Letter Health Consultation

Evaluation of Volatile Organic Compounds (VOCs)

BENNETT LANDFILL FIRE

CHESTER, SOUTH CAROLINA

JUNE 22, 2015

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

An ATSDR health consultation is a verbal or written response from ATSDR 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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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LETTER HEALTH CONSULTATION

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CHESTER, SOUTH CAROLINA

Prepared By

Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Central Branch

DEPARTMENT OF HEALTH & HUMAN SERVICES
Agency for Toxic Substances and Disease Registry

Public Health Service
Division of Community Health Investigations,
Atlanta GA 30333

June 19, 2015

Perry Gaughan
U.S. Environmental Protection Agency
61 Forsyth Street, SW
Atlanta, GA 30303

Dear Mr. Gaughan:

On April 29 and 30, 2015, staff from the Agency for Toxic Substances and Disease Registry (ATSDR) and the United States Environmental Protection Agency (U.S. EPA) Region 4 discussed the air data available for the Bennett Landfill fire. The U.S. EPA requested ATSDR evaluate the results of air monitoring and sampling for volatile organic compounds (VOCs), asbestos, hydrogen cyanide, and mercury to determine if community member exposures may be occurring at levels of health concern. The results for particulate air sampling or monitoring will be discussed by ATSDR in a separate health consultation at a later date. Assuming the results of the sampling in April 2015 are representative, ATSDR concludes that recent levels of VOCs (including benzene and formaldehyde), mercury, hydrogen cyanide, and asbestos in outdoor air near the Bennett Landfill fire are not expected to harm people's health.

Background

The Bennett Landfill is a construction and debris landfill located in Chester, South Carolina. On November 2, 2014, local and state authorities responded to a fire that had been discovered at this landfill (Tetra Tech, 2014). On November 7, 2014, the fire was reported to be "pretty much out" (Manzoni, 2014). However, additional burning debris and smoke were discovered at the landfill just prior to December 17, 2014 (Tetra Tech, 2015). As of April 2015, the landfill was still smoldering (Aiken Standard, 2015). The nearest community to the landfill fire is Lockhart, South Carolina. The nearest business is located approximately 0.2 miles northwest from the landfill and the nearest residence is located approximately 0.4 miles west of the landfill (Tetra Tech, 2014; Personal Communication, U.S. EPA Region 4, April 30, 2015). The prevailing wind direction is from the west, but smoke occasionally still blows into Lockhart (Personal Communication, U.S. EPA Region 4, May 4, 2015; Aiken Standard, 2015).

While asbestos was detected in soil samples taken onsite at the landfill, it has not been detected in any of the air samples taken (Tetra Tech, 2014 and 2015; Personal Communication, U.S. EPA

Region 4, April 30, 2015). Consequently, asbestos is not discussed further in this health consultation. The sampling and real time monitoring data available for volatile organic compounds (including benzene and formaldehyde), hydrogen cyanide, and mercury are discussed below.

Description of Monitoring or Sampling and Results

Real time monitoring or sampling for VOCs, hydrogen cyanide, and mercury took place in November 2014; February 2015; and April 2015. A brief description of the monitoring and sampling and the initial analysis of the results are given below.

November 2014. Real time monitoring for total VOCs, particulate matter, hydrogen sulfide, and carbon monoxide took place at three locations. Portable equipment with a hydrogen cyanide sensor was also onsite at this time, but hydrogen cyanide was not detected above the detection limit of one part per million[1]. Although particulate matter, carbon monoxide, and hydrogen sulfide are not the focus of this health consultation, it is worth noting that the hydrogen sulfide concentrations at all three locations were the same. They were all below the detection limit of one part per million (Tetra Tech, 2014). However, this detection limit is well above the ATSDR acute Minimal Risk Level for hydrogen sulfide (0.07 parts per million). Therefore, ATSDR cannot determine if the levels of hydrogen sulfide were of health concern or not. The three monitoring locations are shown in Figure 1. One monitoring site was located near the landfill. The other two locations were in the nearby city of Lockhart. The water tower site was located both upwind and uphill of the landfill, and the last site was located in a residential area downwind of the fire (Tetra Tech, 2014). It must be understood that the VOC monitoring that took place at this time was for total VOCs and did not give the levels of specific VOCs that may be of interest. Consequently, ATSDR cannot reach a conclusion on the potential health effects of VOCs based on this data alone. Nevertheless, it is possible to compare the levels of VOCs at the different locations. Table 1 shows the results of the total VOCs monitoring that took place in November 2014.

[1] The equipment used was the RAE Systems AreaRAE (Tetra Tech, 2014). Information on this sensor can be found at http://www.raesystems.com.sg/sites/default/files/downloads/tehnical-note-114_sensor-specifications-and-cross-sensitivities_04-15.pdf . It has a range between zero and 50 parts per million and resolution of one part per million.

Figure 1. Total Volatile Organic Compounds Real Time Monitoring Locations for the Bennett Landfill Fire (November 3-7, 2014)

Source: Tetra Tech, 2014

Table 1. Total Volatile Organic Compounds Real Time Monitoring Results for the Bennett Landfill Fire.			
Date (Time)	Concentration Range at Water Tower Location (parts per million)	Concentration Range at S. Main and River Street Location (parts per million)	Concentration Range at Landfill Location (parts per million)
November 3-4 (18:00-06:00)	<0.1-3.7	<0.1-5	<0.1-5.2
November 4 (06:00-13:00)	<0.1-2.9	<0.1-3.3	<0.1-1.5
November 4-5 (18:00-06:00)	<0.1-1.4	<0.1-2.5	<0.1-1.3
November 5 (06:00-18:00)	<0.1-2.9	<0.1-1.6	<0.1-0.5
November 5-6 (18:00-06:00)	<0.1-3.7	<0.1-3.3	<0.1-1.3
November 6 (06:00-18:00)	<0.1-0.7	<0.1-2.8	<0.1
November 6-7 (18:00-06:00)	<0.1-0.7	<0.1-4.7	<0.1
November 7 (06:00-11:00)	<0.1	<0.1-2.8	<0.1-0.2
Source: Tetra Tech 2014. Monitoring locations shown in Figure 1. Monitoring intervals not reported (Tetra Tech 2014).			

As shown in Table 1, the levels of VOCs were fairly similar at all three locations. The highest level of total VOCs was detected during the first monitoring period at the landfill location, but the landfill location had the lowest total VOCs during several of the other monitoring periods. The water tower location (background) also had the highest level of VOCs on November 5, 2014.

February 2015. In February 2015, the U.S. EPA tested the smoke plume of the landfill fire for VOCs and other chemicals. One hour samples were collected for formaldehyde, particulate matter, and metals; and VOCs were collected over a period less than a minute. It must be emphasized that this sampling is not representative of the exposures nearby residents would have experienced since the samples were collected on the landfill in the smoke plume of the fire. The U.S. EPA compared the sample results to Acute Exposure Guideline Levels (AEGLs)[2] as well as other screening levels and determined twelve VOCs could require further focus or evaluation. The twelve VOCs were benzene, 1,3-butadiene, chlorobenzene, chloromethane, cumene (also known as isopropyl benzene), ethylbenzene, formaldehyde, hexane, naphthalene, styrene, toluene, and xylene. The U.S. EPA also determined that mercury and hydrogen cyanide could also require further focus and evaluation (Personal Communication, U.S. EPA Region 4, April 30, 2015). While the maximum detected concentration of benzene, chloromethane, formaldehyde, and toluene exceeded ATSDR acute Minimal Risk Levels (MRLs), none of the maximum detected concentrations of any of the VOCs exceeded U.S. EPA one-hour AEGLs or the Department of Energy's Protective Action Criteria (PAC)[3]. Mercury also did not exceed an AEGL or PAC. The highest detected level of hydrogen cyanide (2.69 parts per million) was slightly above the one-hour AEGL-1 for hydrogen cyanide (2.0 parts per million), but this chemical was not detected in the November or April sampling periods. Moreover, as stated previously, the contaminant levels detected in the February sampling period would not be representative of the levels of contaminants nearby residents would be breathing since the sampling location was on the landfill in the smoke plume. Nevertheless, it is worth noting that the maximum detected concentrations of ethylbenzene, styrene, and xylene did not exceed ATSDR's acute MRLs for these chemicals. The maximum detected concentration of ethylbenzene did not exceed ATSDR's intermediate MRL either. The maximum detected concentrations of styrene and xylene exceed ATSDR's intermediate MRL, but intermediate MRLs are used to evaluate exposures between 15 days and a year. The maximum detected level

[2] AEGLs represent threshold exposure limits for the general public and are applicable to emergency exposure periods ranging from ten minutes to eight hours. There are also three levels of AEGLs with AEGL-1 corresponding to the least severe effects and AEGL-3 corresponding to the most severe. Since samples were collected for a one-hour period, ATSDR compared the results to one-hour AEGL-1 levels except for mercury, 1,3-butadiene, chloromethane, and naphthalene. A one-hour AEGL-1 for mercury is not available so the one-hour AEGL-2 was used. No AEGLs exist for 1,3-butadiene, chloromethane or naphthalene. Further information about AEGLs can be found at http://www.epa.gov/oppt/aegl/index.htm. Protective Action Criteria, which incorporate Emergency Response Planning Guidelines, do exist for 1,3-butadiene, chloromethane and naphthalene (see footnote 3).

[3] ATSDR MRLs 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. MRLs are derived for acute (1-14 days), intermediate (15-365 days) and chronic (365 days and longer) durations for oral and inhalation routes of exposure. The Department of Energy's PAC are used for emergency release situations and incorporate AEGLs, Emergency Response Planning Guidelines, and Temporary Emergency Exposure Limits. Further information about the Department of Energy's PAC is at http://www.atlintl.com/DOE/teels/teel.html. PAC were used to evaluate 1,3-butadiene, chloromethane and naphthalene. AEGLs and PAC are not formally reviewed by ATSDR.

of hexane did not exceed ATSDR's chronic MRL which is used to evaluate exposures of a year or longer.

April 2015. On April 7 and 8, 2015, the U.S. EPA sampled for VOCs, hydrogen cyanide, and mercury at three locations. Sampling equipment was set up at the landfill office trailer, a commercial facility just outside the landfill fence line (the closest business), and in downtown Lockhart, SC. These sample locations are shown in Figure 2. Twenty-four hour time-weighted canister samples were collected on April 7 and on April 8 and analyzed for VOCs (except for formaldehyde). A two to three hour sample was collected at each of the sampling locations on April 7 and April 8 and analyzed for formaldehyde, hydrogen cyanide, and mercury[4]. Cumene, hydrogen cyanide, and mercury were not detected in April 2015 (Personal Communication, U.S. EPA Region 4, April 29, 2015).

The sample results were compared to ATSDR MRLs and Cancer Risk Evaluation Guides (CREGs)[5]. If a chemical did not have an ATSDR screening level, the U.S. EPA's Reference Exposure Concentration (RfC) was used. If a chemical did not have an MRL, CREG, or RfC, its sample results were compared to the U.S. EPA's Regional Screening Levels. If a chemical did not have an MRL, CREG, RfC, or RSL, its sample results were compared to values developed by the Texas Commission on Environmental Quality[6].

[4] The shorter sample periods for these constituents were limited by the design sample collection method. Formaldehyde was analyzed using EPA method TO-11. Hydrogen cyanide and mercury were analyzed using NIOSH methods 6010 and 6009, respectively.

[5] ATSDR CREGs are media-specific comparison values used to identify concentrations of cancer-causing substances that are unlikely to result in a significant increase of cancer rates in an exposed population. ATSDR develops CREGs using EPA inhalation unit risks, a target risk level of 10^{-6} and default exposure assumptions.

[6] The Texas Commission on Environmental Quality has developed Air Monitoring Comparison Values and Effects Screening Levels. These values are chemical-specific air concentrations set to protect human health and welfare. Further information is available at: http://www.tceq.texas.gov/toxicology/AirToxics.html . These values are not formally reviewed by ATSDR. The Texas Commission on Environmental Quality values were only used for six chemicals (1,3,5-trimethylbenzene, 2,2,4-trimethylpentane, 1,3-dichlorobenzene, 4-ethyltoluene, ethanol, and heptane). In the case of cis-1,2-dichloroethene, the chronic MRL for trans-1,2-dichlorethene was used because no MRL, CREG, RfC, RSL, or Texas Commission on Environmental Quality value is available.

Figure 2 April 2015 Sampling Locations for the Bennett Landfill Fire.

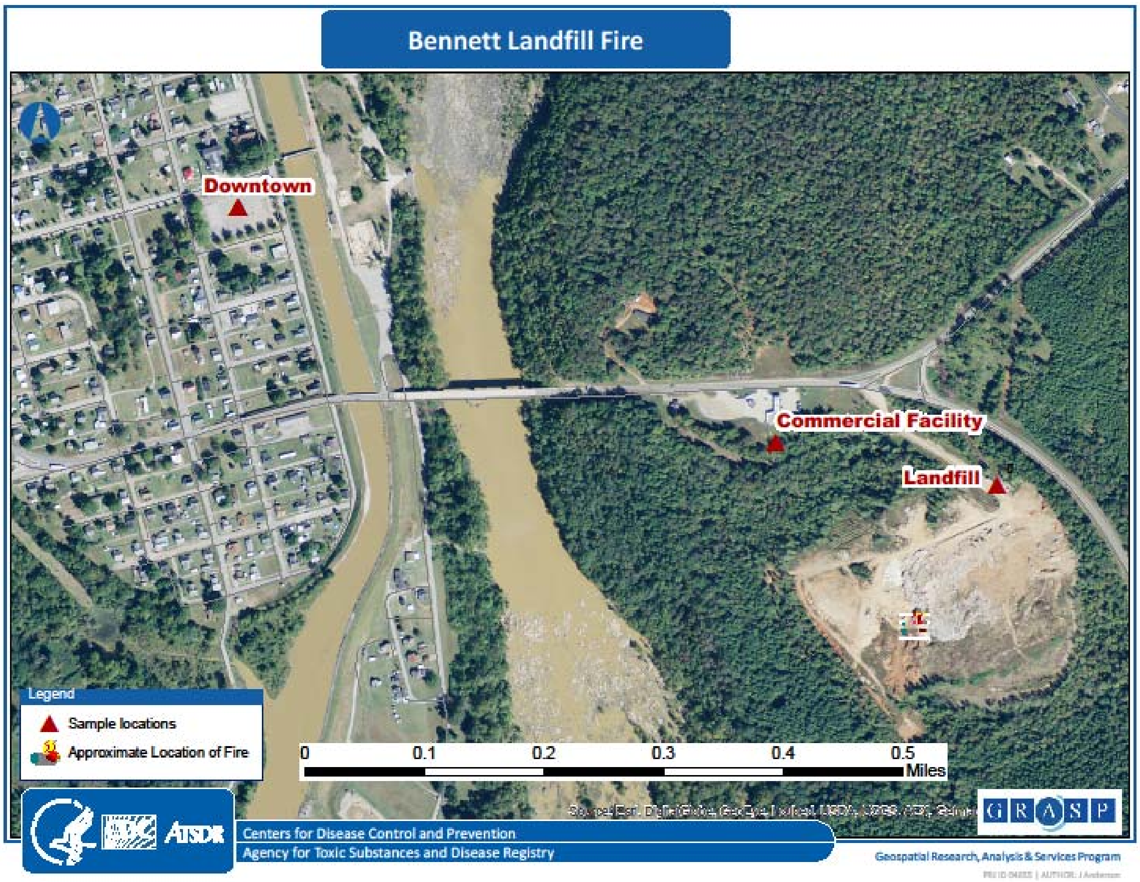

Table 2 shows the maximum detected values of chemicals that exceeded a screening level and the screening levels that were exceeded. The location of all maximum detected levels except 1,1,2,2-tetrachloroethane were at the landfill sampling station. It should be noted that some chemicals such as 1,1,2,2-tetrachloroethane only infrequently exceeded a screening level. Chloroform also had only one sample above its CREG, and it was only detected at the landfill sampling station. 1,3-Butadiene was also only detected at the landfill sampling location.

The maximum detected concentrations shown in Table 2 for carbon tetrachloride and 1,2-dichloroethane are also less than might be expected. Carbon tetrachloride had a maximum detected concentration of 0.076 parts per billion; but concentrations of carbon tetrachloride in air of 0.1 parts per billion in air are common around the world, with somewhat higher levels often found in cities (ATSDR, 2005). 1,2-Dichloroethane has been detected in ambient air samples taken over the north Atlantic Ocean at concentrations of 0.015–0.030 parts per billion, and higher concentrations have been detected in source dominated areas (ATSDR, 2001;Class and

Ballschmiter, 1986; U.S. EPA, 1988). Yet the highest detected concentration of 1,2-dichloroethane was only 0.015 parts per billion.

Table 2 Volatile Organic Compounds Detected Above Screening Levels in April 2015.

Chemical	Maximum Detected Concentration	Screening Level Exceeded (Source of Screening Level)	Number of Sample Results above Screening Level /Total Number of Samples
1,1,2,2-tetrachloroethane	0.010 J	0.0070 (RSL)	1/6
1,2-Dichloroethane	0.015 J	0.0095 (CREG)	5/6
1,3-Butadiene	0.17[L]	0.015 (CREG)	2[L]/6
1,4-Dioxane	0.15 J	0.055 (CREG)	2/6
Benzene	3.1	0.040 (CREG) 3.0 (ATSDR Chronic MRL)	6/6 1[L]/6
Carbon Tetrachloride	0.076 J	0.026 (CREG)	6/6
Chloroform	0.02[L] J	0.0089(CREG)	1[L]/6
Formaldehyde	2.6	0.063 (CREG)	6/6

Notes:
Units = parts per billion.
Samples collected over a 24 hour period except for formaldehyde which was collected over a two to three hour period.
J = Result an estimated value
CREG = ATSDR Cancer Risk Evaluation Guide
RSL = U.S. EPA Regional Screening Level
ATSDR Chronic MRL = ATDR Minimal Risk Level for chronic exposures.
Low levels of 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, and benzene were also detected in the laboratory blank samples. Values shown were not corrected for laboratory blank.
L = Result within landfill fenceline, not found in offsite locations outside the fenceline.

Discussion

Most of the sample results shown in Table 2 are relatively low concentrations. Moreover, low levels of 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, and benzene were detected in the laboratory blank samples[7]. It must be understood that the screening levels exceeded were developed to evaluate long term exposures to chemicals. In fact, the screening level most often exceeded was an ATSDR CREG. CREG's represent an estimated risk of one excess cancer case in an exposed population of one million and assume the entire exposed population is exposed to the same level of a chemical for a lifetime (70 years). Similarly, chronic MRLs were developed to evaluate exposures of a year or longer. Only the maximum detected level of benzene, which is

[7] In the case of 1,1,2,2-tetrachloroethane and 1,2-dichloroethane, the levels detected in the laboratory blank samples were the same order of magnitude as the levels in the field samples. Sample results are still considered valid, but the data review process did note that issue as a caveat (Personal Communication, U.S. EPA Region 4, May 15, 2015).The values shown in Table 2 were not corrected for laboratory blank sample.

discussed further below, exceeded a chronic MRL. It would be more appropriate to compare these sample results to values derived to evaluate exposures for shorter periods of time such as ATSDR's intermediate or acute MRLs. While the February sample results for some chemicals exceeded acute MRLs, samples in February were collected in the plume of the fire and are not representative of the levels to which people living nearby would be exposed. Moreover, as noted previously, none of the February VOC sample results exceeded an U.S. EPA one-hour AEGL or the Department of Energy's PAC.

The additional cancer risk estimate from chemical exposures is often stated as 1×10^{-4}, 1×10^{-5}, or 1×10^{-6} (or 1E-4, 1E-5, or 1E-6). Using 1×10^{-6} (or 1E-6) as an example, it means that a population of one million people exposed to a carcinogen over a lifetime (70 years) at a specific concentration may have one additional case of cancer because of the exposure. An estimated additional cancer risk of 1×10^{-4} (or 1E-4) means that a population of 10,000 people exposed for a lifetime (70 years) at a certain chemical concentration may have one additional cancer case above background levels. For most chemicals in Table 2, the levels correspond to an estimated cancer risk less than one in one hundred thousand (1×10^{-5}) which is a very low increased cancer risk. Only benzene, formaldehyde, and 1,3-butadiene exceeded an estimated 1×10^{-5} cancer risk. However, the maximum 1,3-butadiene result only slightly exceeded the 1×10^{-5} estimated cancer risk. Furthermore, 1,3-butadiene was only detected at the landfill sampling station (onsite). Consequently, nearby residents are not likely to have an increased cancer risk from exposure to 1,3-butadiene greater than 1×10^{-5}. Benzene and formaldehyde are discussed further below.

Benzene

Benzene is present in crude oil, gasoline, and cigarette smoke. Once in the air, benzene reacts with other chemicals and breaks down within a few days (ATSDR, 2007). The concentration of benzene in urban area ambient air is between 0.32 and 19 parts per billion, but in rural areas it is between 0.02 and 0.85 parts per billion (U.S. EPA, 1987; Roberts et. al., 1985; ATSDR 2007).

Benzene was detected at every sampling station in April and these results are shown below. Only one sample result was greater than 0.85 parts per billion.

Table 3. Benzene 24 hour Ambient Air Sample Results for April 2015			
Location	Date	Results (parts per billion)	Average Concentration (parts per billion)
Landfill Office Trailer	April 7, 2015	0.78	1.9
	April 8, 2015	3.1	
Commercial Facility Outside Landfill Fence Line	April 7, 2015	0.26	0.23
	April 8, 2015	0.20	
Downtown Lockhart, SC	April 7, 2015	0.12	0.20
	April 8, 2015	0.28	
Notes: Benzene was also detected in a laboratory blank sample at a concentration of 0.016 J parts per billion.			

Although the maximum detected concentration of benzene at the landfill location (3.1 parts per billion) slightly exceeds the chronic MRL for benzene (3.0 parts per billion), the average concentration does not. Moreover, the concentrations of benzene detected at the other sample locations were an order of magnitude below the chronic MRL. Consequently, ATSDR concludes that noncancerous health effects from exposure to benzene are unlikely. The highest detected concentration of benzene in April corresponds to an estimated cancer risk less than 10^{-4} (or out of 10,000 people exposed for 70 years, one additional person may get cancer) which is a low increased cancer risk. The highest concentration was detected at the landfill sampling locations, and the levels of benzene detected at the other sampling locations corresponds to an estimated cancer risk less than 10^{-5}. It should be noted that sampling results taken over a longer period of time would better represent long-term cancer risk exposure. Short-term exposure to carcinogens is an area of considerable debate and research; however, it is generally believed that any exposure factors that are less than what was used for the estimates will significantly decrease the estimated risk (e.g., exposed for a shorter time period; exposed to lower concentrations; exposed less frequently during the time period, etc.). Nevertheless, the maximum detected concentration of benzene corresponds to an estimated cancer risk less than 10^{-4}.

Formaldehyde

None of the formaldehyde sample results in April exceeded any of the MRLs ATSDR has developed for formaldehyde. Therefore, noncancerous health effects from exposure to recent levels of formaldehyde are unlikely. Sample results were between 1.0 and 2.6 parts per billion. While the concentration of formaldehyde in outdoor air in unpopulated areas is about 0.2 parts per billion, concentrations of formaldehyde in outdoor air in suburban areas is about 2 to 6 parts per billion (ATSDR, 1999). The maximum detected concentration of formaldehyde also corresponds to a low increased cancer risk.

Conclusions and Recommendations

Conclusions

Assuming the results of the sampling in April 2015 are representative, ATSDR concludes that recent levels of VOCs (including benzene and formaldehyde), mercury, hydrogen cyanide, and asbestos in outdoor air near the Bennett Landfill fire are not expected to harm people's health.

Recommendations

1. ATSDR recommends that efforts to extinguish the fire continue.
2. ATSDR recommends that access to the landfill be restricted.
3. ATSDR recommends the U.S. EPA resample for volatile organic compounds and hydrogen cyanide after firefighting activities are complete to determine if there was a reduction in the concentrations of these chemicals in air.
4. Since hydrogen sulfide is often detected at construction and debris landfills in relatively high concentrations, ATSDR also recommends the U.S. EPA resample for this chemical after firefighting activities are complete.

Public Health Action Plan

ATSDR will continue to evaluate ambient air data from the Bennett Landfill fire if requested.

Sincerely,

[signed]

Timothy R. Pettifor
Environmental Health Scientist
Central Branch
Division of Community Health Investigations

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