Health Consultation

Surveys of Residents of Paulsboro, New Jersey Following a Train Derailment and Vinyl Chloride Gas Release

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Prepared by:

Division of Epidemiology, Environmental and Occupational Health
New Jersey Department of Health

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Summary

Introduction

At approximately 7:00 am on November 30, 2012, several chemical tank cars derailed on a railroad bridge over the Mantua Creek at Paulsboro, NJ. Four cars ended up in the creek. One of these cars, which contained about 24,000 gallons of vinyl chloride, ruptured and released the hazardous chemical into the air. More than 200 individuals visited hospital emergency departments as a result of the incident.

There was widespread public concern about the public health impact of the event. In response, the New Jersey Department of Health (NJDOH) and the U.S. Centers for Disease Control and Prevention (CDC)—including the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH)—began assessing the public health implications of the event.

This Health Consultation describes and summarizes the results of health surveys of community residents. The purpose of the surveys was to understand the nature and frequency of symptoms experienced by residents, to what degree residents accessed medical care services, and how residents received information about the incident and instructions about what to do to protect themselves and their families.

NJDOH has reached the following conclusions based on the information presented in this Health Consultation report:

Conclusion 1

A high proportion of Paulsboro residents experienced symptoms consistent with exposure to vinyl chloride released from the train derailment site. Within Paulsboro, those living closer to the derailment site reported symptoms at higher frequencies than those living farther away. Those who reported smelling odors also reported experiencing symptoms more frequently.

Basis for Conclusion

Many types of symptoms were reported frequently by Paulsboro residents, including: headache; upper respiratory (irritation of the nose and throat), cough, and lower respiratory (difficulty breathing);

	eye (irritation); neurological (dizziness); and gastrointestinal (nausea). There is consistency between health symptoms reported on surveys and what would be expected from exposure to symptom-producing levels of vinyl chloride exposures. Based on monitoring data, air dispersion models, and the reporting of odors, many people in the community were likely to have been exposed to vinyl chloride concentrations that could produce acute symptoms.
Conclusion 2	*About one in ten individuals who participated in the survey sought medical care at a hospital emergency department. Individuals were more likely to go to a hospital emergency department if their households were closer to the derailment site.*
Basis for Conclusion	About 9% of In-Person Survey participants reported seeking medical care at a hospital emergency department, as did at least one person in 12% of households participating in the Mailed Survey. Households residing within 1,500 feet of the derailment site were about three times as likely to have someone visit an emergency department than households located more than 3,500 feet away.
Conclusion 3	*Paulsboro residents received information about the derailment and what to do about it from a variety of sources. Social contacts (relatives, friends, neighbors and co-workers) played an important role in spreading information about the incident, as did television broadcasts and local authorities. Many in the community were dissatisfied with official communications to alert the community about the incident and what actions residents should take to protect themselves. Residents wanted more direct communication from persons in authority.*
Basis for Conclusion	More Paulsboro residents first learned of the derailment and vinyl chloride leak from a relative, friend, neighbor or co-worker, or from television, than directly from a person in authority. The most common sources of information about what to do (for example, to stay indoors or shelter-in-place) were: television; a relative, friend, neighbor or co-worker; a person in authority; and a reverse 911

	telephone call. In the days following the incident, most people received information about the situation from television and word-of-mouth. Survey participants expressed a preference to receive information directly from someone in authority, from recorded telephone messages, and from television. However, many residents were unaware that the incident occurred, what actions to take, or what it meant to shelter in place. Many Paulsboro survey respondents expressed frustration regarding a lack of communication and guidance from official responders and from health departments/agencies, which likely increased stress and fear among residents. Many of the concerns noted in the survey could have been addressed by health agencies early on, which may have helped alleviate some anxiety.
Recommended Next Steps	**Communities should develop, test and follow emergency communication plans in which persons in authority notify and communicate instructions to residents during emergency events.** **Local officials should prepare and make available community-specific emergency planning educational materials tailored to the initial response to relevant catastrophic hazards.** **Within the incident command system, public health agencies should be engaged to provide guidance to and address health concerns of the community.**
Conclusion 4	*The school's implementation of lockdown procedures caused an increased exposure in school children who were turned away and sent home.*
Basis for Conclusion	According to survey responses and news reports, the school system's implementation of lockdown procedures in response to the incident resulted in children being turned away from school and sent back home through the cloud of vinyl chloride.
Recommended Next Steps	**Schools should ensure that emergency response plans are designed to protect children and staff from chemical exposures.**

For More Information

Copies of this report will be provided to interested residents through the local library and the NJDOH web site. NJDOH will notify area residents that this report is available and will provide a paper copy upon request.

Questions about this report should be directed to the Environmental and Occupational Health Surveillance Program, New Jersey Department of Health, (609) 826-4984.

1. Statement of Purpose

At approximately 7:00 am on November 30, 2012, several chemical tank cars derailed on a railroad bridge over the Mantua Creek at Paulsboro, NJ. Four cars ended up in the creek. One of these cars, which contained about 24,000 gallons of vinyl chloride, ruptured and released the hazardous chemical into the air (NJOEM 2012a; NTSB 2013a). More than 250 individuals (residents and emergency responders) visited hospital emergency departments as a result of the incident (ATSDR in preparation).

There was widespread public concern about the short-term and long-term impacts of the event. In response, the New Jersey Department of Health (NJDOH) requested assistance from the U.S. Centers for Disease Control and Prevention (CDC), including the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH). The objectives of this "Epi-Aid" assistance were to:

- characterize exposure and health effects of those impacted by the vinyl chloride release;
- assess the occupational health and safety of emergency response personnel;
- describe the response to the incident and develop recommendations for public health preparedness and response to chemical release events; and
- inform residents and emergency responders about results of the investigation and address community health concerns.

This Health Consultation describes the results of health surveys conducted in relation to community or resident exposures and concerns. Separate documents describe a health survey of emergency responders (NIOSH 2013), a health survey of employees of an asphalt refinery near the scene of the incident, and a review of medical records at hospital emergency departments that saw patients complaining of effects from exposure to vinyl chloride gas (ATSDR in preparation).

2. Background

After the derailment, emergency responders began arriving on scene, and incident command was established under the control of the Paulsboro Fire Department. Immediately following the incident, Paulsboro police began instructing the nearest residents to evacuate the area. Around 7:30 a.m. the police began instructing residents to stay home with the windows closed (NTSB 2013a). Residents within about one-half mile of the incident site were advised to "shelter in place" (NJOEM 2012a; NTSB 2013a). Between 7:25 a.m. and 7:40 a.m., schools in Paulsboro were notified of the emergency situation and told to close (NTSB 2013a), while

those in West Deptford were told to shelter students in place. Later, the county issued a shelter-in-place order for all of Paulsboro, West Deptford and East Greenwich. Paulsboro schools went into "lockdown" in which no one was allowed into or out of the school buildings. Children who arrived at the school after lockdown were sent home and many had to walk back through the vinyl chloride cloud.

In the afternoon of November 30, a Unified Command, consisting of the U.S. Coast Guard, the New Jersey Department of Environmental Protection (NJDEP), the State of New Jersey Office of Emergency Management (OEM), Conrail, and the Paulsboro Fire Department was established under the command of the Coast Guard (NTSB 2013a). Around 4:00 pm on November 30, an evacuation order was issued for about 45 residents closest to the derailment site; around 5:00 pm, elevated vinyl chloride readings prompted an expansion of the evacuation area to include approximately 500 more residents (NJOEM 2012a). The evacuation area at that time was bounded by the Mantua Creek, the rail line, North Delaware St., and East Broad St. The rest of Paulsboro remained under instructions to shelter in place.

Short-term exposure to vinyl chloride in the air can result in irritation of the eyes, nose, throat, and lungs, and can cause dizziness, sleepiness, headache, nausea, or tingling in the arms and legs. It is not known whether short-term exposure to vinyl chloride can cause long-term health effects. People who have been exposed to high levels of vinyl chloride at work for long periods of time have been shown to have an increased risk of a rare form of liver cancer and possibly other cancers (ATSDR 2006a; ATSDR 2006b; ATSDR undated; EPA 2012a).

From December 1–3, vinyl chloride levels fluctuated, leading to the lifting and reinstating of shelter-in-place orders. Due to persistently elevated vinyl chloride readings, at 4:00 pm on December 4 the evacuation area was further expanded to include another 300 to 400 residents (NJOEM 2012b). At that time, the shelter-in-place order was lifted for the remainder of Paulsboro. The evacuation area was now bounded by the Mantua Creek, 7th St., North Delaware St., Railroad Ave., Spruce St., and East Broad St. Figure 1 is a map showing the extent of the evacuation zones in Paulsboro.

Based on observations of a dense fog or cloud of vinyl chloride vapors, air dispersion models, and air quality monitoring, it is likely that much of the vinyl chloride was released into the air in the initial hour after the release, followed by a lower level of emissions from the breached tank car until December 5 (NJDOH 2014). Vinyl chloride emissions ceased at that time after the remaining contents of the leaking car were emptied by response personnel.

The concentrations of vinyl chloride in the air to which emergency responders and community residents and others were exposed changed with time, location and weather conditions. Aerial and ground-level photographs and eyewitness accounts indicate that a dense cloud formed near the tank car, which moved quickly into adjacent areas including the residential sections of Paulsboro (NTSB 2013c-d). Air monitoring with hand-held

photoionization detectors (PIDs) began about 90 minutes after the derailment by emergency response personnel from the Paulsboro Refinery. PID readings over 700 parts per million (ppm), corresponding to a vinyl chloride concentration of approximately 1,400 ppm, were detected at Commerce and Jefferson Sts. between 8:30 and 8:40 a.m. PID readings taken at various locations around the community during the morning hours decreased but fluctuated considerably (Paulsboro Refinery Company 2012).

A systematic air monitoring network was established beginning in the early afternoon of November 30; by that time emissions of vinyl chloride had subsided substantially. Data were collected by a contractor to Conrail and by the U.S. Environmental Protection Agency (NJDOH 2014).

Air dispersion models estimated that maximum vinyl chloride concentrations in the first hour could have been in the thousands of parts per million (ppm) up to 0.2 miles from the derailment, and as high as 250 ppm as far as 0.8 miles out from the derailment site (NJDOH 2014). The model predicted that most of the vinyl chloride would have been released from the tank within the first hour, given the size of the breach and the high pressure within the tank.

Once the recovery operational stages of the emergency response undertaken by the Unified Command were completed, NJDOH, ATSDR and NIOSH conducted several surveys of populations potentially impacted by the train derailment. Emergency responders were surveyed to better understand symptoms experienced, use of personal protective equipment, training, and communication issues. Employees of an asphalt plant located to the northeast of the derailment site, who were trapped at the facility and exposed to vinyl chloride for several hours when its lone access road was blocked by the stopped train, were surveyed separately. In addition, ATSDR/CDC and NJDOH conducted medical chart reviews at the emergency departments of five hospitals to which Paulsboro residents and emergency responders went for medical attention in relation to this incident. As noted above, results of these surveys are described separately (NIOSH 2013; ATSDR in preparation).

ATSDR/CDC and NJDOH conducted two surveys of Paulsboro households, described below. The purpose of the surveys was to understand the nature and frequency of symptoms experienced by residents, to what degree residents accessed medical care services, and how residents received information about the incident and instructions about what to do to protect themselves and their families.

3. Survey Methods

Two surveys of households were conducted. The **In-Person Survey** was conducted door-to-door by trained interviewers from ATSDR/CDC and NJDOH. This survey was targeted to residents of randomly selected census blocks in Paulsboro. To ensure that *all*

Paulsboro residents had an opportunity to participate, the **Mailed Survey** was a self-administered questionnaire sent to all postal addresses in Paulsboro.

The population of Paulsboro is estimated to be 6,152, according to the U.S. Census Bureau's American Community Survey 2007-2011 5–Year Estimates (U.S. Census 2012). The total number of households (occupied housing units) is estimated to be 2,237.

3.1 In-Person Survey

Population Surveyed Because more residents were potentially exposed than could be interviewed in a brief period, ATSDR and NJDOH developed a household sampling strategy based on the Community Assessment for Public Health Emergency Response (CASPER) Toolkit (CDC 2012). Paulsboro was divided into four Areas for sampling (Figure 2):

Area A: evacuated at some time on November 30;
Area B: evacuated on December 4;
Area C: never evacuated but immediately adjacent to areas A or B; and
Area D: remaining areas of Paulsboro that were never evacuated.

Census blocks within each zone were randomly selected for in-person surveying; the chance of a block being selected was weighted by the number of housing units on the block. Forty blocks were targeted for surveying, including 10 each from Areas A, B, C and D.

On each targeted block, the objective was to survey seven randomly chosen households. For example, if there were 21 households on a block, survey staff would start from a random location on the block and work their way around the block, attempting to survey every third household. Targeted blocks were visited a minimum of three times, unless seven household surveys were completed in fewer visits.

Time Frame The In-Person Survey asked about experiences during the approximately one-week period between 7:00 am on Friday, November 30 and 12:00 noon on Friday, December 7, 2012. The In-Person Survey was conducted beginning on Friday evening, December 14, through Friday, December 21, 2012.

Survey Instrument The investigation team from ATSDR/CDC and NJDOH followed the existing Assessment of Chemical Exposure (ACE) protocol, which had been developed by ATSDR for use in post-emergency evaluations of public health impact of chemical releases (ATSDR 2010). The team adapted the ACE questionnaire for this incident; the questionnaire consisted of a household section and modules for adults/adolescents and children. The household section asked for the names and ages of people in the household who were at home in Paulsboro at any time between 7:00 am on Friday, November 30 and 12:00 noon on Friday,

December 7, and whether anyone in the household was also an emergency responder. This section also asked for contact information for the household.

The adult/adolescent module asked questions about potential exposure: the amount of time spent indoors or outdoors in Paulsboro during the time frame above; whether the person could smell an odor related to the incident; what they were told or understood about sheltering in place; whether and when the person was evacuated; and whether the person was decontaminated. The module also asked about symptoms the person may have experienced in the week following the incident; whether the symptoms were pre-existing; whether the symptoms got worse after the incident; and whether the person was still experiencing the symptoms. This survey module also asked about medical care that the person may have sought because of the incident, selected aspects of the individual's medical history, and demographic characteristics. Finally, the surveys asked about how the individual heard about the train derailment and vinyl chloride gas release and about what to do, and asked about the best way for local authorities to communicate this information should an event like this happen in the future. The child module (for children less than 13 years of age) was similar but did not include questions about odors or what the child heard about the incident or how to shelter in place.

Outreach, Participant Recruitment, and Interviewing Procedures NJDOH announced the intention to conduct surveys in coordination with ATSDR/CDC at a community meeting in Paulsboro on December 11. The In-Person Survey team set up an "operations center" at the Sons of Italy Lodge at 525 West Broad Street in Paulsboro on December 14, and surveying was field-tested later that day. From December 15 through December 20, after morning briefings about each day's plans, ATSDR/CDC and NJDOH surveyors were dispatched to targeted blocks to recruit participants for the survey. Once at the targeted block, surveyors went to the designated houses to describe the purpose of the survey and ask for agreement to participate. The household section of the survey was then completed for the household by one adult member. Individual adult/adolescent surveys were then completed by either the one respondent or each individual. The adult respondent completed the survey for any children less than 13 years of age. Surveyors recorded the date and start/end times for the household's participation.

3.2. Mailed Survey

Population Surveyed The target population identified by NJDOH for the Mailed Survey was *all households* in Paulsboro, defined as residential postal delivery units. (Note that the White Swan community in West Deptford was also an intended target for distribution of the Mailed Survey; however, it appears that questionnaires were never delivered to this community. NJDOH only became aware of this once there were no surveys returned from this area.)

Time Frame The Mailed Survey asked about experiences from Friday, November 30 through Friday, December 7, 2012.

Survey Instrument NJDOH further adapted the ACE questionnaire so that it could be self-administered by Paulsboro residents, rather than administered by a trained interviewer. This self-administered questionnaire was intended to be completed by one household representative on behalf of all household members. Similar to the In-Person Survey, the Mailed Survey included questions about household members, evacuation status, odors detected, symptoms experienced, medical care sought, medical history, and communications about the incident and what to do. In addition, participating households were asked an open-ended question for residents to express any health-related concerns related to the derailment and vinyl chloride gas release.

Outreach and Participant Recruitment The Mailed Survey was sent to all postal delivery addresses in Paulsboro on or about December 27, 2012, together with a cover letter, informational materials, and a postage-paid return envelope. Households that completed the In-Person Survey were asked not to complete the Mailed Survey, as their responses had already been recorded. NJDOH requested households to return completed surveys by January 20, 2013.

3.3. Confidentiality of Survey Information

In both the In-Person and Mailed Surveys, participants were told that completing the survey was voluntary, and that all information given would be kept private. Participants were assured that names and other individual information would not be made public in any report.

3.4. Data Analysis

Data were analyzed using the statistical analysis software SAS 9.2. Response frequencies were tabulated for each question in the survey, and cross-tabulated by other survey questions as needed. Survey respondent addresses were geo-coded and distance measurements from residences to the derailment site were made using ArcMap 10.1. Residents were categorized into distance bands based on distance in feet from the derailment site. Frequencies were determined for each specific symptom on the survey form, and also for symptoms grouped as follows: any Eye Symptom; any Upper Respiratory Symptom; any Lower Respiratory Symptom; any Gastrointestinal Symptom; and any Neurological Symptom. Headache, increased congestion or phlegm, coughing, heart palpitations, and ringing of the ears remained ungrouped.

4. Survey Results

4.1. Participation in Surveys

In-Person Survey A total of 154 households participated in the In-Person Survey, distributed fairly evenly across the four Areas A-D (Table 1). Households from 38 of the 40 targeted census blocks participated, with 1 to 7 households participating from each of these blocks. From the 154 households, surveys were completed for 459 individuals (Table 2). The number of participating individuals ranged from 1 to 10 per household, with an average of 3.0 individuals per household.

Mailed Survey A total of 580 households participated in the Mailed Survey, including 16 that also participated in the In-Person Survey (Table 1). Surveys from these 580 households reported on the experiences of 1,511 individuals (Table 2). In the Mailed Survey, the number of participating individuals ranged from 1 to 9 per household, with an average of 2.6 individuals per household.

Overall Participation Rate A total of 718 households participated in either survey (Table 1), which is about 32% of all Paulsboro households. Similarly, the surveys collected information on a total of 1,930 individuals, which is about 31% of all Paulsboro residents (Table 2).

Characteristics of Survey Participants In-Person Survey participants included more females (54%) than males (44%) (gender was not reported for 2%), as did the Mailed Survey (54% female and 46% male); these proportions were similar to the entire town's gender distribution of 55% female and 45% male (Table 3). In-Person Survey participants were similar in age distribution to Paulsboro. Mailed Survey participants had fewer persons under age 20 years (25%) than Paulsboro (35%), and more adults aged 65-84 years (14%) vs. 8% in Paulsboro (Table 3). Two households (1%) in the In-Person Survey and 17 households (3%) in the Mailed Survey reported that at least one member was an emergency responder who responded to the incident (Table 4).

4.2. Reported Evacuation Status

In the In-Person Survey, 57% of individuals were from households that were evacuated, while 35% were from households that were not evacuated (this information was not reported for 8% of individuals) (Table 5A). In the Mailed Survey, 63 households (11%) reported being evacuated, while 439 households (76%) were not evacuated and the residents stayed at home. Another 73 households (13%) were not officially evacuated but the household reported that its members left the area (Table 5B). (Those households in which at least one member stayed at home are classified as staying at home.) The most frequent reported dates of evacuation in both Surveys were November 30 and December 4. Evacuation frequencies were higher among

In-Person Survey participants than among Mailed Survey households because evacuated areas were over-sampled by design in the In-Person Survey.

4.3. Reported Odors

Fifty percent of adults in the In-Person Survey reported smelling or tasting unusual odors (Table 6A). In the Mailed Survey, 69% of households (402/580) reported that at least one member of the household smelled or tasted an unusual odor (Table 6B).

4.4. Existing Medical Conditions

In the In-Person Survey, 17% of individuals were reported to have asthma and 3% were reported to have chronic obstructive pulmonary disease (COPD). In the Mailed Survey, 14% of individuals were reported to have asthma and 4% were reported to have chronic obstructive pulmonary disease (COPD). Thirty percent of adult ($\geq$ 18 years of age) In-Person Survey participants were reported to be current smokers, while 22% were considered former smokers and 43% were never smokers. Somewhat lower percentages of current and former smokers among adults were reported from the Mailed Survey, with 23% of adults reported to be current smokers and 16% considered former smokers (Table 7A).

In the In-person Survey, 6 females age $\geq$ 18 years (3%) reported being pregnant, while less than 1% of females reported to be breastfeeding (Table 7A). In the Mailed Survey, 13 households (2%) reported that someone in the household was pregnant, while 5 households (1%) reported that someone was breastfeeding (Table 7B).

4.5. Reported New or Worsened Symptoms

Many Paulsboro survey respondents reported experiencing a variety of *new or worsening* symptoms in the week-long period after the train derailment and vinyl chloride release. Overall, 58% of participants in the In-Person Survey and 66% in the Mailed Survey reported experiencing new or worsening symptoms. Forty-two percent of individuals in the In-Person Survey and 34% of individuals in the Mailed Survey reported experiencing no new or worsening symptoms (Table 8). The most commonly reported symptom or symptom groups were headache, upper respiratory symptoms (predominantly irritation of nose or throat), and coughing (Table 8). Other common symptoms included: neurological symptoms (predominantly dizziness or lightheadedness), eye symptoms (mostly irritation of the eyes) and lower respiratory symptoms (mostly difficulty breathing).

In general, participants in the Mailed Survey consistently reported somewhat higher symptom frequencies than participants in the In-Person Survey. For example, headache was reported for 47% of Mailed Survey participants compared to 36% for In-Person Survey participants; likewise, nausea was reported for 25% of Mailed Survey participants compared to

17% for In-Person Survey participants. Most of the infrequently reported symptoms occurred in about 5% to 8% of participants in both the Mailed and In-Person Surveys. Nosebleed was the least frequently reported symptom.

Symptoms by Existing Health Conditions In both Surveys, among those with existing asthma, there was a higher frequency of respiratory symptoms, including specific symptoms associated with asthma (difficulty breathing, chest tightness, and wheezing). Those with COPD also had higher frequencies of respiratory symptoms. Current smokers reported higher respiratory symptom frequencies than former smokers and the overall participant group (Table 9). There were too few pregnant or breastfeeding participants in either Survey to examine symptom frequencies.

Symptoms by Taste and Odor In the In-Person Survey each *individual* reported whether *he or she* smelled or tasted unusual odors and in the Mailed Survey each *household* reported whether *at least one member of the household* smelled or tasted an unusual odor. Among those who reported smelling or tasting an odor (either an individual or someone in the household) there was a higher frequency of reported new or worsening symptoms, and the reported frequency of each symptom was very similar in the Mailed and In-person Surveys (Table 10). In both surveys, the most frequently reported symptoms among those who smelled an odor were headache, coughing, and irritation of nose and throat, dizziness, irritation or pain or burning of eyes, and difficulty breathing.

Symptoms by Area In both surveys, for most symptoms, the area with the highest percentage of participants reporting the symptom was Area C (census blocks never evacuated but immediately adjacent to blocks that were evacuated) (Tables 11A and 11B). The most frequently reported symptoms in Area C were headache, coughing, nausea, and irritation of the nose or throat. In the Mailed Survey, participants in Area B reported a high frequency of irritation, pain or burning of the eyes and those in Area A reported a high frequency of dizziness or lightheadedness. In the In-Person survey, a high frequency of dizziness or lightheadedness was reported in Area B. Area D (the remaining non-evacuated census blocks) had the lowest percentage of participants who reported symptoms in both surveys.

Symptoms by Reported Evacuation Status Among participants in the In-Person Survey, there were only small differences in the proportion of participants reporting symptoms between those evacuated and those not evacuated. In the Mailed Survey, those who reported being evacuated tended to have a higher percentage with symptoms than those who were not evacuated and stayed or not evacuated and left, though differences were not large (Table 12).

Symptoms by Distance from the Derailment Site In both surveys, symptom frequencies are consistently higher in homes closer than 3500 feet from the incident site than those farther than 3500 feet (Figure 2). In the In-Person survey, most reported symptoms peaked in the 2501 to 3500 feet distance, not in the area closest to the derailment site (Table

13A and Figures 3A through 3G). In the Mailed Survey, the symptom frequencies were fairly consistent in the three distance bands within 3500 feet, although a majority of symptoms had slightly higher frequencies within 0 to 2500 feet from the derailment site (Table 13B and Figures 3A through 3G).

4.6. Reported Medical Care

In the In-person Survey, 10 individuals (2%) reported being provided medical care by an emergency medical technician or paramedic; 40 individuals (9%) reported going to a hospital emergency room; and 22 (5%) sought medical care elsewhere for health concerns in relation to the incident (Table 14A). Similarly, in the Mailed Survey, 15 households (3%) reported that someone in the household received medical care from an emergency medical technician or paramedic; 67 (12%) had a household member who went to a hospital emergency room. Twenty-two percent of households in the Mailed Survey sought medical care elsewhere for health concerns in relation to the incident (Table 14B).

In the Mailed Survey, the percentage of households in which someone received care at a hospital decreased with distance from the train derailment site. Twenty-one percent of households within 1,500 feet of the derailment reported that someone from the household went to a hospital (Table 14C).

4.7. Communications

Adult participants in the In-Person Survey reported most frequently that their first source of information that the derailment and vinyl chloride leak occurred was from a relative, friend, neighbor or co-worker (48%). Smaller percentages (16% each) reported that their first information source was directly from a person in authority or the television (Table 15A). Adult participants reported most frequently that their first source of instructions on what to do was a person in authority (28%), television (20%) and a relative, friend, neighbor or co-worker (16%) (Table 16A). The television was by far the most frequent source of on-going information about the incident (59%), followed by a relative, friend, neighbor or co-worker (23%), a community meeting (17%) and a person in authority (16%) (Table 17A). Adult participants in the In-Person Survey indicated that the best sources of information should there be an incident like this in the future would be telephone calls (58%), officials going door to door (51%), and television (31%) (Table 18A).

Households responding to the Mailed Survey reported most frequently they first heard about the train derailment and vinyl chloride gas release from the television (46% of households), or from a relative, friend, neighbor or co-worker (43%) (Table 15B). Households heard about what to do because of the incident from the television (56%), a relative, friend, neighbor or co-worker (24%), a person in authority (19%) or a reverse 911 telephone call (19%) (Table 16B). The most common sources of on-going information about the incident

were the television (79%), a relative, friend, neighbor or co-worker (28%), reverse 911 calls (28%) and the newspaper (21%) (Table 17B). When asked about the best method for communicating about such incidents, 63% of households in the Mailed Survey listed "directly from a person in authority" as a preferred option, followed by reverse 911 (48%), television (42%) and text message (29%) (Table 18B).

4.8 Open-ended Question

Many Mailed Survey respondents provided information in response to an open-ended question about health concerns related to the train derailment incident. Respondents identified the following areas of concern:

- Persistent symptoms such as headaches, congestion, worsened asthma
- Potential for adverse health effects in the future from the vinyl chloride exposure
- Feelings of stress, anxiety, anger and fear
- Exposures to children who were walking to or from school at the time of the vinyl chloride release
- Inadequate or untimely communication about what to do in response to the incident, and what it means to "shelter in place"
- Unclear explanation of how evacuated zones were defined
- Inadequate communication about health impacts
- Need for better planning and preparation in case of future accidents

5. Discussion

Approximately one-third of the population of Paulsboro participated in the In-Person or the Mailed Surveys. The demographic profile of survey participants was generally similar to the town overall, though there were somewhat fewer children and more adults aged 65-84 years represented in the Mailed Survey.

More than 260 participants in the In-Person Survey reported evacuating the area, either through official action or on their own. In the Mailed Survey, 63 households reported being evacuated, and another 73 households reported that they were not evacuated but left the area anyway. Of those who evacuated or left, most reported leaving on the day of the incident (November 30) or on December 4.

A high percentage of participants in the two surveys reported smelling or tasting an unusual odor in the air in relation to the incident. Vinyl chloride gas is said to have a mild, sweet odor (WHO 2004; ATSDR undated; National Research Council 2012). ATSDR's Medical Management Guidelines state that the odor threshold for vinyl chloride (the level above which an odor is detected) is 3,000 ppm (ATSDR undated). However, the World Health

Organization (WHO) notes that odor thresholds are subjective and dependent on individual sensitivities. WHO indicates that the odor threshold for vinyl chloride may range from 10 to 20 ppm up to 4,000 ppm (WHO 2004). A National Research Council evaluation reported a wide range of odor thresholds from 10 ppm to 25,000 ppm (National Research Council 2012). Health effects may occur from exposure to vinyl chloride at concentrations below the odor threshold (ATSDR undated; ATSDR 2006a).

Paulsboro survey participants reported pre-existing respiratory health conditions—asthma and COPD in higher proportions than in national and state survey data. The percent of participants reporting having asthma was 17% and 14% in the In-Person and Mailed Survey, respectively, which is higher than state data from the statewide Behavioral Risk Factor Survey. Asthma prevalence among New Jersey children in 2009 was 14.3% for ever having asthma and 9% for currently having asthma. Among adults in New Jersey in 2009, 12.6% ever had asthma, and 7.7% currently had asthma (NJDOH 2010). COPD prevalence among adults was 4% in the In-Person Survey and 5% in the Mailed Survey. These percentages are the same as COPD prevalence in the U.S. during 2007-2009, which was about 5.1% in adults; there was a lower rate (4.3%) in the Middle Atlantic States (Akinbami and Liu 2011). Current smoking prevalence among adults in the In-Person Survey was 30%, and was 23% among Mailed Survey participants. These percentages are higher than in the state, where smoking prevalence among adults was 15.8% in 2009 (NJDOH 2011).

The symptoms that were more commonly reported are consistent with what is known to occur from exposure to vinyl chloride, specifically headache, irritation of the eyes, nose, throat and lungs, coughing, nausea, and dizziness or lightheadedness. All of these symptoms have multiple causes, and many may occur as a result of anxiety, fear or stress induced by traumatic events (WebMD 2013). There was a similar pattern of reported symptom frequencies between the In-Person and Mailed Surveys, as well as with the findings of surveys of emergency responders (NIOSH 2013) and employees of a nearby asphalt refinery.

Symptoms were more frequently reported by those with pre-existing respiratory health problems (asthma and COPD) and among those who were current smokers. Those who reported smelling odors associated with the vinyl chloride leak reported symptoms more frequently. This could indicate higher exposure to vinyl chloride, greater awareness of exposure, or higher sensitivity to the effects of exposure, all of which could produce increased frequency or severity of symptoms. Symptoms were most commonly reported from evacuated areas and the area within one block of evacuated areas, and were least frequent in areas farther than 3,500 feet from the derailment incident location.

In consultation with the National Research Council, the U.S. Environmental Protection Agency (EPA) has established Acute Exposure Guideline Levels (AEGLs) designed to help emergency responders evaluate hazards when members of the public are exposed during a hazardous substance release incident (National Research Council 2012). AEGLs are

concentrations of a chemical in air at which most people—including potentially more sensitive individuals such as the sick, elderly or very young—would begin to experience symptoms. AEGLS are developed for three tiers of severity, and for several exposure periods ranging from 10 minutes to 8 hours; AEGLs for 60-minute and 8-hour durations are shown below:

Acute Exposure Guideline Levels (AEGLs) for Vinyl Chloride, in parts per million (ppm) in air.

Severity Tier	**Vinyl Chloride Air Concentration (ppm)**		**Definition**
	Exposure for 60 minutes	Exposure for 8 hours	*The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals…*
AEGL-1	**250**	**70**	*…could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.*
AEGL-2	**1,200**	**820**	*…could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.*
AEGL-3	**4,800**	**3,400**	*…could experience life-threatening health effects or death.*

Sources: EPA 2012b and EPA 2012c

For vinyl chloride, the AEGL-1 is based on a study in humans in which headaches were experienced following inhalation exposure. The AEGL-2 is based on a study in humans in which severe dizziness was experienced after brief exposure, indicating the potential for an impaired ability to escape. The AEGL-3 is based on cardiac sensitization to adrenaline in experimental animals, potentially leading to heart arrhythmia and death (National Research Council 2012).

From the chart above, the concentration of vinyl chloride capable of producing reversible irritant effects following exposure lasting one hour is 250 ppm; lower exposures to 70 ppm of vinyl chloride over an 8-hour period could also produce symptoms. As discussed in the Background section, vinyl chloride levels in the hundreds to thousands of parts per million were likely to have been present at least in the first hour or two after the derailment and vinyl chloride release. While vinyl chloride concentrations were not measured in the first 90 minutes after the derailment, and modeled estimates are uncertain, it is plausible that concentrations could have approached AEGL-2 and even AEGL-3 levels in the populated areas close to the derailment site in the first hour or two (NJDOH 2014). Photographic and eyewitness accounts of a visible gas cloud or fog support the idea that the highest concentrations occurred immediately after the derailment, and that these highest concentrations dissipated before air monitoring could begin. For the most part, monitored levels after mid-day on November 30 were considerably lower and less likely to produce symptoms.

Forty participants in the In-Person Survey reported seeking medical care at a hospital emergency room. In the Mailed Survey, 67 households reported that at least one individual

sought medical care at a hospital. There appeared to be a higher percentage of people in the Mailed Survey seeking care outside the hospital following the event. This difference between the Surveys regarding medical care sought elsewhere may be because the Mailed Survey was distributed and completed weeks after the In-Person Survey was administered, allowing more time for people to have sought care.

Most adults first heard of the incident from a relative, friend, neighbor or coworker; most adults first learned about what to do from persons in authority, television or friends, neighbors and co-workers. The results of the surveys demonstrated that the network among families, neighbors, friends and co-workers in Paulsboro was crucial in the initial communications regarding the incident. This "people network" is a vital component in communicating during emergency events. While most adults continued to receive information regarding the incident from the television, most respondents indicated the best method for receiving additional information would be through direct communication from a person in authority (including officials going door to door or reverse 911 telephone calls). Many survey respondents expressed frustration regarding what they perceived to be inadequate or untimely communication about what to do in response to the incident, the health impacts, and what it means to "shelter in place."

Survey respondents were dissatisfied with the school district's implementation of lockdown procedures, which resulted in children being turned away at school and walking through the vinyl chloride cloud to return home. Guidance to schools on the development of effective emergency response plans has recently been released by the U.S. Department of Education (USDOE 2013).

Mailed Survey respondents expressed ongoing concerns about persistent health effects and the potential for health effects to develop in the future. Symptom onset is usually immediate but may be delayed up to 48 hours after exposure; symptoms usually resolve once exposure is stopped. Long-term health effects from acute-duration exposure to vinyl chloride are considered unlikely (ATSDR undated).

6. Conclusions and Recommendations

Conclusion 1: *A high proportion of Paulsboro residents experienced symptoms consistent with exposure to vinyl chloride released from the train derailment site. Within Paulsboro, those living closer to the derailment site reported symptoms at higher frequencies than those living farther away. Those who reported smelling odors also reported experiencing symptoms more frequently.*

Many types of symptoms were reported frequently by Paulsboro residents, including: headache; upper respiratory (irritation of the nose and throat), cough, and lower respiratory

(difficulty breathing); eye (irritation); neurological (dizziness); and gastrointestinal (nausea). There is consistency between health symptoms reported on surveys and what would be expected from exposure to symptom-producing levels of vinyl chloride exposures. Based on monitoring data, air dispersion models, and the reporting of odors, many people in the community were likely to have been exposed to vinyl chloride concentrations that could produce acute symptoms.

Conclusion 2: *About one in ten individuals who participated in the survey sought medical care at a hospital emergency department. Individuals were more likely to go to a hospital emergency department if their households were closer to the derailment site.*

About 9% of In-Person Survey participants reported seeking medical care at a hospital emergency department, as did at least one person in 12% of households participating in the Mailed Survey. Households residing within 1,500 feet of the derailment site were about three times as likely to have someone visit an emergency department than households located more than 3,500 feet away.

Conclusion 3: *Paulsboro residents received information about the derailment and what to do about it from a variety of sources. Social contacts (relatives, friends, neighbors and co-workers) played an important role in spreading information about the incident, as did television broadcasts and local authorities. Many in the community were dissatisfied with communications to alert the community about the incident and what actions residents should take to protect themselves. Residents wanted more direct communication from persons in authority.*

More Paulsboro residents first learned of the derailment and vinyl chloride leak from a relative, friend, neighbor or co-worker, or from television, than directly from a person in authority. The most common sources of information about what to do (for example, to stay indoors or shelter-in-place) were: television; a relative, friend, neighbor or co-worker; a person in authority; and a reverse 911 telephone call. In the days following the incident, most people received information about the situation from television and word-of-mouth. Survey participants expressed a preference to receive information directly from someone in authority, from recorded telephone messages, and from television.

However, many residents were unaware that the incident occurred, what actions to take, or what it meant to shelter in place. Many Paulsboro survey respondents expressed frustration regarding a lack of communication and guidance from official responders and from health departments/agencies, which likely increased stress and fear among residents. Many of the concerns noted in the survey could have been addressed by health agencies early on, which may have helped alleviate some anxiety.

Recommendations. Communities should develop, test and follow emergency communication plans in which persons in authority notify and communicate instructions to residents during emergency events. Local officials should prepare and make available community-specific emergency planning educational materials tailored to the initial response to relevant catastrophic hazards. Within the incident command system, public health agencies should be engaged to provide guidance to and address health concerns of the community.

Conclusion 4: *The school's implementation of lockdown procedures caused an increased exposure in school children who were turned away and sent home.*

According to survey responses and news reports, the school system's implementation of lockdown procedures in response to the incident resulted in children being turned away from school and sent back home through the cloud of vinyl chloride.

Recommendation. Schools should ensure that emergency response plans are designed to protect children and staff from chemical exposures.

7. Public Health Action Plan

The purpose of a Public Health Action Plan is to ensure that a Health Consultation provides a plan of action for necessary follow-up activities. Included is a commitment to follow up on this plan to ensure that it is implemented. The public health actions to be implemented by the NJDOH are as follows:

Public Health Actions Taken

Federal and state public health agencies conducted health surveys and reviewed medical records to document and assess the health impact on residents and emergency responders. This Health Consultation describes the surveys of residents; other surveys are documented separately (NIOSH 2013; ATSDR in preparation).

NJDOH reviewed available information and relevant data to evaluate air concentrations of vinyl chloride and potential health implications of exposure following the train derailment that occurred in Paulsboro, NJ on November 30, 2012 (NJDOH 2014).

Public Health Actions Planned

Copies of this Health Consultation will be made available to concerned residents through the borough libraries and the Internet. NJDOH may hold public meetings to discuss these findings and address additional community concerns.

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Report Preparation

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Principal Authors

Jerald Fagliano, M.P.H., Ph.D.
Alice Shumate, Ph.D.
Katharine McGreevy, M.P.A., Ph.D.
Pamela Agovino, M.P.H.
Consumer, Environmental and Occupational Health Services
Division of Epidemiology, Environmental and Occupational
Health New Jersey Department of Health

Survey Staff

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State Reviewer

Joseph Eldridge, M.P.H., Director
Consumer, Environmental and Occupational Health Services
Division of Epidemiology, Environmental and Occupational Health
New Jersey Department of Health

Tables and Figures

Table 1. Number of Paulsboro *households* participating in In-Person Survey or Mailed Survey.

Number of *households* participating in In-Person Survey Area A Area B Area C Area D Total	 38 35 41 40 154
Number of households participating in Mailed Survey	580
Total number of households participating in either survey *	718
Estimated number of households in Paulsboro **	2,237
Estimated *household* participation rate in either survey	32

* 16 households participated in both surveys but are only counted once in this total.

** Based on American Community Survey 2007–2011 total households estimate for Paulsboro (U.S. Census 2012).

Table 2. Number of *individuals* from Paulsboro households participating in In-Person Survey and Mailed Survey.

Number of *individuals* in households participating in In-Person Survey Area A Area B Area C Area D Total	 112 114 126 107 459
Number of individuals in households participating in Mailed Survey	1,511
Total number of individuals participating in either survey *	1,930
Estimated number of individuals in Paulsboro **	6,152
Estimated *individual* participation rate in either survey	31

* Of 16 households that participated in both surveys, there were duplicate reports for 40 individuals, so these are excluded from the total number of individuals.

** Based on American Community Survey 2007–2011 total population estimate for Paulsboro (U.S. Census 2012).

Table 3. Demographic characteristics of survey participants.

Characteristic	In-Person Survey		Mailed Survey		Paulsboro *	
	#	%	#	%	#	%
Age Group (years)						
0–19	156	34	373	25	2,136	35
20–44	128	28	440	29	1,879	30
45–64	107	23	422	28	1,466	24
65–84	56	12	212	14	471	8
85+	9	2	39	3	200	3
Not reported	3	1	25	2	--	--
Gender						
Male	202	44	690	46	2,791	45
Female	247	54	813	54	3,361	55
Not reported	10	2	8	<1	--	--

* Based on American Community Survey 2007−2011 population estimates for Paulsboro (U.S. Census 2012).

Table 4. Emergency responders in participating households.

Households with First Responders	In-Person Survey Number and Percent of Households		Mailed Survey Number and Percent of Households	
	#	%	#	%
No first responder in household	136	88	550	95
First responder in household	2	1	17	3
Not reported	16	10	13	2

Table 5A. In-Person Survey: Individuals in participating households by evacuation status.

Reported Evacuation Status	In-Person Survey Number and Percent of Individuals	
	#	%
Individuals not evacuated	161	35
Individuals in evacuated household *	262	57
November 30	86	19
December 1-3	22	5
December 4	58	13
December 5-7	10	2
Date not reported	86	19
Not reported	36	8

* Individuals may have been officially evacuated or self-evacuated.

Table 5B. Mailed Survey: Participating households by evacuation status.

Reported Evacuation Status	Mailed Survey Number and Percent of Households	
	#	%
Not evacuated and stayed in home	439	76
Not evacuated but left the area anyway	73	13
Household evacuated	63	11
November 30	32	6
December 1-3	6	1
December 4	13	2
December 5-7	3	<1
Date not reported	9	2
Evacuation status not reported	5	<1

Table 6A. In-Person Survey: Adults smelling odors related to the event.

	In-Person Survey Number and Percent of Individuals	
	#	%
Individual adult did not smell odors	136	42
Individual adult smelled odor(s)	164	50
Unsure	12	4
Not reported	10	3

Table 6B. Mailed Survey: Households with individuals smelling odors related to the event.

	Mailed Survey Number and Percent of Households	
	#	%
Individuals in household did not smell odors	169	29
Individual in household smelled odor(s)	402	69
Not reported	9	2

Table 7A. Individuals with existing health-related conditions.

Individuals with Existing Health-related Condition	In-Person Survey Number and Percent of Individuals #	In-Person Survey Number and Percent of Individuals %	Mailed Survey Number and Percent of Individuals #	Mailed Survey Number and Percent of Individuals %
Pregnant (among females ≥ 18 years of age)				
Yes	5	3	See Table 7B	
No	171	94		
Not reported	5	3		
Breastfeeding (among females ≥ 18 years of age)				
Yes	1	1	See Table 7B	
No	173	96		
Not reported	7	4		
Has asthma				
Yes	79	17	207	14
No	375	82	--	--
Not reported	5	1	--	--
No or not reported	--	--	1,304	86
Has COPD (among ≥ 18 years of age)				
Yes	14	4	54	5
No	308	96	--	--
Not reported	0	0	--	--
No or not reported	--	--	1,106	95
Smoking status (among ≥ 18 years of age)				
Current smoker	95	30	269	23
Former smoker	72	22	180	16
Never smoker	140	43	--	--
Not reported	15	5	--	--
Never smoker or not reported	--	--	709	61

Table 7B. Mailed Survey: Households with anyone with existing health-related conditions.

Household with Someone with Existing Health-related Condition	Mailed Survey Number and Percent of Households #	Mailed Survey Number and Percent of Households %
Pregnant		
Yes	13	2
No	551	95
Not reported	16	3
Breastfeeding		
Yes	5	1
No	562	97
Not reported	13	2

Table 8. Symptoms reported to be experienced by individuals.

Symptom or Symptom Group	In-Person Survey Number and Percent of Individuals		Mailed Survey Number and Percent of Individuals	
	#	%	#	%
No symptoms reported	*193*	*42*	*517*	*34*
HEADACHE	**161**	**36**	**719**	**48**
EYE SYMPTOMS	**100**	**22**	**531**	**35**
Irritation/pain/burning of eyes	85	19	467	31
Increased eye tearing	64	14	331	22
UPPER RESPIRATORY SYMPTOMS	**152**	**34**	**658**	**44**
Irritation of nose or throat	125	28	559	37
Runny nose	82	18	330	22
Nosebleed	3	1	105	7
INCREASED CONGESTION OR PHLEGM	**85**	**19**	**344**	**23**
COUGHING	**139**	**31**	**574**	**38**
LOWER RESPIRATORY SYMPTOMS	**113**	**25**	**495**	**33**
Difficulty breathing/feeling out of breath	82	18	371	25
Chest tightness	51	11	275	18
Wheezing in chest	51	11	244	16
Irritation of lungs	52	12	233	15
GASTROINTESTINAL SYMPTOMS	**79**	**18**	**393**	**26**
Nausea	75	17	380	25
Vomiting	35	8	125	8
NEUROLOGICAL SYMPTOMS	**125**	**28**	**563**	**37**
Dizziness or lightheadedness	89	20	412	27
Sleepiness	72	16	320	21
Generalized weakness	31	7	128	8
Blurred or double vision	24	5	116	8
Loss of balance	24	5	111	7
Numbness or tingling in the arms or legs	31	7	100	7
Confusion	23	5	85	6
OTHER SYMPTOMS	--	--	--	--
Palpitations or fast heart rate	29	6	110	7
Ringing of the ears	23	5	95	6

Table 9. Percent of individuals reporting symptoms, by existing health-related conditions.

Symptom or Symptom Group	In-Person Survey Percent of Individuals with Symptoms				Mailed Survey Percent of Individuals with Symptoms			
	Among Those Who Had Asthma	Among Adults Who Had COPD	Among Adult Current Smokers	Among Adult Former Smokers	Among Those Who Had Asthma	Among Adults Who Had COPD	Among Adult Current Smokers	Among Adult Former Smokers
No symptoms reported	*29*	*50*	*28*	*43*	*18*	*21*	*20*	*31*
HEADACHE	**51**	**21**	**48**	**39**	**65**	**63**	**65**	**51**
EYE SYMPTOMS	**31**	**29**	**35**	**25**	**49**	**52**	**48**	**41**
Irritation/pain/burning of eyes	31	14	30	22	44	46	43	34
Increased eye tearing	18	21	25	17	33	37	30	26
UPPER RESPIRATORY SYMPTOMS	**53**	**38**	**50**	**34**	**60**	**63**	**55**	**48**
Irritation of nose or throat	45	29	41	22	55	58	46	42
Runny nose	32	15	21	21	30	27	29	23
Nosebleed	3	0	4	4	12	8	9	10
INCREASED CONGESTION OR PHLEGM	**30**	**29**	**28**	**18**	**43**	**44**	**33**	**24**
COUGHING	**50**	**23**	**40**	**30**	**59**	**56**	**45**	**36**
LOWER RESPIRATORY SYMPTOMS	**42**	**43**	**41**	**32**	**66**	**65**	**42**	**38**
Difficulty breathing/out of breath	33	36	32	23	58	58	31	29
Chest tightness	19	7	13	22	45	40	23	23
Wheezing in chest	28	21	20	13	53	38	22	16
Irritation of lungs	16	21	20	14	38	44	21	17
GASTROINTESTINAL SYMPTOMS	**27**	0	**21**	**17**	**44**	**37**	**31**	**24**
Nausea	25	0	21	17	43	37	30	23
Vomiting	15	0	7	9	14	12	8	9
NEUROLOGICAL SYMPTOMS	**39**	**21**	**40**	**30**	**58**	**46**	**51**	**36**
Dizziness or lightheadedness	27	14	33	14	42	27	36	27
Sleepiness	24	7	21	16	40	29	29	19
Generalized weakness	8	0	12	8	18	19	18	9
Blurred or double vision	8	0	5	8	14	13	11	7
Loss of balance	8	0	7	7	13	19	12	9
Numbness or tingling in arms or legs	11	21	13	8	11	21	13	12
Confusion	9	0	6	8	10	12	9	7
OTHER SYMPTOMS	--	--	--	--	--	--	--	--
Palpitations or fast heart rate	12	14	12	6	14	17	10	8
Ringing of the ears	9	7	5	4	10	19	9	6

Table 10. Percent of individuals reporting symptoms, by experience with odors. For the In-Person Survey, the frequency is among adults based on individual experience of odors and symptoms. For the Mailed Survey, the frequencies are symptoms among all participants, based on whether anyone in the household smelled or tasted odors.

Symptom or Symptom Group	In-Person Survey Percent of Adults Symptoms		Mailed Survey Percent of Individuals with Symptoms	
	Individual Smelled Odor	Individual Did Not Smell Odor	Household Where Someone Smelled Odor	Household Where No One Smelled Odor
No symptoms reported	*18*	*64*	*23*	*73*
HEADACHE	**59**	**20**	**57**	**15**
EYE SYMPTOMS	**39**	**10**	**42**	**11**
Irritation/pain/burning of eyes	34	10	37	9
Increased eye tearing	25	7	27	5
UPPER RESPIRATORY SYMPTOMS	**57**	**16**	**52**	**14**
Irritation of nose or throat	46	12	44	12
Runny nose	28	10	26	5
Nosebleed	7	1	8	3
INCREASED CONGESTION OR PHLEGM	**30**	**8**	**28**	**5**
COUGHING	**52**	**13**	**46**	**11**
LOWER RESPIRATORY SYMPTOMS	**47**	**18**	**40**	**8**
Difficulty breathing/feeling out of breath	35	10	30	5
Chest tightness	23	8	22	5
Wheezing in chest	20	4	20	3
Irritation of lungs	21	7	19	2
GASTROINTESTINAL SYMPTOMS	**31**	**9**	**31**	**8**
Nausea	30	9	30	8
Vomiting	13	3	10	2
NEUROLOGICAL SYMPTOMS	**50**	**15**	**45**	**11**
Dizziness or lightheadedness	39	10	33	8
Sleepiness	24	7	26	5
Generalized weakness	14	3	10	2
Blurred or double vision	12	1	9	3
Loss of balance	10	4	9	2
Numbness or tingling in the arms or legs	12	5	8	1
Confusion	10	4	7	2
OTHER SYMPTOMS	--	--	--	--
Palpitations or fast heart rate	12	3	9	2
Ringing of the ears	8	3	7	2

Table 11A. In-Person Survey: Percent of individuals reporting symptoms, by survey areas (A-D)*.

Symptom or Symptom Group	In-Person Survey Percent of Individuals with Symptoms			
	Area A	Area B	Area C	Area D
No symptoms reported	*44*	*38*	*36*	*55*
HEADACHE	**31**	**37**	**43**	**32**
EYE SYMPTOMS	**17**	**22**	**32**	**15**
Irritation/pain/burning of eyes	16	18	27	12
Increased eye tearing	10	11	25	9
UPPER RESPIRATORY SYMPTOMS	**36**	**35**	**43**	**26**
Irritation of nose or throat	28	29	31	24
Runny nose	23	12	26	11
Nosebleed	0	1	2	0
INCREASED CONGESTION OR PHLEGM	**19**	**20**	**29**	**7**
COUGHING	**30**	**29**	**41**	**24**
LOWER RESPIRATORY SYMPTOMS	**22**	**25**	**35**	**22**
Difficulty breathing/feeling out of breath	17	19	23	13
Chest tightness	9	9	16	10
Wheezing in chest	8	9	19	7
Irritation of lungs	11	9	14	13
GASTROINTESTINAL SYMPTOMS	**18**	**12**	**33**	**7**
Nausea	16	11	32	7
Vomiting	9	5	15	1
NEUROLOGICAL SYMPTOMS	**25**	**33**	**39**	**20**
Dizziness or lightheadedness	11	30	26	10
Sleepiness	21	12	21	9
Generalized weakness	3	5	15	2
Blurred or double vision	6	1	10	3
Loss of balance	4	6	9	1
Numbness or tingling in the arms or legs	6	4	13	3
Confusion	5	4	7	4
OTHER SYMPTOMS	**--**	**--**	**--**	**--**
Palpitations or fast heart rate	8	4	9	5
Ringing of the ears	4	4	9	3

* Area A: evacuated at some time on November 30;
Area B: evacuated on December 4;
Area C: never evacuated but immediately adjacent to areas A or B; and
Area D: remaining areas of Paulsboro that were never evacuated.

Table 11B. Mailed Survey: Percent of individuals reporting symptoms, by survey areas (A-D)*.

Symptom or Symptom Group	Mailed Survey Percent of Individuals with Symptoms			
	Area A	Area B	Area C	Area D
No symptoms reported	*35*	*22*	*21*	*37*
HEADACHE	**44**	**58**	**66**	**44**
EYE SYMPTOMS	**38**	**49**	**45**	**32**
Irritation/pain/burning of eyes	34	48	39	28
Increased eye tearing	21	30	26	21
UPPER RESPIRATORY SYMPTOMS	**44**	**49**	**61**	**40**
Irritation of nose or throat	34	43	51	34
Runny nose	18	28	28	21
Nosebleed	11	9	10	6
INCREASED CONGESTION OR PHLEGM	**25**	**15**	**33**	**21**
COUGHING	**48**	**40**	**47**	**35**
LOWER RESPIRATORY SYMPTOMS	**36**	**34**	**45**	**30**
Difficulty breathing/feeling out of breath	28	27	36	22
Chest tightness	15	19	28	17
Wheezing in chest	17	16	22	15
Irritation of lungs	13	16	24	14
GASTROINTESTINAL SYMPTOMS	**26**	**28**	**38**	**24**
Nausea	24	28	38	23
Vomiting	11	3	16	7
NEUROLOGICAL SYMPTOMS	**50**	**46**	**53**	**33**
Dizziness or lightheadedness	42	31	39	23
Sleepiness	22	31	33	18
Generalized weakness	6	12	16	7
Blurred or double vision	10	12	10	7
Loss of balance	10	6	9	7
Numbness or tingling in the arms or legs	12	6	8	6
Confusion	7	4	10	5
OTHER SYMPTOMS	--	--	--	--
Palpitations or fast heart rate	13	7	12	6
Ringing of the ears	6	6	9	6

* Area A: evacuated at some time on November 30;
Area B: evacuated on December 4;
Area C: never evacuated but immediately adjacent to areas A or B; and
Area D: remaining areas of Paulsboro that were never evacuated.

Table 12. Percent of individuals reporting symptoms, by reported evacuation status.

Symptom or Symptom Group	In-Person Survey Percent of Individuals with Symptoms		Mailed Survey Percent of Individuals with Symptoms		
	Never Evacuated	Evacuated	Never Evacuated	Evacuated	Not Evacuated but Left
No symptoms reported	*45*	*40*	*35*	*27*	*36*
HEADACHE	**38**	**36**	**46**	**56**	**47**
EYE SYMPTOMS	**25**	**21**	**34**	**40**	**36**
Irritation/pain/burning of eyes	21	18	30	39	30
Increased eye tearing	18	12	21	23	25
UPPER RESPIRATORY SYMPTOMS	**35**	**36**	**42**	**50**	**46**
Irritation of nose or throat	28	29	36	41	39
Runny nose	19	17	22	21	18
Nosebleed	3	3	6	11	6
INCREASED CONGESTION OR PHLEGM	**17**	**20**	**23**	**23**	**18**
COUGHING	**34**	**29**	**37**	**47**	**37**
LOWER RESPIRATORY SYMPTOMS	**30**	**25**	**31**	**37**	**39**
Difficulty breathing/feeling out of breath	18	19	23	30	31
Chest tightness	13	10	17	19	24
Wheezing in chest	12	11	15	20	18
Irritation of lungs	14	10	15	16	19
GASTROINTESTINAL SYMPTOMS	**19**	**17**	**24**	**30**	**33**
Nausea	19	15	23	30	30
Vomiting	9	7	7	7	14
NEUROLOGICAL SYMPTOMS	**28**	**31**	**34**	**51**	**40**
Dizziness or lightheadedness	19	22	24	42	36
Sleepiness	14	17	20	30	21
Generalized weakness	8	6	8	12	6
Blurred or double vision	6	5	7	12	10
Loss of balance	5	6	7	11	8
Numbness or tingling in the arms or legs	9	6	6	9	5
Confusion	6	6	5	11	2
OTHER SYMPTOMS	--	--	--	--	--
Palpitations or fast heart rate	8	6	7	15	3
Ringing of the ears	6	5	6	9	4

Table 13A. In-Person Survey: Percent of individuals reporting symptoms, by distance from derailment site.

Symptom or Symptom Group	0 to 1500 feet	1501 to 2500 feet	2501 to 3500 feet	3500 to 4500 feet	Over 4500 feet
No symptoms reported	*44*	*37*	*22*	*60*	*77*
HEADACHE	**34**	**38**	**55**	**26**	**16**
EYE SYMPTOMS	**22**	**24**	**40**	**10**	**0**
Irritation/pain/burning of eyes	21	19	38	2	0
Increased eye tearing	12	17	23	10	0
UPPER RESPIRATORY SYMPTOMS	**35**	**40**	**49**	**17**	**8**
Irritation of nose or throat	26	32	44	15	8
Runny nose	19	21	27	2	4
Nosebleed	4	4	0	0	0
INCREASED CONGESTION OR PHLEGM	**18**	**25**	**20**	**2**	**0**
COUGHING	**28**	**35**	**59**	**12**	**4**
LOWER RESPIRATORY SYMPTOMS	**23**	**30**	**46**	**14**	**4**
Difficulty breathing/feeling out of breath	18	20	34	5	0
Chest tightness	10	12	25	2	4
Wheezing in chest	10	13	20	2	0
Irritation of lungs	10	11	22	12	4
GASTROINTESTINAL SYMPTOMS	**16**	**23**	**24**	**0**	**0**
Nausea	14	22	24	0	0
Vomiting	7	11	5	0	0
NEUROLOGICAL SYMPTOMS	**25**	**36**	**41**	**17**	**4**
Dizziness or lightheadedness	14	27	24	5	0
Sleepiness	21	15	20	7	4
Generalized weakness	4	10	8	0	0
Blurred or double vision	4	7	3	5	0
Loss of balance	5	8	3	0	0
Numbness or tingling in the arms or legs	4	10	7	2	0
Confusion	4	6	10	0	0
OTHER SYMPTOMS	--	--	--	--	--
Palpitations or fast heart rate	7	7	13	2	0
Ringing of the ears	2	8	5	2	0

Table 13B. Mailed Survey: Percent of individuals reporting symptoms, by distance of residence from derailment site

Symptom or Symptom Group	0 to 1500 feet	1501 to 2500 feet	2501 to 3500 feet	3500 to 4500 feet	Over 4500 feet
No symptoms reported	*33*	*24*	*29*	*45*	*42*
HEADACHE	**51**	**58**	**51**	**41**	**37**
EYE SYMPTOMS	**40**	**40**	**37**	**30**	**31**
Irritation/pain/burning of eyes	38	36	30	27	28
Increased eye tearing	22	24	27	17	19
UPPER RESPIRATORY SYMPTOMS	**48**	**53**	**47**	**33**	**37**
Irritation of nose or throat	42	45	39	28	33
Runny nose	16	26	29	14	19
Nosebleed	10	9	7	5	6
INCREASED CONGESTION OR PHLEGM	**28**	**26**	**27**	**14**	**21**
COUGHING	**49**	**43**	**42**	**31**	**31**
LOWER RESPIRATORY SYMPTOMS	**39**	**36**	**37**	**26**	**28**
Difficulty breathing/feeling out of breath	33	28	26	20	20
Chest tightness	22	21	21	15	13
Wheezing in chest	20	16	21	12	13
Irritation of lungs	18	19	14	13	15
GASTROINTESTINAL SYMPTOMS	**28**	**32**	**29**	**20**	**22**
Nausea	27	31	27	20	20
Vomiting	9	11	10	6	6
NEUROLOGICAL SYMPTOMS	**50**	**48**	**40**	**29**	**24**
Dizziness or lightheadedness	42	35	29	23	14
Sleepiness	27	29	23	15	13
Generalized weakness	10	12	9	6	6
Blurred or double vision	7	10	10	6	5
Loss of balance	11	7	8	7	5
Numbness or tingling in the arms or legs	15	6	8	4	6
Confusion	10	6	5	5	5
OTHER SYMPTOMS	--	--	--	--	--
Palpitations or fast heart rate	14	9	8	5	5
Ringing of the ears	7	7	5	5	8

Table 14A. In-Person Survey: Individuals provided with medical care.

Individuals Provided with Medical Care	In-Person Survey Number and Percent of Individuals #	%
By an EMT (emergency medical technician or paramedic)		
Yes	10	2
No	423	92
Not reported	26	6
At a hospital		
Yes	40	9
No	394	86
Not reported	25	5
By a doctor or other medical professional, other than by an EMT/ paramedic or at a hospital		
Yes	22	5
No	407	89
Not reported	30	7

Table 14B. Mailed Survey: Households with any individual provided with medical care.

Households with Any Individual Provided with Medical Care	Mailed Survey Number and Percent of Households #	%
By an EMT (emergency medical technician or paramedic)		
Yes	15	3
No	554	96
Not reported	11	2
At a hospital		
Yes	67	12
No	505	87
Not reported	8	1
By a doctor or other medical professional, other than by an EMT/paramedic or at a hospital		
Yes	126	22
No	439	76
Not reported	15	3

Table 14C. Mailed Survey: Percent of households reporting that any individual in household received medical care, by distance from derailment site.

Medical Care Type	Percent of Households				
	0 to 1500 feet	1501 to 2500 feet	2501 to 3500 feet	3500 to 4500 feet	Over 4500 feet
Provided with medical care by an EMT	3	3	3	1	4
Provided with care at a hospital	21	16	13	6	8
Seen by a doctor or other medical professional	36	28	28	7	21

Table 15A. In-Person Survey: Sources of adults' first receipt of information that the derailment and vinyl chloride leak occurred.

First Source of Information about Derailment and Leak	Number and Percent of Adult Individuals	
	#	%
Directly from a person in authority	52	16
TV	52	16
Radio	4	1
Newspaper	0	0
Relative, friend, neighbor, or co-worker	155	48
Reverse 911 telephone call (recorded message)	2	1
Phone call	10	3
Text message on a cell phone	6	2
Email	0	0
Web site	4	1
Other	31	10
Not reported	6	2

Note: Participants were asked to select only one choice.

Table 15B. Mailed Survey: Sources of adults' first receipt of information that the derailment and vinyl chloride leak occurred.

First Source of Information about Derailment and Leak	Number and Percent of Households	
	#	%
Directly from a person in authority	115	20
TV	266	46
Radio	39	7
Newspaper	20	3
Relative, friend, neighbor, or co-worker	251	43
Reverse 911 telephone call (recorded message)	44	8
Text message on a cell phone	31	5
Email	4	<1
Web site	10	2
Other	113	20

Note: Participants could select more than one choice.

Table 16A. In-Person Survey: Source of adults' first receipt of instructions about what to do.

First Source of Instructions about What to Do	Number and Percent of Adult Individuals	
	#	%
Directly from a person in authority	89	28
TV	63	20
Radio	2	1
Newspaper	0	0
Relative, friend, neighbor, or co-worker	50	16
Reverse 911 telephone call (recorded message)	20	6
Phone call	11	3
Text message on a cell phone	2	1
Email	0	0
Web site	7	2
Other	26	8
Not reported	52	16

Note: Participants were asked to select only one choice.

Table 16B. Mailed Survey: Sources of adults' first receipt of information about what to do.

First Source of Information about What to Do	Number and Percent of Households	
	#	%
Directly from a person in authority	110	19
TV	323	56
Radio	27	5
Newspaper	20	3
Relative, friend, neighbor, or co-worker	137	24
Reverse 911 telephone call (recorded message)	109	19
Text message on a cell phone	24	4
Email	5	1
Web site	10	2
Other	73	13

Note: Participants could select more than one choice.

Table 17A. In-Person Survey: Source of adults' continuing receipt of information about the incident.

Continuing Source of Information about the Incident	Number and Percent of Adult Individuals	
	#	%
Directly from a person in authority	51	16
TV	189	59
Radio	19	6
Newspaper	36	11
Relative, friend, neighbor, or co-worker	75	23
Reverse 911 telephone call (recorded message)	36	11
Phone call	41	13
Text message on a cell phone	12	4
Email	10	3
Web site	22	7
Community meeting	54	17
Other	88	27

Note: Participants could select more than one choice.

Table 17B. Mailed Survey: Sources of adults' continuing receipt of information about the incident.

Continuing Source of Information about the Incident	Number and Percent of Households	
	#	%
Directly from a person in authority	79	14
TV	461	80
Radio	46	8
Newspaper	122	21
Relative, friend, neighbor, or co-worker	161	28
Reverse 911 telephone call (recorded message)	161	28
Text message on a cell phone	62	11
Email	22	4
Web site	41	7
Community meeting	59	10
Other	58	10

Note: Participants could select more than one choice.

Table 18A. In-Person Survey: Perceived best source of adults' continuing receipt of information about future incidents.

Best Source of Information about Future Incidents	Number and Percent of Adult Individuals	
	#	%
Official going door to door	163	51
TV	99	31
Radio	21	7
Newspaper	12	4
Phone call	187	58
Text message on a cell phone	57	18
Email	16	5
Web site	24	7
Community meeting	9	3
Other	103	32

Note: Participants could select more than one choice.

Table 18B. Mailed Survey: Perceived best sources of adults' continuing receipt of information about future incidents.

Best Source of Information about Future Incidents	Number and Percent of Households	
	#	%
Directly from a person in authority	368	63
TV	245	42
Radio	84	14
Newspaper	76	13
Relative, friend, neighbor, or co-worker	37	6
Reverse 911 telephone call (recorded message)	276	48
Text message on a cell phone	170	29
Email	84	14
Web site	69	12
Community meeting	91	16
Other	80	14

Note: Participants could select more than one choice.

Figure 1. Areas of Paulsboro evacuated following the train derailment and vinyl chloride leak of November 30, 2012. The area outlined in yellow includes blocks evacuated on November 30 and December 4.

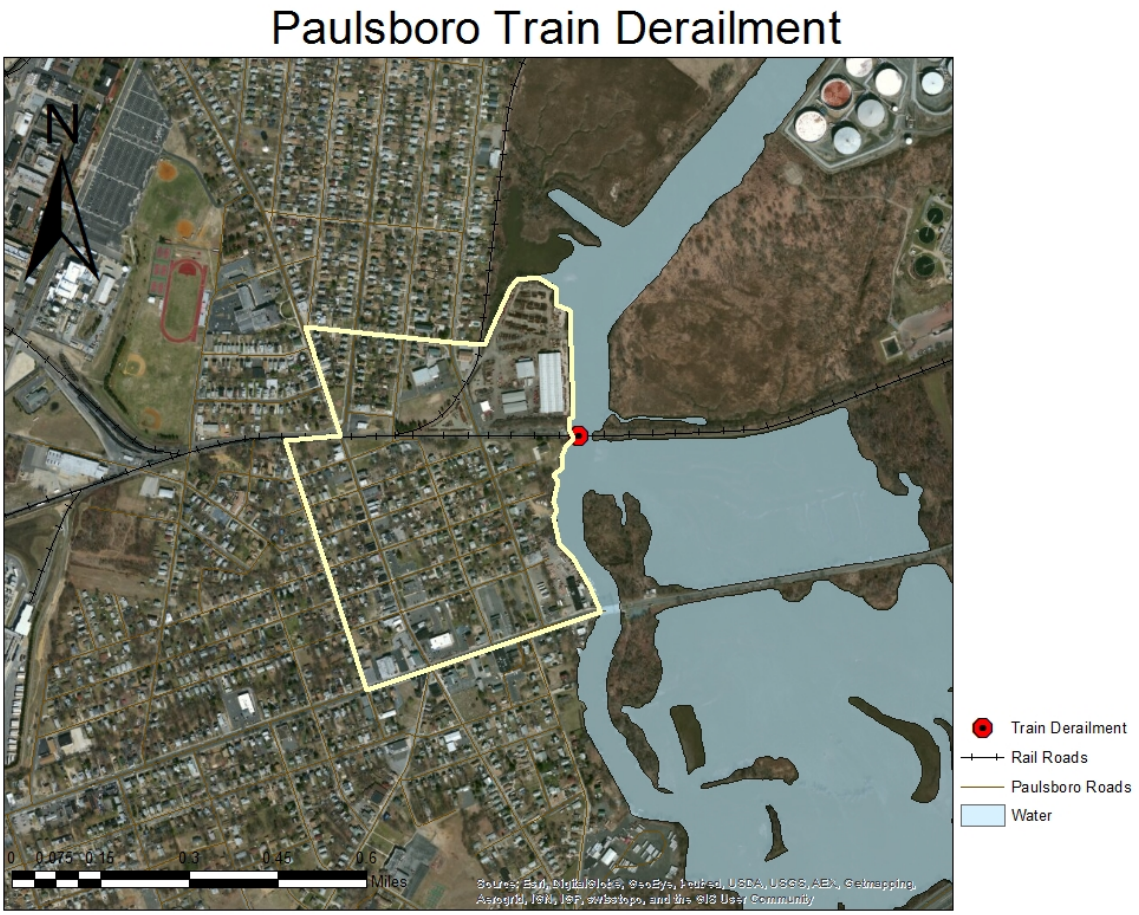
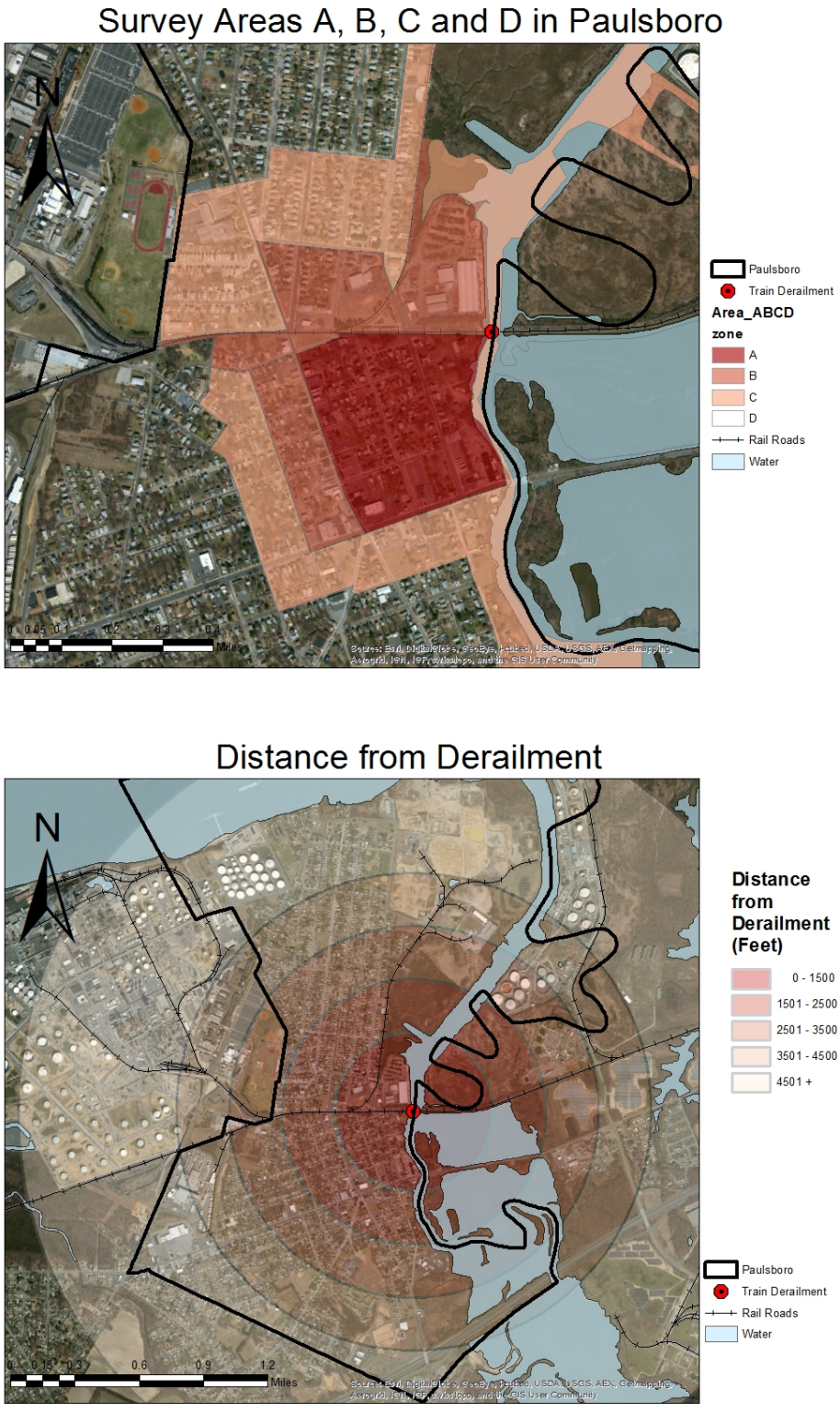


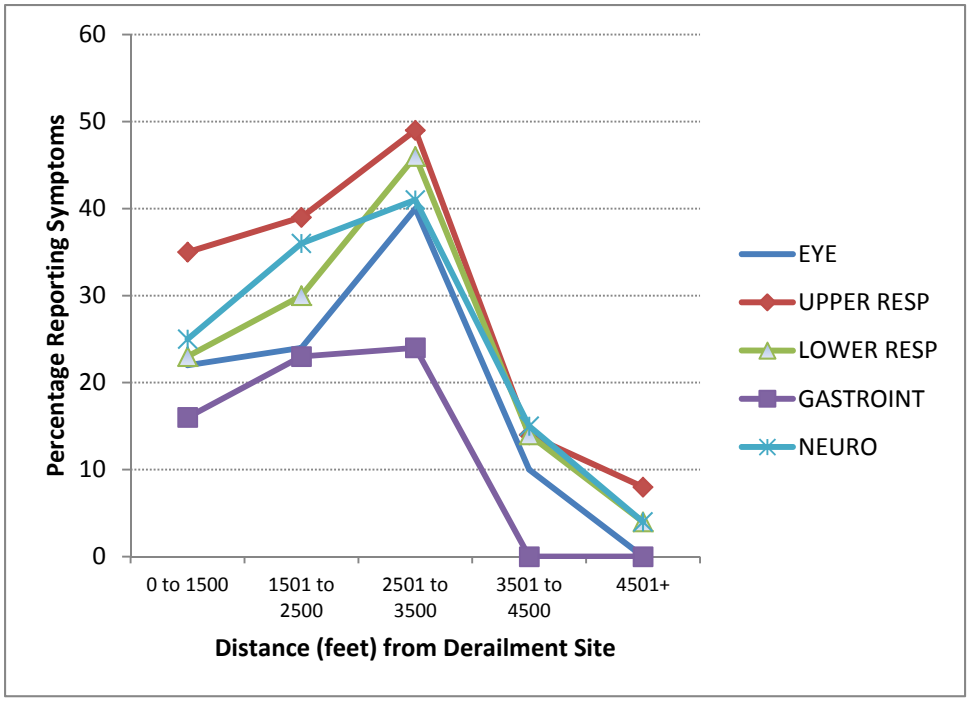
Figure 2. Maps of Paulsboro showing Survey Areas A through D, and distance in feet from the train derailment location.



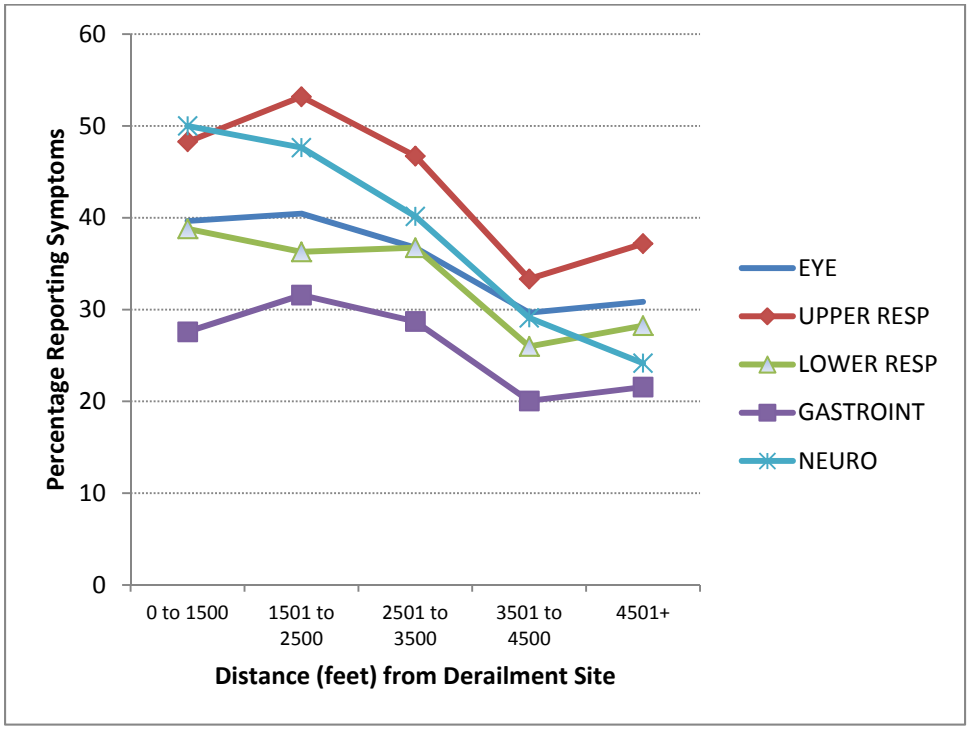
Figures 3A to 3G. Percentages of individuals reporting symptoms, by distance of household address to derailment site, for In-Person Survey and Mailed Survey.

3A – SYMPTOM GROUPINGS

In-Person Survey

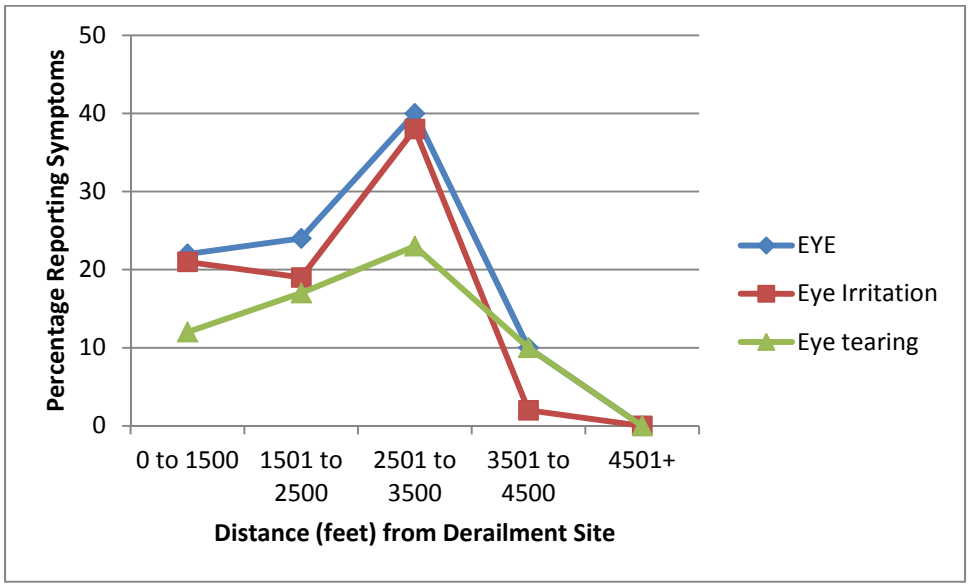


Mailed Survey

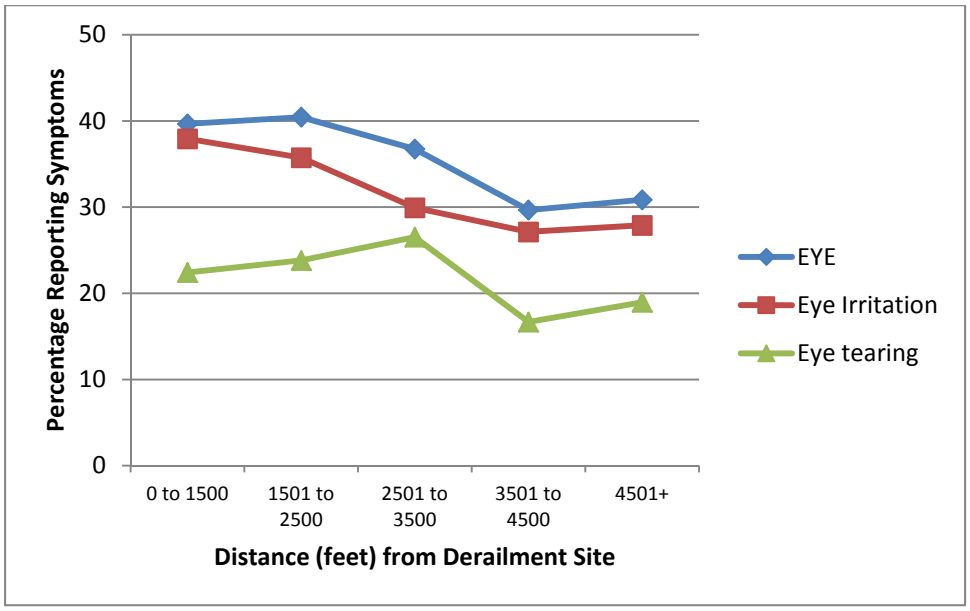


3B - EYE SYMPTOMS

In-Person Survey

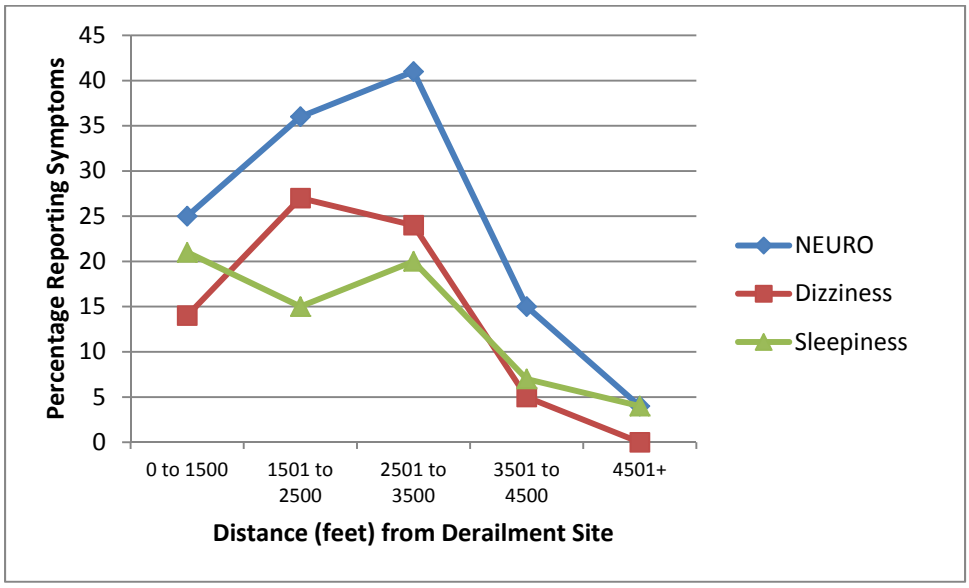


Mailed Survey

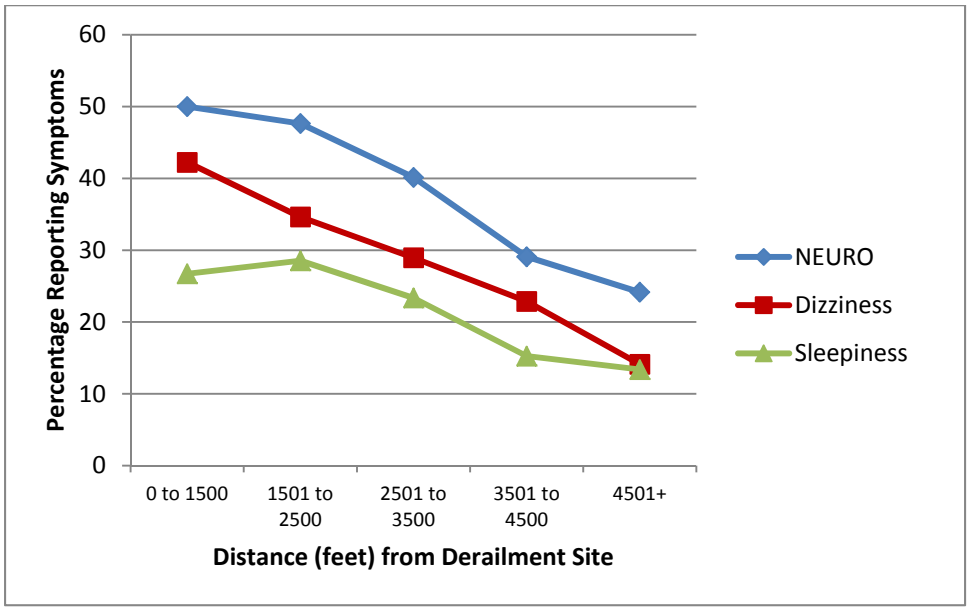


3C - NEUROLOGICAL SYMPTOMS (NEURO)

In-Person Survey



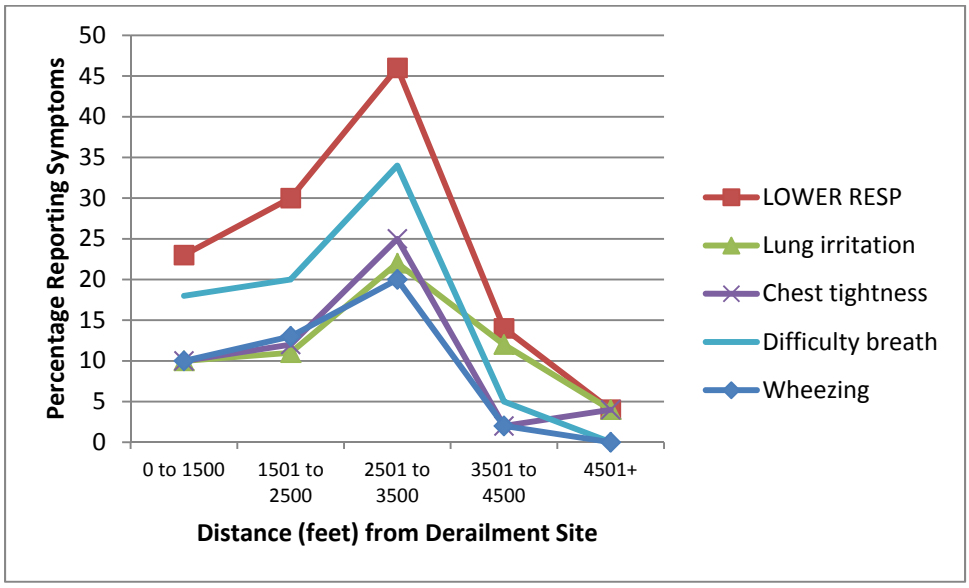
Mailed Survey



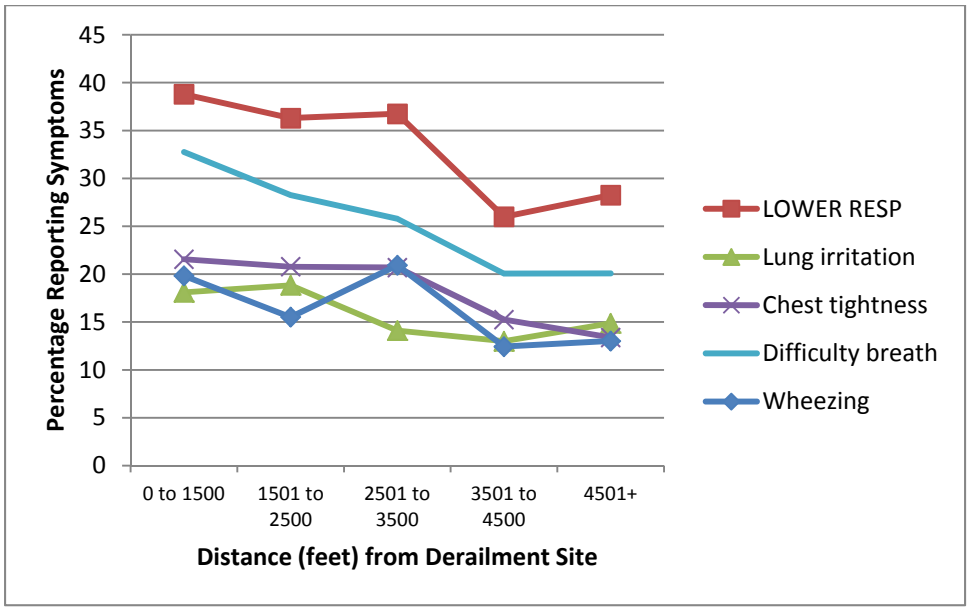
Note: less frequent neurological symptom frequencies are not shown.

3D - LOWER RESPIRATORY SYMPTOMS (LOWER RESP)

In-Person Survey

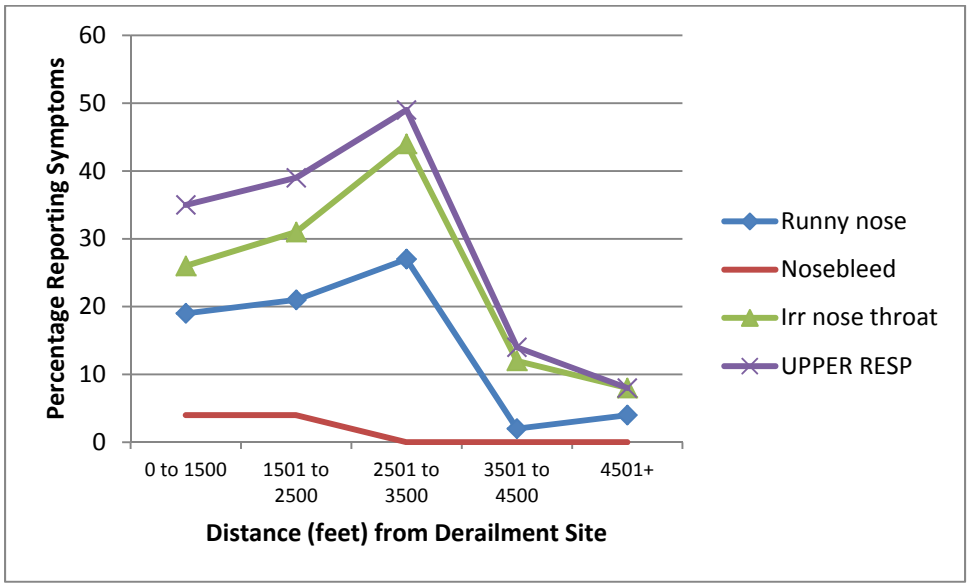


Mailed Survey

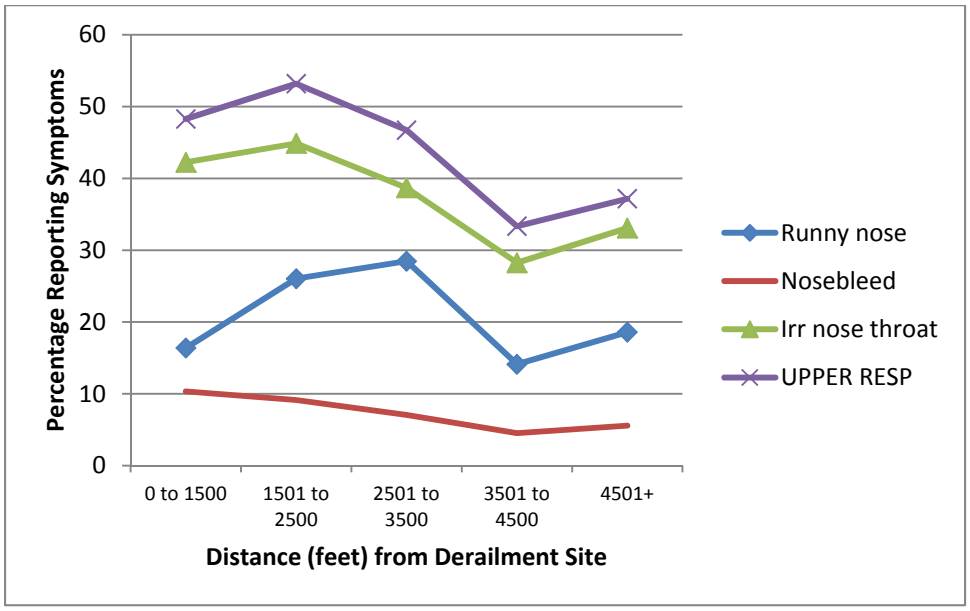


3E - UPPER RESPIRATORY SYMPTOMS (UPPER RESP)

In-Person Survey

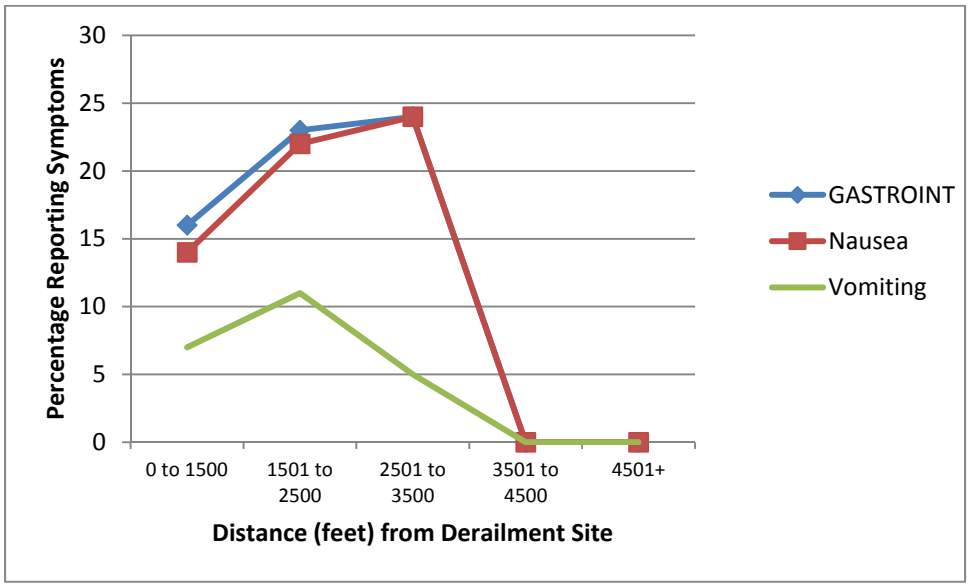


Mailed Survey

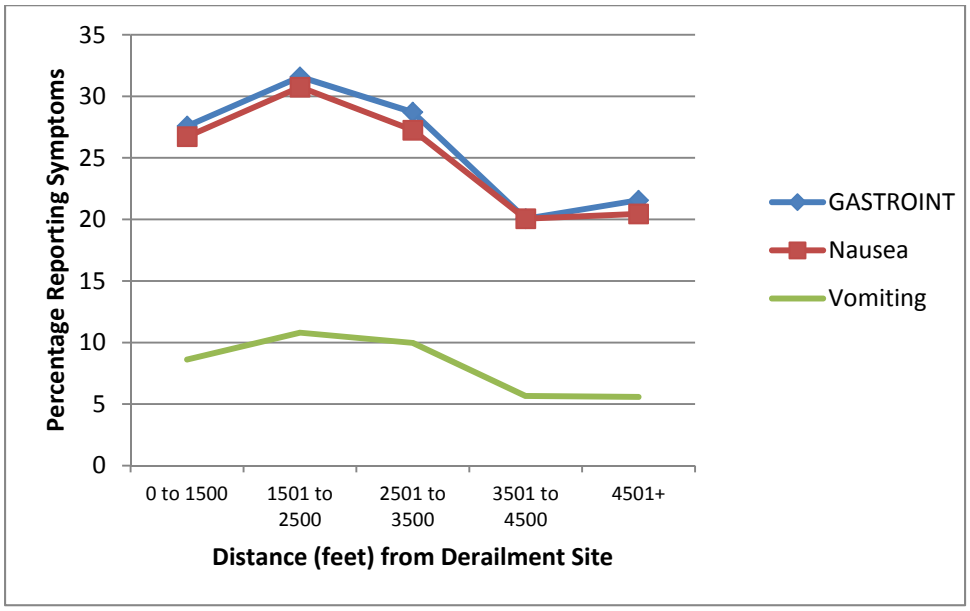


3F - GASTROINTESTINAL SYMPTOMS (GASTROINT)

In-Person Survey

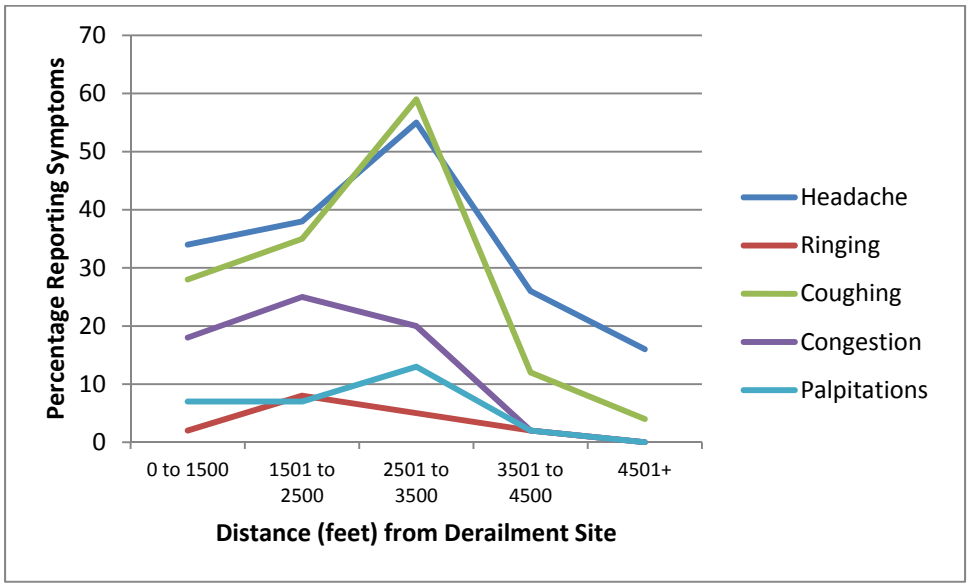


Mailed Survey



3G - UNGROUPED SYMPTOMS

In-Person Survey



Mailed Survey