Health Consultation

MR. ZIP CONVENIENCE STORE

KNOXVILLE, KNOX COUNTY, TENNESSEE

MARCH 14, 2007

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

Health Consultation: A Note of Explanation

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

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

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HEALTH CONSULTATION

MR. ZIP CONVENIENCE STORE

KNOXVILLE, KNOX COUNTY, TENNESSEE

Prepared By:

Tennessee Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

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Foreword

This document summarizes an environmental public health investigation performed by Environmental Epidemiology of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people could be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be actions items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

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Introduction

In October 2006, the Tennessee Department of Environment and Conservation (TDEC), Division of Underground Storage Tanks (UST) contacted the Tennessee Department of Health, Environmental Epidemiology (TDH-EEP) concerning the presence of gasoline odors in a residential duplex located near a UST regulated facility in Knoxville, Tennessee. The TDH-EEP was asked to review air-sampling data from inside and outside the duplex and evaluate any potential public health hazard that could result from the exposure of the occupants to the gasoline vapors. Additionally, TDH-EEP contacted the Knox County Health Department (KCHD), notified them of the situation, and requested their assistance to review the site.

TDEC-UST field office personnel in Knoxville received a complaint concerning gasoline odors inside one of the apartments of a duplex located on Drinnen Avenue, in Knoxville, Tennessee (Figures 1 and 2). Knoxville UST personnel conducted three site investigations during the first half of October 2006. The investigations confirmed the presence of gasoline odors at the duplex, prompting an initial round of air sampling at the duplex.

Utilizing standard SUMMA™ canisters, five "grab" air samples were taken at the site on October 19, 2006. Additionally, on November 6, 2006, two 8-hour air samples were collected at the site. The analysis of the indoor and outdoor air samples obtained from the duplex property revealed the presence of gasoline related chemical vapors at this site. Thus, the focus of this public health consultation will be to assess any potential human health and safety concerns for the residents on Drinnen Avenue from the chemical vapors detected in the air sampling events.

Background

Site

The duplex home is located on Drinnen Avenue, Knoxville, Tennessee, which is an older, urban area of south Knoxville. The duplex is approximately 150 feet west of the Mr. Zip convenience store located at 3925 Chapman Highway, in Knoxville, Tennessee, 37920 (Figures 1 and 2). The hilly terrain in the site vicinity is characteristic of the environs of Knoxville.

Additionally, the duplex is approximately 200 feet west-southwest from Chapman Highway. Chapman Highway is a heavily traveled thoroughfare because it is one of the primary roadways that connect the suburban areas in southern Knox County, which lie on the south side of the Tennessee River, to downtown Knoxville.

The actual duplex structure is a wood framed house containing two separate apartments. The house does not have a basement, but there is a crawlspace underneath the structure. A portion of the crawlspace is of sufficient height to allow for a person to enter. This portion of the crawlspace was being used for storage.

Topographically, the duplex is located at an elevation approximately 35 to 50 feet below that of the convenience store building (Figure 3 and 8). The topography of the duplex property itself has necessitated the installation of surface water storm drains because of past flooding problems that occur during heavy rainfall events. The storm drains on the duplex property connect to a main storm drain system that also serves the convenience store property (Figure 2).

Gasoline Releases on the Convenience Store Property

The Mr. Zip convenience store was originally an Amoco service station. Phillips Petroleum purchased the property in 1989 (Figure 7). Prior to their purchase of the property, an environmental investigation revealed that there had been a release of an unknown quantity of gasoline from an underground storage tank. Environmental cleanup activities began in 1990 under the oversight of the TDEC, Division of Underground Storage Tanks (UST 2006a).

A groundwater and soil vapor extraction system was subsequently installed on the convenience store property, in the effort to remove gasoline from the subsurface environment (Figure 8). This system was in operation from January 1994 through August 2003 (UST 2006a).

A second release of gasoline from the convenience store property was discovered in November 2004. A complaint of gasoline odors from the occupant of the rear duplex apartment (i.e., the apartment where the subsequent indoor air samples were taken) prompted an investigation by the gasoline supplier to the convenience store. Gasoline was discovered in an observation well, indicating that gasoline had again been released from one of the underground storage tanks. The release was reported to TDEC-UST, and the convenience store's owners initiated an environmental cleanup (UST 2006b).

During past environmental investigations, several monitoring wells have been installed on the convenience store property, and also on adjacent properties. Gasoline related chemicals have been detected in water samples taken from a sump located adjacent to the storm-water catch basin along Edgar Street (across the street from the duplex) and in monitoring wells 1, 4, and 5 (Figure 2)(UST 2006b).

After the clean up of the November 2004 spill on the convenience store property, the problem with gasoline odors in the duplex continued. Though there are two apartments in the duplex, the rear apartment seemed to be most affected. There were never any complaints of gasoline odors from the occupant of the front duplex apartment. It was reported that the odors were more noticeable following heavy rainfall events (UST 2006b).

The duplex owner contacted the TDEC-UST in Knoxville for assistance. Knoxville UST personnel conducted an investigation of the odor complaint in early October 2006. UST personnel noted the presence of a storm drain at the southwest corner of the duplex (Figure 3). The gasoline odors/vapors emanating from the storm drain were very strong.

Gasoline related chemicals were known to be present in the sump adjacent to the storm-water catch basin on Edgar Street (Figure 4). It was suspected that there might be a connection to the drain at the southwest corner of the duplex. Though no gasoline-contaminated water was noted to be present in the storm drain, gasoline vapors can enter and move through storm-water drainpipes. Thus, this was suspected to be the source of the gasoline vapors entering the rear duplex apartment (UST 2006b).

Discussion

Environmental Sampling

Since the tenant of the rear duplex apartment was the only person expressing complaints concerning gasoline odors, the data gathering efforts at the site focused on the indoor air of this rental unit and the outdoor air on the duplex property. TDEC-UST in Knoxville scheduled an air-sampling event for October 19, 2006. Personnel from SEI Environmental, on behalf of owners of the Mr. Zip convenience store, collected 5 grab air samples at the site under the direction of Knoxville UST staff.

All of the grab air samples were collected with standard, six-liter SUMMA™ canisters. Three air samples were taken from various locations outside the duplex, on the duplex property. One of the outdoor air samples was taken at the surface opening to the storm drain at the southwest corner of the duplex, where the strong gasoline odors were found. One sample was taken from the crawlspace of the duplex, and one sample was taken in the rear duplex apartment where the occupant had complained of gasoline odors. During this sampling event, it was noted that the occupant of the rear duplex apartment was a smoker (UST 2006b). Cigarette smoke contains some of the same chemical constituents that are found in gasoline.

The air samples from the October 19, 2006 grab air-sampling event were analyzed for 67 chemical analyites. Of the 67 analyites, 28 were detected in the grab samples. Of the 28 chemicals detected at the site, 18 were detected inside the rear duplex apartment. The analytical results of the 5 grab air samples are presented in Tables 1A, 1B, 1C, 1D and 1E.

After the initial air sampling was completed, Knoxville UST personnel contacted TDH-EEP to discuss the data and the possible need for additional sampling at the site. Since grab samples are generally obtained in very quick manner and thus tend to reveal the environmental condition at a specific point in time, TDH-EEP recommended conducting an 8-hour air-sampling event at the site. An 8-hour air sample is considered a standard sample. It provides more comprehensive information about environmental conditions and sufficient data to more thoroughly evaluate the potential for airborne chemical exposure.

Knoxville UST personnel were able to arrange the collection of two additional air samples from the duplex property. One SUMMA™ canister was placed inside the rear duplex apartment and one canister was placed outside the rear duplex apartment entrance (location similar to where the grab sample in Table 1D was collected) to collect the 8-hour air samples.

The 8-hour air samples were collected on November 6, 2006. In addition to the Knoxville UST personnel providing oversight, a representative from the KCHD was present to observe this air-sampling event. These samples were analyzed for 67 chemical analyites. Of the 67 analyites, 21 were detected in both indoor and outdoor 8-hour air samples. Of the 21 chemicals detected at the site, 20 were detected inside the rear duplex apartment. The analytical results of the 8-hour air samples are presented in Tables 2A and 2B.

Introduction to Chemical Exposure

To determine whether persons are, have been, or are likely to be exposed to chemicals, Environmental Epidemiology of the Tennessee Department of Health evaluates mechanisms that could lead to human exposure. An exposure pathway contains five parts:

1. a source of contamination
2. contaminant transport through an environmental medium,
3. a point of exposure
4. a route of human exposure, and
5. a receptor population

An exposure pathway is considered complete if there is evidence that all five of these elements are, have been, or will be present at the site. The pathway is considered either a potential or an incomplete exposure pathway if there is no evidence that at least one of the five elements listed is, has been, or will be present at the site, or if there is a lower probability of exposure.

When a chemical is released from an area such an industrial plant or from a container such as a drum, it enters the environment. A chemical release does not, however, always lead to human exposure. Persons can be exposed to a chemical when contact is made by breathing, eating, drinking, or otherwise touching the chemical.

Furthermore, physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will develop adverse health effects. A chemical's ability to affect public health is controlled by a number of other factors, including:

- the amount of the chemical that a person is exposed to (dose)
- the length of time that a person is exposed to the chemical (duration)
- the number of times a person is exposed to the chemical (frequency)
- the person's age and health status
- the person's diet and nutritional habits.

TDH-EEP evaluated human exposure scenarios to the chemicals detected the duplex property located on Drinnen Avenue. There is a completed inhalation pathway for the occupants of the residence. Since rental property occupants vary over time (i.e., number, age, gender, period of time living in a rental unit, etc.), we looked at the health screening values for any population that may possibly live in one of the duplex apartments. We then compared the environmental levels of the chemicals health screening values established by the federal Agency for Toxic Substances and Disease Registry (ATSDR) to determine if further evaluation was needed.

Chemical Exposure at the Drinnen Avenue Duplex Property

The purpose of this public health consultation is to examine any potential health hazard from the exposure of the persons from any of the chemicals detected in the air (indoor and outdoor) at the site. To look more closely at populations that might be exposed to a hazardous substance, health assessors use health-screening levels determined for specific chemicals.

For non-carcinogenic effects of hazardous chemicals, ATSDR has derived a minimal risk level (MRL) for many chemicals. We have used the MRLs for inhalation exposure as a starting place in determining if health hazards may exist for any occupants of the duplex. MRLs apply to acute (14 days or less), intermediate (15–365 days), and chronic (365 days or more) exposures. To examine the inhalation route of exposure, we used the chronic inhalation MRLs, as this would be the most conservative assumption about chemical exposure. If an MRL for the chronic exposure was not listed, the intermediate exposure MRL was utilized.

If the chemical concentrations are below the screening level for a particular chemical, health assessors can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the screening levels for a particular chemical, then the public health implications need to be evaluated further.

Analytical Data Screening

Although gasoline contains over 150 chemicals (ATSDR 1995), 28 chemicals were detected on the duplex property in the overall air sampling events at the site. Twenty-three of those 28 chemicals detected were also found to be present inside the rear duplex apartment (Tables 1A and 2A). The majority of compounds, and those at highest concentrations, were related to gasoline.

To determine which chemicals would be of concern for this site, we utilized the MRLs as the health-screening level. The three chemicals found to exceed their respective MRLs in any of the air samples (either indoor or outdoor), all being constituents of gasoline, were benzene, xylene and methyl *tert*-butyl ether (MTBE). Thus, we will consider these three constituents to be the chemicals of concern for the site.

Background Chemical Concentrations

When examining chemical exposure through inhalation, it is necessary to take into account the amount of the chemical that is already in the environment. This is often referred to as the background level. Ambient air in urban areas generally has higher levels of contaminants or pollutants due to many factors including, the concentration of industry, number of commercial facilities that utilize chemicals (e.g., drycleaners), and the volume of vehicular (i.e., automobiles, tractor trailer trucks, rail yards, etc.) traffic. In this case, a residential property is in close proximity to a commercial gasoline station. Studies have demonstrated that air levels of gasoline and its constituents are higher at vehicle service stations (ATSDR 1995).

Benzene

Benzene in the environment comes from both human activities and natural processes. Benzene is found in air, water, and soil. It is a constituent of crude oil and gasoline and is released with motor vehicle exhaust and evaporation from gasoline stations. Another important source of benzene in the air is from industrial discharges and the burning of coal and oil. Benzene is also found in tobacco smoke. Background concentrations of benzene in air range from 2.8 to 20 parts per billion (ppb) (ATSDR 1997b). The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen (can cause cancer). Both the International Agency for Cancer Research (IARC) and the EPA has determined that benzene is carcinogenic to humans.

Xylene

Xylene is primarily a synthetic chemical, but it also occurs naturally in petroleum and coal tar. It is a colorless, flammable liquid with a sweet odor. It is used as a solvent in the printing, rubber, and leather industries. It is also widely used as a cleaning agent, a thinner for paint, and in varnishes. Xylene is found in airplane fuel and gasoline, and is also part of tobacco smoke. It evaporates and burns easily. Xylene is primarily detected in air. Background concentrations of xylene range from 1 to 30 ppb in outdoor air and from 1 to 10 ppb in indoor air (ATSDR 2005b). The DHHS has not classified xylene as to its carcinogenicity. Both IARC and EPA have determined that xylene is not classifiable as to its carcinogenicity in humans, due to inadequate evidence for the carcinogenicity of xylenes in humans and animals.

Methyl tert-*Butyl Ether (MTBE)*

MTBE is a synthetic chemical and does not occur naturally, and is released to the environment solely by human activities. It is released with motor vehicle exhaust and evaporation from gasoline stations. It is a flammable liquid made from combinations of chemicals like isobutylene and methanol, and has a distinctive odor that most people find disagreeable. MTBE readily evaporates and once in the air, it will quickly break down into other chemical compounds, with half of it disappearing in about 4 hours. The EPA has estimated that an annual mean MTBE concentration in ambient air in the United States is less than 0.2 ppb (ATSDR 1996). The EPA has identified MTBE as a possible human carcinogen. Neither the IARC, nor the National Toxicology Program has a cancer classification for MTBE (ATSDR 1996).

Gasoline related Chemicals inside the Duplex

Benzene, xylene, and MTBE were detected in the grab air sample from rear duplex apartment in the October 19, 2006, air-sampling event (Table 1A). Benzene and xylene concentrations were less than 1.00 ppb and the MTBE concentration was 2.10 ppb. None of the three chemicals exceeded their respective MRLs. Although the benzene and xylene levels were below background concentrations, the MTBE level was above background, but still well below its MRL of 700 ppb.

The results from the 8-hour indoor air sample, taken on November 6, 2006, indicated the presence of only benzene (1.20 ppb) and xylene (2.60 ppb) inside the rear duplex apartment. MTBE was not detected above the analytical reporting limit of 0.20 ppb (Table 2A). The long-term air sample confirmed that the chemicals of concern were below the MRLs and within known background concentrations. No adverse health effects are expected to occur based on the concentrations found during the two air sampling events.

Gasoline related Chemicals Outdoors on the Duplex Property

Four outdoor air samples were taken at the duplex property. The three grab air samples and one long-term 8-hour air sample. The analytical results from these samples are presented in Tables 1C, 1D, 1E, and 2B, respectively.

Three of the October 19, 2006, outdoor grab air samples had levels of benzene that equaled or exceeded the MRL of 3 ppb (Tables 1C, 1D, and 1E). The outdoor samples taken near the back porch and in the side yard, near Edgar Street, had concentrations of 3.00 ppb and 3.20 ppb, respectively. These concentrations are within the national background concentration range for benzene (ATSDR 1997b).

The sample from the ground level opening to the storm drain at the southwest corner of the duplex had the highest level of benzene of any sample (Table 1C). The benzene concentration was 149 ppb, 49 times higher than the MRL, and 7 times higher than the highest background level. Xylene and MTBE concentrations from this sampling location also exceeded their respective MRLs. The xylene concentration was 141 ppb and the MTBE concentration was 902 ppb. The MRL for xylene is 50 ppb and the MRL for MTBE is 700 ppb. These measurements lead to environmental investigators to suspect the storm drain as the source of the gasoline odors.

Less than a month later, the results from the November 6, 2006, outdoor 8-hour air sample did not show any MRL exceedances from any of the chemicals of concern, or any of the other gasoline related chemicals shown in the analytical results (Table 2B). This type of variation gives an indication of the somewhat problematic nature of outdoor air sampling. Changes in weather conditions on the dates the samples were taken, likely account for the variations.

The outdoor air sampling data implies that the ground level opening to the storm drain, at the southwest corner of the duplex, was the source of the gasoline odors entering the duplex. Though the concentrations of the chemicals of concern in air right at the storm drain opening were in excess of the MRLs on that sampling date, it appeared that the chemical concentrations

dissipated rapidly once away from the storm drain opening. Subsequently, the 8-hour outdoor air sample data provided a more accurate representation of average outdoor air quality conditions on the duplex property. Based on the outdoor air sampling data, no adverse health effects are expected to occur based on the concentrations found during the two air sampling events.

Gasoline Odors

Even though the indoor air sampling data does not indicate an increased risk of adverse health effects from chemical exposure, it is important to recognize that the initial environmental complaint was about gasoline odors inside the rear duplex apartment. Most people smell gasoline at about 250 ppb (ATSDR 1997b). Thus, exposure to the unpleasant odors associated with gasoline can lead to a decreased quality of life. As a measure of good public health practice, the gasoline odors should be eliminated.

Remedial Actions

During TDH-EEP's preparation of this public health consultation, Knoxville UST personnel indicated that an engineering solution to the gasoline vapor emissions from the storm drain opening at the southwest corner of the duplex, was being prepared by the environmental consultants working for the convenience store owner (UST 2006b). On January 17, 2007, Knoxville UST personnel informed TDH-EEP that the engineering controls had been approved and implemented at the site. Since the installation of the engineering controls, initial indications are that the gasoline odors have been eliminated at the duplex property (UST 2007). The duplex owner has not had any complaints of gasoline odors.

Child Health Considerations

In communities faced with environmental contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances (ATSDR 1997a, 1998). Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Children, whether occupants or guests of rental unit residents, could have been exposed to benzene, xylene, and MTBE via the inhalation pathway, while playing outside, in close proximity to the ground level storm drain opening at the southwest corner of the duplex. While children's lungs may be smaller than adults, they breathe a greater relative volume of air compared to adults. Benzene is a known human carcinogen. Thus, prudent public health practice dictates that potential child exposure to benzene should be eliminated.

Conclusions

The purpose of this public health consultation is to examine any potential health hazard from exposure to chemicals detected in the air (indoor and outdoor) at a duplex located on Drinnen Ave, Knoxville, Knox County, Tennessee. The consultation includes information from the Tennessee Department of Environment and Conservation (TDEC), Division of Underground Storage Tanks (UST), which documents gasoline releases on the Mr. Zip convenience store property that is adjacent to the duplex property. Based on the air sampling data obtained from the rear apartment of the duplex, there is no apparent public health hazard from gasoline vapors at this site. An indeterminate past public health hazard existed for exposure to benzene, xylene, and MTBE in outdoor air for any persons that may have been in close proximity, for an extended period of time to the ground level storm drain opening located at the southwest corner of the duplex, prior to the implementation of the engineering controls in the storm drain system.

Recommendations

Since the Knoxville UST staff reports that the implemented engineering controls appear to be alleviating the gasoline odors/vapors from the rear duplex apartment and the opening to the storm drain at the southwest corner of the duplex, TDH-EEP recommends that those engineering controls be maintained.

Public Health Action Plan

Tennessee Department of Health, Environmental Epidemiology (TDH-EEP) will provide copies of this public health consultation to the duplex owner, tenants, any concerned local residents, and the TDEC-UST. TDH-EEP will continue to provide health education to environmental regulatory agencies and community members concerned about the site, and continue to work with the Knoxville UST personnel as needed. TDH-EEP is available to review additional data.

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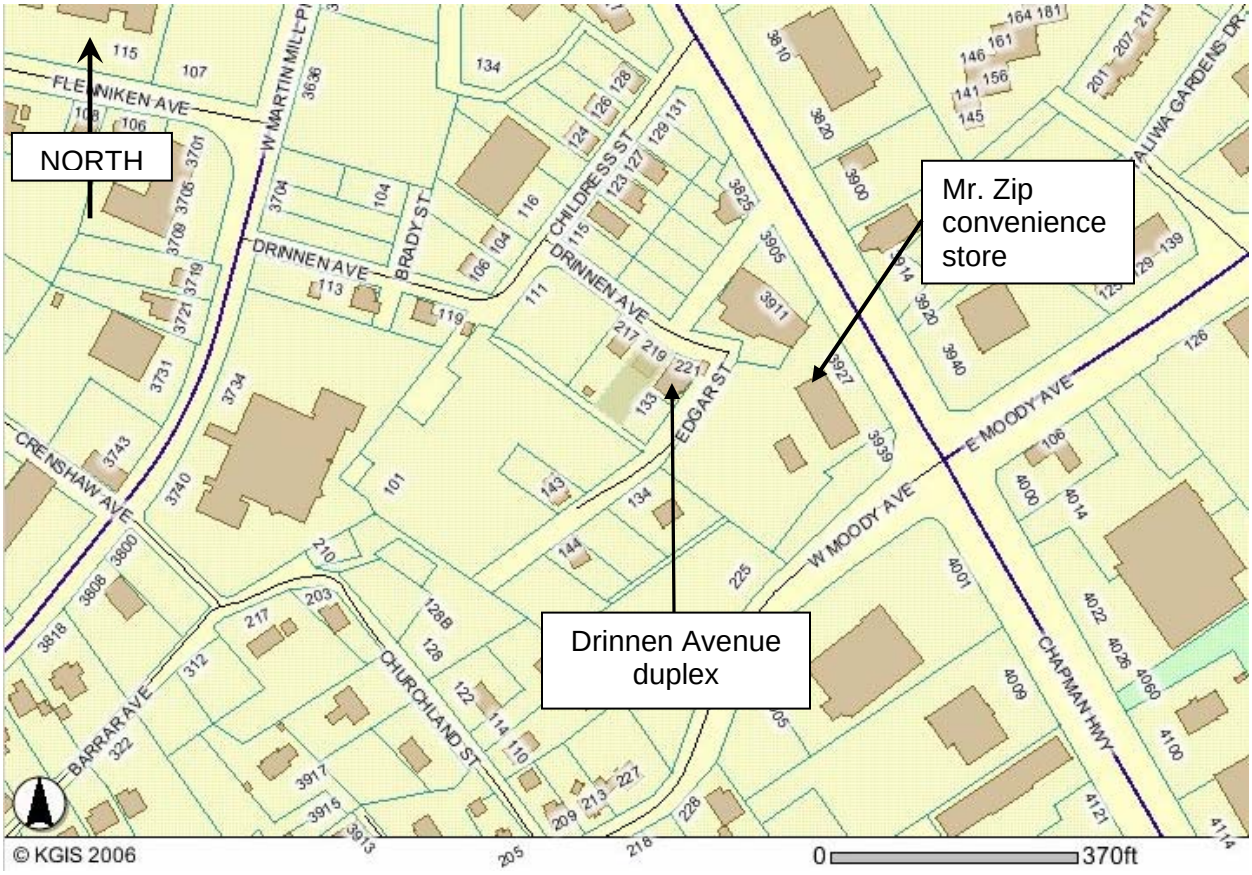
[TDEC-UST] Tennessee Department of Environment and Conservation, Division of Underground Storage Tanks. 2006c. October 19, 2006, Laboratory Analytical Data for 221 Drinnen Avenue site provided by Mr. Steve Wilson, Environmental Field Office Manager, October 31, 2006. Knoxville, TN.

[TDEC-UST] Tennessee Department of Environment and Conservation, Division of Underground Storage Tanks. 2006d. November 6, 2006, Laboratory Analytical Data for 221 Drinnen Avenue site provided by Mr. Rick Huchison, UST Project Manager. November 28, 2006. Knoxville, TN.

[TDEC-UST] Tennessee Department of Environment and Conservation, Division of Underground Storage Tanks. 2007. Personal communication with Mr. Steve Wilson, UST Field Office Manager, January 17, 2007. Knoxville, TN.

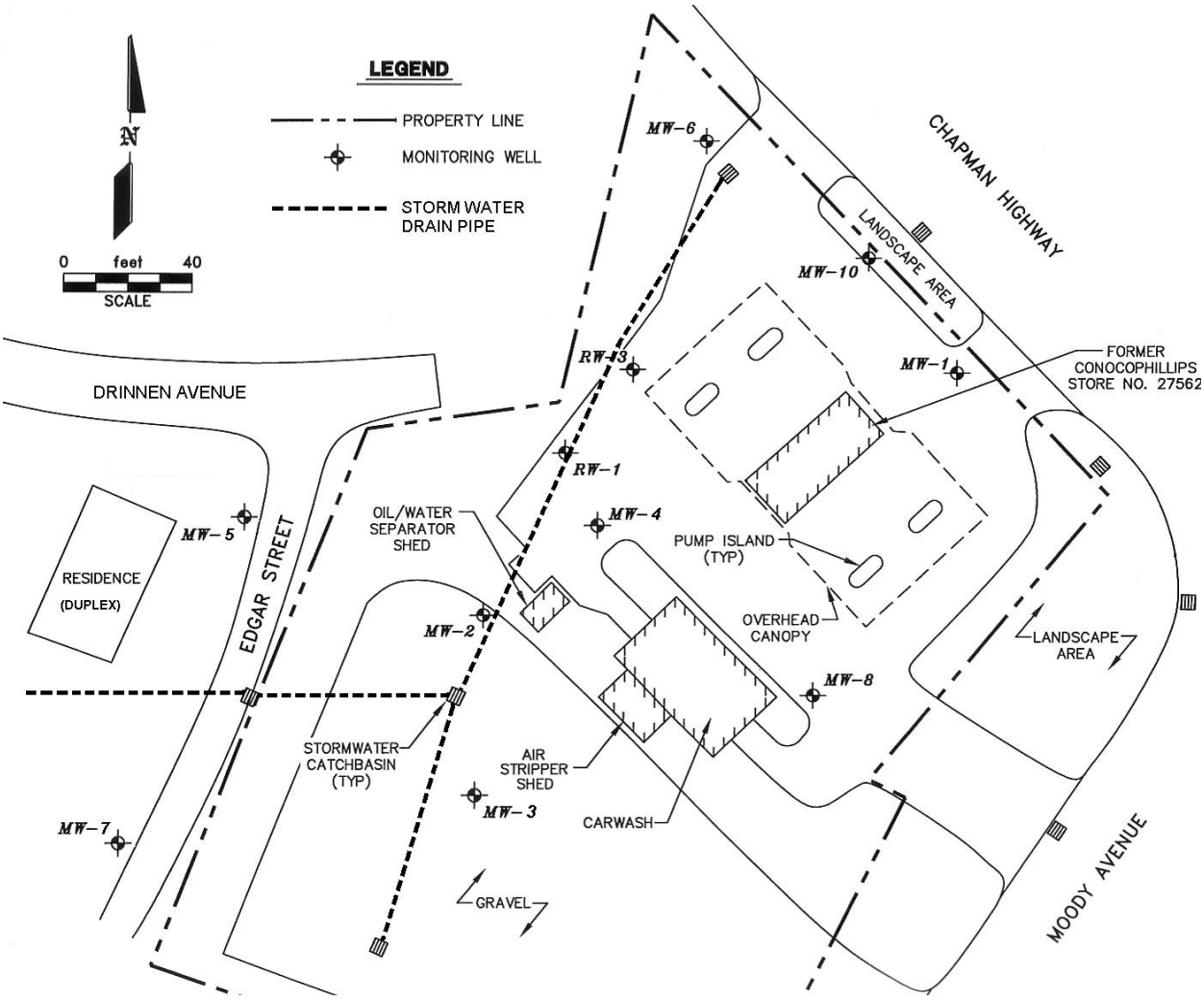
Figures

FIGURE 1 - Map showing the location of the Mr. Zip convenience store (vendor of automotive gasoline) located at 3925 Chapman Highway and the duplex located on Drinnen Avenue, Knoxville, Knox County, Tennessee.



(Map credit: Knox County Geographic Information Systems website, www.kgis.org)

FIGURE 2 - Scaled site map showing the spatial relationship between the duplex on Drinnen Avenue and the Mr. Zip convenience store located at 3925 Chapman Highway, Knoxville, Knox County, Tennessee.



(Map credit: Earth Tech International; UST 2006a)

FIGURE 3 - Photograph from the Drinnen Avenue duplex property, Knoxville, Knox County, Tennessee.

Surface opening of the storm-water drain located at the southwest corner of the duplex.

(Photo credit: Rick Huchison, TDEC-UST, 10-6-06)

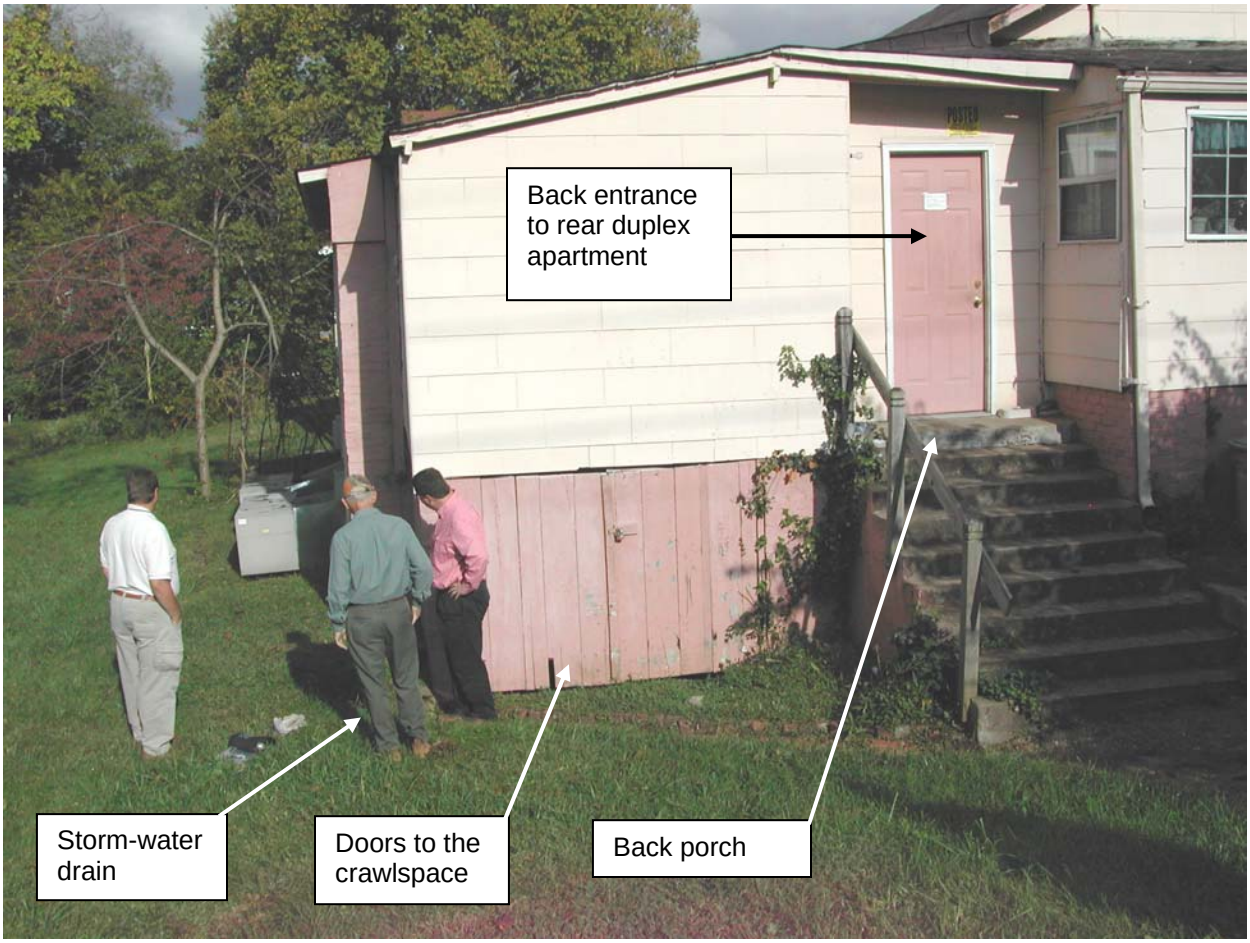
FIGURE 4 - Photograph from the Drinnen Avenue duplex property, Knoxville, Knox County, Tennessee.

Looking south to the storm drain catch basin and sump located on the south side of Edgar Street.

This view shows the nature of the topography in the site vicinity. The Mr. Zip convenience store is located on top of the hill behind the people in the photograph.

(Photo credit: Rick Huchison, TDEC-UST, 10-6-06)

FIGURE 5 - Photograph from the Drinnen Avenue duplex property, Knoxville, Knox County, Tennessee. The picture shows the southwest corner of the duplex. Edgar Street is behind the photographer.



(Photo credit: Rick Huchison, TDEC-UST, 10-6-06)

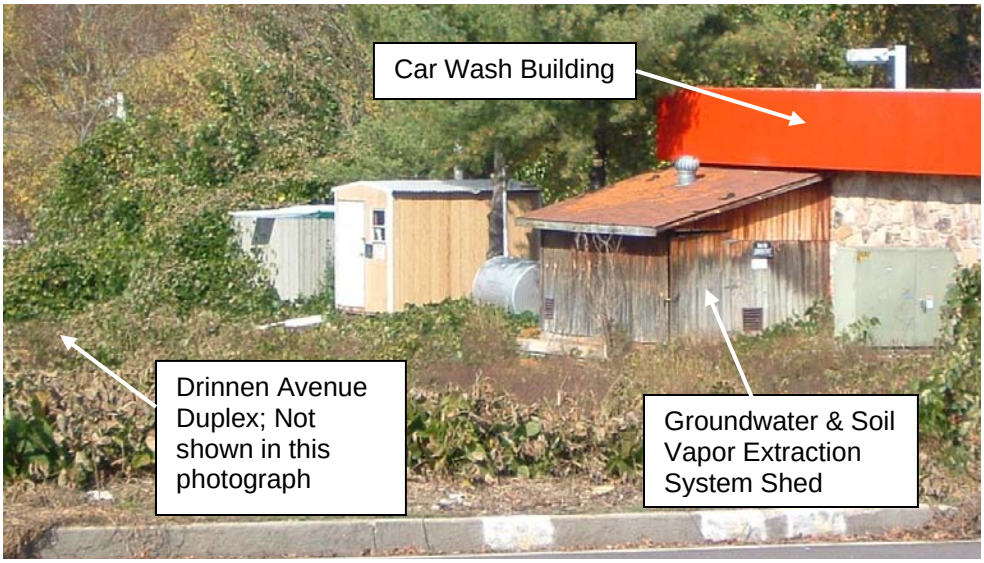
FIGURE 6 - Photograph from the Drinnen Avenue duplex property, Knoxville, Knox County, Tennessee. The picture shows the SUMMA™ canister that was positioned to collect the 11-6-06 outdoor air sample at the site. The canister was approximately 10 feet away from the rear duplex apartment doorway.

(Photo credit: Al Iannacone, KCHD, 11-6-06)

FIGURE 7 - Photograph of the Mr. Zip convenience store located at 3925 Chapman Highway, Knoxville, Knox County, Tennessee.

(Photo credit: Al Iannacone, KCHD, 10-30-06)

FIGURE 8 - Photograph of the Mr. Zip convenience store property located at 3925 Chapman Highway, Knoxville, Knox County, Tennessee. This picture shows the carwash building and the shed housing the mechanical apparatus of the groundwater and soil vapor extraction system.



(Photo credit: Al Iannacone, KCHD, 10-30-06)

Tables

TABLE 1A - Analytical results for the grab air sample taken from inside the rear apartment of the duplex on Drinnen Avenue; the air sample was collected on October 19, 2006; Values for the analytical results are in parts per billion (ppb) (TDEC-UST 2006c).

Chemical Compound	MRL* (ppb)	CREG (ppb)	Reporting Limits (ppb)	Analytical Result (ppb)
Acetone (CS)	13000		0.20	3.80
Benzene (G), (CS)	3	0.03	0.20	0.76
Carbon disulfide	300		0.20	U
Chlorobenzene			0.20	U
Chloroform	20	0.01	0.20	U
Chloromethane (CS)	50		0.20	0.32
Cyclohexane (G)			0.20	0.36
o-Dichlorobenzene			0.20	U
Dichlorodifluoromethane			0.20	0.47
Ethanol (G)			0.50	1.10
Ethylbenzene (G), (CS)	1000 (Int.)		0.20	0.25
4-Ethyltoluene (G)			0.20	U
Heptane (G)			0.20	U
Hexane (G)	600		0.20	0.22
Isopropyl alcohol (G)			0.20	0.41
Methyl *tert*-Butyl Ether (G)	700		0.20	2.10
Styrene (CS)	60		0.20	4.10
tert-Butyl alcohol (G)			0.20	U
Tetrachloroethylene	40		0.20	U
Toluene (G), (CS)	80		0.20	0.71
Trichloroethylene	100 (Int.)		0.20	0.20
Trichlorofluoromethane			0.20	0.24
1,2,4-Trimethylbenzene (G)			0.20	0.34
1,3,5-Trimethylbenzene (G)			0.20	U
2,2,4-Trimethylpentane (G)			0.20	0.15
m,p-Xylene (G)	50		0.20	0.51
o-Xylene (G)	50		0.20	U
Xylenes (total) (G), (CS)	50		0.20	0.66

U = Undetected (i.e., constituent was either not present or at levels below the analytical reporting limit)
* = Values in this column are for chronic MRLs, unless otherwise noted (ATSDR 2005a).
Int. = ATSDR Intermediate MRL.
BOLD = Analytical result that is equal to or exceeds an MRL value.
(G) = Chemical is found as a constituent in automotive gasoline.
(CS) = Chemical is found as a constituent in cigarette smoke.

TABLE 1B - Analytical results for the grab air sample taken from the crawlspace area (Figure 5) of the duplex on Drinnen Avenue; the air sample was collected on October 19, 2006; Values for the analytical results are in parts per billion (ppb) (TDEC-UST 2006c).

Chemical Compound	MRL* (ppb)	CREG (ppb)	Reporting Limits (ppb)	Analytical Result (ppb)
Acetone (CS)	13000		0.20	U
Benzene (G), (CS)	3	0.03	0.20	2.50
Carbon disulfide	300		0.20	U
Chlorobenzene			0.20	U
Chloroform	20	0.01	0.20	U
Chloromethane (CS)	50		0.20	0.33
Cyclohexane (G)			0.20	U
o-Dichlorobenzene			0.20	U
Dichlorodifluoromethane			0.20	0.49
Ethanol (G)			0.50	2.70
Ethylbenzene (G), (CS)	1000 (Int.)		0.20	1.20
4-Ethyltoluene (G)			0.20	0.47
Heptane (G)			0.20	1.00
Hexane (G)	600		0.20	3.10
Isopropyl alcohol (G)			0.20	U
Methyl *tert*-Butyl Ether (G)	700		0.20	4.70
Styrene (CS)	60		0.20	2.90
tert-Butyl alcohol (G)			0.20	U
Tetrachloroethylene	40		0.20	0.23
Toluene (G), (CS)	80		0.20	5.40
Trichloroethylene	100 (Int.)		0.20	0.24
Trichlorofluoromethane			0.20	0.27
1,2,4-Trimethylbenzene (G)			0.20	1.20
1,3,5-Trimethylbenzene (G)			0.20	0.39
2,2,4-Trimethylpentane (G)			0.20	2.10
m,p-Xylene (G)	50		0.20	3.20
o-Xylene (G)	50		0.20	1.20
Xylenes (total) (G), (CS)	50		0.20	4.30

U = Undetected (i.e., constituent was either not present or at levels below the analytical reporting limit)
* = Values in this column are for chronic MRLs, unless otherwise noted (ATSDR 2005a).
Int. = ATSDR Intermediate MRL.
BOLD = Analytical result that is equal to or exceeds an MRL value.
(G) = Chemical is found as a constituent in automotive gasoline.
(CS) = Chemical is found as a constituent in cigarette smoke.

TABLE 1C - Analytical results for the grab air sample taken outdoors, from the storm drain opening at the southwest corner (Figures 3 and 5) of duplex on Drinnen Avenue; the air sample was collected on October 19, 2006; Values for the analytical results are in parts per billion (ppb) (TDEC-UST 2006c).

Chemical Compound	MRL* (ppb)	CREG (ppb)	Reporting Limits (ppb)	Analytical Result (ppb)
Acetone (CS)	13000		0.20	U
Benzene (G), (CS)	**3**	0.03	1.60	**149.00**
Carbon disulfide	300		0.20	0.26
Chlorobenzene			0.20	U
Chloroform	20	0.01	0.20	U
Chloromethane (CS)	50		0.20	0.32
Cyclohexane (G)			1.60	85.8
o-Dichlorobenzene			0.20	U
Dichlorodifluoromethane			0.20	0.62
Ethanol (G)			0.50	U
Ethylbenzene (G), (CS)	1000 (Int.)		1.60	80.80
4-Ethyltoluene (G)			0.20	30.50
Heptane (G)			0.20	2.9
Hexane (G)	600		0.20	19.70
Isopropyl alcohol (G)			0.20	U
Methyl *tert*-Butyl Ether (G)	**700**		1.60	**902.00**
Styrene (CS)	60		0.20	2.20
tert-Butyl alcohol (G)			0.20	8.30
Tetrachloroethylene	40		0.20	U
Toluene (G), (CS)	80		0.20	35.10
Trichloroethylene	100 (Int.)		0.20	0.25
Trichlorofluoromethane			0.20	0.29
1,2,4-Trimethylbenzene (G)			1.60	110.00
1,3,5-Trimethylbenzene (G)			0.20	18.00
2,2,4-Trimethylpentane (G)			0.20	24.4
m,p-Xylene (G)	**50**		1.60	**121.00**
o-Xylene (G)	50		0.20	18.90
Xylenes (total) (G), (CS)	**50**		1.60	**141.00**

U = Undetected (i.e., constituent was either not present or at levels below the analytical reporting limit)
* = Values in this column are for chronic MRLs, unless otherwise noted (ATSDR 2005a).
Int. = ATSDR Intermediate MRL.
BOLD = Analytical result that is equal to or exceeds an MRL value.
(G) = Chemical is found as a constituent in automotive gasoline.
(CS) = Chemical is found as a constituent in cigarette smoke.

TABLE 1D - Analytical results for the grab air sample taken outdoors, on the porch of the entrance (Figure 5) to the rear apartment of the duplex on Drinnen Avenue; the air sample was collected on October 19, 2006; Values for the analytical results are in parts per billion (ppb) (TDEC-UST 2006c).

Chemical Compound	MRL* (ppb)	CREG (ppb)	Reporting Limits (ppb)	Analytical Result (ppb)
Acetone (CS)	13000		0.20	U
Benzene (G), (CS)	**3**	0.03	0.20	**3.00**
Carbon disulfide	300		0.20	U
Chlorobenzene			0.20	0.50
Chloroform	20	0.01	0.20	U
Chloromethane (CS)	50		0.20	0.49
Cyclohexane (G)			0.20	U
o-Dichlorobenzene			0.20	1.50
Dichlorodifluoromethane			0.20	0.70
Ethanol (G)			0.50	U
Ethylbenzene (G), (CS)	1000 (Int.)		0.20	0.95
4-Ethyltoluene (G)			0.20	0.43
Heptane (G)			0.20	0.22
Hexane (G)	600		0.20	U
Isopropyl alcohol (G)			0.20	U
Methyl *tert*-Butyl Ether (G)	700		0.20	14.60
Styrene (CS)	60		0.20	4.60
tert-Butyl alcohol (G)			0.20	U
Tetrachloroethylene	40		0.20	0.25
Toluene (G), (CS)	80		0.20	1.20
Trichloroethylene	100 (Int.)		0.20	0.34
Trichlorofluoromethane			0.20	0.33
1,2,4-Trimethylbenzene (G)			0.20	1.20
1,3,5-Trimethylbenzene (G)			0.20	0.25
2,2,4-Trimethylpentane (G)			0.20	0.58
m,p-Xylene (G)	50		0.20	1.50
o-Xylene (G)	50		0.20	0.36
Xylenes (total) (G), (CS)	50		0.20	1.90

U = Undetected (i.e., constituent was either not present or at levels below the analytical reporting limit)
* = Values in this column are for chronic MRLs, unless otherwise noted (ATSDR 2005a).
Int. = ATSDR Intermediate MRL.
BOLD = Analytical result that is equal to or exceeds an MRL value.
(G) = Chemical is found as a constituent in automotive gasoline.
(CS) = Chemical is found as a constituent in cigarette smoke.

TABLE 1E - Analytical results for the grab air sample taken outdoors in the side yard (Figure 4), near Edgar Street, of the duplex on Drinnen Avenue; the air sample was collected on October 19, 2006; Values for the analytical results are in parts per billion (ppb) (TDEC-UST 2006c).

Chemical Compound	MRL* (ppb)	CREG (ppb)	Reporting Limits (ppb)	Analytical Result (ppb)
Acetone (CS)	13000		0.20	22.90
Benzene (G), (CS)	**3**	0.03	0.20	**3.20**
Carbon disulfide	300		0.20	U
Chlorobenzene			0.20	U
Chloroform	20	0.01	0.20	1.90
Chloromethane (CS)	50		0.20	U
Cyclohexane (G)			0.20	U
o-Dichlorobenzene			0.20	U
Dichlorodifluoromethane			0.20	0.50
Ethanol (G)			0.50	86.60
Ethylbenzene (G), (CS)	1000 (Int.)		0.20	1.90
4-Ethyltoluene (G)			0.20	0.60
Heptane (G)			0.20	7.10
Hexane (G)	600		0.20	2.80
Isopropyl alcohol (G)			0.20	64.90
Methyl *tert*-Butyl Ether (G)	700		0.20	U
Styrene (CS)	60		0.20	1.90
tert-Butyl alcohol (G)			0.20	U
Tetrachloroethylene	40		0.20	U
Toluene (G), (CS)	80		0.20	18.30
Trichloroethylene	100 (Int.)		0.20	0.33
Trichlorofluoromethane			0.20	1.20
1,2,4-Trimethylbenzene (G)			0.20	2.00
1,3,5-Trimethylbenzene (G)			0.20	0.59
2,2,4-Trimethylpentane (G)			0.20	8.30
m,p-Xylene (G)	50		0.20	5.50
o-Xylene (G)	50		0.20	1.90
Xylenes (total) (G), (CS)	50		0.20	7.50

U = Undetected (i.e., constituent was either not present or at levels below the analytical reporting limit)
* = Values in this column are for chronic MRLs, unless otherwise noted (ATSDR 2005a).
Int. = ATSDR Intermediate MRL.
BOLD = Analytical result that is equal to or exceeds an MRL value.
(G) = Chemical is found as a constituent in automotive gasoline.
(CS) = Chemical is found as a constituent in cigarette smoke.

TABLE 2A - Analytical results for the 8 hour indoor air sample taken in the rear apartment of the duplex on Drinnen Avenue; the air sample was collected on November 6, 2006; Values for the analytical results are in parts per billion (ppb) (TDEC-UST 2006d).

Chemical Compound	MRL* (ppb)	CREG (ppb)	Reporting Limits (ppb)	Analytical Result (ppb)
Acetone (CS)	13000		0.20	9.10
Benzene (G), (CS)	3	0.03	0.20	1.20
Carbon disulfide	300		0.20	U
Chlorobenzene			0.20	U
Chloroform	20	0.01	0.20	0.23
Chloromethane (CS)	50		0.20	0.57
Cyclohexane (G)			0.20	U
o-Dichlorobenzene			0.20	U
Dichlorodifluoromethane			0.20	0.59
Ethanol (G)			0.50	49.60
Ethylbenzene (G), (CS)	1000 (Int.)		0.20	0.68
4-Ethyltoluene (G)			0.20	U
Heptane (G)			0.20	0.88
Hexane (G)	600		0.20	0.47
Isopropyl alcohol (G)			0.20	6.00
Methyl *tert*-Butyl Ether (G)	700		0.20	U
Styrene (CS)	60		0.20	0.50
tert-Butyl alcohol (G)			0.20	U
Tetrachloroethylene	40		0.20	0.32
Toluene (G), (CS)	80		0.20	17.00
Trichloroethylene	100 (Int.)		0.20	U
Trichlorofluoromethane			0.20	1.20
1,2,4-Trimethylbenzene (G)			0.20	0.78
1,3,5-Trimethylbenzene (G)			0.20	0.25
2,2,4-Trimethylpentane (G)			0.20	0.40
m,p-Xylene (G)	50		0.20	2.00
o-Xylene (G)	50		0.20	0.66
Xylenes (total) (G), (CS)	50		0.20	2.60

U = Undetected (i.e., constituent was either not present or at levels below the analytical reporting limit)
* = Values in this column are for chronic MRLs, unless otherwise noted (ATSDR 2005a).
Int. = ATSDR Intermediate MRL.
BOLD = Analytical result that is equal to or exceeds an MRL value.
(G) = Chemical is found as a constituent in automotive gasoline.
(CS) = Chemical is found as a constituent in cigarette smoke.

TABLE 2B - Analytical results for the 8 hour outdoor air sample (Figure 6) taken near the back entrance (Figure 5) of the rear apartment of the duplex on Drinnen Avenue; the air sample was collected on November 6, 2006; Values for the analytical results are in parts per billion (ppb) (TDEC-UST 2006d).

Chemical Compound	MRL* (ppb)	CREG (ppb)	Reporting Limits (ppb)	Analytical Result (ppb)
Acetone (CS)	13000		0.20	2.90
Benzene (G), (CS)	3	0.03	0.20	0.64
Carbon disulfide	300		0.20	U
Chlorobenzene			0.20	U
Chloroform	20	0.01	0.20	U
Chloromethane (CS)	50		0.20	0.45
Cyclohexane (G)			0.20	U
o-Dichlorobenzene			0.20	U
Dichlorodifluoromethane			0.20	0.61
Ethanol (G)			0.50	2.60
Ethylbenzene (G), (CS)	1000 (Int.)		0.20	0.22
4-Ethyltoluene (G)			0.20	U
Heptane (G)			0.20	U
Hexane (G)	600		0.20	U
Isopropyl alcohol (G)			0.20	U
Methyl *tert*-Butyl Ether (G)	700		0.20	1.00
Styrene (CS)	60		0.20	0.35
tert-Butyl alcohol (G)			0.20	U
Tetrachloroethylene	40		0.20	0.59
Toluene (G), (CS)	80		0.20	1.20
Trichloroethylene	100 (Int.)		0.20	U
Trichlorofluoromethane			0.20	0.27
1,2,4-Trimethylbenzene (G)			0.20	0.25
1,3,5-Trimethylbenzene (G)			0.20	U
2,2,4-Trimethylpentane (G)			0.20	0.23
m,p-Xylene (G)	50		0.20	0.48
o-Xylene (G)	50		0.20	U
Xylenes (total) (G), (CS)	50		0.20	0.65

U = Undetected (i.e., constituent was either not present or at levels below the analytical reporting limit)
* = Values in this column are for chronic MRLs, unless otherwise noted (ATSDR 2005a).
Int. = ATSDR Intermediate MRL.
BOLD = Analytical result that is equal to or exceeds an MRL value.
(G) = Chemical is found as a constituent in automotive gasoline.
(CS) = Chemical is found as a constituent in cigarette smoke.

Certification

This Public Health Consultation *Mr. Zip Convenience Store, Knoxville, Knox County, Tennessee* was prepared by the Tennessee Department of Health Environmental Epidemiology under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun.

Technical Project Officer, CAT, SPAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health assessment and concurs with the findings.

Team Leader, CAT, SPAB, DHAC, ATSDR