (25,407 µg/m^3) to 100,000 ppb (127,035 µg/m^3).

Particulate Matter

Particulate matter, or PM, is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. These solid and liquid particles come in a wide range of sizes. $PM_{2.5}$ is a fraction of total PM and refers to particulate matter with an aerodynamic diameter of 2.5 microns or less. Some of these small particles can be suspended in the air for long periods of time. $PM_{2.5}$ particles are referred to as "fine" particles and are believed to pose the greatest health risks. There are natural and manmade sources of particulate matter. Particulate matter is a mixture with physical and chemical qualities that vary by source and location. “Primary” emissions sources, or sources that release $PM_{2.5}$ directly into the air, are responsible for some airborne $PM_{2.5}$. In addition to primary emission sources, “secondary” particles form in the air from chemical reactions involving precursor gaseous emissions, such as sulfur dioxide, nitrogen oxides, and VOCs. Note that these secondary particles can form at locations far from those emissions sources that released the precursors.

References for Appendix H

[ATSDR] Agency for Toxic Substances and Disease Registry. 2004. Toxicological Profile for Ammonia. Atlanta, GA: Department of Health and Human Services; September 2004. Available from: https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=11&tid=2

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological Profile for Benzene. Department of Health and Human Services. Atlanta, GA. [Updated 2007; accessed 2016 November 2]. Available from: https://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=40&tid=14

[ATSDR] Agency for Toxic Substances and Disease Registry. 2015. Formaldehyde ToxFAQs. [Updated 2015 May; accessed 2016 November 2]. Available from: http://www.atsdr.cdc.gov/toxfaqs/tfacts111.pdf

[ATSDR] Agency for Toxic Substances and Disease Registry. 2016. Hydrogen sulfide ToxFAQs. [Updated 2016 December; accessed 2017 October 27]. Available from: https://www.atsdr.cdc.gov/toxfaqs/tfacts114.pdf

[EPA] U.S. Environmental Protection Agency. 1989. Chemical Assessment Summary for Formaldehyde. [Updated 1989 October 1; accessed 2016 November 2]. Available from: https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0419_summary.pdf

[EPA] U.S. Environmental Protection Agency. 2003. Integrated Risk Information System (IRIS) Chemical Assessment Summary for Benzene Carcinogenicity Assessment. [Updated 2003 January; accessed 2016 November 2]. Available from: https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0276_summary.pdf

[HSDB] Hazardous Substances Data Bank. 1994. MEDLARS Online Information Retrieval System, National Library of Medicine.

[U.S. DHHS] U.S. Department of Health and Human Services. 2014. Report on Carcinogens, Thirteenth edition. Available at: http://www.niehs.nih.gov/health/materials/report_on_carcinogens_13th_edition_the_508.pdf

[NTP] National Toxicology Program. 2011. Report on Carcinogens, Twelfth Edition. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

[RIOPA] Relationships of Indoor Outdoor and Personal Air. 2005. Part I. Collection methods and descriptive analyses. Research Report (Health Effects Institute). Weisel CP, Zhang J, Turpin BJ, Morandi MT, Colome S, Stock TH, et al. 2005. Nov; 130 Pt 1:1-107; 109-27.

Vigliani EC. 1976. Leukemia associated with benzene exposure. Ann NY Acad Sci. 271:143-151.

Rinsky RA, Smith AB, Hornung R, et al. 1987. Benzene and leukemia: An epidemiological risk assessment. *N Eng J Med* 316:1044-1050.

Roberts JM, Hutte RS, Fehsenfeld FC, et al. 1985. Measurements of anthropogenic hydrocarbon concentration ratios in the rural troposphere: Discrimination between background and urban sources. Atmos Environ 19:1945–50.

Verberk MM., et al. 1977. Effects of ammonia in volunteers. Int Arch Occup Environ Health 39:73-81.

Yin SN, Li GL, Tain FD, et al. 1987. Leukemia in benzene workers: A retrospective cohort study. Br J Ind Med 44:124-128.

Appendix I
Responses to Public Comments

The public comment version of the KSL health consultation dated December 14, 2017 was made available for public comments and questions until February 14, 2018. The report was available on the PADOH web page at http://www.health.pa.gov, with a link for submitting comments via email. PADOH and ATSDR held a public availability meeting on January 29, 2018 at the MVH at Throop, PA. Copies of the public comment version of KSL health consultation (the Report), executive summary, and the fact sheet were distributed to the community during the meeting. Comments and questions were received during the meeting as well as from the environmental health concerns email account. We received comments from various interested parties such as Earth Resource Engineers and Consultants, Pennsylvania Waste Industries Association, American Lung Association, and a Pennsylvania Senator regarding suspected exposures to contaminants or health effects from the KSL and related activities. Some of these public comments go beyond PADOH's authorities and the scope of this health consultation. In order to be as responsive as possible to the community, PADOH collaborated with PADEP to include responses from PADEP when appropriate. Some of the repeated questions and comments were combined and provided a single response as below. Note, page numbers referred to in this section relate to the public comment version of this report.

1. Can PADOH and ATSDR advocate with EPA to revise the policies to landfill expansions in community locations? The impression I got was that the landfill was being treated as a person would be - innocent until proven guilty. Landfills and chemicals are not people. I hope I am wrong in this impression and would humbly suggest that the PADOH and ATDSR advocate for EPA to use the precautionary principle. What unknown health effects are going to occur in 25 or 50 years from now from exposure to landfill chemicals? Asbestos and cigarettes were thought to be fine 50 years ago. No landfill expansion near the community location should be given.

   Response: EPA develops regulations, guidance and policies that ensure the safe management and cleanup of solid and hazardous waste. The Resource Conservation and Recovery Act (RCRA) is the public law that created the framework for the proper management of hazardous and non-hazardous solid waste, and the basis of EPA's RCRA program. While EPA develops minimum standards and guidance, states play the lead role in implementing non-hazardous waste programs under Subtitle D of the RCRA. States issue permits to ensure compliance with EPA and state regulations, and states may also implement policies that are more stringent than federal standards.

2. Will PADEP approve and allow the landfill's continued degradation of the nearby community as we progress into the twenty-first century under the false assumption that there will be no negative impact on our physical landscape and shared psyche?

   Response (This response is from PADEP): PADEP must approve an Environmental Assessment (EA) of the proposed KSL phase III expansion proposal before the application can move on to the technical review. The EA is designed to ensure that environmental harms from proposed municipal and residual waste disposal are mitigated completely if possible. If harms are not completely mitigated, the benefits of the project to the public must clearly outweigh the known and potential environmental harms. The term "clearly" refers to the level of proof required, not to the amount of the benefits provided in relation to the remaining harms. Five general principles mentioned below are considered when evaluating harms and benefits in EAs.

- Compare the proposed facility or modification to the conditions that would exist if the project did not move forward and not to other potential uses of the property or to other properties.

- Focus on harms and benefits that relate to the proposed modification when a facility has previously been subject to an environmental assessment.

- Look at and beyond compliance with statutes and regulations. Harms may exist even when the law is complied with, and benefits may arise inherently from the project, through compliance with the law, or by intention.

- Evaluate harms individually and collectively; evaluate mitigation measures individually and collectively; and evaluate benefits individually and collectively because the impact from the facility may be greater than the sum of its parts.

- Consider the anticipated closing of the facility in determining the duration of known and potential harms and benefits. Some harms and benefits will last for a limited time period and others may last longer even after the facility closes.

3. What the panelists made clear was that the data were very limited in what could be inferred from it. My question is given that it is more or less impossible to conduct a definitive study linking the landfill to negative health outcomes, how does the PADOH and ATDSR recommend the data from this (and potentially other studies) be used in the decision-making process?

   Response: The landfill's expansion permit decision may require additional parameters beyond the Report's conclusions and recommendations, depending on site specific circumstances. PADEP may use the Report along with an EA of the proposed phase III expansion proposal and other factors in their decision-making process. The intention of our evaluation was not to identify the source of detected contaminants but rather to find out what contaminants are present in the air near the landfill and to evaluate if levels currently found in the air posed a concern for public health. The 90-day design provided a basic picture of the local air quality near KSL. The Report evaluated the community ambient air data near the landfill and discussed the limitations and uncertainties in the monitoring procedures. In addition, we recommended fence line monitoring surrounding the landfill to identify the potential source of the contaminants.

4. Have any of you ever seen a landfill of this size, so close to a residential neighborhood?

   Response: The KSL is one of the largest landfills in Pennsylvania located close to a residential neighborhood. Alliance and Imperial landfills are a couple other landfills that are located close to residential neighborhoods.

5. What agency is responsible to track the production of these toxins found in the study? What is being done to eliminate the source of all contaminants detected and protect the public health? Can the Report indicate that KSL is or is not the source of the contaminants detected?

Response: PADEP regulates, monitors and controls the release of regulated substances from potential source locations. Contaminants are routinely present in our environment, including in ambient air, soils and water, and it is not possible to remove all contaminants. However, if a source of contamination is identified by PADEP, possible exposures can be evaluated by PADEP and/or by PADOH for any potential health effects. The purpose of this Report was to evaluate community concerns on potential environmental exposures and human health impacts near the landfill and was not designed to identify the source of any detected contamination. To protect public health, PADOH and ATSDR recommend that PADEP (1) continue to closely oversee landfill activities and enforce landfill permit regulations, including nuisance odor rules; (2) consider a fence line air monitoring program that includes publicly accessible real time results for selected limited analytes as part of the landfill's future permit requirements; (3) make publicly available the response and oversight activities that PADEP has conducted at the landfill; and (4) conduct timely responses to nuisance odor complaints and consider maintaining and posting an odor complaint log to document the frequency of odor complaints, intensity of odors, duration, odor characteristics, and weather conditions such as wind direction.

6. What health studies or assessments were being conducted in Throop and Dunmore by your agency and PADEP prior to 2/17/2015, particularly those pertaining to KSL? Was there ever a baseline study conducted? If not, why?

   Response: PADOH and ATDSR have reviewed cancer statistics for Lackawanna County since the 1990s. Specific colorectal cancer types have been observed to be elevated in Lackawanna County and Northeast Pennsylvania overall in the past. In addition, PADOH and ATSDR have conducted a number of public health evaluations related to the Marjol Battery site and lead contamination in the Borough of Throop over the 1999-2010 time period. Because there were no prior requests, no health assessments or studies were done pertaining to KSL before 2/17/2015.

7. What are the reasons for conducting only a 90-day study with sampling every third day? How is this study considered valid when it is so limited? Even this limited monitoring lead to findings of several chemicals greater than their CVs or odor threshold levels leading to short-term acute health effects. Imagine how many chemicals could have shown up if there was daily testing for a year or more.

   Response: A 90-day period was the maximum length of time that data could be collected with the time and resources available (PADEP needed to appropriate funds to cover the expenses for the monitoring. The monitoring project was funded through the Solid Waste Abatement Fund). Data was collected using Summa Canisters, every third day to obtain a random and representative sample, as we have mentioned in the Report under community-based summa canister ambient air monitoring section (pg. 9). A year or more of continuous monitoring (covering all seasons) at multiple locations would be an ideal methodology. However, 90-day monitoring provided a basic picture of the local air quality near KSL.

8. During the public comment period meeting, constraint of resources (time and money) was mentioned and discussed as part of this process. How would the departments and agencies design an ideal, and if there is no ideal, an improved process for situations like this?

Response: We do acknowledge that our Report has some limitations and we therefore made recommendations to address some of those limitations. A year or more of continuous monitoring (covering all seasons) at multiple locations would be an ideal methodology. However, the 90-day air quality monitoring provided a basic picture of the local air quality near KSL.

9. While these chemicals (acetaldehyde, ammonia, hydrogen sulfide, and methylamine) were only documented as exceeding limits one or two times at each location out of the 29 samples used, it is exposure nonetheless. How many results would have exceeded the threshold limits had there been 180 samples, equivalent to a full school year tested, or a year's worth of 365 samples? How many airway irritations may have occurred because of this? Should the investigators suspect that there may be frequent occasions when actual maximum short-term concentrations are likely to exceed their CVs when monitored continuously for a year or more?

   Response: As mentioned in the data screening and comparison values section (pg. 12), concentrations above a CV will not necessarily be harmful. Contaminants that exceed a CV were further evaluated using other standards and/or scientific studies, where appropriate, to determine whether adverse health effects are likely. Without additional data, it is not possible to say that these chemicals (acetaldehyde, ammonia, hydrogen sulfide, and methylamine) would have been detected more often if monitored for a year or longer.

10. Why does pg. 6 in the Report state that not all contaminants were tested?

    Response: There could be a number of contaminants present near the landfill which could not be tested with the present scientific knowledge and technology. As mentioned in the Report, we included and tested for all contaminants as comprehensively as feasible based on a literature review of common landfill gas contaminants and the MAU screening results collected from the surrounding community and at the landfill.

11. Were the chemicals that were evaluated chosen because they are known chemicals related to landfill gas contaminants?

    Response: Yes, as mentioned in the response above, the selected chemicals were evaluated based on the results of the preliminary MAU screening in addition to a review of the literature on chemicals related to common landfill gas.

12. What date or dates was the MAU utilized? Does the MAU provide a location of where the sample/results were obtained? How often was MAU monitoring done during the study? How often will MAUs be utilized now that a preliminary Report is done? Are multiple MAUs available to determine the source of contamination?

    Response: As mentioned in the environmental data section (pg. 8), MAU monitoring occurred from April 27-30, 2015; June 15-18, 2015 and March 29-31, 2016 at the following six locations: SHP, MVH parking lot, MVH athletic field, Swinick neighborhood, the working face of the landfill where waste is actively deposited, and the leachate lagoon. MAU data were collected three times in this area to determine the presence of any contaminants near those locations. There is no plan for additional MAU monitoring at this time. The MAU is used for screening purposes.

Theoretically, multiple MAUs could be used to help determine the source of contaminants detected in the air. However, PADEP has only a single MAU available for air characterization efforts in the Commonwealth.

13. Why was there an “observed difference in our monitoring datasets” (MAU and Summa Cannister differences for hydrogen sulfide results) as mentioned on pg. 6 in the Report? What could be factors responsible for this?

    Response: The observed difference in hydrogen sulfide values from MAU and Summa canister monitoring was due to the two different methodologies and timing followed for each monitoring. The MAU and Summa canister monitoring were not run simultaneously. Contaminant concentration could vary in just a few hours due to local changes in wind speed, directions, humidity, rain, etc. Hence, the time and methodological difference could be factors for the observed difference.

14. PADOH and ATSDR selected the methods to achieve desired detection limits during the monitoring, so the limitation in detection limits was self-imposed. The main text indicates that the MAU results were used as an initial screening procedure; but the results were presented in very limited detail and “not evaluated for further assessment” based on variability in its high detection limits. The cited “detection” at MVH (not at KSL), however, is clearly within the range of detection limits achieved, and was contradicted by all the canister measurements, so was most likely a false positive or a very local effect unconnected with the landfill.

    Response: PADOH and ATSDR collaborated with PADEP to select analytical approaches with the lowest detection limits achievable with the technology and resources available. As discussed in the answer above, the differences in MAU and Summa canister detections can be attributed to the variability in monitoring methods and times. We are conservative in our evaluations to protect the public health. Hence, the short-term maximum concentration (9,745 ppb) of hydrogen sulfide detected during MAU monitoring at the MVH was further evaluated. This evaluation was not designed to identify the source of any detected contaminants, but rather whether contaminants were present.

15. Why wasn’t it realized over course of investigating and reporting that findings and monitoring locations may not be adequate? Why was monitoring not conducted in the direction of prevailing winds? Without that data, the Report is not reflective of the true health impact. Could the results have been false positives? Do the wind results confirm that the landfill was *not* the source? Can recommendations be made to address all the limitations mentioned on pg. 6?

    Response: We were aware of the monitoring location limitations at the time of data collection. It was important to place the air monitors within the community to measure residents’ exposure. There are no residents living in the predominant wind direction, which is towards Interstate 81 and Casey Highway 6. The results are not false positives. This evaluation was designed to identify the contaminants at the monitoring locations and not to determine the source of that contamination. Limitations are considered when interpreting the results of any evaluation. The Report includes our recommendations to address some of those limitations.

16. Was KSL fully compliant with requests by PADEP to conduct gas/air monitoring at the KSL?

    Response (This response is from PADEP): Yes, KSL cooperated with and responded to PADEP's requests to conduct gas/air monitoring at the KSL.

17. Were KSL permit compliance records fully available to investigate for the preparation this Report? Was there any information you requested from PADEP or KSL or from other parties that was not produced despite your request?

    Response: PADOH and ATSDR did not request any records from KSL to investigate and write this Report. However, PADEP provided all the information we requested pertaining to our evaluation.

18. What additional reports, studies, information would you recommend being conducted reviewed, or analyzed before allowing an expansion of the KSL (such as deficiencies or inadequate samples and sample times in the reports)? Who is the responsible entity for following through with such matters?

    Response: The landfill's expansion permit decision may require additional parameters beyond the Report's conclusions and recommendations, depending on site specific circumstances. PADEP may use the Report along with an EA of the proposed phase III expansion proposal and other factors in their decision-making process. PADOH's recommendations for future action can be found within the Report under recommendations section (pg. 26). The specific recommendations are addressed to the agencies or entities (PADEP, KSL and residents) that would be responsible for executing each recommendation.

19. On pg. 12 the Report concluded that exposure from landfill leachate water is eliminated in part because people do not have access to leachate on the landfill property. KSL representatives acknowledged that they have used a combined sewer line to dispose of leachate on several occasions. This combined line passes through several residential neighborhoods in both Dunmore and Scranton. While residents do not ingest the leachate that passes through this line, they are nonetheless exposed to fumes from the line. Why was leachate water not tested? Additionally, according to EPA, landfill liners can degrade over time, which could allow leachate to migrate into the groundwater.

    Response (This response is from PADEP): KSL's treated leachate discharge is regularly tested to verify compliance with the Industrial Wastewater Discharge Permits (IWDP), issued by PA American Water Scranton Wastewater (AWSW). There are voluminous amounts of data verifying that the KSL discharge to the sewer lines generally complies with the standards of IWDP. If any deviations from the permitted standards are found, PA AWSW handles the enforcement of the permit limits. Any past direct discharges of leachate to the sewer lines were approved by the operator of the Scranton Wastewater Treatment plant. Any future discharges of raw leachate to the sewer lines would need to comply with IWDP issued by PA AWSW. Raw leachate is regularly sampled by the landfill and these results are reported to PADEP quarterly. PADEP has also sampled KSL's raw leachate. PA Landfills are required to have a ground water monitoring network of wells to insure they are not contaminating the groundwater. This network of wells is monitored to verify the liner systems are working properly. PA Landfills are required to monitor these wells quarterly and evaluate the results of the monitoring data annually. PA Landfills are required to monitor these wells for at least 30 years after the landfill closes. Leachate water was not tested because the community members are not directly exposed to leachate from the landfill. However, independent of any concerns related to the landfill, gases from sewer lines can be a nuisance and a public health concern in communities. Residents can minimize exposure to sewer gases by adding water to floor drains and sink drains, especially those used less often, to prevent the traps in the pipes from drying out; maintaining septic systems (if applicable) and calling a licensed plumber if you have wet spots in crawlspaces under your home or in your yard that do not go away. This information has been added to the Report.

20. Why doesn't the Report state distance from KSL to: SHP, Dunmore; MVH Fields; Washington Street Park, Throop; Throop little league fields; Penn State Fields (Throop/Dunmore/Scranton Border); Line Street Park, Olyphant (Throop/Olyphant border); School side Estates Throop; Residential Housing Development; Swinick Community Development (Dunmore); Saint Anthony Field, Dunmore PA; Perri Daycare Center, Dunmore; Dunmore High School Fields (Dunmore/Scranton); Throop Civic Center; and Hill Street Park, Jessup?

    Response: The SHP and MVH monitoring locations are both within two miles from KSL, as provided in the community-based summa canister ambient air monitoring section (pg. 9). Distances to the other locations are not mentioned because these locations were not included in our exposure evaluation in the Report.

21. No one can say for absolute certainty that long-term exposure to these chemicals does not pose a risk. Our health is much too important to be left to words like "may", "could", and "possible." Does "not expected" definitively mean "not expected"? It is very distracting does it mean it won't happen?

    Response: Conclusions are drawn based on the results of our data evaluation and the available scientific information (for more information please see the data screening and comparison values section on pg. 12 of the Report). Although environmental and health screening guidelines are designed to be protective for most of the population, including sensitive populations, it is important to remember that they may not apply to all populations of potential interest. There is inter-individual variability (such as family health history, age, existing health conditions, etc.) that affect how people's bodies respond to environmental contaminants. Hence, finding a definite answer to whether a harmful effect will occur equally for all is not possible.

22. The community near KSL claim to experience shortness of breath, headaches, nausea, irritation of the eyes, nose and respiratory tract due to landfill pollution, odors, noise, traffic and/or disturbances known to be present from time to time in this neighborhood. However, the data as presented in the Report do not in fact demonstrate that any pollutants in neighborhood air would have caused health effects, even transiently.

    Response: The Report (pages 2, 13, 17, 18, 19) does mention that a few contaminants such as ammonia and methylamine were detected once at levels above their acute health-based CVs, which could have potentially resulted in transient, acute health effects in some individuals, especially sensitive populations.

23. The Report reviewed the Scranton Air Monitoring station from which data was evaluated/compared. Though this facility is existing, would a different distance/site have been preferable for data collection and evaluation even if temporary in nature?

    Response: We evaluated the available yearlong ambient $PM_{2.5}$ data from nearby Scranton Air Monitoring station which is located approximately 1.5 miles NW from KSL. If these data were not available, we would have preferably recommended monitoring $PM_{2.5}$ along with other parameters in at least one of the three monitoring locations (MVH, KSL and SHP) setup to monitor landfill air contaminants.

24. Although this was not designed to consider the expansion, is it more likely or less likely that the exposure to chemicals would increase with more garbage put on the site and the increased length of time for ongoing operations? How will air quality be affected if the landfill capacity increases by 134 million cubic yards? Is there any correlation between increased capacity and an increase in contaminant levels in the air?

25. **Response:** This evaluation was not designed to identify the source of contaminants in the air. An expansion and increase in landfill capacity could increase contaminant levels in air; but it is not possible to quantify the potential future changes in air quality with the information available. PADEP will continue to monitor the landfill and insure compliance with all environmental regulations during operation under its current permit and any potential future permits. PADOH has not identified any studies analyzing the relationship between increased landfill capacity and changes in air quality.

26. Have any occupational health studies been conducted on landfill workers?

    Response: Municipal solid waste workers have an elevated risk of occupational injuries and some diseases including skin and gastrointestinal disorders. For example, a health study from New York City Department on Sanitation landfill employees (Gelberg, KH. J Occup Environ Med. 1997 Nov; 39(11):1103-10) indicated a higher prevalence of work-related dermatological, neuromuscular, respiratory, hearing, gastrointestinal symptoms and injuries among landfill workers than among the control group participants. In addition, there are some international studies in the literature evaluating health outcomes in landfill workers. Please click on the links below for more information. (https://www.ncbi.nlm.nih.gov/pubmed/16078639; https://www.ncbi.nlm.nih.gov/pubmed/10971930; https://www.ncbi.nlm.nih.gov/pubmed/18410715).

27. Stress over extended periods increases cortisol levels in the body. How does long-term elevated cortisol levels (because of repeated transitory exposure) affect the immune system/health in sensitive populations?

    Response: Cortisol is a hormone that is released by the body under stress. Stress is a part of our daily lives and cortisol is important for physiological and psychological development and functioning. Cortisol levels vary throughout the day and are often higher in the morning. Repeated short-term spikes in cortisol levels are to be expected and may not be of concern, provided the body is effectively able to relax after the stress event. A state of chronic stress can develop if the body is stressed frequently (usually from multiple sources throughout the day) and cannot return to normal. The prolonged elevation of cortisol associated with chronic stress can result in health problems such blood sugar imbalances, calcium loss in bones, lowered immune responses, high blood pressure, weight gain, anxiety, depression and loss of cognitive function.

It is possible to minimize the body's reaction to stressful events by employing stress management strategies. ATSDR has developed a factsheet for people experiencing stress from environmental contamination (https://blogs.cdc.gov/yourhealthyourenvironment/2017/11/13/stressful-environments-coping-with-contamination-in-your-community/). People who are concerned about the effects of chronic stress should consult their physicians to develop a stress management plan.

28. What are the combined health effects of the contaminants (ammonia, methylamine, and acetaldehyde) that exceeded the health CVs? Acknowledge in more detail that these chemical exposures do cause health effects in non-sensitive populations. Is it likely that any of the maximum detections are invalid?

    Response: As mentioned in Conclusion 2, short-time exposure to some of the contaminants (ammonia, methylamine, acetaldehyde, and hydrogen sulfide) detected in ambient air near the landfill could have caused transitory health effects. Currently, public health agencies are limited in our ability to evaluate the combined acute health effects from exposure to multiple contaminants in air. In this evaluation, contaminants were detected only once or twice exceeding the acute CV or odor level on different days. Therefore, we do not expect combined health effects from the detected levels of ammonia, methylamine, acetaldehyde and hydrogen sulfide, since these chemicals were not detected at the same time and/or the same location.

    Non-sensitive populations were considered in our evaluation, in addition to sensitive populations. Both sensitive and non-sensitive individuals might have experienced similar health issues from separate short-term exposure to ammonia, methylamine, acetaldehyde and hydrogen sulfide. However, we know from scientific studies that there is inter-individual variability in responses to exposure to air pollution. Therefore, two people could respond differently to the same air pollution level. For example, one person with asthma may experience some respiratory discomfort and maybe an asthma attack; whereas, another asthmatic exposed to the same level may not react at all. Additional statements on this issue were added to the Report.

    Though there was uncertainty regarding the representativeness of the maximum detection of ammonia due to field sampling issues and weather conditions on that particular day of sampling (see language in health consultation for these data points), the laboratory analysis was valid. While there is always variability and uncertainty in environmental measurements, we are conservative in our evaluations of environmental data to protect public health.

29. What is acrolein and what potential harm can it cause to humans? Is it commonly detected in all air samples? The ATSDR.CDC.GOV website states inhaled acrolein is "highly toxic." Pg. 6 of the Report refers to acrolein being detected several times at all three monitoring locations. When was it detected and what were the levels? Which agencies decided not to further evaluate this finding and why? Why weren't the health effects of acrolein discussed in Appendix H?

    Response: Acrolein is a colorless or yellow liquid with a disagreeable odor. It dissolves in water and quickly changes to a vapor when heated. Small amounts of acrolein can be formed and enter the air when trees, tobacco, other plants, gasoline, and oil are overheated or burned. Acrolein can be found in outdoor and indoor air. Indoor air concentrations are typically higher ranging from 0.046 $\mu g/m^3$ to 28 $\mu g/m^3$.

Frequency and levels of detection of acrolein at three monitoring locations are given in Appendix C, Table C1. Also, as mentioned in the evaluation of community-based ambient air monitoring data section (pg. 13), acrolein is a highly reactive chemical and this complicates analysis and detection. In 2010, EPA reported a study that raised significant concerns about the reliability of acrolein monitoring results using summa canisters and the currently available methods. Health agencies decided not to further evaluate this finding given that summa canisters were used in air sampling.

30. Can one-time chemical exposure cause chronic obstructive pulmonary disease (COPD) and asthma exacerbation?

    Response: One-time exposure to contaminants at the levels detected are not expected to result in chronic illnesses such as COPD. COPD is usually caused by long-term exposure to lung irritants at high concentration that damage the lungs and the airways (especially in an occupational setting). In the United States, the most common irritant that causes COPD is cigarette smoke. As stated in the Report, acute exposure to the detected contaminants could potentially exacerbate asthma symptoms; some people who have asthma can develop COPD over time. COPD and asthma exacerbations may also be caused by infections, indoor and outdoor pollution, cardiovascular diseases, asthma COPD overlap syndrome, COPD obstructive sleep apnea syndrome, pulmonary embolism, gastro-esophageal reflux, anxiety-depression, and pulmonary hypertension.

31. Do you agree that children's exposure to toxins is much more significant and can be more damaging than an adult at even one-time exposure? What is currently being done to protect children and other sensitive populations?

    Response: Yes, PADOH and ATSDR recognize that developing fetuses, infants, and children have unique vulnerabilities. PADOH and ATSDR considered potential health effects for children as part of this public health evaluation. This is discussed in the Report under the "Child Health Considerations" section (pg. 22). As mentioned in the Report, residents can monitor the air quality in their zip code via EPA's Air Now website (https://www.airnow.gov) and take recommended precautions. PADOH informed the neighboring school districts of the EPA Air Quality Flag Program training so they can learn how to check the daily air quality forecast; help students, teachers and staff be more aware of the air they breathe; and learn when and how to modify outdoor activities to reduce exposure to air pollution.

32. How can children safely play outside when there are daycares less than a mile from KSL? How will the owner and teachers know if the harmful chemicals are in the air that day? Do they only show up when it smells? Can you be sure? How should the owner decide between following the law (the daycare owner must allow children 40 minutes of outside time daily) or risk putting our children directly in harm?

    Response: Daycare owners and teachers can monitor the air quality in their zip code via EPA's

Air Now website (https://www.airnow.gov) and take recommended precautions. The EPA Air Quality Flag Program provides training, so they can learn how to check the daily air quality forecast; help students, teachers and staff be more aware of the air they breathe; and learn when and how to modify outdoor activities to reduce exposure to air pollution. PADOH and ATSDR may be able to assist local organizations in getting started with the air quality flag program; please reach out to us if you are interested.

33. Was there any notification given to the public and/or schools when peak levels of contaminants were detected? Were indoor or outdoor sporting or extracurricular activities cancelled at MVH? Were school health officials consulted to see if there was a correlation between ill students and elevated levels of contaminants were detected?

    Response: This air quality assessment was not designed to provide real-time results, but rather to obtain representative data for human health assessment. Therefore, it was not within the scope of this evaluation for PADOH to give notification to MVH when elevated levels of hydrogen sulfide, methylamine, and ammonia were detected. School officials were not consulted to correlate student's illness on days when elevated levels of contaminants were detected, but PADOH did reach out to the neighboring school districts after the public comment report was released to discuss options for monitoring air quality in the area. PADOH recommends school officials monitor the EPA AirNow website https://airnow.gov/index.cfm?action=airnow.local_city&mapcenter=%200&cityid=608) to protect children on days with elevated contaminants in air, thereby preventing illness in children.

34. What is your position on granting this application when MVH School children's wellbeing is at stake?

    Response: We recommend PADEP ensure acceptable standards are met before issuing a permit, as is their standard practice. In addition, PADOH and ATSDR agree that this situation warranted additional public health review. We included chemicals that are regulated and those not specifically regulated by ambient air quality standards or specific-permits; these were chosen based on the source (a large landfill with a long history of disposal activities before and after modern engineering controls were in place). Further, we assisted PADEP with assessing human exposure pathways to our best knowledge and then evaluated the data PADEP collected. This air assessment and the look at past environmental data in the area is above the steps required in issuing the permit. We assessed the air quality near the school and provided our conclusions in the Report. It is the responsibility of PADEP to determine whether a permit can be issued, and PADEP has stated that this Report will be considered in their determination.

35. Who is going to make sure PADEP gets this information and protect the children? If you have KSL providing samples your study is invalid by conflicts of interest.

    Response: PADEP has reviewed the Report. We shared all public comments and our responses with PADEP. The air monitoring results that were the basis of the Report were collected by PADEP and not KSL.

36. How would extended exposure to methylamine at the levels detected affect health? Would the effects remain transitory?

Response: Methylamine was detected only once in excess of its acute health CVs and was, therefore, not evaluated for chronic health effects. However, extended or repeated exposure to high levels of methylamine may cause both acute and chronic health effects. Repeated exposure may cause chronic irritation of eyes, nose, throat and bronchitis to develop with cough, phlegm, and/or shortness of breath.

37. What is the known half-life of each of the toxins found during the monitoring periods? How were the half-lives of toxins determined if no biomonitoring was conducted? Can the absence of biomonitoring be mentioned as one of the limitations?

    Response: Biological monitoring was not conducted as part of this evaluation. As described in ATSDR's Public Health Assessment Guidance manual (https://www.atsdr.cdc.gov/hac/phamanual/pdfs/phagm_final1-27-05.pdf), ATSDR and our state health partners primarily rely on measurements of chemicals in the environment to conduct our public health evaluations. Biomarkers and biological half-lives for many of the toxins detected during the monitoring period have not been well documented in humans. Based on the exposure concentration of toxins detected, it was not necessary to conduct biological monitoring or estimate half-lives of toxins. We added additional information to the Report on why biological monitoring was not a part of the assessment to the Health Effects Evaluation section of the Report.

38. How do you define "chronic (long-term) exposure" as mentioned on pg. 1, Conclusion 1? Is this exposure that lasts for a year or longer? Why is it not defined in the Report?

    Response: Chronic exposure is defined in the Report in Appendix G as "any chemical exposure occurring over a long time (365 days and longer)."

39. The conclusion "chronic exposure is not expected to cause cancer" cannot be made based on the statement that the cancer risk estimates were within EPA's acceptable cancer risk range. A cancer risk estimate within the EPA risk range is not equivalent to zero risk.

    Response: Agree, conclusion 1 is revised as 'PADOH and ATSDR conclude that chronic (long-term) exposure to the chemicals detected in ambient air near the landfill is not expected to cause harmful non-cancer health effects under the landfill's current operating conditions. However, chronic exposure to benzene and formaldehyde may cause a very low increased cancer risk (i.e., the chance of getting cancer range from 3 in 100,000 to 6 in 1,000,000). Conclusion 1 is revised and updated in the Report.

40. What criteria or statistics were used to determine that non-cancer health effects are not expected?Is there a "rare disease registry" by zip-code or smaller to evaluate the geographic association of non-cancer health effects? If not, how can the non-cancer health effects conclusion be made?

    Response: The criteria for non-cancer health effects conclusions are based on contaminants levels detected during the monitoring period. As described in ATSDR's Public Health Assessment Guidance manual (https://www.atsdr.cdc.gov/hac/phamanual/pdfs/phagm_final1-27-05.pdf), the contaminants detected were screened against non-cancer health effects CVs established from ATSDR's Minimal Risk Levels, EPA's Reference Doses or EPA's Reference Concentrations.

These CVs are an estimate of the daily human exposure to a substance that is likely to be without appreciable risk of adverse non-cancer health effects during a specified duration of exposure. The contaminants detected are below those CVs and the Report concluded that non-cancer health effects are not expected. There are few health-based registries in the U.S., but there is no comprehensive "rare disease registry" (similar to cancer) to evaluate non-cancer health effects.

41. At the public meeting it was mentioned that an air monitoring location at Penn State Worthington Scranton campus on the Throop/Dunmore/Scranton borders was relocated to Marywood University. What was the reason this station was relocated from Penn State to Marywood University? What were the test results while it was at the Penn State Worthington site? What were the test results while at the Marywood site?

    Response (This response is from PADEP): PADEP operated a multi-parameter air monitoring station on the Pennsylvania State University's Worthington Scranton branch campus in Scranton, PA (Lackawanna County) beginning in September 19, 1972. Penn State contacted PADEP in late July 2013 to provide notification of plans to construct a field house complex at the exact monitoring site location starting in May 2014. PADEP initially considered incorporating the site into the new construction, however, technical difficulties and costs were prohibitive. PADEP then located an alternative site approximately 0.37 mile to the west on Marywood University property. PADEP entered into a lease agreement with Marywood University on March 1, 2014. Monitoring at the new location commenced in April 2014. Data collected at PADEP Scranton station and Marywood University (EPA ID 420692006) can be obtained via the EPA AQS database https://www.epa.gov/aqs.

42. Was testing done to determine sulfur dioxide (SO_2), nitrogen dioxide (NO_2), chromium or mercury levels? If so, what were the levels? If not, why weren't they tested?

    Response (This response came from PADEP): NO_2 is continuously monitored at the nearby COPAMS station located at Marywood University. There have been no ambient air NO_2 levels detected that would indicate a problem. SO_2 levels were monitored for over 30 years at the Scranton COPAMS station and Penn State Worthington Campus station (mostly at Penn State Worthington Campus). Due to many years of record of compliance with ambient SO_2 standards, monitoring of SO_2 was discontinued in 2008. For these reasons, NO_2 and SO_2 were not sampled for during this 3-month monitoring period. Chromium and mercury were not tested for because these contaminants are not expected to be of concern in municipal waste landfill air emissions.

43. How do you define "similar communities" (top of pg. 2 in the Report)?

    Response: "Similar communities" in the Report means other suburban/urban locations within the United States. The levels of benzene and formaldehyde detected at the monitoring locations were similar to typical suburban/urban locations in the USA.

44. What type of monitoring issues occurred with the ammonia detection (pg. 2 in the Report)? ATSDR.CDC.Gov website indicates that "permanent damage to airways" can occur at high exposure levels. Why doesn't the Report state this?

    Response: As mentioned in the Report, the one-time maximum detection of ammonia (8,000 micro grams per cubic meter [μg/m^3]) occurred on a foul weather day (rain, snow, thunderstorm, 40+ mile per hour winds), causing problems for the sampling device. PADOH and ATSDR conservatively assumed the data were acceptable and evaluated this result further. The highest level of ammonia detected (8,000 μg/m^3) was at the MVH location and was about four times lower than the lowest observed adverse effect level for ammonia (34,760 μg/m^3) noted in a scientific research study of human volunteers (ATSDR 2004 Toxicological Profile for Ammonia). Permanent damage to airways and lungs would occur only at very high levels (above 34,760 μg/m^3). For example, if you walked into a dense cloud of ammonia or if your skin comes in contact with concentrated ammonia, your skin, eyes, throat, or lungs may be severely burned. These burns might be serious enough to cause permanent blindness, lung disease, or death. Likewise, if you accidentally ate or drank concentrated ammonia, you might experience burns in your mouth, throat, and stomach. However, at the one-time detected level (8,000 μg/m^3) none of these health effects would be expected.

45. The anomalous "detection" of ammonia is almost certainly erroneous and should not be treated as if it were valid let alone as if it were both valid and had harmed anyone.

    Response: As mentioned in the Report, this high detection may have been the result of sampling equipment issues and it was evaluated to be more conservative with the assessment.

46. Why doesn't the health consultation Report state that, according to the National Institute of Health, acetaldehyde is a "known carcinogen," is broken down in the liver, and can cause irritation of the eyes, skin, and respiratory tract and liver damage? Were liver problems evaluated in the Throop/Dunmore area?

    Response: Yes, acetaldehyde is a known carcinogen, but it was rarely detected (2 days out of 29 days) above ATSDR's chronic health CVs for cancer or non-cancer health effects. Exposure to acetaldehyde at the site is not considered chronic. Therefore, exposure to acetaldehyde at the detected concentrations is not a health concern.

47. Pg. 3 in the Report refers only to peak short-term exposure to hydrogen sulfide. Why weren't the harms such as damage to the nervous system, cardiac tissue and renal tissue listed, as mentioned in ATSDR.CDC.GOV website?

    Response: According to ATSDR's Toxicological Profile for hydrogen sulfide, inhaling 10,000 parts per billion (ppb) of hydrogen sulfide for two 30-minute sessions of submaximal exercise found no significant changes in cardiovascular or nervous system responses. The ATSDR website says that acute exposure to high concentrations of hydrogen sulfide (500,000 ppb for less than one hour) could cause damage to the respiratory and nervous systems. No renal effects are expected from one-time inhalation exposure to hydrogen sulfide. According to the ATSDR.CDC.GOV website there was no renal effects observed in animal studies with exposure to a high concentration (80,000 ppb) of hydrogen sulfide.

    The short-term maximum concentration (9,745 ppb) detected during MAU monitoring at the MVH was less than the 10,000 ppb where no significant changes in cardiovascular or nervous system were observed.

48. Any approved permit must include a permanent monitoring station next to the Archbald plant that burns the landfill gas (LFG). The concern is that mercury and the compounds mentioned in the Report are not being fully burned and are being released into our community.

Response: PADOH and ATSDR did not identify mercury as a contaminant of concern in the air near KSL. Mercury was not cited in the Report except for the surface storm water runoff sample from 2015. **(The following response is from PADEP)** Archbald plant (PEI Power Corp.) does receive landfill gas (LFG) from KSL to be combusted in either of their 2 boilers and 2 LFG turbines as well as an enclosed flare. PEI maintains continuous emission monitors on the main boiler for NOx and CO and the natural gas turbine for NOx. Based on PADEP's understanding of emissions from this type of facility, their TV 35-00002 permit does not require mercury monitoring or testing. PADEP does not require mercury monitoring stations at or near facilities combusting LFG to evaluate mercury or other air toxic compounds. PEI has conducted stack testing for non-methane volatile organic compounds (VOCs) and demonstrated compliance with the 20 parts per million limit when testing both LFG turbines in 2012, 2014, and 2016 and when flare testing was conducted most recently in 2015 and 2016.

49. What are the current days and hours the KSL is permitted to operate at the facility?

Response (This response is from PADEP): KSL is currently permitted to operate Monday through Saturday from 5 am to 4 pm.

50. A condition of the landfill permit must be that waste cannot be accepted into the landfill on days when elevated levels of $PM_{2.5}$ are detected at the Scranton COPAMS Station until acceptable/low levels of $PM_{2.5}$ are reached.

Response (This response is from PADEP): There are no waste acceptance criteria associated with ambient air quality conditions in the regulations or any municipal waste landfill permit. KSL is permitted to accept waste Monday through Saturday.

51. What were the exact dates in May 2015 and July 2016 when $PM_{2.5}$ levels were particularly high? Was the public made aware of the $PM_{2.5}$ levels at the time?

Response: The two peak $PM_{2.5}$ values of 147.3 μg/m^3 and 159.7 μg/m^3 were detected on May 29, 2015 (19:00) and July 2, 2016 (3:00) respectively. These appeared to be isolated events that were preceded and followed by days with much better air quality.
Please note, $PM_{2.5}$ results for all ambient air quality monitors in the state are publicly available online through the PADEP website. The most current data is updated 15 minutes after each hour: http://www.ahs.dep.pa.gov/aq_apps/aadata/. Please note, you can sign up for air quality notifications that take into account information about local air quality (using air monitoring stations like PADEP's monitor in Scranton) and weather information at http://www.enviroflash.info/. Your daily air quality forecast information can be sent to you via email, twitter, or your mobile phone.

52. Was there a landfill facility closure or stop increase in operations during the two months when $PM_{2.5}$ levels were very low or high (May 2015 and July 2016)?

Response (This response is from PADEP): PADEP is not aware of any air emission source anomalies or deviations from normal operations at KSL during the 2 months in question.

53. Pg. 4, conclusion 5 refers to inadequate studies and insufficient quality available to suggest a causal link between laryngeal cancer and municipal solid waste disposal. What is being done to get adequate studies sufficient to make a conclusion on this point to a reasonable degree of medical and/or scientific certainty? If you can't say what causes cancer, how can you say what doesn't? An increase in laryngeal cancer is sufficient evidence to deny this expansion request.

    Response: Our cancer analysis depicts association and not a causal effect. We can only say that a higher/lower rate is associated with this area and we cannot say that the higher/lower rate is caused by living in this area.

    Factors known to impact cancer incidence generally include heredity, occupation, life style (smoking, diet, exercise) etc. According to the American Cancer Society, the known environmental risk factors for laryngeal cancer are long and intense exposures to wood dust, paint fumes, and certain chemicals used in the metalworking, petroleum, plastics, and textile industries. In most cancer cases, it is difficult to find a direct cause-and-effect relationship between one exposure or risk factor and the cancer type. One of the reasons for this is the long latency period (time gap between initial exposure time and diagnosis or appearance of signs and symptoms). For many cancer types, it may take decades for a cancer to develop and be diagnosed. People also migrate from one location to another, and therefore it becomes difficult to find the source of exposure that may have caused a cancer. Research regarding whether certain environmental exposures (such as common landfill contaminants) could possibly cause cancer is primarily conducted through research entities, and not within the scope and resources of PADOH.

54. Why are 2005–2014 rates being used and not more recent rates?

    Response: PADOH used the most recent available data from the Pennsylvania cancer registry at the time of analysis. Cancer registry data is typically delayed 18 to 24 months or more due to reporting lags and quality checks.

55. Was your agency able to determine if there was any increase in each of these cancers in 2005–2006 vs. 2013–2014 vs. present day?

    Response: PADOH did not perform a trend analysis (2005–2006 vs. 2013–2014 vs. present day) for this Report.

56. PADEP screens (air) "near the landfill." What constitutes "near"?

    Response (This response is from PADEP): PADEP's Bureau of Air Quality maintains a COPAMS monitoring site approximately 2 miles from the landfill.

57. Is the fracking waste monitored for radioactive materials before it is accepted into landfill? The Report did not include any data on radioactive levels of material entering KSL. Several panelists acknowledged that cancer has a latency period that can extend from 5, 10 to 15 years. The introduction of drill cuttings to KSL is a recent phenomenon, well within the latency period for the cancers of which the panel spoke.

Response (This response is from PADEP): All waste disposed of at the landfill must first go through the radiation monitoring system. PADEP is not aware of any fracking waste being disposed of at KSL. Although KSL has received authorization to dispose of some fracking waste types, a review of KSL's residual waste disposal reports indicates no such wastes have been disposed of at KSL.

58. Like canaries in a mine, doesn't harm to vulnerable populations warn us that the general population is at risk as well?

    Response: The risk to the general population was considered in this evaluation as the screening CVs are calculated based on health guidelines with uncertainty factors and safety factors applied to ensure that they are adequately protective of general population health.

59. Will there be a siren to warn Dunmore residents of poor air quality?

    Response (This response is from PADEP): There is a system in place to inform the public of high pollution days in locations across the state, based on data obtained through the COPAMS network Air Quality Index (https://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/AirQualityIndex/Pages/default.aspx).

    Please note, you can sign up for air quality notifications that take into account information about local air quality (using air monitoring stations like PADEP's monitor in Scranton) and weather information at http://www.enviroflash.info/. Your daily air quality forecast information can be sent to you via email, Twitter, or your mobile phone.

60. From a public health standpoint, would the public be better off if health consultations and assessments such as these were a mandatory part of the Environmental Assessment (EA) process?

    Response: PADOH and ATSDR's public health assessment and consultation work is initiated by a request, whether from a community member or another agency, such as PADEP. Public health assessments are not mandatory for a site except when that site is proposed for the EPA National Priority List or "Superfund". Under our authorities, we evaluate the public health impact of environmental exposures from activities that occurred in the past or are occurring in the present. A process called "Health Impact Assessment" is an approach that is more proactive in nature and might be considered for EA process. Currently, public health agency review is not formally part of the EA process.

    (The following response came from PADEP) A health consultation to PADEP provides an estimation of the effect an existing operation/activity has on public health. The health consultation would not aid the EA process that PADEP conducts when evaluating municipal waste processing and disposal permit applications. The EA process for a new facility, or expansion of an existing facility requires PADEP to consider all known and potential health risks of the proposed project. When evaluating the likelihood of harm, including a health risk, PADEP considers the applicant or a related party's compliance history. If PADEP believes current or proposed operations pose potential health risks to the community, PADEP could require additional controls or monitoring as a condition of the permit or deny the application all together.

PADEP regulations for operation of facilities, which include a compliance history review, and the permit conditions for the specific site are based on protecting public health and the environment. PADEP has enforcement authority to use if an existing facility is failing to meet regulatory standards or permit conditions which threaten public health or the environment. Issues and/or concerns brought to PADEP's attention can be addressed at any time, including throughout the permit application process or during the operation of an existing facility.

61. Although the landfill creates a tremendous amount of jobs and provides monetary compensation to the area and nonprofits, it doesn't need to be expanded upward. In addition, the possibility of cave-ins, leachate contaminating our groundwater, the continued truck traffic and potential health effects outweighs any benefits. Why not move the landfill to an unpopulated area? Why would a landfill expansion be permitted so close to a densely populated area?

    Response (This response is from PADEP): A complete EA of the KSL Phase III expansion application will be performed by PADEP before a decision is made regarding the expansion request. All the potential harms listed in the paragraph above will be considered.

62. Where did you get the data? This monitoring should be done by PADEP and should not be left up to the landfill staff. Can you test soil, water, air (year-long study and in the direction of predominant winds coming from the landfill, inclusive of additional chemicals), and conduct a model assessment of air and subsurface based on landfill expansion? Landfill owner should fund a more thorough health study before the expansion. The study should include more air monitoring stations, including within the landfill and along the fence-line, that provide continuous monitoring.

    Response: PADEP funded and collected the air sampling data that was the basis for our analysis.

    (The following response came from PADEP) PADEP will consider whether model assessment, soil or water testing and continuous long-term air monitoring in all directions is warranted during the EA of the Phase III expansion application.

    Should interested parties wish to, the data collected from this assessment is available (https://www.dep.pa.gov/About/Regional/Northeast-Regional-Office/Community%20Information/Pages/default.aspx) and can be used as input for modeling of emissions.

63. What is the purpose of expanding the landfill if it will not accept more waste per day?

    Response (This response is from PADEP): A landfill may request to expand to extend its operating life. A landfill is limited to a specific volume of air space available for waste placement. This volume is calculated from the footprint of the waste disposal area and final approved elevations. A landfill's request to expand their approved volume of air space is to allow them to continue to operate when their current permitted air space is reaching the maximum capacity.

64. If the landfill is approved to expand upward, will the towering trash mountain act like a dam of prevailing winds and push more gases, chemicals and intolerable smells back into Dunmore and Throop?

    Response (This response is from PADEP): Any effects that the landfill height might have on the potential for KSL to create a nuisance will be evaluated in PADEP's review of KSL's Phase III expansion application.

65. Why is the expansion and operating permit for half a century, instead of a shorter time period?

    Response (This response is from PADEP): The proposal of the expansion project is the applicant's decision. PADEP does not impose limitations on the applicant regarding the size, duration, or complexity of the proposed project. That said, if the permit is issued for the expansion as currently designed, the expected life of the landfill is projected to be 47.5 years. If approved, the permit would only be issued for a 10-year term. PADEP would evaluate the permit every 5 years to determine whether it reflects current operating requirements, technology and management practices. KSL is required to submit a renewal application at least 1 year prior to the expiration of the permit. During the renewal process, PADEP evaluates the operation and any new applicable regulations before renewing the permit. New conditions could be added to the permit at that time or if warranted the renewal application could be denied.

66. Why can't PADEP wait until a thorough and adequate study is conducted before approving the expansion permit? What is the rush?

    Response: PADEP has agreed to use our Report as part of the overall approval process. The landfill's expansion permit decision may require additional parameters beyond this Report's conclusions and recommendations depending on site specific circumstances. PADEP may use this Report along with an EA of the proposed phase III expansion proposal in their decision-making process. PADEP will consider whether additional monitoring of the air, soil, or water is warranted during the EA of the Phase III expansion application.

67. PADEP did not record or consider any violations for direct discharges of untreated leachate into the sewer system. PADEP did not take enforcement action when the landfill exceeded leachate lagoon reserve capacity. And, PADEP did not issue any violations for groundwater degradation that was detected by a monitoring well intermittently for 14 years.

    Response (This response is from PADEP): PADEP does not consider the direct discharge of untreated leachate to the sewer line as a violation. Documentation exists verifying that KSL gained approval of the discharge to the sewer line from the Scranton Sewer Authority. PADEP required KSL to implement a plan to reduce leachate levels in the leachate lagoons. KSL implemented the plan and the lagoon levels were brought down to acceptable levels. The handling of leachate lagoon levels in this manner is consistent statewide. PADEP issued KSL a notice of violation for the degradation of ground water on November 9, 2016.

68. What is it that I'm smelling when I drive along the Casey highway or Interstate 81 near KSL? Depending on the wind, it can also be smelled in the Price Chopper parking lot in Dunmore and when driving on Interstate 81 passing the Commonwealth Environmental Systems Landfill by

Hegins, PA. It's not a garbage smell. Is there also a material safety data sheet for that chemical? Additionally, what is the floral odor I smell occasionally when walking in school side estates.

Response: The floral odor may be coming from odor neutralizing agents sprayed at the landfill to mask landfill odors. Odor levels vary due to meteorological conditions. Monitoring was conducted on the residential side of the landfill and not along Interstate 81 and the Casey Highway 6. Without knowing what chemicals were present in ambient air in those locations, we cannot say what may have produced the smell.

69. What is the odor complaint process? Contact information?

    Response: Complaints to PADEP can be phoned-in 24/7 through these two numbers:
    570- 826-2511
    571- 866-255-5158 ext. 2
    Or email using this link:
    https://www.dep.pa.gov/About/Regional/Northeast-Regional-Office/Pages/Environmental-Complaints.aspx

70. Were chemicals detected by the monitoring equipment only when there was an odor? If so, how was the machine able to know that? Or did someone smell it and make note? If there is no correlation to odor and chemicals, then we are literally playing a game of risk with our children's health.

    Response: Air samples were collected at specified time intervals regardless of whether an odor was present. Monitoring equipment can detect odor- and non-odor-producing contaminants in the ambient air. During this monitoring period, odor- and non-odor-producing chemicals were detected.

71. Why does the Report state that the highest volume of complaints occurred during the winter months and that the chosen monitoring period (Jan–Apr) allowed us to capture air quality data during the months of greatest concerns about odors in the community when Table C4 identifies Sept—Dec as the months with the most complaints? Also, there are other four-month periods (e.g. Aug—Nov) that had more complaints than the four months picked.

    Response: For this Report preparation, we did not specifically choose the monitoring period (Jan—Apr) to be during the period with the most odor complaints. The monitoring was delayed due to challenges that occurred in establishing our analysis plan, contracting with a private laboratory, and selecting monitoring locations in the community near the landfill that could provide the necessary resources for monitoring, such as electricity, security, and specific topographic characteristics that gave us confidence that the data represents better ambient air conditions in the community location. We agree that the statements on pg. 6, 9, 26 and 40 in the Report do not reflect Table C4. We have removed the statements that identify the monitoring period (Jan—Apr) as having the most odor complaints.

72. As stated in the Report, air monitoring took place during the period with the most odor complaints. The ATSDR.CDC.GOV website states odor level itself is not a true indication of the

toxins abundancy in the air, correct? Why was that period chosen when it's possible that toxins are more abundant at times when there are no odors?

Response: As explained in our answer above, we did not specifically choose the monitoring period (Jan-Apr) during the period with the most odor complaints. Yes, the odor level itself is not a true indication of the toxins abundancy in the air. If strong odors are observed in the community in the future, please contact PADEP for entry into their odor log.

73. How is it possible that air quality standards are being met when there are noxious odors present? This smell causes nausea and headaches.

    Response (This response came from PADEP): There are many compounds that can be present in the air that are perceptible to the human sense of smell at levels far below any regulatory standards. The presence of these odors can have nuisance effects on sensitive people. It is for these reasons that PADEP also has malodor regulations. Even if some air contaminants are at levels below any type of health standards, PADEP can still hold the source of these odors accountable by citing them for creating a public nuisance. If strong odors are observed in the community in the future, please contact PADEP for entry into their odor log to take further actions. See response 68 for PADEP contact information.

74. If the landfill is closed on Saturdays and Sundays, why does it still create odors on those days? What is going on?

    Response: Odor production and dispersion from the landfill site varies based on meteorological conditions such as temperature and wind speed. In addition, bacterial decomposition, volatilization, and chemical reactions of landfill waste occurs at different phases. It is possible for odors to be released during non-operating days.

75. I would also be interested to know how the odor complaints at the KSL compare to those at the nearby Alliance Landfill managed by Waste Management. My anecdotal experience with the two landfills suggests that the Alliance Landfill is managed much better than the KSL.

    Response (This response came from PADEP): Each landfill is different. We cannot say whether a landfill is managed better than the other landfills based on the number of odor complaints.

76. KSL representatives suggested that there is a different polluter releasing contaminants into the air. What are the known pollutants produced by nearby facilities including KSL, Dunmore Materials, Maid Rite Steak Co Inc., and Scranton Sewer Authorities in Throop, Dunmore, Jessup, Olyphant, and Archbald areas? What studies have been done or are being conducted to determine the source of the toxins? There must be an investigation to determine and eliminate the source of contamination before a permit is approved. Without an inventory of all potential sources, the Report is incomplete.

    Response: This evaluation was not a source investigation. This evaluation was designed to identify the concentration of contaminants at the community monitoring locations and not to determine the source of that contamination. It was also designed to determine if those levels can produce adverse health effects. There are no source investigations or studies currently being conducted.

(The following response came from PADEP) PADEP's Bureau of Air Quality maintains emission inventories for numerous permitted air pollution sources in the areas surrounding the landfill. PADEP's Bureau of Air Quality also maintains a COPAMS monitoring site approximately 2 miles from the landfill. There has been no indication that any source of air pollution in the area is causing an ambient air quality problem.

77. Has the PA Attorney General's Office assistance been requested to pinpoint the location of the substances being released into the air?

    Response: We have not identified a need to contact the PA Attorney General's Office with regards to this evaluation.

78. Were former and current Throop and Dunmore borough officials (zoning officers, Department of public work heads, councilmen, mayors) contacted to discuss air quality and their knowledge of air quality issues within the borough from investigations they conducted or complaints they responded to over the past decade?

    Response: PADOH did not specifically request this information from borough officials. However, we hosted a public availability session before sampling was performed and then a public comment period with public meeting after releasing the draft Report. Local officials attended both public events and were invited to share their perspectives at those times and during the public comment period for the draft Report.

79. What was the daily tonnage received by the landfill during the time frame when monitoring took place? Was the tonnage received by the landfill the same, less than, or greater than the tonnage received by the landfill during similar lengths of time throughout the year? What was the daily tonnage received by the landfill over the same time frame in prior years (Example: April 2016 vs April 2015 vs April 2014, etc.)? Are there monthly records of waste inflows into KSL?

    Response (This response is from PADEP): Daily tonnage rates were evaluated during the first quarter of each year. The most recent five-year first quarter results are as follows:

Year	Tons/Day
2013	374,570
2014	436,936
2015	414,420
2016	382,821
2017	371,075

Information regarding waste acceptance rates are contained in quarterly and annual reports submitted to PADEP by KSL. These reports can be reviewed upon request. A breakdown of waste received at KSL by quarter can be found at http://www.dep.pa.gov/Business/Land/Waste/SolidWaste/MunicipalWaste/Pages/MW-Disposal-

Info.aspx

80. An EPA toxic release inventory from 2005 includes companies in the Throop and Dunmore area that are known to release toxins into the air. What follow up has been done to ensure up-to-date compliance with state and federal air quality regulations of each of these companies? Is the EPA involved or have they been consulted regarding the current investigation or air quality?

    Response (This response is from PADEP): PADEP's Bureau of Air Quality maintains emission inventories for numerous permitted air pollution sources in the areas surrounding the landfill. There has been no indication that any source of air pollution in the area is causing an ambient air quality problem and EPA has not been involved.

81. In the 1980s a spring water source along Marsh Wood Road in Jessup (just above the KSL) was capped and closed. It had supplied many residents with drinking water for years. Who capped this source, when and why was it capped, and what was the result of it being capped?

    Response (This response is from PADEP): PADEP was only able to obtain limited information regarding this spring water source. PA American Water (PAW) currently provides Throop and Dunmore with potable water. Representatives of PAW and a former employee of Pennsylvania Gas & Water were contacted. None of the individuals contacted were familiar with the spring mentioned above. PADEP also reached out to local municipal officials for Throop and Olyphant. Although there was some recollection of the existence of the spring, it was unclear as to who capped it and why. It is speculated that the spring was capped as part of a construction project for the Jefferson Township sewer main installation and/or a gas line installation.

82. The study should have included health information on residents. Will you go forth with accepting the Emergency Medical Record (EMR) data that community members and those affiliated with health practices are so willing to provide you? Future studies should include data from other sources, such as local Medical Schools, Universities, EMR from local doctors, as well as from citizen participants, in addition to PADEP.

    Response: Currently PADOH does not have the information technology infrastructure to accept and review electronic medical records for a community-based health study. However, PADOH looked at the cancer incidence rate data (2005–2014) for six zip codes. As described in ATSDR's Public Health Assessment Guidance manual (https://www.atsdr.cdc.gov/hac/phamanual/pdfs/phagm_final1-27-05.pdf), ATSDR and our state health partners primarily rely on measurements of chemicals in the environment to conduct our public health evaluations. PADOH and ATSDR did review health conditions reported by community members to plan our health consultation work in this community.

83. A correction: Where the text (on pg. 14) currently has, "The EPA inhalation unit risk for benzene is 0.0000078 $\mu g/m^3$," this should read, "… 0.0000078 per $\mu g/m^3$."

    Response: Noted – the Report has been updated. Thank you.

84. The column “Air Quality Index Category Range” in Table D could be made more understandable to the reader if this column could be divided into the following five columns “Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy,” with the correct number of days for each of the 20 months recorded in each column.

Response: The table has been revised per this recommendation. Thank you.

85. A correction: Where the text (on pg. 27) currently has, "Principle Investigator" this should read, "Principal Investigator"

Response: Noted – the Report has been updated. Thank you.

86. The entry under zip code 18519 for “Other Cancers” in Table F should be colored red.

Response: Noted – the Report has been updated. Thank you.

87. How many other landfill expansions (or initial permit requests) has PADEP engaged with PADOH and ATSDR on in the past?

Response: As of now we have worked on one other landfill expansion permit request (IESI landfill). For the IESI landfill, only MAU data was collected and assessed.

88. What health hazards may the traveling seagulls bring with them?

Response: As stated in the Report in Appendix B, gulls are attracted to landfills as a food source, and landfills may contribute to an increase in gull populations. Federal regulations mandate that landfills prevent or control potential vectors, such as gulls (40 CFR 258.22). Birds can play a significant role in the transmission of diseases to people, when people come into contact with fecal droppings of those birds. Research has shown that gulls carry various species of bacteria such as Bacillus spp., Clostridium spp., Campylobacter spp., Listeria spp., Salmonella spp., and Escherichia coli. Transmission of bacteria from gulls to humans is difficult to document. Contamination of public water supplies by gull feces has been stated as the most plausible source for disease transmission. Gull feces also contribute to accelerated nutrient loading of aquatic systems, which has serious implications for municipal surface water drinking water sources, such as the one near KSL.

89. Can the findings of the Report better depict the number of children potentially affected and the duration of their exposure by incorporating the children participating in sports leagues and attending YMCA pre-school and daycare programs, as well as other daycare centers in very close proximity to the landfill, which all have outdoor play areas?

Response: The Report includes demographic information regarding the number of children living in the area. It is possible that the number of children attending the child care programs mentioned above is not reflected in the demographic information provided in the Report. Regardless, PADOH’s data evaluation considered the potential health effects for any child in the area. The specific number of children does not affect the methods used to evaluate the data.

90. The similarities in contaminant concentrations (Table C2) from the KSL location to the SHP and MVH locations indicate that KSL is the most probable source of methylamine and acetaldehyde. The Report should better clarify these similarities.

Response: Regarding the methylamine detections on 2/4/16, both KSL and MVH had 1200 $\mu g/m^3$ concentrations. However, winds were not blowing from the landfill to the school at any time during that day. On 4/1/16, acetaldehyde detections were similar at all 3 locations (14 – 19 $\mu g/m^3$). On this day, winds were variable, and acetaldehyde may have originated from the landfill or from another source. For detailed wind rose analysis, please refer to Appendix J. As mentioned previously, the purpose of this Report was not designed to identify the source of any detected contamination. Such conclusions cannot be made from the available data.

91. There is no basis for recommendation 2 to consider near real time fence line monitoring and should be removed for three reasons: (1) near real time monitoring is not technically feasible, (2) there can be no environmental or public health benefit from any type of fence line monitoring, and (3) because of specific data limitations and concerns regarding alternative emission sources and misrepresentation of the "pollutants of concern".

Response: Landfills are known sources of environmental contamination based on previous studies. PADOH and ATSDR conduct conservative evaluations and recommendations to protect public health. Real-time monitoring is feasible, and hence the recommendation was made to better identify any potential contaminants released from the landfill which is located very close to the residential neighborhood.

92. Recommendations 3 and 4 are the normal operational situation and ignore that such data are already publicly available through PADEP.

Response: We made those recommendations to ensure that PADEP continues such practices.

93. It would be appreciated if the authors would attempt to address the issue of prospective risks, and if they would explore what could or could not be said about KSL or other locations as explanatory sources of high daily $PM_{2.5}$.

Response: We evaluate the current data and write conclusions and recommendations based on the available data. Also, as mentioned previously this evaluation was not designed to identify sources of contamination nor was it designed to model future contaminant concentrations in the community. Appendix H identifies some common potential sources for $PM_{2.5}$ emissions.

94. Environmental concentrations of $PM_{2.5}$ are not harmful over periods as short as one hour and are certainly not regulated over any period shorter than 24 hours. The final health consultation should clearly state that none of the $PM_{2.5}$ measurements were expected to harm people's health.

Response: All $PM_{2.5}$ levels were 24-hour averages and were compared to AQI moderate category range of 12.1 – 35.4 $\mu g/m^3$ (https://www.airnow.gov/). The 24-hour average range of $PM_{2.5}$ levels above 12.1 $\mu g/m^3$ for 18 of 20 months were a health concern for unusually sensitive populations such as individuals with heart, lung, and cardiopulmonary disease. Hence, these levels could harm people's health, particularly unusually sensitive populations. This revised statement is updated in the Report wherever it was necessary.

95. It may be worthwhile to clarify, in the last statement of "Basis for Conclusion," that the form of the U.S. EPA's NAAQS) for the short-term $PM_{2.5}$ standard requires averaging the annual 98th-percentile daily 24-hour average over three consecutive calendar years. The Report mentions, but fails to emphasize as it should, that all the ambient air $PM_{2.5}$ concentrations—regardless of whether the sources are local, regional, (or most likely) both—as measured at the monitor in Scranton, are entirely compliant with the U.S. EPA's NAAQS.

    Response: No further clarification is needed. On pages 3 and 4, the Report states that ambient air $PM_{2.5}$ concentrations were in compliance with U.S. EPA's NAAQS.

96. The final Report should omit unsupported speculation about subsurface changes and report the absence of any detected migration and the expectation of no future off-site subsurface migration. No vapor intrusion has been detected, and none is expected given the negative pressure applied to the landfill, and the use of impermeable liners. Indeed, no vapor migration off-site has been detected or is expected, and the Report did not evaluate either subsurface conditions or vapor intrusion.

    Response: Subsurface investigations in the Report had only limited residential monitoring for VOCs. The source of the VOCs (especially toluene which was detected widely at high levels) was never conclusively determined. The past data (1997 – 2002) collected on VOC monitoring were incomplete and these data do not represent the current conditions. Hence, we recommended precautionary measures on subsurface vapor conditions be considered when assessing the landfill expansion.

97. The probability for seeing by chance (with the usual assumptions) the incidence for four or more cancers lower than the selected lower confidence limit is tiny (0.028%), so that observation is highly significant. Particularly remarkable is the melanoma rate; the chance probability for all six zip codes to be below their expected lower confidence limit is 2.4×10^{-10}, while the chance probability for the combined rate to be as extreme as measured is 2.7×10^{-13} (again, with the usual assumptions). Such low rates suggest an investigation to examine the cause—one possibility being lack of health care leading to under-diagnosis. On the other hand, the probability for a chance observation of a single combined rate (out of the 24 provided) above the upper confidence limit is 45.5%, so the observation of the elevation of laryngeal cancer rate is unsurprising and likely to be by chance, particularly because there is no corresponding elevation of cancers (lung, oral) that would be expected in conjunction with a non—chance elevation. The Report should give the probabilities as specified above and point out the high likelihood for a random occurrence of one high rate, and the very low likelihood for the occurrence of four low rates.

    Response: The proposed calculations above are not practically accurate. Statistical significance is based on the sample size. The method mentioned above assumes that each cancer type has the same probability of being statistically significant. This assumption usually is violated and is not accurate.

98. Since the monitoring completely failed to indicate any effect of the landfill on current air quality, it is pure speculation to suggest that the proposed expansion might change air quality. Such speculation should not be part of the final Health Consultation.

Response: This evaluation was designed to measure the contaminants detected in the air of the community near the KSL under current conditions. We write conclusions based on current information. As mentioned in the Report, any future changes at the site might affect the air quality and will then need further evaluation.

99. The Report suggests, without basis, that contaminants related to landfill emissions would have been detected offsite if the monitoring stations had been located elsewhere. Such speculation does not belong in a Health Consultation and should be removed.

Response: As stated in the limitation of the findings section (pg. 6) the monitoring locations were placed within the community location and not in the direction of the prevailing winds from the landfill. This is because the evaluation was to determine human exposure and not the source of contamination. We noted that, if the landfill was emitting contaminants, they may not have been detected at the community monitoring locations.

100. There is also an ambiguity that we have been unable to resolve about zip code 18447. There is a "unique" zip code 18448 (https://ribbs.usps.gov/cassmassguidelines/CASS%20and%20MASS%20Guidelines/508Version/address_match_sec4_determine_correct_last_line.html) assigned within Olyphant (within zip code 18447) that is apparently used for multiple addresses (Google searching on <Olyphant, PA 18448> brings up examples). We have been unable to determine whether the PA Cancer Registry codes such addresses (if any occur in their data) into the correct zip code of 18447.

Response: The URL provided above is not active and the unique zip code 18448 is a building in Olyphant. Based on www.unitedstateszipcodes.org, 18447 is a correct zip code for Olyphant.

101. Suggesting that a single 8-hour maximum value above a Cancer Risk Evaluation Guide (CREG), or even (potentially) two such events out of 29 measurements is "likely to cause adverse health effects" is scientifically incorrect. Further, the CVs listed in Table C1 are not values such that any single exceedance (of a correctly designed average) is "likely to cause adverse health effects" as suggested by the Report. The Report grudgingly acknowledges this in the next paragraph—"Concentrations above a CV will not necessarily be harmful," but the preceding verbiage is misleading for non-experts. It should be emphasized instead that while the screening procedure described is adequate to eliminate chemicals from further consideration, it is inadequate to identify chemicals "likely to cause adverse health effects."

Response: Based on worst case scenario, for chronic health effects evaluations (both cancer and non-cancer analysis), we selected contaminants if they were detected 5 or more days out of 29 days during the monitoring period. We did not select the less frequently detected chemicals such as 1, 4-dioxane (1 day out of 29 days of monitoring period) or naphthalene (2 days out of 29 days of monitoring period) or acetaldehyde (2 days out of 29 days of monitoring period) for further evaluation. Table C1 summarizes the contaminants detected during the January through April 2016 monitoring event. Based on number of detections and the levels during the monitoring period contaminants were selected for further cancer risk evaluations.

Based on our data screening process only benzene (detected 7 days out of 29 days of monitoring period) and formaldehyde (26 days out of 29 days monitoring period) were selected for further cancer risk evaluations.

102. In this investigation, methylamine was the only chemical analyzed according to OSHA method 40 (see pg. 9 of the Report). Notably, OSHA reports that method 40 "has not been field tested." Also, methylamine is not known to be a constituent of landfill gas, per U.S. EPA's AP–42, and the Report provides no evidence to the contrary. Furthermore, it is essentially impossible that outdoor ambient air–even close to actual emission sources of methylamine–could contain on the order of 1,000 µg/m^3 of air. The Final Health Consultation should not include methylamine as a "contaminant selected for acute public health analysis"–let alone suggest that these methylamine "maximum values" are (1) accurate, (2) likely reflective of emissions from the KSL, and/or (3) "could have resulted in odor induced acute health effects such as mild irritation of the nose, eyes, and throat, particularly for sensitive populations."

Response: As mentioned previously this evaluation was designed to conservatively analyze the contaminants detected in the community near the KSL. Although methylamine is not a landfill contaminant, it was monitored along with other amines that are commonly found near landfills. Methylamine was detected on February 1, 2016 at SHP (1,100 µg/m^3) and on February 4, 2016 at KSL (1,200 µg/m^3) and MVH locations (1,000 µg/m^3). We write conclusions and recommendations based on the available data.

103. The Report (pg. 18) notes that there were "six odor complaints which occurred during the air monitoring period (Jan–Apr 2016)." The data collected for this Report, however, appear to bear no relationship to these complaints. The data fail to reliably indicate any instance of any malodors due to any of the compounds detected in this investigation. Further, the Report discusses four chemicals that could have "potentially affected nearby community's quality of life" by making ambient air malodorous. This claim is speculative and unsupported.

Response: The six odor complaints were included in the Report as an observation. The Report did not relate the complaints to the air monitoring results. Additionally, chemicals identified in the Report were detected above their odor thresholds levels and have the potential to affect quality of life. None of these observations are speculative.

104. Automobiles are well known to be important sources of acetaldehyde in outdoor air. Given the proximity of all monitoring locations to major highways, traffic-related emissions are likely the dominant sources for this and many of the other VOCs detected in this investigation. If KSL was the source of acetaldehyde concentrations detected, the maximum would be expected at the source location; however, it was essentially the same at all three monitoring locations—14 µg/m^3, 15 µg/m^3, and 17 µg/m^3. In addition, the Report claims that odor threshold for acetaldehyde in air is only 3 µg/m^3, while EPA reports that odor thresholds for acetaldehyde in air are higher—ranging from 14 µg/m^3 to 60 µg/m^3. When compared to the EPA odor threshold range for acetaldehyde,

the levels detected at the monitoring stations are dilute. The Report notes that dilute concentrations of acetaldehyde smell "fruity and pleasant"; however, people smelling landfill gas do not find that it smells "fruity and pleasant." It is not clear if people are smelling acetaldehyde or not.

Response: Acetaldehyde is a common landfill gas emission and at dilute concentrations the odor is fruity and pleasant. Alternatively, the floral odor is possibly coming from odor neutralizing agents sprayed at the landfill to mask landfill odors. We received at least one complaint that specifically identified a floral smell near the landfill. Odor threshold and perception levels varies, and people are capable of smelling chemicals at very low or dilute concentrations. Yes, we agree that the EPA has an odor threshold level of 90 $\mu g/m^3$ for acetaldehyde, but we identified and compared with the most stringent value of 3 $\mu g/m^3$. This Report did not aim to identify the source of the contaminants and the monitoring locations were not in close proximity to major highways.

105. There is no study indicating very small concentrations of acetaldehyde such as 14 $\mu g/m^3$, 15 $\mu g/m^3$, and 17 $\mu g/m^3$, could cause "irritation of the eyes, nose, and throat," as stated on pg. 18 of the Report. Extremely high concentrations of acetaldehyde can be irritating, but a controlled study using human volunteers found no adverse effects—whether self-reported irritation or any measures of upper-respiratory tract inflammation—from exposures to acetaldehyde at a concentration of 90,000 $\mu g/m^3$.

    Response: In Conclusion 2, the Report concludes both on odor exceedance (acetaldehyde, ammonia, hydrogen sulfide methylamine) and acute health CVs exceedance (ammonia). Both odor and acute CVs have similar symptoms, such as mild irritation of the eyes, nose, throat and respiratory tract. Symptoms such as irritation of the eyes, nose, and throat based on odor exposure levels usually resolve when the odor goes away.

106. Scientific assessments, especially those to be used by decision-makers regarding public health policy, should provide tests of statistical significance, and should be presented with a full discussion of the uncertainties associated with the data, the tests, and the conclusions drawn by the investigators. The Report fails to provide such analyses or discussions. For example, as noted previously, explicit discussion of the probabilities of finding both "positive" and "negative" results when making multiple comparisons should be provided but was not.

    Response: This Report followed ATSDR's guidance for all analysis and discussions. The findings and uncertainties associated with the data (limitations) are provided in the Report. The landfill's expansion permit decision may require additional parameters beyond the Report's conclusions and recommendations depending on site specific circumstances. A complete EA of the KSL Phase III expansion application will be performed by PADEP before a decision is made regarding the expansion request.

107. Why was a less sensitive method of detection used? For example, the 2010 results from COPAMS sampling site (see http://www.dep.pa.gov/Business/Air/BAQ/MonitoringTopics/ToxicPollutants/Pages/Toxic-Monitoring-Sites-in-Pennsylvania.aspx) had a method detection limit of 0.052 parts per billion (ppb) for benzene. The method detection limit for the benzene in the current investigation was only 0.24 ppb.

Response (This response came from PADEP): Based on the Code of Federal Regulations (https://www3.epa.gov/ttn/amtic/files/ambient/airtox/to-15r.pdf), the method detection limit for an analytical procedure may vary. Though the detection limit for benzene in the current investigation was comparatively high (0.24 ppb), we calculated all the non-detects of benzene by dividing the method detection limit value by 2, for our cancer risk evaluation.

108. As I understand the methodology, the filter collected data over 24 hours and then the filter was sent to a lab to analyze. The results take all of the chemicals/contaminants found in the filter and divide it over 24 hours (the exposure time). The issue with this approach is that it does not account for acute blasts or rapid increases in exposure (since everything divided over 24 hours). Is that correct? Would a dual testing situation better serve the study and the public? For example, one device pulling data every 30 minutes to see if acute exposure; the other doing the 24-hour exposure at the same time.

Response (This response came from PADEP): Yes, the filter collected data over 24 hours and was sent to the lab for analysis. As mentioned above, dual testing maybe ideal, but due to cost and logistical issues, we followed the acceptable methodology that provided sufficient information to determine whether any contaminants near KSL poses potential acute or chronic health effects or not.

109. The Report should include a protocol detailing, inter alia, the monitoring plan giving methodologies, reasons for adoption of such methodologies, detection limits required and reasons for requiring such detection limits, the analysis methods to be applied a priori, and the conditions under which conclusions could be drawn from the observations and analysis methods. In the absence of a protocol, it is unclear why the chemicals listed in Table 3 are mentioned, except that they (presumably) happen to be on the TO-15 list of chemicals analyzed; although a protocol should specify why a particular chemical is to be analyzed. A description of any deviations from the protocol, chain of custody records should also be included. A specification of the conclusions based on a priori analysis method specified in the protocol, and of those that are post-hoc, using analyses not documented in the protocol.

Response: The list of chemicals identified in Table 3 are some of the carcinogenic VOCs potentially emitted from landfills and their related activities. These contaminants have very low cancer CVs (below detection limit), hence they are included in our discussions. **(The following response came from PADEP)** Air sampling instructions, air sampling methods, chain of custody record, detection limit requirements and other details can be found at: https://www.dep.pa.gov/About/Regional/Northeast-Regional-Office/Community%20Information/Pages/default.aspx.

110. A significant portion of Dunmore Borough, including part of the footprint of the landfill itself, has been identified by PADEP as an Environmental Justice (EJ) Area, hence we recommend that the Health Consultation also specifically address the EJ status of the community as it falls within the areas of concern discussed in the Report's Appendix A. In other words, a comprehensive assessment should identify the pre-existing EJ-related health challenges that the community faces

(due to abandoned mining shafts) and how they interact with additional health challenges posed by environmental stressors discussed in the Report.

Response: PADOH and ATSDR acknowledge that environmentally-burdened communities have additional factors that can impact health including but not limited to environmental contaminant exposures (e.g., access to healthy foods, open space, and health care). Each of these factors can affect community health outcomes. Based on EPA's EJ Screen Report 2017 (See Appendix C Table C8), in Dunmore the EJ indexes for $PM_{2.5}$, ozone, air toxic cancer risk, respiratory hazard index, Superfund site proximity, and hazardous waste proximity are greater than 50th percentile (ranking) in PA state. The ranking in Throop is similar to Dunmore with an additional parameter (Diesel PM) greater than 50th percentile. EJ indexes are calculated by combining the environmental and demographic information of Dunmore and Throop. These EJ indexes of Dunmore and Throop were ranked (as percentile) with the state of Pennsylvania, the EPA region (Pennsylvania, Virginia, West Virginia, District of Columbia, Maryland and Delaware) and the US. Slightly higher percentage of population over 64 years of age live in Dunmore and Throop when compared to state, regional and national level. We added this EJ discussions under Appendix B of the Report.

111. Can the raw data be released to the public including a list of all contaminants, monitoring locations, dates and levels detected? The Report would also be strengthened by presenting the complete set of data from the MAU measurements and summa canister monitoring, analysis of previous monitoring efforts in the vicinity, dates, times, and locations of measurement. Or, hosting the data on a web site and providing a link to them if they are too large for incorporation in the Report itself. The raw data with results of all individual measurements need to be provided.

Response: All MAU and summa canisters raw data (original lab report), a list of all contaminants monitored, monitoring locations, dates and levels detected can be found at: https://www.dep.pa.gov/About/Regional/Northeast-Regional-Office/Community%20Information/Pages/default.aspx. There were no prior investigation efforts in the KSL vicinity prior to this Report, since there were no requests.

112. The Final Health Consultation should explain why meteorological data from all the most relevant stations (including KSL on-site stations) are not evaluated. Without adequate proof, one cannot assume that wind directions measured at the COPAMS site accurately represent winds at the location of the landfill, or winds passing over the landfill down into the valley.

Response: Measuring wind direction from the top of the landfill may identify initial transport direction but does not indicate whether the emissions will impact a receptor location (i.e., community exposure location) at a distance from the landfill. Winds are not consistent at varying heights, and emission migration patterns will be heavily influenced by topography, the built environment and characteristics of the emitted contaminants (vapors, particles, etc.). Only wind directions at the receptor location can determine where the contaminants came from. To determine specific transport of emissions, wind monitors would need to be placed in many locations between release point and receptor and at different elevations and distances from the release point. Even this level of wind monitoring may not result in certainty of emissions transport due to environmental factors and chemical and physical characteristics of the emitted chemicals. The

Keystone Landfill-specific meteorological data provided to PADOH and ATSDR were very limited, and less accurate (i.e., nominal wind direction only) with no guarantee of data validity (equipment type, methods used etc.). Although the COPAMS station is not the best location for monitoring wind data for emissions from the landfill, it is of high quality, valid and representative of the wind characteristics of the area and the data were collected using approved equipment and federal methods.

113. How were the winds blowing when peak levels of contaminants were detected?

Response: To assess the prevailing wind patterns near the landfill, PADOH and ATSDR obtained wind direction data from the Scranton meteorological station (COPAMS) located about 1.5 miles northwest of the landfill.

On February 25, 2016, ammonia was detected at the MVH monitoring location at a concentration of 8,000 $\mu g/m^3$. As mentioned in the in the contaminants selected for acute public health analysis section under ammonia (pg. 17), it was a day of stormy, wintry weather, resulting in field sampling issues. Only for a portion of the sampling period (3 of 24 hours) were winds blowing from the landfill towards the MVH area, but for a majority of the sampling window, winds were not blowing from the landfill towards the MVH.

On February 1, 2016, methylamine was detected at SHP monitoring location at a concentration of 1,100 $\mu g/m^3$. Wind direction was highly variable throughout the sampling period. For a portion of the sampling period (8 of 24 hours), winds were from the landfill towards the SHP area, but for a majority of the sampling window, winds were not blowing from the landfill towards SHP.

On February 4, 2016, methylamine was detected at both KSL and MVH monitoring location at a concentration of 1,200 $\mu g/m^3$. There were no winds blowing from the landfill towards the KSL or MVH.

On March 17, March 29 and April 1, 2016, acetaldehyde was detected from 13 to 19 $\mu g/m^3$ at each of the 3 monitoring locations (MVH, SHP, and KSL). On March 17, for a portion of the sampling period (4 of 24 hours) winds were blowing from the landfill towards the MVH location and for 2 additional hours, the winds were blowing from the landfill towards the SHP area. For a majority of the sampling period (14 of 24 hours) the winds were blowing from open face to the KSL monitor. On March 29 and April 1, winds were not blowing from the landfill to any of the monitoring locations (MVH, SHP, and KSL).

On March 31, 2016 at 11:09 am, hydrogen sulfide was detected at MVH at a concentration of 13,624 $\mu g/m^3$. There were no winds blowing from the landfill towards the MVH location on that day. For detailed wind rose analysis, please refer to Appendix J.

114. How were the meteorological data cleaned for analysis (pg. 60 in the Report)? Specifics were not provided in the Report.

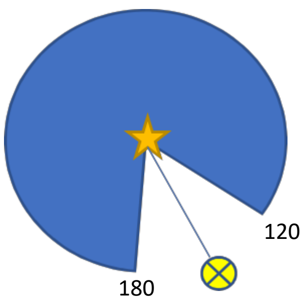
Response: Wind data from the Scranton monitoring location was downloaded via csv files, and each csv file represented one month of data (data was downloaded for 2015 and 2016), and either wind speed or wind direction. Data from each month were formatted by day (row) and by hour (columns). To analyze the data and produce polar plots, the data were melted (reshaped). The melted data had two columns: date/time, and wind direction or wind speed. Date/time data were converted to POSIXt format. Once all months of data were read in and melted, the wind speed and wind direction data were merged together by date/time to create one data frame with date/time, wind speed, and wind direction. Data were then quality assured to ensure each wind speed and wind direction corresponded to the appropriate date. Once the wind speed and wind direction data were quality assured, the $PM_{2.5}$ data frame was merged by date with the wind data frame. The same quality assurance procedures used on the wind data frame were used for this final data frame. The final data frame was used to create polar plots.

Appendix J

Wind Rose Analysis on Days when High Concentrations were Detected

There was a total of three sampling/monitoring locations: SHP positioned to the southwest of the landfill; KSL positioned to the west of the open face working area of the landfill; and MVH, located northwest of the landfill. These locations are downwind of the landfill when the wind direction is from the northeast, east and southeast, respectively. For evaluation purposes, a range of 60 degrees of direction was assumed to potentially impact the receptor location from the landfill (see Figures J1 below). The landfill is represented by the yellow circle with an “x” and the monitoring location is the yellow star. For landfill emissions to impact the sampling/monitoring location, wind would need to be from the direction of the landfill, or within about +/- 30 degrees of that wind direction. For the figures starting on page 2, when the striped or red wedge overlaps the white wedge of the circle, the landfill is upwind of the sampling/monitoring location and emissions from the landfill may have been impacting air quality at the sampling/monitoring location.

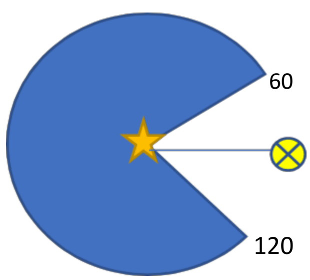
Figure J1: Wind directions needed for landfill emissions to reach target monitoring locations



MVH

Winds would need to be from the southeast (direction of the landfill), illustrated with the white wedge, to impact MVH with landfill emissions

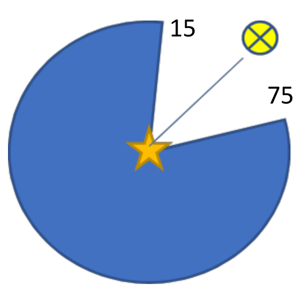
Winds from approximately 120 to 180 degrees range



KSL (west of administrative building)

Winds would need to be from the east (direction of the landfill), illustrated with the white wedge, to impact this monitoring location with landfill emissions

Winds from approximately 60 to 120 degrees range



SHP

Winds would need to be from the northeast (direction of the landfill, illustrated with the white wedge, to impact SHP with landfill emissions

Winds from approximately 15 to 75 degrees range

Legend for all figures:

Target receptor = ★ MVH, SHP, west of KSL office building

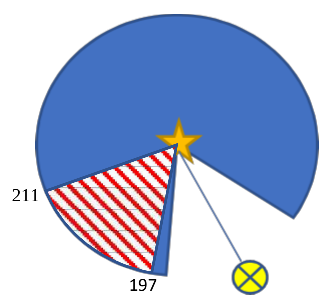
Landfill = ⊗

Chemical-Specific Wind Conditions on Days of Detections

Hydrogen Sulfide (H_2S)

H_2S detection occurred with OPFTIR-MAU monitoring on 3/31/2016 at11:09am at the MVH school athletic fields. Maximum time-weighted concentration of H_2S was 9,745 ppb on this date and time. Wind direction for the 12 hours before and up to the detection was from the southwest at 195- 216 degrees, and the mean wind direction for the 24 hours leading up the detection at 11:09 am was 206 degrees (south southwest). For the MVH to be downwind of the landfill, wind direction would need to be from the south to south southeast (120-180 degrees). There were no detections of H_2S at the landfill during OPFTIR monitoring (March 28–March 31) or at other locations monitoring for H_2S during this event.

Figure J2: Wind conditions at MVH during peak H_2S detection



Winds were from the south-southwest direction (red wedge) for 24+ hours up to the detection at the school. Winds were from 197-211 degrees from 9am through noon on the day of OPFTIR monitoring. Winds would need to be from the south southeast (white wedge, line and "x" box) to be from the landfill during this H_2S detection. Source of H_2S does not appear to be from the landfill during these hours.

Acetaldehyde

On March 17, March 29 and April 1, 2016, acetaldehyde was detected from 13 to 19 µg/m3 at each of the 3 monitoring locations (MVH, SHP, and KSL). The predominant wind direction during the month of March was from the northwest and southwest, which places each of the three monitored locations upwind for a majority of the time in March; however, for some hours, winds blew from the landfill to sampling/monitoring locations. More specific wind regimes for the 24 hours of sampling during these acetaldehyde detections are provided in detail in Figures J3–J6 below.

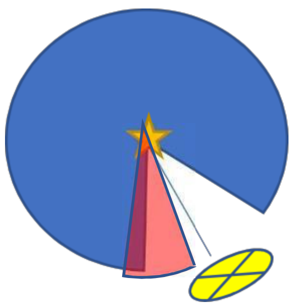
Summary for March 17, 2016 sampling event

For ten of twenty-four hours, the winds were blowing from the landfill to one of two community monitors and for four additional hours, the winds were blowing from the open face to the KSL monitor locating on the west end of the landfill property.

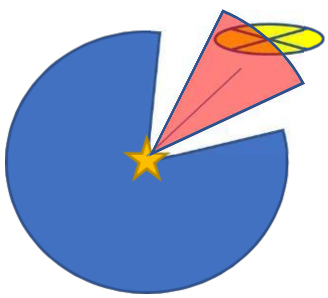
Figure J3: Winds during 24-hr period (March 16–March 17)

From 10 am on March 16th through 10 am on March 17th, winds were variable, blowing from all directions except west (range from 39 through 223 degrees and from 340 to 357 degrees – see red wedges to the left). MVH and SHP were downwind for a portion of the sampling day (see Figure J4).

Figure J4: Wind conditions at MVH and SHP during peak acetaldehyde detections, March 16–17



MVH: Four of twenty-four hours of winds from landfill to MVH. From 11 am through 3 pm on March 16, the landfill was upwind of MVH (160-180 degrees wind direction) and wind speeds were from 2.4 to 7 miles per hour (MPH). All other hours, winds were not blowing from landfill to MVH.

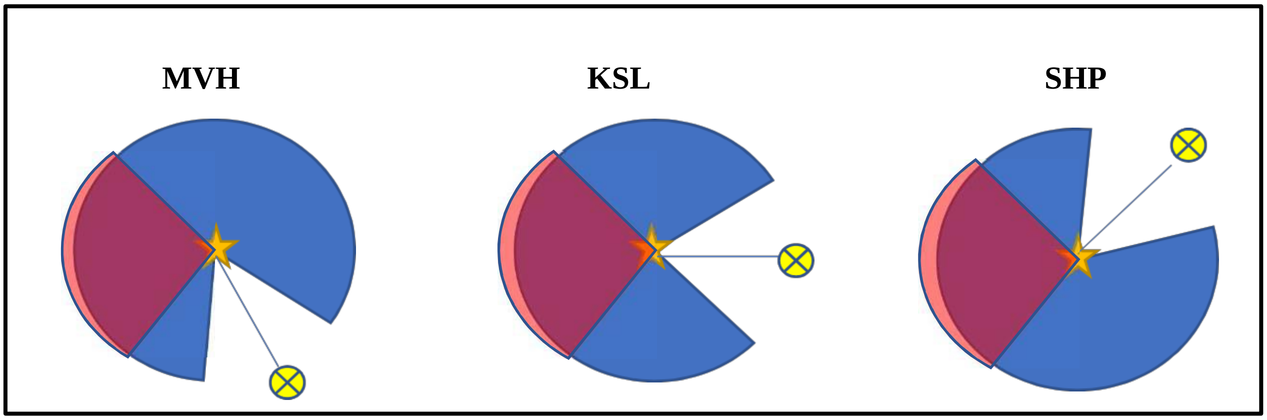


SHP: Six of twenty-four hours of winds from landfill to SHP. From 10 to 11 am on March 16, from midnight through 3 am on March 17, and from 6 am to 8 am on March 17, the landfill was upwind of SHP (38-68 degrees wind direction). Winds speeds during these hours were from 0.5 to 1.3 mph. All other hours, winds were not blowing from landfill to SHP.

Summary for March 29, 2016 sampling event

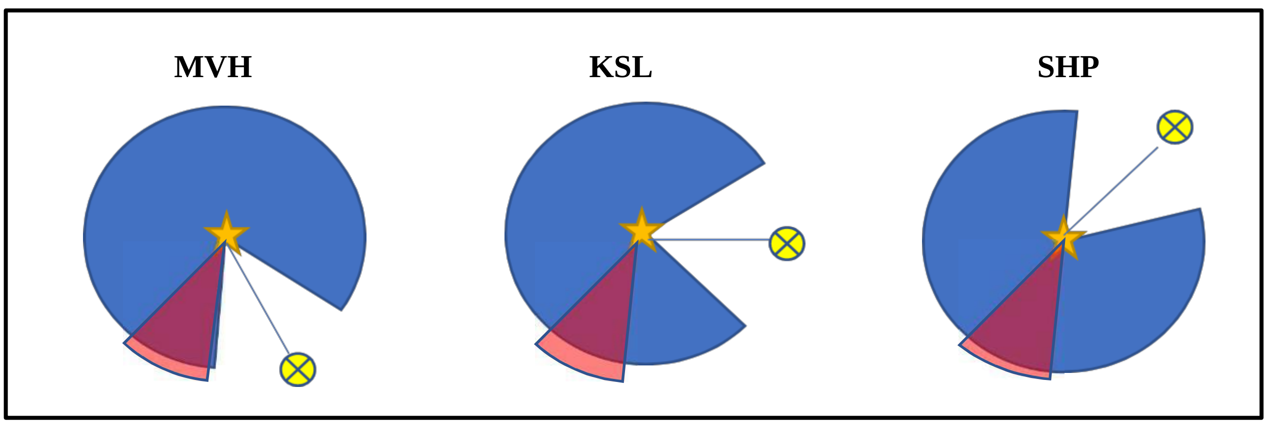
Winds were consistently blowing from the southwest through northwest (223 through 316 degrees) at 2.2 to 13.1 mph (18 hours from 9 -13 mph). None of the sampling/monitoring locations were downwind for any portion of this sampling period (i.e., red wedge does not overlap white wedge in Figure J5 below).

Figure J5: Wind conditions at MVH, KSL and SHP during peak acetaldehyde detections, March 29



Summary for April 1, 2016 sampling event
Winds were consistently blowing from the south through southwest (187 through 236 degrees) from calm to a wind speed of 11.4 mph (average of 6.2 mph). None of the sampling/monitoring locations were downwind for any portion of this sampling period (i.e., red wedge does not overlap white wedge in Figure J5); however, from 4 to 5 pm on March 31, the winds were blowing from 187 degrees. This wind angle places the landfill almost, but slightly east, of upwind from the MVH (see red and white wedge near overlap in Figure J5 below).

Figure J6: Wind conditions at MVH, KSL and SHP during peak acetaldehyde detections, April 1



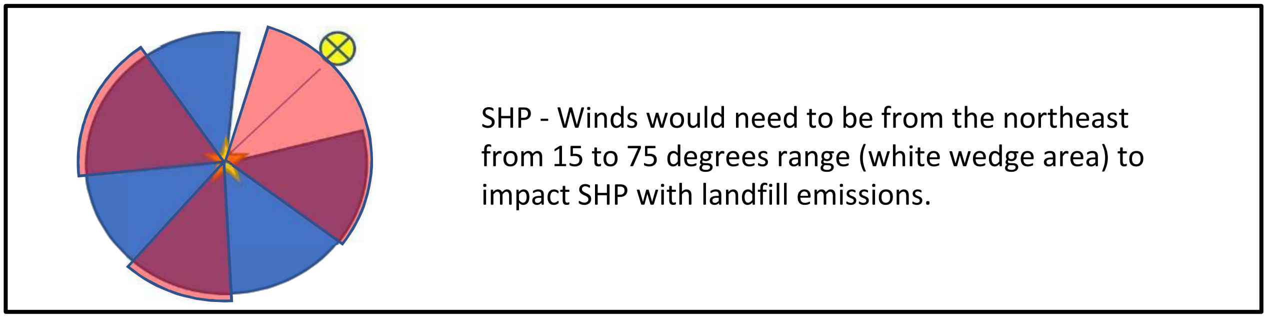
Methylamine
Detection of methylamine exceeding odor detection levels were noted on February 1 at SHP (1,100µg/m^3), on February 4 at KSL (1,200 µg/m^3) and on February 4 at MVH (1,200µg/m^3).

Summary for February 1, 2016 sampling event
Wind direction was highly variable through the 24 hours of sampling (transparent red wedges below in Figure J7), with light winds speeds (0-6 mph). Winds were from the direction of the landfill to Sherwood Park for approximately one third of the sampling window (January 31 at 11 am through February 1 at 11 am). These 8 hours when winds blew from the landfill to the park occurred primarily in the night of February 1, 2016 from 2 – 7 am, but also for three prior and intermittent hours on January 31, 2016 (5, 7, and 9 pm with winds from 73, 33, and 34 degrees). Average hourly wind

speeds when SHP was downwind of the landfill ranged from 0.4 to 1 mph (0.71 mph average). Average wind speed for the day was 1.5 mph.

Winds for a portion of the sampling period (8 of 24 hours) indicate the methylamine detection on February 1, 2016 may have originated from the landfill and impacted the SHP area, but for a majority of the sampling window, winds were not blowing from the landfill towards SHP.

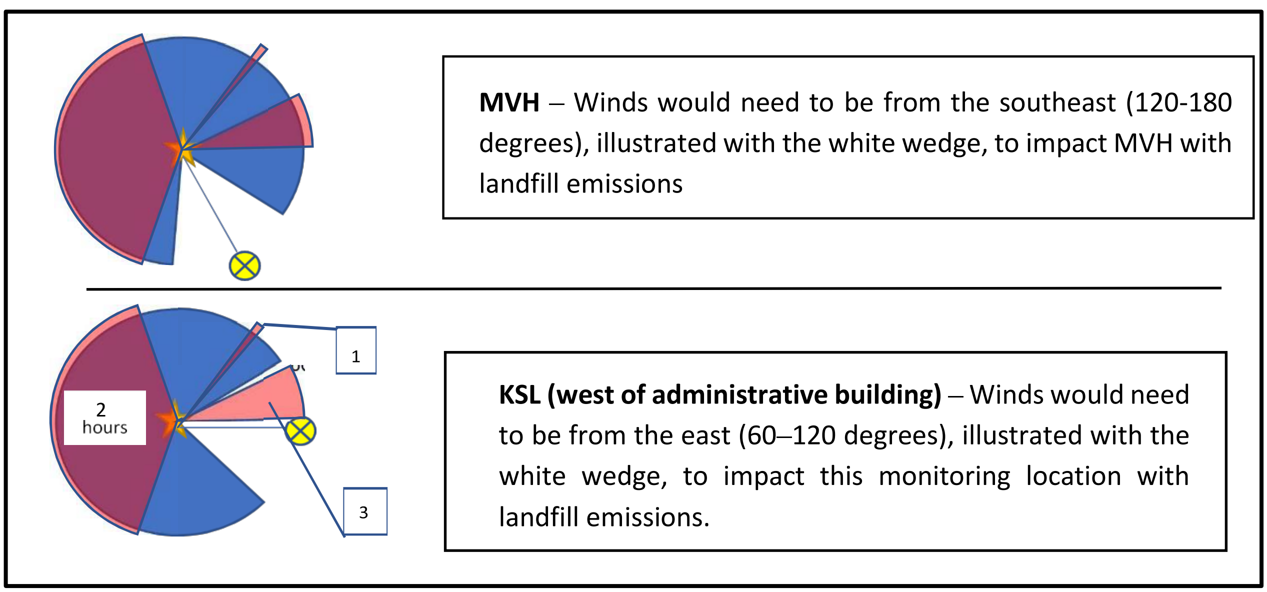
Figure J7: Wind conditions at SHP during peak methylamine detections, February 1



Summary for February 4, 2016 sampling event

There were two methylamine detections this date on this date at KSL and MVH (1,200 µg/m^3). Average wind speed for the day was 2.1 mph and winds blew from west to east for most of the day (21 hours). For three of twenty-four hours, the KSL monitoring/sampling location was downwind of landfill emissions (blowing generally from east to west), and wind speeds were from 0.1 to 1 mph. There were no winds blowing from the landfill towards the MVH monitor on February 4, 2016.

Figure J8: Wind conditions at MVH and KSL during peak methylamine detections, February 4



Ammonia

On one day, February 25, 2016, ammonia was detected at the MVH monitoring/sampling location at a concentration of 8,000 µg/m^3. February 25 was a day of stormy, wintry weather, resulting in field sampling issues that included pump failures. The certainty regarding the volume of air sampled on this day is in question and cannot be resolved with available information. While ammonia was positively detected, it is not certain when that ammonia had absorbed to the sample media during the sampling period. Due to power failures, the field sample collection team determined the total sampling time when the pump was active, was 30 minutes, with a total volume of 2.05 liters of air, as opposed to the expected 98 liters for a 24-hour sample. The sampling tube with absorbent media remained exposed to the ambient air but the pump was not believed to be pulling air through the media in the tube. This affects our ability to determine whether (1) ammonia was at an elevated concentration, or (2) that our sampled air volume is incorrect (i.e., assumed to be about 50 times lower than the actual volume of air sampled). If the sampling pump was active for the full-time period (24 hours) and the volume of air was 98 liters, the concentration in air would be approximately 160 µg/m^3 (exceeding the chronic EMEG but well below the acute CV of 1,700 µg/m^3). Since it was assumed to be a 30-minute sample, the concentration assumed to be in air is above the acute screening value. Average wind speed during the sampling period was 2.9 mph. Winds for the majority of the sampling period were from the south, with 3 hours of winds from the south southeast (landfill upwind).

Figure J9: Wind conditions at MVH during peak ammonia detection, February 25