Health Consultation

PUBLIC COMMENT VERSION

GMH ELECTRONICS NPL SITE
ROXBORO, PERSON COUNTY, NORTH CAROLINA

EPA FACILITY ID: NCN000410161

Prepared by
North Carolina Department of Health

December 15, 2010

COMMENT PERIOD ENDS: FEBRUARY 15, 2011

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

PUBLIC COMMENT RELEASE

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EPA FACILITY ID: NCN000410161

Prepared By:

North Carolina Health and Human Services
Division of Public Health
Occupational and Environmental Epidemiology Branch
Under Cooperative Agreement with
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry (ATSDR)

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Acronyms

AF	Attenuation factor
AT	Averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Center for Disease Control and Prevention
CF	Conversion factor
cm	Centimeter
CREG	ATSDR Cancer Risk Evaluation Guide
CR	Contact rate
CV	Comparison Value
DAF	Dermal absorption efficiency
DPH	N.C. DHHS Division of Public Health
DWM	N.C. DENR Division of Waste Management
DWQ	N.C. DENR Division of Water Quality
ED	Exposure duration
EF	Exposure frequency
EMEG	ATSDR Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
HG	Health Guideline value
IRi	Inhalation rate
IUR	Inhalation Unit Risk factor
Kg	Kilogram
L	Liter
LOAEL	Lowest Observed Adverse Effect Level
MCLG	EPA Maximum Contaminant Level Goal
MCL	EPA Maximum Contaminant Level
M	Meter
mg	milligram
$\mu g/m^3$	micro-gram per cubic meter
µg	microgram
ng	nano-gram
NA	Not applicable
NC DENR	North Carolina Department of the Environment and Natural Resources
NC DHHS	North Carolina Department of Health and Human Services
NIOSH	National Institute for Occupational Safety and Health
NOAEL	No Observed Adverse Effect Level
ppm	Parts per million
ppb	Parts per billion
RfC	Reference Concentration
RfD	Reference Dose
SVOC	Semi-volatile organic compound
VOC	Volatile organic compound

*** These acronyms may or may not be used in this report**

SUMMARY

INTRODUCTION	The NC Division of Public Health (DPH) understands the community's concerns about potential exposure to chemicals from the GMH Electronics NPL site. GMH Electronics manufactured electronic components at the site from 1972 to 2004. Chlorinated solvents were disposed of in the on-site septic system. The chlorinated solvents along with gasoline from leaking underground storage tanks contaminated the groundwater. The EPA and NC Department of Environment and Natural Resources (DENR) performed sampling of groundwater, surface water, and soil gas in 2008. Bottled water or carbon filtration units were provided to residents with contaminant levels above EPA's maximum contaminant level (MCL). NC DPH evaluated the data in a health consultation that was released in September 2008. EPA collected additional private well drinking water samples in November and December 2008. The intent of the sampling was to determine the extent of contamination in private drinking water wells. NC DPH evaluated the new drinking water data as part of this health consultation.
CONCLUSION 1	**The NC DPH concludes that drinking or inhalation of 1, 1-dichloroethylene in the drinking water is not expected to harm people's health.**
Basis for decision	Residents with the highest concentrations of contaminants in the drinking water were provided alternate sources of clean drinking water. The dose calculated from the highest concentration of consumed water (post filtration system) was far below the level that could harm people's health. However, the prolonged consumption of unfiltered drinking water at locations without carbon filtration systems could harm people's health. The highest concentration of 1, 1-dichloroethylene post-filtration system was used to calculate the inhalation exposure while showering. The 1, 1-dichoroethylene exposure was less than the level that could harm people's health.

Conclusion 2	**The NC DPH concludes that drinking or inhalation of benzene in the drinking water is not expected to harm people's health.**
Basis for decision	The peak benzene concentration occurred at a residence that was previously provided bottled water. The exposure dose was calculated based on the highest concentration of benzene measured even though bottled water was provided. The dose was less than the level that could harm people's health. The peak well water concentration was used to calculate inhalation exposure from showering. The calculated exposure was significantly less than the level that could harm people's health.
Conclusion 3	**The NC DPH concludes drinking of (or inhalation of contaminants from) private well water that is contaminated with 1,2-dichloroethane, benzene, carbon tetrachloride, 1,4-dioxane, methylene chloride, and 1,1,2-trichloroethane are not expected harm people's health.**
Basis for decision	The number of theoretical cancer cases is less than 100 additional cancers in 1 million exposed. The number of additional cancers calculated based on 30 years consumption of the highest (pre-filter) concentration of a contaminant ranged from 2 to 40 cancers per million people exposed. The number of additional cancers calculated based on 30 years inhalation of the highest concentration of a contaminant ranged from 2 to 48 cancers per million people exposed. If the highest concentration measured post filtration system was used in the calculation, the number of additional cancers calculated for inhalation or ingestion was reduced significantly.
Next steps	The NC DPH recommends that the activated carbon filtration systems be maintained to prevent any contaminant breakthrough until the residents are connected to the municipal drinking water system.
Information	If you have concerns about your health as it relates to this site you should contact your health care provider. You can also call the NC Division of Public Health at (919) 707-5900, or send an e-mail to nchace@dhhs.nc.gov, and ask for information on the GMH Electronics NPL Site Health Consultation.

PURPOSE AND HEALTH ISSUES

The GMH Electronics NPL Site (EPA ID: NCN000410161) is located at 1800 Virgilina Road near Roxboro, North Carolina. The former GMH Electronics facility consists of a single 8,000 square foot brick structure on a 0.455-acre parcel of land. The building is currently occupied by an automotive repair shop. The contaminated groundwater area (plume) extends approximately three-quarters of a mile beyond the boundary of the property. Both owner occupied and rental residential properties are located within the contaminated groundwater plume.

NC Department of Environment and Natural Resources (NC DENR) requested a health consultation for the site after an initial survey determined there was potential for exposure to 1,1-dichloroethene (DCE) at the site. The NC Division of Public Health (DPH), Health Assessment, Consultation and Education program (HACE) evaluated sampling data that was collected by U.S. Environmental Protection Agency (EPA) and NC DENR. The data included private well water samples, soil vapor, and sub-slab vapor surveys. The initial health consultation was released in September 2008. The report concluded the site is considered to be no apparent public health hazard contingent on the continued use of the water filtration systems.

EPA performed a Focused Remedial Investigation of the site in October and November of 2008. Samples were collected from private well locations within one half to three-quarters of a mile of the site. The objective of the sampling was to determine the extent of groundwater contamination in private wells and to evaluate the potential impact on human health. The Agency for Toxic Substances and Disease Registry (ATSDR) requested that NC HACE evaluate the additional private well water sampling data because the site was added to the proposed list of National Priorities List (NPL) sites. This document presents the findings of the follow-up Health Consultation.

The objective of this Health Consultation is to determine if the site presents a potential health hazard to the community. An important component of an Health Consultation is the determination of a person's potential to come into contact with any potentially harmful substances, how that contact may occur, and for how long that contact may have continued in the past, or may occur in the future. This information is used to determine whether past, current, or future contact with the substances may result in adverse health effects. Highly health protective methods are used throughout the evaluation process. The information reviewed for the Health Consultation was taken from reports and analytical data generated by EPA and their contractors.

BACKGROUND

SITE DESCRIPTION AND HISTORY

GMH Electronics began operations in 1972 and ceased operations in 2004. During this time, GMH Electronics produced electronic components such as printed circuit boards. GMH Electronics used chlorinated solvents as part of its parts washing operations. The wash water was apparently discharged to an on-site septic system without proper treatment.

Prior to GMH Electronics operations, the property was used as a store and gasoline station. In the mid-1980s, two 4,000-gallon underground gasoline storage tanks were removed from the property. Two 550-gallon underground gasoline tanks were also removed from a second former gas station located across the intersection.

In 1987, the NC DENR Groundwater Section received a complaint that gasoline was contaminating the well water at a nearby private residence. Sampling of the well indicated the presence of 1,2-dichlorethane (DCA), benzene, toluene, 1,1,1-trichloroethane (TCA), and other volatile organic compounds. The contaminated well prompted the state to recommend avoiding drinking, cooking and prolonged bathing in the well water. A carbon filter system was installed at the contaminated residential well. Additional sampling was performed in 1990 and the results indicated that a volatile organic compound (VOC) plume generated by GMH Electronics' operations was co-mingled with petroleum hydrocarbons that leaked from one or both former gas stations.

In 1992, the Person County Health Department conducted sampling of residential drinking water wells in the area. This sampling event revealed the existence of VOC contamination in several private drinking water wells near the site. NC DENR recommended that residents of two houses not consume water from their impacted wells due to potential health risks.

In November 2007 following a citizen complaint, additional sampling was conducted in the area surrounding the former GMH facility by the Person County Health Department. The results of this sampling effort indicated VOC contamination in several of the private drinking water wells near the site. One contaminant, 1,1-dichloroethene (DCE) was measured at a concentration in excess of 6,000 parts per billion (ppb). Based on these results, NC DENR Superfund program requested that EPA Region 4 Emergency Response and Removal Branch provide emergency drinking water to residents with contaminated wells.

In December 2007, EPA Region 4 Emergency Response and Removal Branch expanded the scope of sampling to more than 30 residential wells surrounding the former gas station and the GMH Electronics property. The contaminants detected included 1,1,1 -trichloroethane, 1,1-dichloroethene, carbon tetrachloride, 1,2-dichloroethane, and benzene. Based on the sampling results, 17 homes were supplied bottled water and five homes had carbon filters installed on their wells by EPA. Additional filter systems were installed at two residences adjacent to the site by NC DENR.

In February 2008, representatives of the NC DENR Superfund program and EPA collected samples of surface water, groundwater, and soil gas. The purpose of this investigation was to verify the source of contamination and to determine if vapor intrusion was a health threat to nearby residents. EPA determined that although contaminants were present, vapor intrusion did not pose an immediate threat to human health.

In September 2008, ATSDR released a health consultation (HC) of the site performed by NC HACE. The HC included an analysis of all sampling data that was collected prior to June 2008. The report concluded there was no apparent public (non-cancer) health hazard exposures for people who drank contaminated well water. An increased risk of cancer was calculated for people exposed to benzene and carbon tetrachloride in the well water.

In October and November 2008, EPA conducted a Focused Remedial Investigation on the area surrounding the site. In this investigation, eighty-nine residential wells located in the vicinity of the site were sampled for VOCs. Contamination was detected in 45 of the 89 wells. Concentrations exceeded EPA's Maximum Contaminant Levels (MCL) in 17 of the drinking water wells. EPA provided bottled water to homes with contamination levels above the MCL and replaced the filters on the filtration systems maintained by EPA.

In April 2009, EPA signed an interim Record of Decision to extend water lines to the area impacted by the site. EPA proposed that the site be added to the National Priorities List (NPL) sites.

In September 2009, GMH was added to the list of Final NPL sites.

CURRENT SITE CONDITIONS

EPA is providing bottled drinking water to 10 residences where contamination levels are above the MCL until a permanent solution is in place. In addition, EPA and DENR have installed carbon filtration systems on 7 residential homes with high levels of contamination. In September 2009, NC DENR installed one additional filtration system at a location that was previously provided bottled water.

In April 2009, EPA proposed that the site be added to the National Priorities List. Recovery Act funding was allocated to this site to extend the existing City of Roxboro's municipal drinking water line to the area affected by the contamination. Approximately 50 residences that have contamination attributable to the site in their private drinking water wells, or are located within a 500-foot buffer area of the contaminated ground water plume, will be offered a connection to this public water supply.

On-site construction of the waterline began on November 30, 2009. Construction of the waterline is anticipated to be completed by October 2010.

DEMOGRAPHICS

According to Census 2000 figures, 1080 persons live within one mile of the site. Approximately 53% of the population is White, 43.6% African-American, 0.3% Hispanic and 2.8% Multi-racial. The percent minority population is higher than Person County or

North Carolina. Approximately 8.4% of the population is children 5 years old or younger and 28% is 17 years old or younger. The poverty level is 18.2%, which is higher than the county or state. Fifteen percent (15%) of the population has less than a 9th grade education. There are approximately 457 housing units in the area. The percentage of renter occupied housing units is 38.6% (EnviroMapper).

SITE GEOLOGY AND HYDROGEOLOGY

The site is located in the Carolina Slate Belt. Soil at the site is characterized as Appling sandy loam. It typically consists of a surface layer of brown sandy loam with a subsurface layer of yellow/brown sandy loam, clay, and clay-loam. The layer of clay-rich weathered rock in the area is thin and bedrock outcrops are visible. The soil typically has a depth to bedrock of more than 60 inches.

Groundwater wells near the site are generally bored into the bedrock because the overburden layer does not provide adequate water capacity for a bored well. Depths of wells in the area typically range from 30 to 150 feet.

SITE VISIT

The NC HACE visited the site on April 22, 2010 and met with a representative of the Person County Health Department. Construction of the municipal water line was well under way. Residential properties are located adjacent to the former GMH site. A number of rental properties are dispersed among owner occupied residences in the area. Photographs of the site are included in Appendix B.

DISCUSSION

Review of Site Environmental Data

EPA performed a Focused Remedial Investigation of the site in October and November 2008. The intent of the investigation was to identify the number of residential drinking water wells contaminated by the site. All wells within one-half to three quarters of a mile of the GMH Electronics site were identified and sampled. Pre-filtration and post-filtration samples were collected from the seven residences with carbon filtration systems.

A total of 17 drinking water wells were contaminated with at least one chemical at concentrations above EPA's Maximum Contaminant Level (MCL). The MCLs are treated as guidelines rather than regulatory limits for private wells. However, all 17 locations were previously provided bottled water or carbon filtration systems. Pre- and post-filter samples were collected at locations with carbon filtration systems to verify chemicals were captured by the filtration system. Seven compounds, 1,2-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichlorethane, benzene, 1,4-dioxane, carbon tetrachloride, and 1,1,2-trichloroethane were measured at concentrations above the ATSDR comparison value. A summary of the drinking well water data is included in Appendix D.

Locations Provided Filtration Systems
The pre-filter samples at locations with carbon filtration systems typically had the highest number and concentration of contaminants. As many as 15 contaminants were identified at several pre-filter sampling locations. Four chemicals were present at concentrations above their respective screening value at one of the pre-filter sampling locations. The number of contaminants detected at post filter sampling locations ranged from none detected to as many as 7 chemicals at one location. Two post filter drinking water sample locations had at least one contaminant above the ATSDR screening value (See Appendix D).

Locations Provided Bottled Water
The number of contaminants detected at locations provided bottled water typically ranged from 3 to 5 chemicals. However, 10 contaminants were identified at one location close to the former GMH Electronics site. Most locations that were provided bottled water had a single contaminant above the ATSDR screening value.

Locations Drinking Private Well Water
No contaminants were detected in 40 of the private drinking wells tested. Low levels of contaminants were measured in the remaining wells. The contaminant most frequently detected in these wells was chloroform or methyl tertiary butyl ether (MTBE). None of the locations that were currently drinking private well water had contaminants above the ATSDR screening value.

A brief description of the contamination follows. Additional details on contaminants may be found in Table 2 and Appendix D.

1,1-Dichoroethylene (1,1-DCE)
1,1-Dichloroethylene exceeded EPA's MCL (7 ppb) at 6 pre-filter sampling locations. Some breakthrough occurred and 1,1-dichloroethylene levels exceeded the MCL on post-filter samples at 3 locations. It was also measured at levels that exceed the MCL at 8 residences without filtration systems. These 8 homes were provided bottled drinking water. EPA's MCL is lower than ATSDR's screening value (90 ppb child) for 1, 1-dichloroethylene. ATSDR's screening value was exceeded in 7 sampling locations.

1, 2-Dichloroethane (1,2- DCA)
Contaminant levels of 1,2-dichloroethane were measured above EPA's MCL (5ppb) at 6 pre-filter sampling locations and 3 locations without filtration systems. The ATSDR cancer screening value (0.4 ppb) for 1,2-dichlorethane is lower than EPA's MCL. Contaminant levels exceeded the ATSDR cancer screening value at 6 pre-filter locations, 1-post filter location, and 5 residences that were provided bottled water. ATSDR's non-cancer screening value is 2,000 ppb and was not exceeded at any of the sample locations.

1, 1-Dichloroethane (1, 1- DCA)
1,1-Dichloroethane was detected in 23 private well water samples. There is not a MCL or ATSDR screening value for 1,1-dichloroethane. However, EPA does have a Regional Screening Value (12 ppb) for drinking water. The Regional Screening Level (RSL) was

exceeded in 5 pre-filtration system samples. The post-filtration system samples or locations without filtration systems did not exceed the RSL.

Benzene

Benzene was detected at values above the MCL (5 ppb) at one residence. The ATSDR cancer screening value (0.6 ppb) is lower than EPA's MCL. Benzene levels exceeded the ATSDR screening value at 3 additional locations. One location exceeded the non-cancer screening value of 5 ppb. All 4 locations used filtration systems or were provided bottled drinking water.

1,1,1-Trichloroethane

Contaminant levels of 1,1,1-trichloroethane were measured above the MCL at 3 locations. EPA's MCL and ATSDR's screening value are the same (200 ppb) for 1,1,1-trichloroethane. The 3 samples with concentrations above ATSDR's screening value were collected prior to the filtration units.

1,4-Dioxane

EPA collected and analyzed drinking water samples for 1,4-dioxane at ten locations. The locations were selected because of the presence of 1,1,1-trichloroethane in the drinking water samples. 1,4-Dioxane has been used as a catalyst in the 1,1,1,-trichloroethane manufacturing process and can be present as an impurity in solutions containing 1,1,1-trichloroethane. 1,4-Dioxane was detected in 3 pre-filter samples and one post-filter sample at a concentration above ATSDR's screening value (3 ppb). It was not detected at locations without filtration systems.

Carbon tetrachloride

Carbon tetrachloride levels did not exceed EPA's MCL of 5 ppb. Levels did exceed ATSDR screening value (0.3 ppb) at 2 pre-filter sample locations. It did not exceed the screening value in the post-filter sample.

1,1,2-Trichloroethane

Concentrations of 1,1,2-trichloroethane did not exceed EPA's MCL (5 ppb) in any of the samples collected. Concentrations did exceed the ATSDR screening value (0.6 ppb) at 5 locations. All 5 samples were pre-filter drinking water samples. It was not detected in the post-filtration samples.

Methylene chloride

Methylene chloride was detected in 5 pre-filter and 1 post-filter samples. None of the samples exceeded ATSDR's screening value for drinking water. The calculated air concentration for showering did exceed ATSDR's cancer screening value for the post filtration system sample.

Chloroform

Chloroform was detected in 26 drinking water samples. It did not exceed ATSDR's screening value for drinking water at any of the sample locations. However, ATSDR's cancer screening value for air (0.4 ug/m^3) was exceeded when a peak shower concentration was calculated. ATSDR's non-cancer screening value for air (100 ug/m^3) was not exceeded at any of the sample locations.

Table 1: Groundwater Data (October-December 2008) and Comparison Values

Contaminant	Highest Conc. ug/L	Number of Detections	Samples > CV	Screening Value ug/L	CV Source
1,2-Dichloroethane	37[1]	21	12	0.4	CREG[3]
1,1-Dichloroethane	50[1]	23	5	12	EPA RSL[4]
1,1-Dichloroethylene	3100[1]	21	8 (child) 5 (adult)	90 child 300 adult	Chronic EMEG[5]
1,1,1-Trichloroethane	900[1]	22	3	200	LTHA[6]
1,4-Dioxane	38[1]	6	5	3	CREG
Carbon tetrachloride	2.9[1]	3	2	0.3	CREG
1,1,2-trichloroethane	1.9[1]	6	5	0.6 3	CREG LTHA
Benzene	61[2]	10	4	0.6	CREG
Benzene	61[2]	10	1 (child) 1 (adult)	5 child 20 adult	Chronic EMEG

[1] Sample was collected prior to filtration system
[2] No filtration system was present
[3] Cancer risk evaluation guide
[4] EPA Regional screening level
[5] Chronic environmental media evaluation guide
[6] Lifetime health advisory for drinking water

Exposure Pathway Analysis

An exposure to a chemical and the possibility of adverse health effects requires persons to come into contact with the chemical through:

- ingestion (eating or drinking the chemical),
- inhalation (breathing the chemical), or
- dermal (absorbing the chemical through the skin)

Having contact with a chemical does not necessarily result in adverse health effects. A chemical's ability to result in harmful health effects is influenced by a number of factors in the exposure situation, including:

- how much of the chemical a person is exposed to (the dose)
- how long a time period a person is exposed to the chemical (the duration)
- how often the person is exposed (the frequency)
- the amount and type of damage the chemical can cause in the body (the toxicity of the chemical)

To result in adverse health effects, the chemical must be present at concentrations high enough and for long enough to cause harm. Exposures at concentrations or time periods less than these levels do not cause adverse health effects. Knowing or estimating the frequency with which people have contact with hazardous substances is essential to assessing the public health importance of these contaminants.

Responses of persons to potentially harmful substances may vary with the individual or particular groups of individuals, such as children, the elderly, or persons with weakened immune responses, or other chronic health issues. These susceptible populations may have different or enhanced responses to toxic chemicals. Reasons for these differences may include:

- genetic makeup
- age
- health status
- nutritional status
- exposure to other toxic substances (like cigarette smoke or alcohol)

These factors may limit that person's ability to eliminate the harmful chemicals from their body or may increase the effects of damage to their organs and systems. Child-specific exposure situations and susceptibilities are also considered in DPH's health evaluations.

The exposure pathway (how people may come into contact with substances contaminating their environment) is evaluated to determine if people have come into contact with site contaminants, or if they may in the future. A **completed exposure pathway** is one that contains the following elements:

- a **source** of chemical of concern (contamination), such as a hazardous waste site or contaminated industrial site,
- movement **(transport)** of the contaminant through **environmental media** such as air, water, or soil,
- an **point of exposure** where people come in contact with a contaminated medium, such as drinking water, soil in a garden, or in the air,
- a **route of exposure**, or how people come into contact with the chemical, such as drinking contaminated well water, eating contaminated soil on homegrown vegetables, or inhaling contaminated air, and
- an **exposed population** of persons that can come into contact with the contaminants

The elements of an exposure pathway may change over time, so the time frame of potential exposure (contact) is also considered. Exposure may have happened in the past, may be taking place at the present time, or may occur in the future. A completed pathway is one in which all five pathway components exist in the selected time frame (the past, present, or future). If one of the five elements is not present, it is considered an **incomplete exposure pathway**. The length of the exposure period, the concentration of the contaminants at the time of exposure, and the route of exposure (skin contact, ingestion, and inhalation), are all critical elements considered in defining a particular exposure event.

Completed Exposure Pathways

The population of concern for this site is people living near the former GMH Electronics site and using private drinking water wells. The possible exposure routes investigated are ingestion and inhalation. Absorption of well water contaminants through the skin is possible but generally considered minor when compared to ingestion or inhalation. The exposure pathway was considered complete for ingestion and inhalation because chemicals were detected in 49 individual wells. The exposure pathway was complete for past and current exposure scenarios. The conversion to municipal water will eliminate the point of exposure for the future.

Table 2. Completed Exposure Pathways

Source	Medium	Exposure point	Exposure Route	Exposed population	Time Frame
Ground-water	Contaminated groundwater	Private well water	Drinking Inhalation	People with contaminated well water	Past Current

The highest concentration detected for each contaminant was used in the data analysis. As previously discussed, these locations were previously provided filtration systems or bottled water. Calculating the exposure doses using the highest concentration assures the most health protective values are considered.

Contaminant levels above EPA's Maximum Contaminant Level (MCL) and ATSDR's screening value were measured in post filter samples. The highest concentration of a contaminant in "consumed water" was also used in calculations if the value exceeded ATSDR's screening value.

Summary of Environmental Exposure Potential at the Site

NC DPH reviewed site conditions and environmental analytical data generated by EPA since the previous ATSDR Health Consultation was published in September 2008. EPA performed additional private drinking well water sampling in October/November 2008. The exposure pathways for the ingestion of the drinking water and inhalation of contaminants generated during showering were evaluated in this Health Consultation and considered complete. The previous Health Consultation evaluated sampling data for surface water, soil, soil gas, and vapor intrusion. The exposure pathways were not considered complete in the previous Health Consultation. No new sampling was performed for these media so the pathways were not re-evaluated.

EPA provided filtration systems or alternate sources of drinking water to residents with contamination above the MCL. ATSDR screening values are lower than EPA's MCL for some compounds. Contaminants were detected above the MCL and ATSDR screening values in some post filter drinking water samples. Chemicals were also detected in private well drinking water samples at homes without filtration systems.

Potential exposure can also occur when volatile chemicals are released from shower water inside the home during showering and bathing. To be health protective, the highest groundwater concentration was used to estimate shower exposures. Estimates of the maximum airborne concentrations were compared to screening values, an inhalation dose calculated, and the dose compared to ATSDR's Minimal Risk Levels (MRL).

Public Health Implications

Ingestion
The highest level for each contaminant from the private drinking water well samples was compared to ATSDR Comparison Values. Contaminant concentrations below the Comparison Value were dropped from further consideration. The highest value was selected to be health protective even though it was often a pre-filter location. Contaminant breakthrough can occur with carbon filtration systems and if it occurs it results in exposure. Breakthrough did occur with some of these systems. It is not possible to know peak breakthrough concentrations so the highest pre-filter value was used for screening.

Seven chemicals (See Table 2) exceeded the ATSDR Comparison Value and were carried forward to the second step of the screening process. If no ATSDR Comparison Values (CV) existed for a contaminant, alternate screening values were used in the initial screening process. No ATSDR CV exists for 1,1-dichloroethane but the highest measured concentration exceeded EPA's screening value so it was also carried forward for more detailed analysis.

The second step of the screening process is the calculation of a site specific dose using the highest concentration and standard assumptions on body size and water intake rates. The standard assumptions used by ATSDR are:

- children between the ages of 1 and 6 drink 1 liter of water a day
- children weigh an average of 16 kilograms
- Adults ingest an average of 2 liters of water per day
- Adults weigh an average of 70 kilograms

An exposure dose (expressed as milligrams of a chemical per kilogram of body weight per day) was calculated for each of the chemicals using the highest concentration identified from the well water sampling data. The exposure levels were compared with ATSDR Minimal Risk Levels (MRL) to determine whether further toxicological evaluation is needed. MRLs are estimates of daily exposure below which non-cancerous adverse health effects are unlikely to occur. The exposure dose and health guidelines for the 5 contaminants that exceeded the non-cancer screening value are listed in Table 3.

Table 3: Exposure Dose Via Ingestion-contaminants Exceeding Non-Cancer CV

Contaminant	Highest Concentration ug/L[1]	Calculated dose mg/kg/day[2]		MRL[3] mg/kg/day
		Child	Adult	
1,1-Dichloroethane	50	0.003	0.001	0.2[4]
1,1-Dichloroethylene	3100	0.19	0.09	0.009
1,1,1-Trichloroethane	900	0.06	0.026	20
1,1,2-Trichloroethane	1.9	0.0001	0.0001	0.04
Benzene	61	0.0038	0.0017	0.0005

Shaded areas denote calculated dose exceeds the MRL
[1] microgram per liter
[2] milligram per kilogram per day
[3] Minimum Risk Level (ATSDR)
[4] EPA Regional Screening Level. No MRL exists.

The calculated dose exceeded the MRL for 1,1-dichloroethylene (DCE) and benzene. The maximum concentration for 1,1-dichloroethylene was from a pre-filter location. The calculated child dose was 21 times the MRL and the calculated adult dose was 10 times the MRL. One post-filter drinking water sample (97 ug/L) exceeded the screening value for 1,1-dichloroethylene (See Appendix D). The calculated dose (child 0.006/adult 0.003 mg/kg/day) for this post-filter drinking water sample did not exceed the MRL (0.009 mg/kg/day) for the post-filter drinking water sample.

The highest concentration for benzene was measured at a location without a filtration system. Residents were provided bottled drinking water at this location. The calculated dose for children was more than 7 times the MRL and 3 times the MRL for an adult. Benzene levels exceeded the ATSDR Cancer Risk Guide (CREG) screening value at 3 other locations. However, the benzene levels were less than 20% of the non-cancer related screening values (see Table 2) at these locations.

If the ATSDR screening value that was exceeded is a CREG, a theoretical cancer risk was calculated using the estimated dose and EPA's cancer slope factor. CREGs are estimated concentrations that are expected to cause no more than one excess cancer in a million persons exposed daily during their lifetime. The cancer slope factor is generated using mathematical models applied to epidemiologic or experimental data.

The limitations of this approach are that higher doses are extrapolated to lower dose situations and the value calculated is an estimate of risk. The actual risk is not known. A second limitation is that the contaminant levels in the drinking water will fluctuate depending on site conditions. The calculated theoretical cancer risk for the highest concentration of each substance based on a 30 yr exposure is listed in Table 4. A 30 year exposure period was selected because GMH Electronics began operations in 1972 and it is not known when contaminants initially reached the wells. A 30 year exposure period was thought to be a health protective estimate.

Table 4: Theoretical Cancer Risk From Ingestion

Contaminant	Highest Concentration ug/L	Number of additional cancers predicted in 1 million exposed	Number of Persons exposed to predict 1 additional cancer	Qualitative Cancer Risk
1,2-Dichloroethane	37	20	50,000	Low
1,4-Dioxane	38	5	200,000	Very Low
Carbon tetrachloride	2.9	5	200,000	Very Low
1,1,2-Trichloroethane	1.9	2	500,000	Very Low
Benzene	61	40	25,000	Low

ug/L: microgram per liter

The number of additional cancers predicted was also calculated for each of the above contaminants using the average value for all wells exceeding the CREG. The theoretical cancer risk associated with each contaminate is reduced to “very low” if the average concentration for all wells exceeding the CREG was utilized for the calculation.

Inhalation

A number of studies have shown residents may be exposed to VOCs in contaminated water while showering or bathing. The contaminants are volatilized from the water droplets and can be inhaled. Complex models are available to estimate the transfer of chemicals from water to air in showers. However, detailed site specific measurements are necessary to capture all the data needed to complete the calculation and this data is not available. Therefore, an alternative model that is not dependent on unavailable data was used to estimate the maximum concentration of contaminants in the air in the bathroom.

The maximum concentration is calculated using the following equation (ATSDR, 2004):

$$C_{air} = \frac{C_{water} \times f \times F_w \times T}{V_{air}}$$

Where, C_{air} = concentration in air (mg/m$^{3)}$

C_{water} = concentration in water (mg/L)

f = fractional volatilization rate

F_w = shower water flow rate (L/min)

V_{air} = bathroom volume (m$^{3)}$

T = time in minutes

The shower water volume was based on 10 minute shower with 8 liter per minute flow rate. The fractional volatilization rate was assumed to be 0.9 and the bathroom volume 10 cubic meters. The limitations of this method are it does not account for exhaust ventilation, water temperature, or differences in volatilization rates. Therefore, it will overestimate the actual concentrations.

The maximum concentration in water was used to calculate the peak shower air concentrations for contaminants. The peak concentration was compared to ATSDR Air Comparison Values. If the peak concentration exceeded the screening value an inhalation dose was calculated and compared to ATSDR's MRL. As indicated in Table 5, a total of 9 contaminants exceeded one or more of the CVs.

Table 5: Inhalation Peak Shower Concentration

Contaminant	Max Water Conc ug/L	Peak Air Conc ug/m^3	CV Air Ug/m^3	Type CV	Further Analysis
1,2-Dichloroethane	37	266.4	0.04 2000	CREG Chr. EMEG[1]	Yes No
1,1-Dichloroethane	50	360	500	RfC[2]	No
1,1-Dichloroethylene	3100	22,320	80	Int. EMEG[3]	Yes
1,1,1-Trichloroethane	900	6,480	4,000	Int. EMEG	Yes
1,4-Dioxane	38	274	4,000	Chr. EMEG	No
Carbon tetrachloride	2.9	21	0.07 200	CREG Chr. EMEG	Yes No
Methylene chloride	1.8	13	2 1000	CREG Chr. EMEG	Yes No
1,1,2-Trichloroethane	1.9	13.7	0.06	CREG	Yes
Trichloroethylene	1.9	13.7	500	Int. EMEG	No
Chloroform	3.3	23.8	0.04 100	CREG Chr. EMEG	Yes No
Benzene	61	439	0.1 10	CREG Chr EMEG	Yes Yes

[1] Chronic EMEG
[2] Provisional value established by EPA
[3] Intermediate EMEG

Theoretical cancer rates were calculated for all compounds that exceeded their respective CREG value (see Table 7). The non-cancer health effects were evaluated for 1,1-dichloroethylene, 111-trichloroethane, and benzene because shower concentrations exceeded the non-cancer comparison values. 1,4-Dioxane and trichloroethylene levels were less than 10% of the CV and were not carried forward for more detailed analysis.

The peak inhalation concentration calculated for the shower exposure was adjusted to a time weighted average concentration because it is a ten minute exposure in 24 hour period (Table 6). The value was converted to parts per billion (ppb) and compared to the inhalation MRL. The time weighted average adjustment is necessary because the inhalation MRLs are derived for continuous 24 hour a day exposures.

Table 6: Shower Inhalation Dose Non-cancer

Contaminant	Peak Air Conc ug/m3	Molecular Weight	Inhalation Dose ppb	MRL ppb	Further Analysis
1,2-Dichloroethane	266.4	98.97	0.5	600	No
1,1-Dichloroethylene	22,320	96.95	39.1	20	Yes
1,1,1-Trichloroethane	6,480	133.42	8.2	700	No
Carbon tetrachloride	21	153.24	0.02	30	No
Methylene chloride	13	84.93	0.03	300	No
Chloroform	23.8	119.38	0.02	20	No
Benzene	439	78.11	0.95	3	Yes

ug/m^3: microgram per cubic meter
ppb: part per billion
MRL: Minimum Risk Level (ATSDR)

The calculated inhalation dose was substantially less than the MRL for 1, 2-dichloroethane, 1,1,1-trichloroethane, carbon tetrachloride, 1,4-dioxane, methylene chloride, and chloroform. The inhalation dose for 1,1-dichloroethylene exceeded the MRL. The inhalation dose for benzene was 33% of the MRL. The potential adverse health impacts of both compounds will be discussed in subsequent sections.

The cancer risk was also calculated for all contaminants that exceeded a CREG screening value. The theoretical number of cancer cases per million exposed is included in Table 7. The cancer risk was estimated by multiplying the time weighted average inhalation dose and the inhalation unit risk (IUR). The IUR is estimate of cancer risk per ug/m^3 developed by EPA.

Table 7: Shower Inhalation Theoretical Cancer

Contaminant	Inhalation Dose ug/m^3	IUR	Theoretical Cancer per million	Number Exposed for 1 case	Qualitative Description
1,2-Dichloroethane	1.86	2.6E-5	48	20,833	Low
Carbon tetrachloride	0.15	1.5E-5	2	500,000	Very Low
Methylene chloride	0.09	4.7E-7	<1	-	None
1,1,2-Trichloroethane	0.09	1.6E-5	2	500,000	Very Low
Chloroform	0.10	2.3E-5	2	500,000	Very Low
Benzene	3.05	2.2-7.8E-6	7-24	142,857-41,667	Low

ug/m^3: microgram per cubic meter
IUR: Inhalation unit risk ($[ug/m^3]^{-1}$)

A substance by substance discussion of each chemical follows.

1,2-Dichloroethane

It is a volatile compound that may be found as a contaminant in soil or water. It is a man made product that does not naturally occur in the environment. Common uses include chemical manufacturing, varnishes, and as a solvent to clean oil or grease from metal. It has also been used in household products. People may be exposed to 1,2-dichloroethane by inhalation, ingestion of contaminated water, or absorption through the skin.

Adverse health effects associated with ingestion or inhalation of high concentrations of 1,2-dichloroethane by humans include liver damage, kidney failure, and neurological disorders. Animal studies confirmed target organs as liver, kidney, central nervous system, and the immune system. No human data is available on incidence of cancer following ingestion of 1,2-dichloroethane. However, an increased incidence of cancer was observed in animals exposed to 1, 2-dichloroethane. It is considered a probable human carcinogen based on animal data.

The ATSDR Comparison Value for 1,2-dichloroethane was exceeded in 12 drinking water samples. The highest concentrations were measured pre-filter at residences equipped with carbon filtration systems. However, concentrations near or above ATSDR's Comparison Value were observed in several post filter drinking water samples and at homes without filtration systems.

The highest concentration (pre-filter) measured was used to calculate a site specific ingestion dose. The calculated dose was 10% of the Minimal Risk Level. Therefore, non-cancer related health effects are not anticipated. The estimated number of excess cancers calculated for 1,2-dichloroethane was 20 cases per million exposed. It was calculated based on a 30 year exposure to the highest concentration measured. The estimated number of excess cancers based on the highest concentration measured in post filter drinking water samples was less than 1 per million.

The inhalation (cancer and non-cancer) risk was also calculated using the highest concentration (pre-filter) measured in the well water. The inhalation dose was less than 1% of the Minimal Risk Level. Therefore, adverse (non-cancer) health effects are unlikely. The cancer risk from inhalation is considered "low" based on the peak concentration. The combined inhalation and ingestion cancer risk is "low" based on highest (pre-filter) concentration.

The highest concentration that was observed, post filter or with no filtration system, was also used to calculate the inhalation risk. The estimate of the inhalation cancer risk is still considered "low" but it was reduced more than 60% to 17 cases per million exposed.

1,1-Dichloroethane

It is a volatile chemical used in chemical manufacturing and as a paint or varnish remover. It also may occur as a decomposition product of 1,1,1-trichloroethane. There is no data on the health effects of 1, 1-dichloroethane on humans. Animal data (inhalation studies) indicate high doses of 1,1-dichloroethane can produce kidney damage. No animal data was available on adverse effects of ingestion of 1.1-dichloroethane. Animal data is inconclusive regarding the carcinogenic properties.

ATSDR does not have a screening value and EPA does not have an MCL for 1, 1-dichloroethane. A site exposure dose was calculated using the highest concentration identified in the well water samples. The dose was compared to EPA's Mid Atlantic Risk Assessment screening value. The calculated dose was less than 2% of the EPA screening value.

The inhalation risk was calculated using the highest concentration measured (pre-filter) in the well water samples. The inhalation dose was less than 1% of the provisional Reference Concentration established by EPA. Therefore, adverse health effects associated with ingestion or inhalation are not anticipated.

1,1-Dichloroethylene

It is a man made chemical that is not naturally found in the environment. It is used in manufacturing chemicals, adhesives, and carpet. It is also present in the environment as a decomposition product of other chlorinated solvents. Exposure can occur by inhalation, ingestion, or absorption through the skin. Surveys conducted by the U.S. Geological Survey found 3% of urban and 0.3% of rural wells were contaminated with 1,1-dichloroethylene.

Limited data is available on exposure to 1,1-dichloroethylene in humans. Animal studies indicate that ingestion of 1,1-dichloroethylene produced liver and kidney damage. An increase in congenital heart malformations was also observed in animals exposed to 1,1-dichloroethylene before and during pregnancy. Inhalation of high doses of 1,1-dichloroethylene also lead to liver, lung, and kidney damage in animals.

It is not known if 1,1-dichloroethylene causes cancer in humans. There is limited data available from occupational exposure studies and animal studies produced mixed results. The International Agency for Research on Cancer (IARC) does not classify it as a carcinogen. EPA considers it a possible carcinogen.

The highest concentration of 1,1-dichloroethylene was 3100 ug/L and it was measured prior to the carbon filtration system. A total of 8 samples exceeded the ATSDR screening value for children (90 ug/L). The site specific dose exceeded the Minimal Risk Level for the 6 samples collected upstream of the carbon filtration units. The highest concentration of 1,1-dichloroethylene measured downstream (post-filter) of a carbon filtration system was 97 ug/L. The calculated dose for the post-filter sample was 67% of the MRL for this location.

The 3100 ug/L drinking water concentration corresponds to a child dose of 0.19 mg/kg/day and adult dose of 0.09 mg/kg/day. The highest post filter concentration of 97 ug/L corresponds to a child dose of 0.006 mg/kg/day. The no observable adverse health effect level (NOAEL) based on chronic animal exposures ranged from 9 to 30 mg/kg/day. The child dose based on the pre-filter concentration was 2% of the NOAEL. The adult dose is approximately 1% of the NOAEL. The child dose based on the highest post filter sample was less than 0.1% of the NOAEL.

Limited human data is available on the adverse health impacts associated with inhalation of 1,1-dichloroethylene. The existing data indicates neurotoxicity following acute inhalation exposure. Chronic low level exposures are potentially associated with kidney and liver damage. Animal data confirms 1,1-dichloroethylene is associated with liver, kidney, central nervous system, and lung damage. The lowest NOAEL reported for chronic inhalation was 10,000 ppb (mouse). A second study reported LOAEL (rat) at 25,000 ppb. The inhalation dose based on the highest well water (pre-filter) concentration was 39.1 parts per billion (ppb). This is roughly 0.2 % of the NOAEL observed in animal data. The inhalation dose calculated based on the highest post filter well water concentration is 1 ppb which is less than 0.01% of the NOAEL. Therefore adverse health effects from inhalation of 1,1-dichloroethylene are not anticipated.

1,4-Dioxane

It is a chemical used as a solvent, laboratory reagent, and chemical intermediary. Exposure to 1,4-dioxane can occur by inhalation, ingestion, or absorption through the skin. Human and animal exposure data identify the target organs as the liver and kidneys. There is limited data available on the carcinogenicity of 1,4-dioxane in humans. However, animal studies have demonstrated ingestion of 1,4-dioxane can cause cancer in animals. An increase in the number of cancers was not observed for inhalation exposures in occupational or animal studies. Based on the animal (ingestion) data EPA considers 1,4-dioxane a probable human carcinogen. International Agency for Research on Cancer lists 1,4-dioxane as a possible carcinogen.

The highest concentration of 1,4-dioxane measured was 38 ug/L. This sample was collected before the carbon filtration unit. A site specific drinking water exposure was calculated and the value compared to the Minimal Risk Level. The highest concentration measured was less than 1% of the MRL. The inhalation dose was also calculated and was less than 0.1% of the MRL. Therefore, non-cancer related adverse health effects are not anticipated.

The number of excess cancers was estimated based on the consumption of the unfiltered water for 30 years. The number of excess cancers predicted for the highest concentration of 1,4-dioxane measured are 1 case for every 166,667 people exposed. The highest contaminant level found in the drinking water downstream (post-filter) of the filtration units was 23 ug/L. The number of excess cancers predicted based on this concentration is 1 case in 323,000. This is considered a very low risk.

Carbon Tetrachloride

It is a clear volatile liquid that does not occur naturally in the environment. It was used as a cleaning solution, fumigant, and refrigerant. People can be exposed to carbon tetrachloride by inhalation, ingestion, or absorption through the skin. High exposures can result in liver, kidney, and central nervous system damage.

Animal studies demonstrated exposure to carbon tetrachloride can cause cancer. The Department of Health and Human Services (DHHS) has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has classified carbon tetrachloride as possibly carcinogenic to humans. EPA has determined that carbon tetrachloride is a probable human carcinogen.

The highest concentration (pre-filter) of carbon tetrachloride measured was 2.9 ug/L. The dose, calculated based on consumption of contaminated water, was less than 5% of the non-cancer screening value. Therefore, non-cancer related health effects are not anticipated.

Two pre-filter samples exceeded the CREG value. The exposure dose was calculated and the number of excess cancer deaths estimated as 1 in 200,000 based on 30 years exposure to unfiltered drinking water. Carbon tetrachloride was detected in one post filter sample but the concentration was less than the CREG.

The inhalation dose was also calculated for carbon tetrachloride. The time weighted average dose was less than 0.1% of the inhalation MRL. Therefore no non-cancer adverse health effects are anticipated. The theoretical cancer risk based on inhalation of carbon tetrachloride during showering was 2 cases per million exposed. The combined inhalation and ingestion cancer risk is “very low” for carbon tetrachloride.

Methylene Chloride
It is a widely used industrial chemical used as a solvent and paint stripper. It has been used in spray paint, cleaners, and automotive products. It was also used in household products. Methylene chloride is volatile chemical and is often present as a background contaminant in the air.

There is some human data available on methylene chloride from occupational studies. The studies indicated acute inhalation exposures can impact the central nervous system, hematological system, and reduce sperm count in males. Cancer studies produced mixed results. One study indicated an increased risk for liver cancer. The increased risk was not observed in other studies.

Liver, kidney and immune system changes were observed in animals exposed to methylene chloride. Animal studies indicate an increased risk of liver and lung cancer among some species tested. U.S. DHHS classifies methylene chloride as “reasonably anticipated’ to cause cancer. IARC considers it a possible carcinogen and EPA classifies methylene chloride as a “probable” carcinogen.

The highest concentration in the well water did not exceed the screening value for drinking water. Therefore, an exposure dose was not calculated for ingestion. However, the peak shower concentration calculated exceeded the air screening value. The time weighted exposure was less than 0.1% of the inhalation Minimal Risk Level. The theoretical cancer risk was calculated and found to be less than 1 per million. Therefore, no adverse health effects are anticipated.

1,1,2-Trichloroethane

It is a man-made compound that is used as a solvent or is sometimes present as an impurity with other solvents. Potential adverse health effects associated with high exposures to 1,1,2-trichloroethane include liver damage, kidney damage, gastrointestinal system impairment, and skin irritation. Some animal studies demonstrated 1,1,2-trichloroethane could produce liver cancer in mice. It was not shown to produce cancer in rats. EPA classifies it as a possible human carcinogen. IARC lists it as not classifiable because of limited data.

The highest concentration measured in the well water was 1.9 ug/L. It is significantly less than the non-cancer (oral) screening value. Therefore, non-cancer heath effects are unlikely. However, 5 samples were above the CREG. All 5 samples were collected prior to the carbon filter. No 1,1,2-trichloroethane was detected downstream of the filter or in wells without filtration systems. The site specific dose was calculated based on the highest concentration of 1,1,2-trichloroethane measured in the pre-filter drinking water sample. The estimated number of excess cancers based on 30 years exposure is 1 cancer in 500,000 people exposed. This is considered a very low cancer risk.

The inhalation concentration for 1,1,2-trichloroethane exceeded the CREG. The time weighted average inhalation exposure and IUR were used to calculate the increased cancer risk. The risk was 2 cases per million people exposed. This is considered a "very low" risk. The combined cancer risk for inhalation and ingestion is considered a "very low".

Benzene

Benzene is a volatile chemical that is both man made and occurs naturally. Benzene is used to manufacture chemicals, rubber, pesticides, and drugs. It is a component of gasoline and a combustion by-product in tobacco smoke. Natural sources of benzene include crude oil, volcanoes and forest fires.

Benzene exposure can occur through inhalation, ingestion, or absorption through the skin. Long term exposure can impact the bone marrow and result in anemia and excess bleeding. Benzene has also been shown to adversely impact the immune system and is associated with acute myeloid leukemia. U.S. DHHS classifies benzene as a known human carcinogen. EPA and IARC classify it as a human carcinogen.

The highest concentration of benzene measured was 61ug/L in a private well without a filtration system. This concentration exceeds the screening value for drinking water. None of the other private well sampling data exceeded the non-cancer screening value.

The child and adult dose was calculated based on ingestion of the highest concentration of benzene. Using the standard parameters the ingestion dose was 0.0038 mg/kg/day for a child and 0.0017 mg/kg/day for an adult. The ATSDR Minimal Risk Level for ingestion is 0.0005 mg/kg/day. ATSDR reports the lowest observable adverse effect level (LOAEL) based on human exposure was 0.29 mg/kg/day. The health effect observed was a reduction in white blood cell and platelet counts. The estimated child dose was 75 times below the LOAEL and the estimated adult dose was 150 times below the LOAEL. Therefore, no non-cancer health effects are expected.

Four drinking water samples had levels above the CREG. The theoretical cancer risk based on the highest value and 30 year exposure period is estimated as 1 excess cancer in 25,000 people exposed. This is considered a "low risk" for cancer. The theoretical cancer risk calculated using the average concentration of all samples exceeding the CREG was 1 excess cancer in 100,000 people exposed.

The peak shower concentration exceeded both the chronic EMEG and CREG inhalation screening values. The time weighted average concentration of 0.95 ppb was 33% of the chronic inhalation MRL. The NOAEL (inhalation) based on human studies was reported as 550 ppb. Therefore, non-cancer adverse health effects are not anticipated.

EPA provided a range for the IUR rather than a single number. The theoretical cancer risk based on the peak concentration is 7 to 24 excess cancers per million people exposed. Residents with the highest concentration of benzene in the well water were provided bottled water. However, exposure through inhalation of volatilized benzene in the shower is considered a completed exposure pathway. The theoretical cancer rate is considered a "low" to "very low" cancer risk. The combined inhalation and ingestion cancer risk is considered "low".

COMMUNITY HEALTH CONCERNS

The Person County Health Department held a community meeting to address community questions and concerns about the site in December, 2007. Representatives from EPA, ATSDR, NC DENR, and NC HACE were available to answer questions. The majority of the questions focused on the contamination of the drinking water wells.

Person County held another community meeting on February 12, 2009. Representatives from EPA, NC DENR, and the City of Roxboro discussed the results of EPA's Focused Feasibility Study and the plan to extend water lines to the area. Community members asked questions regarding the safety of using well water for gardens and washing cars. Additional questions were raised about monthly fees and the impact of system pressure and chlorination on the integrity of existing residential water lines/fixtures.

CHILD HEALTH CONSIDERATIONS

The ATSDR recognizes there are unique exposure risks concerning children. Children are at a greater risk than are adults to certain kinds of exposures to hazardous substances. Children are smaller, resulting in higher doses of chemical exposure per body weight. If toxic exposures occur during critical growth stages, the developing body systems of children can sustain permanent damage. Probably most important, however, is that children depend on adults for risk identification and risk management, housing, and access to medical care. Thus, adults should be aware of public health risks in their community, so they can guide their children accordingly. Child-specific exposure situations and health effects are taken into account in NC DPH health effect evaluations.

Benzene and 1,1,-dichloroethylene are of concern because the highest exposures exceeded the Minimal Risk Level for children. Benzene can pass from the mother's blood to the fetus. However, it is not known if children are uniquely susceptible to the adverse heath effects associated with benzene or 1,1-dichloroethylene exposure. The estimated child dose for both contaminants was well below levels found in health studies to cause adverse health effects.

CONCLUSIONS

NC DPH reviewed site conditions and environmental data reported by EPA for the GMH Electronics site. At least 1 contaminant was found in 45 of the 89 private wells EPA sampled. Seven contaminants were measured in the well water at concentrations above ATSDR's screening value. Point of entry filtration systems or bottled drinking water was previously provided to residents with contaminant levels above the ATSDR's screening level. However, contaminant breakthrough was detected in some of the filtration systems.

Potential adverse health effects from mixtures of similarly acting chemicals can be a concern. However, in this instance the two chemicals (1,1-dichloroethylene and benzene) with exposure doses above the MRL have different mechanisms of toxicity. The combined inhalation and ingestion exposure to 1,1-dichloroethylene was less than 3% of the NOAEL. The estimated exposure dose to benzene by inhalation and ingestion was less than 2% of the LOAEL for child and 1% of the LOAEL for an adult. In addition, point of entry filtration systems and bottled water were previously provided to the residents for the duration of the time period addressed in this report.

NC DPH concludes drinking or inhalation of the private well water that is contaminated with 1,1-dichloroethane is not expected to harm people's health.
The exposure dose based on the highest pre-filter drinking water sample was 2% of the NOAEL. The dose calculated for samples collected post-filtration system, was less than 0.1 % of the NOAEL. The inhalation exposure was significantly less than ATSDR's Minimal Risk Level.

NC DPH concludes that drinking or inhalation of private well water that is contaminated with benzene is not expected to harm people's health. The exposure dose calculated based on ingestion of the highest concentration of benzene was 1% of the LOAEL. The exposure dose calculated based on the highest concentration of benzene in drinking water that was still being consumed was less than ATSDR's Minimal Risk Level. The inhalation exposure (highest concentration) calculated based on showering was less than 0.2% of the NOAEL.

NC DPH concludes that drinking or inhalation of private well water that is contaminated with 1,2-dichloroethane, benzene, carbon tetrachloride, 1,4-dioxin, methylene chloride, and 1,1,2-trichloroethane are not expected to increase people's risk for developing cancer. The basis for this conclusion is the estimates of the theoretical cancer risk are within the acceptable cancer risk range (less than 100 additional cancers in 1 million exposed). NC DPH categorizes the theoretical cancer risk based on 30 years of exposure as "low" to "very low".

The completion of and connection of residents to the municipal water supply this fall will eliminate the need for and maintenance of the carbon filtration systems. It will also eliminate potential inhalation exposures for residents without filtration systems.

RECOMMENDATIONS

The N.C. DPH makes the following recommendations:

- Clean drinking water should continue to be provided to residents with wells that have contaminants above the respective Maximum Contaminant Level until the municipal connections are completed.

- No new private drinking water wells should be permitted within the contaminated area or the designated buffer zone.

- The migration of the contaminated plume should continue to be periodically monitored to ensure drinking water wells outside the designated buffer zone do not become contaminated.

- Some of the properties within the contaminated area are rental properties. An effort should be made to ensure any new tenants are informed of the drinking water contamination and are provided clean drinking water.

- Communicate the status of investigation/remediation phase with residents.

PUBLIC HEALTH ACTION PLAN

The purpose of the Public Health Action Plan (PHAP) is to ensure that this Public Health Assessment provides a plan of action designed to mitigate or prevent potential adverse health effects.

A. Public Health Actions Completed

- NC DPH has evaluated site information, environmental media analytical data, and health effects information to determine the potential for the health of the local community to be adversely impacted by substances identified on the GMH Electronics NPL site.

B. Public Health Actions Planned
- A draft copy of NC DPH's Health Consultation will be made available to U.S. EPA, NC DENR, and Person County officials prior to final publication through ATSDR.
- A final draft copy of the HC will be made available to the public for review and comment prior to final publication by ATSDR. Copies will be available electronically from HACE and ATSDR web sites. Hard copies will be made available to the public at locations in Roxboro, NC selected as document repositories. An availability session will be held to discuss any resident concerns.
- The final HC will be available on the ATSDR and HACE web site. Print copies can be requested through ATSDR.
- A summary factsheet will be prepared by HACE and be made available to the public and government agencies. Copies will be available at locations selected as document repositories. Electronic copies will be available from the HACE web site.
- NC DPH will continue to monitor health-relevant data generated by Federal, State, or County agencies, or other groups, regarding this site.
- NC DPH will provide contact information to agencies, organizations, and the public desiring additional inquiries about the site or the HC.

Contact information for additional inquiries regarding the GMH electronics site:

Web links:
NC DPH HACE: http://www.epi.state.nc.us/epi/oee/hace/reports.html
ATSDR access to HC: http://www.atsdr.cdc.gov/HAC/PHA/index.asp

NC HACE e-mail address: nchace@dhhs.nc.gov

NC HACE telephone number: (919) 707-5900
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CERTIFICATION

This Public Health Assessment for the GMH Electronics NPL Site (EPA ID: NCN000410161) was prepared by the North Carolina Division of Public Health (N.C. DHHS) under a cooperative agreement with the Federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consult and update was initiated. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.

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ATSDR *Health Consultation Myrtle Grove Trailer Park.* May 2004

ATSDR *Minimum Risk Levels*. Last Update December 2009
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ATSDR *Toxicological Profile for Benzene*. Updated August 2007
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ATSDR *Toxicological Profile for Carbon Tetrachloride.* Updated August 2005
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ATSDR *Toxicological Profile for Chloroform.* Updated September 1997
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ATSDR *Toxicological Profile for 1,2-Dichloroethane.* Updated September 2001
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ATSDR *Toxicological Profile for 1,1-Dichloroethylene.* Updated May 1994
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ATSDR *Toxicological Profile for 1,4-Dioxane.* Draft for Public Comment September 2007 http://www.atsdr.cdc.gov/toxprofiles/index.asp

ATSDR *Toxicological Profile for Methylene Chloride.* Updated September2000
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ATSDR *Toxicological Profile for 1,1,2-Trichloroethane.* December 1989
http://www.atsdr.cdc.gov/toxprofiles/index.asp

EnviroMapper. U.S. EPA
http://www.epa.gov/emefdata/em4ef.home

EPA Integrated Risk management System (IRIS)
http://www.epa.gov/iris/index.html

EPA *GMH Electronics NPL Summary.* Last Update February 2010

EPA *Regional Screening Level Tapwater Supporting Table* December 2009 http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

EPA *GMH Electronics Narrative Summary and Document Record.* April 2009

EPA *Technology Transfer Network Air Toxics 1,1-Dichloroethane* Revised January 2000 **http://www.epa.gov/ttn/atw/hlthef/dichloro.html**

Appendix A: Aerial Photo

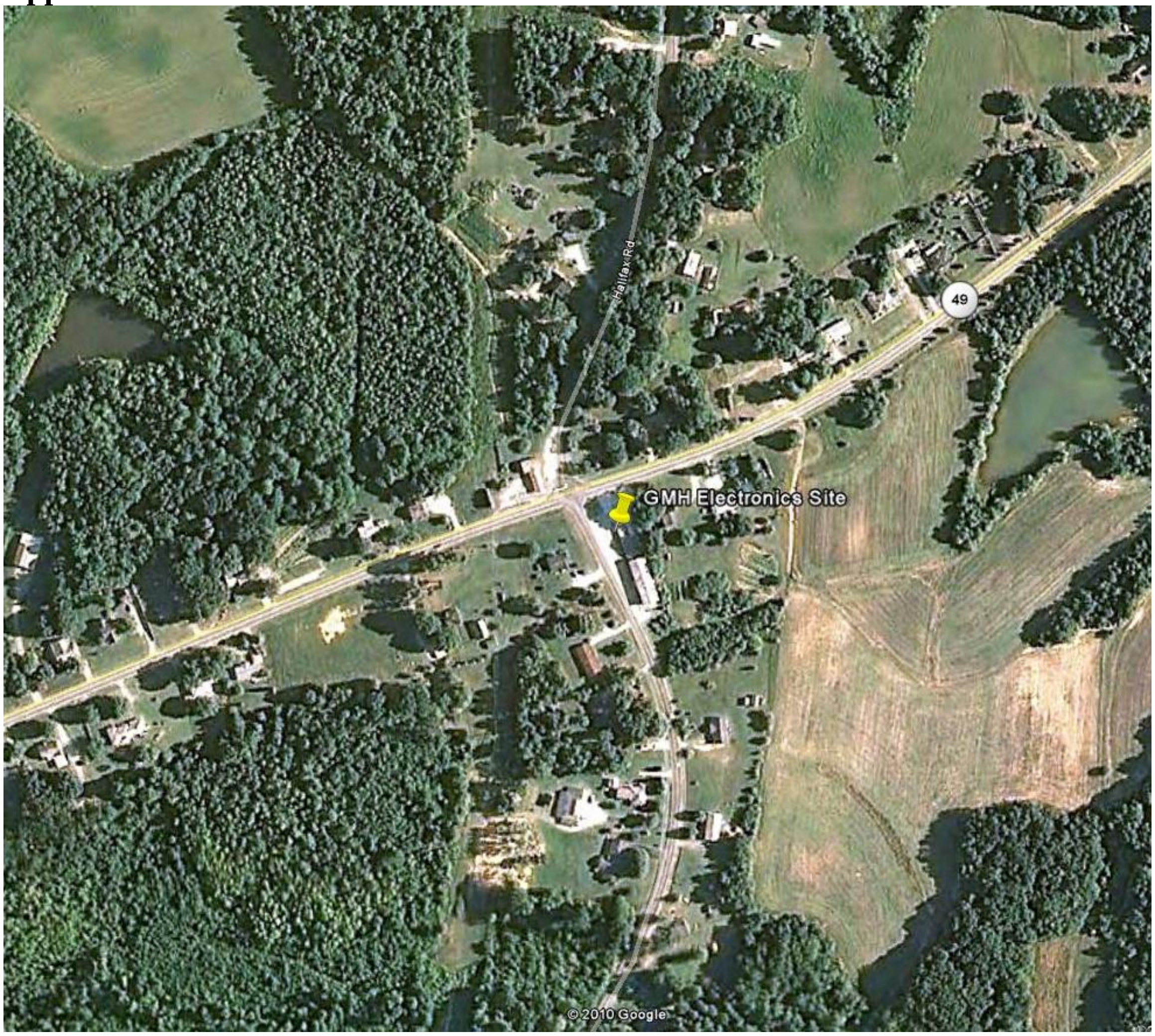
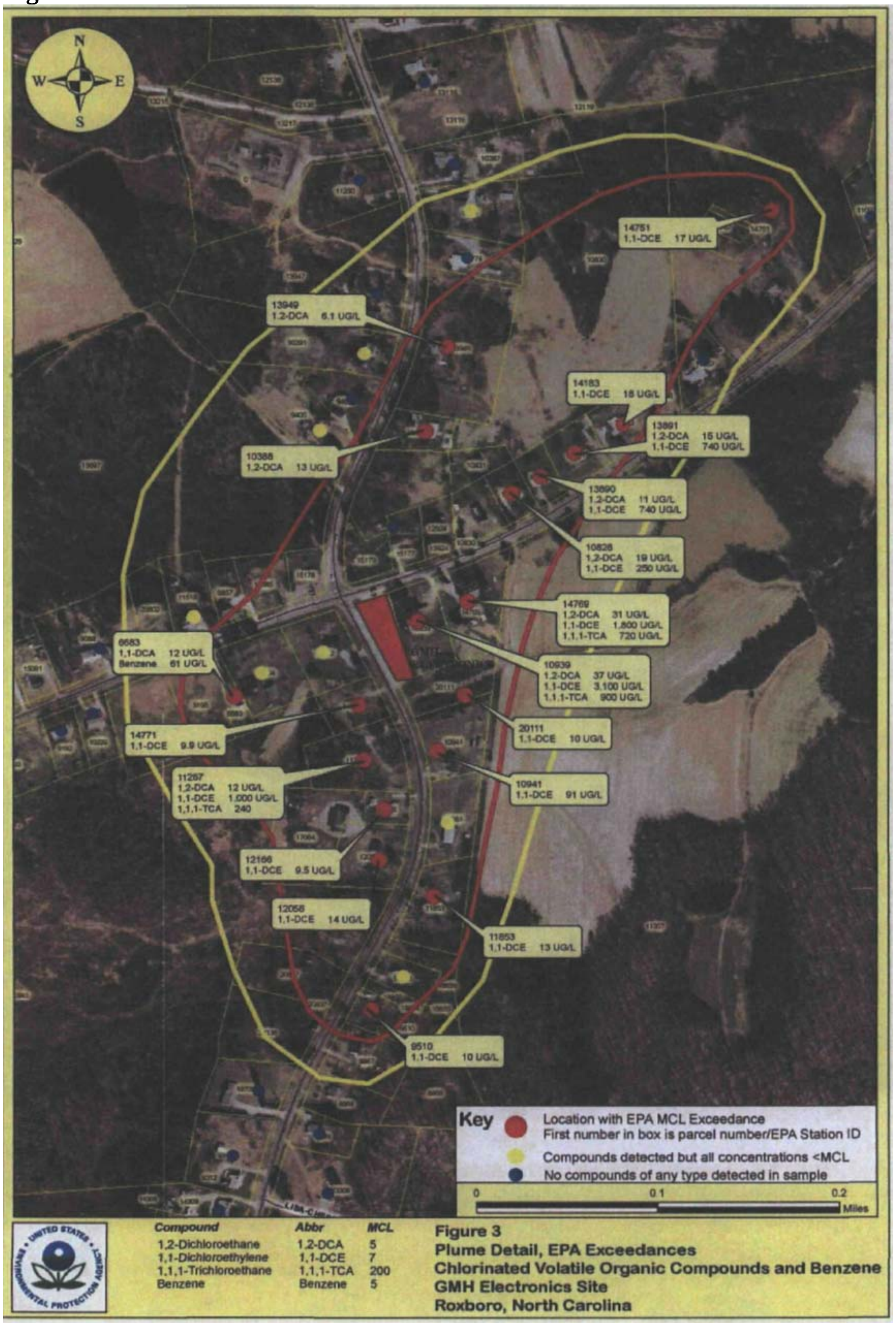


Figure 1: Contaminated Plume



Appendix B: Site Photographs

Automotive shop located at former GMH Electronics building

Business Northwest corner of Virgilina and Halifax Road intersection

Waterline construction east on Virgilina Road

Residential property on Halifax Road adjacent to former GMH building

Appendix C: The ATSDR Health Effects Evaluation Process

The ATSDR health effects evaluation process consists of two steps: a screening analysis, and at some sites, based on the results of the screening analysis and community health concerns, a more in-depth analysis to determine possible public health implications of site-specific exposure estimates.

In evaluating data, ATSDR uses comparison values (CVs) to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific medium (soil, water, or air) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water and soil that someone may inhale or ingest each day.

The two step screening analysis process provides a consistent means to identify site contaminants that need to be evaluated more closely through the use of "comparison values" (CVs). The first step of the screening analysis is the "environmental guideline comparison" which involves comparing site contaminant concentrations to medium-specific comparison values derived by ATSDR from standard exposure default values. The second step is the "health guideline comparison" and involves looking more closely at site-specific exposure conditions, estimating exposure doses, and comparing them to dose-based health-effect comparison values.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. CVs are not thresholds of toxicity and do not predict adverse health effects. CVs serve only as guidelines to provide an initial screen of human exposure to substances. Contaminant concentrations at or below the relevant CV may reasonably be considered safe, but it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on validated toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are the media concentrations at which there could be a one additional cancer in a one million person population (one in a million excess cancer risk for an adult) eating contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and non-cancer CVs exist, the lower level is used to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

After completing a screening analysis, site contaminants are divided into two categories. Those not exceeding CVs usually require no further analysis, and those exceeding CVs are selected for a more in-depth analysis to evaluate the likelihood of possible harmful effects.

The North Carolina Department of Public Health (NC DPH) uses the following screening values for public health assessments:

1. **Environmental Media Evaluation Guide (EMEG):** EMEGs are estimated contaminant concentrations in water, soil or air to which humans may be exposed over specified time periods and are not expected to result in adverse non-cancer health effects. EMEGs are based on ATSDR "minimum risk levels" (MRLs) and conservative (highly health protective) assumptions about exposure, such as intake rate, exposure frequency and duration, and body weight.

2. **Reference Dose Media Evaluation Guides (RMEGs):** RMEGs represent concentrations of substances in water and soil to which humans may be exposed over specified time periods without experiencing non-cancer adverse health effects. The RMEG is derived from the U.S. Environmental Protection Agency's (EPA's) oral reference dose (RfD).

3. **Cancer Risk Evaluation Guide (CREG**): CREGs are estimated media-specific contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a 70-year lifetime. CREGs are calculated from EPA's cancer slope factors (CSFs) or inhalation unit risk (IUR) values.

4. **Maximum Contaminant Levels (MCL):** A Federal Maximum Contaminant Level (MCL) is the regulatory limit set by EPA that establishes the maximum permissible level of a contaminant in water that is deliverable to the user of a public water system. MCLs are based on health data, also taking into account economic and technical feasibility to achieve that level. (ATSDR 2005a)

5. **EPA Regional Screening Levels (RSL):** "Regional Screening Levels for Chemical Contaminants at Superfund Sites" are tables of risk-based screening levels, calculated using the latest toxicity values, default exposure assumptions and physical and chemical properties. The Regional Screening table was developed with input from EPA Regions III, VI, and IX in an effort to improve consistency and incorporate updated guidance. (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)

Contaminant concentrations exceeding the appropriate CVs are further evaluated against ATSDR health guidelines. NC DPH also retains for further assessment contaminants that are known or suspected to be cancer-causing agents. To determine exposure dose, NC DHHS uses standard assumptions about body weight, ingestion or inhalation rates, and duration of exposure. Important factors in determining the potential for adverse health effects also include the concentration of the chemical, the duration of exposure, the route of exposure, and the health status of those exposed. Site contaminant concentrations and site-specific exposure conditions are used to make conservative estimates of site-specific exposure doses for children and adults that are compared to ATSDR health guidelines (HGs), generally expressed as Minimal Risk Levels (MRLs). An exposure dose (generally expressed as milligrams of chemical per kilogram of body weight per day or "mg/kg/day") is an estimate of how much of a substance a person may come into contact based on their actions and habits. Exposure dose calculations are based on the following assumptions as outlined by the ATSDR (ATSDR 2005a):

- Children between the ages of 1 and 6 ingest an average of 1 liter of water per day
- Children weigh an average of 16 kilograms
- Infants weigh an average of 10 kilograms
- Adults ingest an average of 2 liters of water per day
- Adults weigh an average of 70 kilograms

Ingestion of contaminants present in drinking water

Exposure doses for ingestion of contaminants present in groundwater are calculated using the maximum and average detected concentrations of contaminants in milligrams per liter (mg/L). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated groundwater:

$$ED_w = \frac{C \times IR \times AF \times EF}{BW}$$

Where:

ED_w = exposure dose water (mg/kg/day)
C = contaminant concentration (mg/L)
IR = intake rate of contaminated medium (liters/day)
AF = bioavailability factor (unitless)
EF = exposure factor
BW = body weight (kilograms)

Ingestion of contaminants present in soil

Exposure doses for ingestion of contaminants present in soil are calculated using the maximum and average detected concentrations of contaminants in milligrams per kilogram (mg/kg [mg/kg = ppm]). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated soil:

$$ED_s = \frac{C \times IR \times AF \times EF}{BW}$$

Where:

ED_s = exposure dose soil (mg/kg/day)
C = contaminant concentration (mg/kg)
IR = intake rate of contaminated medium (kilograms/day)
EF = exposure factor (unitless)
BW = body weight (kilograms)

The exposure factor is an expression of how often and how long a person may contact a substance in the environment. The exposure factor is calculated with the following general equation:

$$EF = \frac{F \times ED}{AT}$$

Where:

F	=	frequency of exposure (days/year)
ED	=	exposure duration (years)
AT	=	averaging time (ED x 365 days/year)

Inhalation (breathing) of contaminants present in air

Inhalation is an important pathway for human exposure to contaminants that exist as atmospheric gases or are adsorbed to airborne particles or fibers. Exposure doses for breathing contaminants in air were calculated using the maximum or average detected concentrations in milligrams per cubic meter (mg/m^3) or parts per billion by volume (ppbv). The following equation is used to estimate the exposure doses resulting from inhalation of contaminated air.

$$D = (C \times IR \times EF) / BW$$

Where:

D	=	exposure dose (mg/kg/day)
C	=	contaminant concentration (mg/m^3)
IR	=	intake rate (m^3/day)
EF	=	exposure factor (unitless)
BW	=	body weight (kg)

Calculations of Contaminant Exposures During Showering

When showering in contaminated water a person may be exposed to the chemicals in the water by breathing a portion of the chemical that comes out of the water into the air (inhalation exposure), or by absorbing the chemical from the water through their skin (dermal exposure). Inhalation and dermal exposures to volatile organic compounds (VOCs) in the shower or bath may be equal to or greater than exposures from drinking the contaminated water. ATSDR uses conservative assumptions to estimate "worst case" exposures to VOCs during showering with contaminated water. The maximum concentration of VOC in the bathroom air is estimated with the following equation (Andelman 1990).

$$C_a = (C_w \times f \times F_w \times t)/V_a$$

Where:

C_a	=	bathroom air concentration (mg/m^3)
C_w	=	tap water concentration (mg/L)
f	=	fractional volatilization rate (unitless)
F_w	=	shower water flow rate (L/min)
t	=	exposure time (min)
V_a	=	bathroom volume (m^3)

Conservative calculation parameters are assumed, including a fractional volatilization of 0.9 for chlorinated VOCs, a flow rate of 8 L/min, and a small bathroom volume of 10 m^3. Conservative calculations are also made by using the maximum concentration found for each VOC in the tap water. Calculated bathroom air concentrations of VOCs can then be compared to ATSDR inhalation comparison values. Inhalation exposure dose estimates can be made using ATSDR's inhalation dose calculations.

Health guidelines represent daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects during the specified exposure duration. The potential for adverse health effects exists under the representative exposure conditions if the estimated site-specific exposure doses exceed the health guidelines and they are retained for further evaluation. A MRL is an estimate of daily human exposure to a substance (in milligrams per kilogram per day [mg/kg/day] for oral exposures) that is likely to be without non-cancer health effects during a specified duration of exposure. Exposures are based on the assumption a person is exposed to the maximum concentration of the contaminant with a daily occurrence.

Generally, site-specific exposure doses that do not exceed screening values are dropped from further assessment. Exposure doses that exceed MRLs, or are known or suspected cancer-causing agents, are carried through to the health-effects evaluation. The health-effects evaluation includes an in-depth analysis examining and interpreting reliable substance-specific health effects data (toxicological, epidemiologic, medical, and health outcome data) related to dose-response relationships for the substance and pathways of interest. The magnitude of the public health issue may be estimated by comparing the estimated exposures to "no observed" (NOAELs) and "lowest observed" (LOAELs) adverse effect levels in animals and in humans, when available.

ATSDR's toxicological profiles serve as the primary source of the health-effects data. Other sources of toxicological data include EPA's Integrated Risk Information System (IRIS) database, International Agency for Research on Cancer (IARC) Monographs, and the National Toxicology Program (NTP). Standard toxicology textbooks and peer-reviewed scientific journals of environmental toxicology or environmental health can also be consulted.

Cancer Health Effect Evaluations

Theoretical increased numbers of cancers are calculated for known or suspected cancer-causing contaminants using the estimated site-specific exposure dose and cancer slope factor (CSF) provided in ATSDR health guideline documents. This theoretical calculation is based on the assumption that there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in the exposed population, but estimates a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime or other selected period of exposure. For example, an estimated cancer risk of 1×10^{-4} predicts the probability of one additional cancer over the background number of cancers in a population of 10,000. Qualitative assessment of the predicted increased numbers of cancers is also used and represents terminology suggested by ATSDR and N.C. DPH.

The N.C. Central Cancer Registry states:

"*Although much has been learned about cancer over the past couple of decades, there is still much that is not known about the causes of cancer. What we do know is that cancer is not one disease, but a group of diseases that behave similarly. We know that different types of cancers are caused by different things. For example, cigarette smoking has been implicated in causing lung cancer, some chemical exposures are associated with leukemia, and prolonged exposure to sunlight causes some types of skin cancer. Genetic research has shown that defects in certain genes result in a much higher likelihood that a person will get cancer. What is not known is how genetic factors and exposures to cancer causing agents interact.*

Many people do not realize how common cancers are. It is estimated that <u>one</u> out of every <u>two</u> men and <u>one</u> out of every <u>three</u> women will develop a cancer of some type during his or her lifetime. As a result, it is common to find what appear to be cancer cases clustering in neighborhoods over a period of years. This will occur in any neighborhood. As people age, their chance of getting cancer increases, and so as we look at a community, it is common to see increasing numbers of cancer cases as the people in the community age.

Cancers are diseases that develop over many years. As a result, it is difficult to know when any specific cancer began to develop, and consequently, what the specific factor was which caused the cancer. Because people in our society move several times during their lives, the evaluation of clusters of cancer cases is quite challenging. One can never be certain that a specific cancer was caused by something in the community in which the person currently resides. When we investigate clusters of cancer cases, we look for several things that are clues to likely associations with exposures in the community. These are:

1. *Groups of cases of all the same type of cancer (such as brain cancer or leukemia). Because different types of cancer are caused by different things, cases of many different types of cancer do not constitute a cluster of cases.*
2. *Groups of cases among children, or ones with an unusual age distribution.*
3. *Cases diagnosed during a relatively short time interval. Cases diagnosed over a span of years do not constitute a cluster of cases unless there is consistency in the type of cancer.*
4. *Clusters of rare cancers. Because lung, breast, colon, and prostate cancers are so common, it is very difficult to find any association between them and exposures in a community.*"

Limitations of the Health Evaluation Process

Uncertainties are inherent in the public health assessment process. These uncertainties fall into the following categories: 1) the imprecision of the risk assessment process, 2) the incompleteness of the information collected and used in the assessment, and 3) the differences in opinion as to the implications of the information. These uncertainties are addressed in public health assessments by using worst-case assumptions when estimating or interpreting health risks. The health assessment calculations and screening values also incorporate safety margins. The assumptions, interpretations, and recommendations made throughout this public health assessment err in the direction of protecting public health.

Appendix D: Tables

Drinking Water Samples Above ATSDR's CV

Contaminant			Pre filter	Post filter	Pre-filter	Pre filter	Pre filter	Post filter	Pre-filter
	Units	**CV**	10939APW	10939BPW	13890APW	13891APW	11267APW	11267BPW	14769APW
1,2-Dichloroethane	ug/L	0.4	37	0.31J	11	15	12	1.1	31
1,1-Dichloroethylene	ug/L	90 child	3,100	81	740	740	1,000	97	1,800
1,1,1-Trichloroethane	ug/L	200	900	49	150	160	240	27	720
1,4-Dioxane	ug/L	3	21	23	5.0	38	1.4J	--	23
Carbon tetrachloride	ug/L	0.3	2.9	0.19J	--	--	0.38J	--	--
1,1,2-Trichloroethane	ug/L	0.6	1.9	--	0.65	0.81	0.42J	--	1.4
Benzene	ug/L	0.6	0.98	--	0.21J	0.21J	0.29J	--	0.19J

ug/L: micrograms per liter
CV: ATSDR Comparison Value
J: The identification of the analyte is acceptable but the reported value is an estimate

Drinking Water Samples Above ATSDR's CV

Contaminant			Pre filter	Bottled Water	Bottled Water	Bottled Water	Bottled Water	Bottled Water	Bottled Water
	Units	**CV**	10828APW	10941PW	13949PW	6683PW	10388PW	9289PW	9405PW
1,2-Dichloroethane	ug/L	0.4	19	0.19J	6.1	12	13	0.72	4
1,1-Dichloroethylene	ug/L	90 child	250	91	--	--	--	--	--
1,1,1-Trichloroethane	ug/L	200	41	18	--	--	--	--	--
1,4-Dioxane	ug/L	3	NA	--	NA	NA	NA	NA	NA
Carbon tetrachloride	ug/L	0.3	--	--	--	--	--	--	--
1,1,2-Trichloroethane	ug/L	0.6	0.88	--	--	--	--	--	--
Benzene	ug/L	0.6	0.7	--	--	61	0.92	--	0.47J

ug/L: micrograms per liter
CV: ATSDR Comparison Value
J: The identification of the analyte is acceptable but the reported value is an estimate
NA: Not Applicable