Health Consultation

KEENE ROAD LANDFILL

LAKE JEWEL COMMUNITY

APOPKA, ORANGE COUNTY, FLORIDA

EPA FACILITY ID: FLD984169060

NOVEMBER 1, 2006

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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Prepared by:

Florida Department of Health
Bureau of Community Environmental Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Foreword

This document summarizes public health concerns around the Keene Road Landfill in Apopka, Florida. The Florida Department of Health (DOH) evaluates site-related public health issues through the following processes:

- Evaluating exposure: Florida DOH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where the contamination occurs, and how people might be exposed to it. Usually, the Florida DOH does not collect its own environmental sampling data. We rely on information provided by government agencies, businesses and the public. Orange County Health Department (CHD), Orange Environmental Protection Division (EPD), and Florida Department of Environmental Protection (DEP) provided the information for this health consultation.
- Evaluating health effects: If there is evidence that people are being exposed, or could be exposed to hazardous substances in the future, Florida DOH scientists will determine whether that exposure could be harmful to human health. This report focuses on public health; that is, the health impacts on the community as a whole, and we base it on the available scientific information.
- Developing recommendations: In this evaluation report, the Florida DOH outlines its conclusions regarding any potential health threat posed a site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of the Florida DOH in dealing with hazardous waste sites is primarily advisory. For that reason, the evaluation report will typically recommend actions other agencies, including the Florida DEP and Orange CHD, should take. If, however, an immediate health threat exists or is imminent, DOH will issue a public health advisory warning people of the danger, and will work to resolve the problem.
- Soliciting community input: The evaluation process is interactive. The Florida DOH starts by soliciting and evaluating information from various government agencies, individuals, or organizations responsible for cleaning up the site, and those living in communities near the site. We share any conclusions about the site with the groups and organizations providing the information. *If you have questions or comments about this report, we encourage you to contact us.*

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Summary and Statement of Issues

In January 2006, the Orange County Health Department (CHD) asked the Florida Department of Health (DOH) to evaluate the public health threat posed by the Keene Road Landfill. Lake Jewel residents, along with ACORN (Association of Community Organizations for Reform Now, Inc.) are concerned that the proximity of the Keene Road Landfill and other sources are making people sick.

Between 2001 and 2006, the Orange CHD and the Florida Department of Environmental Protection (DEP) took samples from 26 private wells and analyzed for nitrate, nitrite and purgeable organics, which includes volatile organic compounds (VOCs). In March 2006, the DOH requested that Orange CHD sample private wells within 0.25 miles of the boundary of the Keene Road Landfill for VOCs, primary metals and semi-volatile organic compounds. However, in the interim, most Lake Jewel residents had switched to municipal water and most private wells have recently been capped.

Waste Management, Inc. (WMI) is the owner of the Keene Road Landfill and thus responsible for meeting the permit requirements set by DEP. Keene Road Landfill is a construction and demolition waste landfill (Class III). They are required to monitor groundwater and some surface water around the landfill for a suite of chemicals that includes metals, VOCs, and inorganics. In addition, WMI hired Grove Scientific and Engineering Company (GSE) in September 2004 to complete ambient hydrogen sulfide gas concentration measurements.

Current exposures are **no apparent public health hazard** for residents now hooked up to city water. All but three nearby residences are on city water; current exposures for these residents are an **indeterminate public health hazard** because of insufficient data for these wells.

Past exposures might be a concern for residents that used groundwater from private wells because of ammonia and manganese levels found in monitoring wells. Private wells were not sampled for those contaminants though, so it is unknown if residents were exposed to contaminants at the same level as the monitoring wells. We evaluated monitoring well results because groundwater connects private wells and monitoring wells. However, private wells tend to be deeper than monitoring wells and often have lower levels of contaminants.

This health consultation evaluated the public health threat posed by Keene Road Landfill to the Lake Jewel community in South Apopka. The Florida DOH conducted this health consultation in cooperation with the federal Agency for Toxic Substances and Disease Registry (ATSDR). This is the first assessment of this site by either the Florida DOH or the ATSDR. This report addresses data collected between January 2001 and June 2006 by the Florida DEP, Florida DOH, Orange County Environmental Protection Division (EPD), and the Orange CHD.

Background

Site Description and History

The Lake Jewel community is located in South Apopka, Orange County, Florida. The Keene Road Landfill is at 255 West Keene Road, Apopka, FL 32703. At its closest point, the community is located less than 0.5 miles north of the landfill.

Demographics

In 2000, approximately 2,642 people lived within one mile of the Keene Road landfill. Of the total population, 55% were black or African American, 40% were white, and 5% were Native American, Asian, and/or other ethnic groups (US Bureau of the Census, 2000).

Land Use

Land use surrounding Keene Road landfill is primarily agricultural. The main agricultural activity is ornamental plant propagation. There is some residential land use, primarily along the north, east and west perimeter of the landfill (Grove Scientific & Engineering Company, 2005).

Community Health Concerns

At a meeting on January 12th, 2006, the Lake Jewel community and ACORN met with DEP, Orange CHD, Orange EPD, and DOH to express their concerns. They are concerned about: lupus, high death rate, heart disease, heart attack, hepatitis, pancreatic cancer, leukemia, bronchitis, nosebleeds, colon cancer, respiratory illness, liver cysts, diabetes, low birth weight, and asthma. They are concerned that the Keene Road landfill and other sources are causing these symptoms, illnesses and adverse health outcomes.

Discussion

This section identifies levels of chemicals present in environmental media, identifies exposure pathways for people's contact with those chemicals, and evaluates whether people's typical daily exposure might cause illness. We attempt to moderate the uncertainties inherent in the health consultation process by using health protective assumptions when estimating or interpreting health risks. Therefore, we base our dose calculations on the highest measured levels of a chemical. Also, the health-based values (established by the federal ATSDR, US EPA and DEP) we use to screen the data include wide margins of safety. The assumptions, interpretations, and recommendations in this health consultation are protective of public health.

Environmental Contamination

In this section, we review environmental data collected at and near the site between January 2001 and June 2006. We evaluate the sampling adequacy and identify the contaminants of concern at the site. In this section, we refer to tables that list the maximum concentration and detection frequency for that contaminant in the groundwater and air. No soil data were available. We selected the contaminants of concern by considering the following factors:

1. Concentrations of contaminants found on and around the site. Contaminants are eliminated from further consideration if the measured on-site and off-site concentrations are below standard comparison values established by ATSDR, EPA, and DEP.
2. Field-data quality, laboratory-data quality, and sample design.
3. Community health concerns. These are concerns expressed by members of the nearby community about possible adverse health effects from exposure to site contaminants.
4. Comparisons of the maximum concentrations of contaminants identified at the site to ATSDR-published standard comparison values for contaminated environmental

media for which a completed exposure pathway, or potential exposure pathway, is found to exist at the site. Standard comparison values are specific to the type of environmental media (water, soil, air) that is contaminated. These standard comparison values are used to select site contaminants for further evaluation. These values are not used to predict health effects or to establish clean-up levels. When site contaminants are found to have media concentrations that are above ATSDR's chemical-specific standard comparison values, the contaminant is selected for further evaluation. This does not necessarily mean that a contaminant represents a health risk. Site contaminants that fall below an ATSDR chemical-specific standard comparison value are unlikely to be associated with illness and consequently are not evaluated further unless the community has expressed a specific concern about the contaminant.

5. Comparisons of maximum site concentrations found in completed and potential exposure pathways to toxicological information published in ATSDR's chemical-specific toxicological profiles (available on the internet at http://www.atsdr.cdc.gov/toxpro2.html). These chemical-specific profiles summarize information about the toxicity of chemicals from the scientific literature.

Florida DOH used the following ATSDR (ATSDR, 2005c) and Florida DEP (Florida DEP, 2005) standard comparison values, in order of priority, to select contaminants of concern:

1. CREGs (Cancer Risk Evaluation Guides) – A CREG is the contaminant concentration estimated to result in no more than one excess cancer per 1 million persons exposed during a lifetime (70 years). ATSDR calculates CREGs from the U.S. Environmental Protection Agency (EPA) established cancer slope factor.
2. EMEGs (Environmental Media Evaluation Guides) – ATSDR derives EMEGs from Minimal Risk Levels (MRLs) using standard exposure assumptions, such as ingestion of 2 liters of water per day and body weight of 70 kg for adults. MRLs are estimates of daily human exposure, generally for a year or longer, to a chemical likely to be without an appreciable risk of non-cancerous illnesses. EMEGs used in this report were either for chronic (>365 days), intermediate (15–364 days) or acute (<14 days) exposures, where established.
3. RMEGs (Reference Dose Media Evaluation Guides) – ATSDR derives RMEGs from EPA's oral reference doses, which are developed based on EPA evaluations. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse noncarcinogenic effects.
4. LTHAs (Lifetime Health Advisories) – ATSDR derives LTHAs based on EPA analyses of toxicity data.
5. MCLs (Maximum Contaminant Levels) – The Florida Department of Environmental Protection (DEP) derives MCLs from EPA standards or from health data compiled from state and federal resources. MCLs are fully enforceable standards and must be equal to or more stringent (lower) than federal MCLs (such as the EPA's).

The above standard comparison values are designed with large safety margins to protect the most sensitive individuals. Thus, exposure to contaminants at levels below the standard comparison

values is not likely to cause illness. We select contaminants at levels above the standard comparison values as contaminants of concern.

Identification of a contaminant of concern in this section does not necessarily mean that exposure will cause illness. Rather, identification serves to narrow the focus of the health consultation to those contaminants most important to public health. DOH evaluates contaminants of concern to determine whether exposure is likely to cause illness (ATSDR, 2005a).

When we select a contaminant of concern in one environmental medium at a site, we report the levels of the contaminant for the other environmental media, even if the measured amounts do not exceed a screening level for other media. This allows the reader to assess the relative contributions that exposures to different site media might contribute for a contaminant of concern.

In this section, DOH reviews groundwater, private well, and hydrogen sulfide ambient air data. DEP, Grove Scientific & Engineering (GSE), Keene Road Landfill, Orange EPD, and Orange CHD collected this data between January 2001 and June 2006.

The completeness and reliability of the referenced environmental data determine the validity of the analyses and the conclusions we draw for this health consultation. DOH used existing environmental data to prepare this health consultation. We assumed that these data were valid. Governmental agencies oversee the consultants and laboratories that collect and analyze these samples.

Using the above criteria, we identified arsenic, bromodichloromethane and dibromochloromethane as contaminants of concern. During the January 12, 2006, meeting with the Lake Jewel community and ACORN, community members expressed concerns about mercury, nitrate, ammonia, and benzene levels. Based on monitoring well levels, ammonia, manganese, and acrylonitrile were also selected as contaminants of concern.

All of the following were selected as contaminants of concern for the reasons described above (Tables 1 and 2):

- Acylonitrile
- Ammonia
- Arsenic
- Benzene
- Bromodichloromethane
- Dibromochloromethane
- Manganese
- Mercury
- Nitrate

Ammonia, arsenic, benzene, manganese, mercury, and nitrate are naturally occurring substances (ATSDR, 2004a; ATSDR, 2000a and ATSDR 2005b; ATSDR, 2005D; ATSDR, 2001a; ATSDR, 1999a; ATSDR, 2001b). Acrylonitrile is a colorless, man-made liquid with a sharp, onion- or garlic-like odor. It is used to make plastics, synthetic rubber, and acrylic fibers (ATSDR, 1999b). Ammonia is a form of nitrogen, which is an important nutrient for plants and animals. It is applied directly to farm fields and is used to make fertilizers for crops, lawns, and plants (ATSDR, 2004a). Industries use benzene to make rubber, lubricants, dyes, detergents,

drugs, and pesticides. Benzene is a natural component of volcanoes and forest fires, as well as crude oil, gasoline and cigarette smoke (ATSDR, 2005d). Bromodichloromethane and dibromochloromethane are by-products formed when chlorine is added to drinking water, though some laboratories use bromodichloromethane to make other chemicals. Both chemicals can be formed by pouring bleach down a well as part of the well-disinfection process (ATSDR, 1989; ATSDR, 2005e). Manganese is an essential human nutrient. It is naturally occurring in many types of rocks. People may be exposed to excess levels of manganese if they improperly use pesticides such as maneb and mancozeb (ATSDR, 2001a). Mercury comes in many different forms because it combines with other elements such as chlorine, sulfur and oxygen (to make mercury salts), as well as carbon. Some thermometers, dental fillings, and batteries have metallic mercury in them. Some skin lightening creams, antiseptic creams and ointments contain mercury salts (ATSDR, 1999a).

Exposure Pathways

Most chemical contaminants in the environment will only harm people through direct exposure. It is essential to determine or estimate the frequency of contact people could have with hazardous substances in their environment in order to assess the public health significance of the contaminants.

Chemical contaminants in the environment can harm one's health under certain exposure characteristics which include sufficient dose, but only if one contacts those contaminants at a high enough concentration to cause a health effect. Knowing or estimating the frequency with which people could have contact with chemical contaminants is essential to assessing the public health importance of those contaminants.

To decide if people can contact contaminants at or near a site, DOH looks at human exposure pathways. An exposure pathway has five parts:

1. a source of contaminants;
2. an environmental medium such as, air, water, or soil that can hold or move the contamination;
3. a point at which people come in contact with a contaminated medium, such as in drinking water, or in soil in a garden;
4. an exposure route, such as drinking contaminated water from a well, or eating contaminated soil on homegrown vegetables; and
5. a population who could come in contact with the contaminants.

We eliminate an exposure pathway if at least one of the five parts is missing and will not occur in the future. Exposure pathways not eliminated are either completed or potential. For completed pathways, all five pathway parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur. For potential pathways, at least one of the five parts is missing, but could exist. Also for potential pathways, exposure to a contaminant could have occurred, could be occurring, or could occur in the future.

This health consultation addresses the public health implications of drinking untreated groundwater and breathing ambient air in the Lake Jewel community. For past and current exposures, there are completed pathways for both groundwater and air. Prior to being connected to municipal water, some residents used private wells. Currently, some residents use private wells. Most residents, however, are on municipal water and thus, do not have a completed

pathway for groundwater exposure. For future exposures, exposure to ambient air is a completed pathway. All of the known private wells are being capped and residents connected to municipal water.

Public Health Implications

To evaluate exposure, DOH estimates the daily dose of each contaminant of concern found at the site. Kamrin (1988) explains a dose in this manner:

> "…all chemicals, no matter what their characteristics, are toxic in large enough quantities. Thus, the amount of a chemical to which a person is exposed is crucial in deciding the extent of toxicity that will occur. In attempting to place an exact number on the amount of a particular compound that is harmful, scientists recognize they must consider the size of an organism. It is unlikely, for example, that the same amount of a particular chemical that will cause toxic effects in a 1-pound rat will also cause toxicity in a 1-ton elephant."
>
> "Thus instead of using the amount that is administered or to which an organism is exposed, it is more realistic to use the amount per weight of the organism. Thus, 1 ounce administered to a 1-pound rat is equivalent to 2000 ounces to a 2000-pound (1-ton) elephant. In each case, the amount per weight is the same: 1 ounce for each pound of animal. This amount per weight is the dose. We use dose in toxicology to compare the toxicity of different chemicals in different animals."

DOH evaluates exposures by estimating daily doses for children and adults. Dose refers to the amount of chemical per weight; expressed in milligrams (mg) of contaminant per kilogram (kg) of body weight per day (mg/kg/day). A milligram is 1/1,000 of a gram; a kilogram is approximately 2 pounds.

To calculate the daily dose of each contaminant, DOH uses standard assumptions about body weight, ingestion and inhalation rates, and duration of exposure. We assume a person's exposures to the maximum concentrations measured at the site occur daily in each environmental medium (soil, air, and water). Acute exposures are those with duration of 14 days or less; intermediate exposures are those with duration of 15 to 364 days; and chronic exposures are those that occur for 365 days or more (or an equivalent length for animal exposures).

To estimate exposure from drinking private well water, DOH used the following assumptions (ATSDR, 2005a):

- children ingest an average of 1 liter of water per day,
- adults ingest an average of 2 liters of water per day,
- children weigh an average of 15 kilograms (kg),
- adults weigh an average of 70 kg,
- children ingest contaminated groundwater and inhale contaminated air at the maximum concentration measured for each contaminant for 3 years, and
- adults ingest contaminated groundwater and inhale contaminated air at the maximum concentration measured for each contaminant for 30 years (a worst-case default assumption used because some residents have lived in the area longer than 30 years, and some have not).

To assist in the evaluation of potential health effects, ATSDR has developed Minimal Risk Levels (MRLs) for contaminants commonly found at hazardous waste sites. An MRL is an estimate of daily human exposure to a contaminant below which non-cancerous, adverse health effects are unlikely to occur. ATSDR might develop MRLs for each route of exposure, such as ingestion and inhalation. ATSDR also develops MRLs for the length of exposure, such as acute (less than 14 days), intermediate (15–364 days), and chronic (equal to or greater than 365 days).

ATSDR includes these MRLs in its toxicological profiles. These chemical-specific profiles provide information on health effects, environmental transport, human exposure, and regulatory status. Please refer to Tables 3, 4 and 5 for more information.

The following sections detail the contaminant effects based on exposure route (groundwater and air).

Groundwater – Private wells

This section only applies to residents who are currently using private wells for their cooking and drinking water or who used private wells in the past. This exposure route will not affect residents who are and have always been on municipal water.

In total, 26 private wells were sampled numerous times between January 2001 and June 2006. Private wells were tested for nitrate, nitrite and purgeable organics (includes volatile organic compounds: VOCs) between January 2001 and March 2004 (Figure 3). This includes the following contaminants of concern: benzene and nitrate. For these contaminants of concern, the levels are not likely to cause illness because all of the levels are below the screening values.

In March 2006, the DOH requested Orange CHD to sample private wells within 0.25 miles of the boundary of Keene Road Landfill for volatile organic compounds (VOCs), semi-volatile organic compounds, and primary metals, which includes the following contaminants of concern: arsenic, benzene, bromodichloromethane, dibromochloromethane, and mercury. By this time, only eight wells remain within 0.25 miles of the Keene Road landfill. These wells were sampled for VOCs in March 2006. Most homes in the area are already on public water. Other wells are slated to be removed for road construction (personal communication, Robert Wayne). In May 2006, only three private wells remained. These three wells were sampled for semi-volatile organic compounds, VOCs and primary metals.

The following chemicals were found in private wells at levels above screening values: arsenic, bromodichloromethane and dibromochloromethane (Table 1). Bromodichloromethane and dibromochloromethane are commonly found in water disinfected with chlorine and may not be site related. Sections for each of the contaminants of concern follow, even though most of them were not found in private wells above the screening values.

Both private wells and monitoring wells around the Keene Road landfill were sampled for many different contaminants. Where there are data for both monitoring wells and private wells, the private well data was used because it is a direct measurement of what people were being exposed to.

The private wells were not tested for ammonia, acrylonitrile or manganese. Thus, it is not possible to determine the levels of ammonia, acrylonitrile or manganese in these wells. Because these private wells were not tested for ammonia, acrylonitrile and manganese, we assessed the health threat based on the highest concentrations found in the landfill monitoring wells. Although

the direction of groundwater flow is unknown, the private wells are within 0.25 mile of the landfill monitor wells (Figure 3).

North of the landfill in the shallow surficial aquifer the groundwater flow is southeast/southwest. There are private wells to the south of the landfill that could be affected. The groundwater flow in the intermediate zone of the surficial aquifer radiates from approximately Lake Gentile outward (Figure 4). Groundwater flow in the Floridan aquifer is north. Thus, pollutants found in monitoring wells may also affect private wells to the north of Keene Road landfill. Private wells may be screened in several aquifers or at several depths within an aquifer. We do not know the depth of the private wells. Thus, we evaluated the highest levels of contaminants found in all of the private wells to be the most protective of public health.

For the following sections, please refer to Tables 3, 4 and 5.

Arsenic

The highest estimated arsenic doses for adults and children are not likely to cause non-cancer illness. The highest measured arsenic concentration in a private drinking water well of 10 parts per billion (ppb) translates to an ingestion dose of 0.0007 mg/kg/day for a child (the most sensitive population). This dose is three times lower than the lowest LOAEL (lowest observable adverse effect level) for non-cancerous effects associated with increased prevalence of stroke in humans (0.002 mg/kg/day). The dose for adults (0.0003 mg/kg/day) is seven times lower than the lowest LOAEL.

One of the most common and characteristic effects of chronic exposure to arsenic from drinking water is the appearance of skin lesions (hyperkeratotic warts or corns) on the palms and soles. Other sensitive effects include generalized hyperkeratosis (thickening of the skin) and areas of hyperpigmentation (dark skin) interspersed with small areas of hypopigmentation (light skin) on the face, neck, and back. The lowest dose associated with these effects (0.01 mg/kg/day) is 14 times higher than the highest dose (0.0007 mg/kg/day) for a child and 33 times higher than the highest dose (0.0003 mg/kg/day) for an adult near Keene Road landfill. These effects are not likely at the levels found in the community around Keene Road landfill.

Chronic exposure to low doses of arsenic in people has been linked to lung and bladder cancer. At the highest arsenic level found, the theoretical increased risks of cancer from consuming water is a 2 in 10,000 risk for adults drinking 2 liters of water daily for 30 years and a 4 in 100,000 risk for children. This is a low increased risk for cancer.

Arsenic is not volatile, thus there would not be an inhalation (breathing) exposure from showering. Arsenic is a metal and the skin does not absorb metals well. The average daily dose to arsenic from dermal exposure is 0.000001 mg/kg/day for a child and 0.0000007 mg/kg/day for an adult. These doses are six million times and nine million times, respectively, lower than the LOAEL (6 mg/kg/day) associated with gross hyperplasia and ulceration for intermediate exposure in mice. Therefore, no dermal or inhalation problems from showering with this water are likely (ATSDR, 2000a and ATSDR, 2005b).

Benzene

Benzene was not detected in private drinking water wells above the detection limit of 0.21 ppb. This is about three times lower than the ATSDR screening level of 0.6 ppb. This screening value is protective of both cancer and non-cancer illness for both adults and children. Thus, it is

unlikely that drinking benzene in private well water will cause cancer or non-cancer illness in either adults or children.

Bromodichloromethane

Worst-case exposure scenarios for drinking bromodichloromethane from private wells did not generate doses for children or adults high enough to cause cancer or non-cancer health effects. The dose for an adult (0.0003 mg/kg/day) and child (0.0007 mg/kg/day) are both lower than the chronic oral MRL. The theoretical increased risks of cancer from consuming water with this level of bromodichloromethane for children (2 in a million) and adults (8 in a million) are insignificant.

Bromodichloromethane is very volatile; however, no studies were located regarding toxic effects in humans or animals following inhalation exposure. Studies were not located regarding toxic effects in humans or animals following dermal exposure. Thus, it is unknown whether toxic effects will result from inhalation or dermal exposure to bromodichloromethane (ATSDR, 1989).

Bromodichloromethane belongs to a group of chemicals known as trihalomethanes. The drinking water standard for trihalomethanes is 80 parts per billion (ppb). Trihalomethanes are a common byproduct of well disinfection processes. They can be formed by pouring bleach down a well.

Dibromochloromethane

The highest estimated dibromochloromethane doses for adults and children are not likely to cause cancer or non-cancer illness. The highest measured dibromochloromethane concentration in a private drinking water well of 3.5 parts per billion (ppb) translates to an ingestion dose for children of 0.0002 mg/kg/day (the most sensitive population). This is lower than the chronic oral MRL. The dose for an adult (0.0001 mg/kg/day) is also lower than the chronic oral MRL. The theoretical increased risk of cancer from drinking dibromochloromethane at the highest level found in a private well is insignificant for both children (less than 1 in a million) and adults (4 in a million).

Dibromochloromethane is very volatile; however, no studies were located regarding health effects of dibromochloromethane in humans or animals following inhalation exposure. No studies were located regarding health effects in humans or animals following dermal exposure to dibromochloromethane. Thus, it is unknown whether toxic effects will result from inhalation or dermal exposure to dibromochloromethane (ATSDR, 2005f).

Dibromochloromethane belongs to a group of chemicals known as trihalomethanes. The drinking water standard for trihalomethanes is 80 parts per billion (ppb). Trihalomethanes are a common byproduct of well disinfection processes. They can be formed by pouring bleach down a well.

Mercury

Private wells near the Keene Road landfill were analyzed for mercury, but it was not found above the detection limit of 0.02 ppb. This detection limit is 100 times lower than the maximum contaminant level (MCL) for mercury (2 ppb). This is a health-based standard set to protect human health. Using (drinking or bathing) water with levels of mercury below the MCL is not likely to cause illness for either children or adults.

Nitrate

Worst-case exposure scenarios for nitrate in drinking water did not generate doses high enough to cause non-cancer health effects for adults or children. The highest measured nitrate concentration of 9,000 ppb is less than the MCL of 10,000 ppb, which is protective of infants (the most sensitive population), as well as children and adults.

Although acquired methemoglobinemia is not likely at the levels found in private wells around Keene Road landfill, the following are possible health effects from nitrate exposure at higher doses. Nitrates are hazardous when consumed by infants at levels above 10,000 ppb, which may cause acquired methemoglobinemia or "blue-baby" syndrome. Infant formula should not be made with water at nitrate levels above 10,000 ppb. Infants, especially those under four months old, have underdeveloped digestive systems that promote bacterial growth. These bacteria can convert ingested nitrates to nitrites. The nitrites can react with hemoglobin (the oxygen carrier in blood) to form methemoglobin. If enough hemoglobin transforms into methemoglobin, then oxygen deficiencies throughout the body can result because methemoglobin does not transport oxygen to the tissues. Oxygen deficiency can cause the baby to look blue, slate-grey, or chocolate brown (cyanosis) because there is too much methemoglobin (10-20% of total hemoglobin) in the blood. Other adverse reactions include labored breathing, headache, dizziness, nausea, vomiting, and diarrhea at methemoglobin levels between 20-45% of total hemoglobin. If concentrations of methemoglobin increase even further (45-55% of total hemoglobin), irregular heartbeat, shock, convulsions, or coma may result. At methemoglobin levels greater than 70%, death may result. Babies consuming only their mother's milk are not affected. Recovery from methemoglobinemia is quick once treated by a doctor (ATSDR, 2001b).

Infants are not the only population sensitive to nitrate levels above 10,000 ppb. Pregnant women around the 30th week of pregnancy (because their methemoglobin level naturally increases) and adults with methemoglobin reductase enzyme deficiencies or an abnormal hemoglobin molecule as in hemoglobin M disease are also sensitive to nitrate levels above 10,000 ppb (ATSDR, 2001b and US EPA, 2006a). Other susceptible populations include adults with achlorhydria or atrophic gastritis or similar disease that increase the pH of the gastric fluids because this promotes conversion of nitrate to nitrites. This conversion within the body results in an increased risk of acquired methemoglobinemia. Nitrates have not been examined for their carcinogenicity (US EPA, 2006a).

Nitrates are not volatile compounds and thus inhalation effects from showering with water at the highest nitrate level are not likely. No studies were found detailing effects following nitrate dermal exposure. However, it is unlikely that nitrate would be absorbed well by the skin because it is not lipid soluble. Nitrates are very water soluble, which means it would wash right off your skin in the shower.

Groundwater – Monitoring wells

The following subsections detail contaminants of concern found in the groundwater monitoring wells around Keene Road landfill. Monitoring wells are typically shallower than private drinking water wells. However, not all contaminants of concern were sampled in private wells, thus it is helpful to evaluate the monitoring wells. This evaluation assumes that private well contaminant levels are the same as the monitoring wells. As mentioned previously, monitoring wells are generally shallower than private wells so that contaminant levels are usually lower in private

wells than in monitoring wells. However, we do not know the depth of the private wells. Thus, we evaluated the highest levels of contaminants found in the groundwater to be the most protective of public health. Direct measurements of private wells are preferable to monitoring well measurements for this reason. This section only concerns residents who have private wells or who had private wells in the past. People who have always been on municipal water have not been exposed to the groundwater.

Though not contaminants of concern, calcium, magnesium, potassium, chloride, and phosphorus were also measured in groundwater. These minerals are generally non-toxic and do not have drinking water standards.

Though a number of other chemicals besides ammonia, manganese and acrylonitrile were found in monitoring wells – they were also sampled for in private wells. The private well data was used instead because it is a direct measurement of what people were exposed to. Ammonia, manganese and acrylonitrile may be a health threat based on the groundwater monitoring data. Unfortunately, these three compounds were not analyzed in the private wells.

Copper, magnesium, methyl iodide, methyl isobutyl ketone, vanadium, 2-chloroethyl vinyl ether, and 1,4-dichloro-2-butene were found in monitoring wells around the landfill but were not tested for in private drinking water wells. Not enough information is available to determine the health threat from these chemicals.

Please refer to Tables 2 - 5.

Acrylonitrile

The highest estimated acrylonitrile doses for adults and children are not likely to cause non-cancer illness. The highest measured acrylonitrile concentration in a monitoring well was 250 ppb. This translates to an oral dose for adults of 0.007 mg/kg/day and for children of 0.02 mg/kg/day. Both are lower than the chronic oral MRL.

Breathing the highest level of acrylonitrile while showering is unlikely to cause adverse effects. The maximum inhalation dose for both children and adults showering with water at the highest acrylonitrile level is 1.1 ppm. This is 14.5 times lower than the doses causing skin irritation and irritability (16 ppm) in humans for an acute exposure. It is 18 times lower than the lowest dose causing adverse effects in animals for a chronic exposure (20 ppm).

Adverse dermal effects to children or adults from showering with the highest level of acrylonitrile are highly unlikely. The dermal dose for a child showering with water at the highest acrylonitrile level is 0.00009 mg/kg/day and for an adult is 0.00006 mg/kg/day. These doses are between 2.5 million and 3.8 million times lower than the lowest LOAEL causing adverse effects in animals (226 mg/kg/day) (ATSDR, 1990).

At the highest acrylonitrile level found, for children there is a 4 in 10,000 theoretical risk of cancer from ingestion and 2 in 10,000 theoretical risk of cancer from inhalation. The increased risk of cancer for children is considered “low” for both ingestion and inhalation. For adults, there is a 2 in 1,000 theoretical risk of cancer from ingestion and an 8 in 10,000 theoretical risk of cancer from inhalation. The risk of cancer for adults is considered “moderate” for ingestion and “low” for inhalation. No studies were located regarding cancer in humans following chronic exposure to acrylonitrile. Chronic exposure to acrylonitrile in animals has been linked to multiple

tumors at doses between 3.4 and 70 mg/kg/day. Doses for children and adults are far below the lowest dose known to cause tumors in animals.

Ammonia

No health effects have been found in humans exposed to typical environmental concentrations of ammonia. High levels of ammonia in air may irritate skin, eyes, throat and lungs, as well as causing coughing and burns. Some people with asthma may be more sensitive to breathing ammonia than others. You may be exposed to high levels of ammonia if you use cleaning products that contain ammonia, apply ammonia fertilizers, or go into enclosed buildings that contain lots of animals, such as on farms (ATSDR, 2004a).

Although residents have not reported an ammonia taste or smell, You can taste ammonia in water at levels of about 35,000 ppb. The highest ammonia level found in a monitoring well was 100,000 ppb. At this level, a person would consider the water undrinkable. Swallowing even small amounts of liquid ammonia in your household cleaner might cause burns in your mouth and throat. A few drops of liquid ammonia on the skin or in the eyes will cause burns and open sores if not washed away quickly. Exposure to larger amounts of liquid ammonia or ammonium ion in the eyes causes severe eye burns and can lead to blindness (ATSDR, 2004b).

Drinking groundwater with the highest ammonia levels found near Keene Road landfill will not cause adverse effects. The highest estimated oral doses for adults (2.9 mg/kg/day) and children (6.7 mg/kg/day) are lower than the lowest dose known that will not cause adverse effects (NOAEL: 22 mg/kg/day) (ATSDR, 2004b). There is no evidence that ammonia causes cancer (ATSDR, 2004a).

Ammonia has a very strong odor that is irritating and that you can smell when it is in the air at a level higher than 50 ppm. Therefore, you will probably smell ammonia before you are exposed to a concentration that may harm you (ATSDR, 2004b).

Showering with water at the highest ammonia level found in monitoring wells may cause adverse effects. Using Risk Assistant™ software, the highest estimated exposure to ammonia while showering is 1141 ppm for children and adults. The LOAEL (adjusted for humans) for inhalation is 2.7 ppm (US EPA, 2006b). The following are possible adverse reactions to groundwater at the highest level found in a monitoring well based on the available toxicological literature. For humans, 150 ppm caused decreased minute volume (breathing out less carbon dioxide) and increased tidal volume (taking bigger breaths), 72 ppm caused nasal and throat irritation, and 50 ppm causes moderate nasal irritation, throat irritation and urge to cough. For humans, 500 ppm causes nasal and throat irritation, increased minute volume, and increased respiratory rate, as well as ocular lacrimation (tears). Private well users have not reported any of these symptoms.

In rats, 500 ppm causes respiratory irritation, increased kidney weight, and decreased body weight and food intake. In mice, 500 ppm causes decreased resistance to infection. In pigs, 50 ppm causes frequent coughing, oral and nasal irritation, and reduced weight gain and food intake. In dogs and rabbits, 1086 ppm causes temporary dyspnea (shortness of breath) during first week of exposure and temporary tear secretion. In rats, 1086 ppm causes nonspecific inflammation for chronic exposure. In cats, 1000 ppm causes dyspnea (shortness of breath), rhonchi (wheezing), and rales (crackling sounds heard while breathing). In rats, exposure to 642 ppm ammonia for 90 days caused 98% mortality, interstitial pneumonitis, myocardial fibrosis, fatty changes of liver plate cells, and renal tubular calcification. In a guinea pig, 1086 ppm

causes nonspecific inflammation, and 170 ppm caused increased hemosiderin (insoluble iron deposits), and congestion. In rats, 500 ppm caused reduced resistance to infection. The chronic-duration inhalation MRL of 0.1 ppm was derived from a study involving humans with a NOAEL of 9.2 ppm for respiratory and ocular effects.

The highest estimated dermal ammonia dose for adults is 0.02 mg/kg/day and for children it is 0.03 mg/kg/day. Most dermal effects in humans resulted from eye exposure to airborne ammonia (described in the previous paragraph). Direct application of 71.9 mg/L for 30 minutes to the skin of rats caused death of 50% of the rats, while direct application of 48.4 mg/L for an hour to the skin of rats caused death of 50% of the rats. Most of the other reports do not have doses with which to compare to determine the likely effects (ATSDR, 2004b).

Manganese

The highest level of manganese found in a monitoring well was 103,000 ppb. This level translates to an ingestion dose of 3 mg/kg/day for an adult and 7 mg/kg/day for a child. Manganese is an essential nutrient necessary for good health at low levels. However, pesticides exist that contain organic manganese, including maneb and mancozeb. Manganese compounds can be inorganic or organic. There are separate health effects for each. Since the laboratory analysis does not differentiate the form of the manganese, we evaluated both exposure types. There is no information that would indicate if the manganese is more likely to be in the inorganic or organic form.

The following health effects may occur to individuals exposed to the highest level of inorganic manganese found in a monitoring well. Acute effects from this level of inorganic manganese are not likely. Rats gained weight at a rate of only 44% of what weight control rats gained with normal food consumption (6 mg/kg/day) during intermediate exposure. Neonatal rats suffered from neuronal degeneration and altered brain enzymes (1 mg/kg/day) during intermediate exposure. The highest estimated dose of manganese from drinking out of a landfill monitor well is about 50 times higher than a dose that caused mild neurological signs in one person exposed for 50 years (0.059 mg/kg/day). Since private drinking water wells were not tested for inorganic manganese, we do not know if the concentration of inorganic manganese in private drinking water wells was similar to the concentrations in these landfill monitor wells.

The following health effects many occur to individuals exposed to the highest level of organic manganese (pesticides: maneb and mancozeb) found in a monitoring well. Rats fed maneb and mancozeb (5.7 mg/kg/day) showed a significant decrease in liver p-nitroanisole O-dealkylase and aniline hydroxylase during an acute exposure. Rats suffered from significant decreases in exploratory activity and changes in regional neurochemical levels during an intermediate exposure to maneb (1 mg/kg/day). If all the manganese found was in the organic form, it may result in some subclinical biological changes in humans, but is unlikely to cause overt signs of illness.

Due to its chemical properties, manganese present in water is not expected to volatilize into air or to result in significant exposures through inhalation. Therefore, inhalation exposure to manganese in groundwater during showering is not expected to occur.

The dermal dose for an adult is 0.007 mg/kg/day and for a child it is 0.01 mg/kg/day. For inorganic manganese compounds, dermal exposure is not a typical way that people get exposed because manganese does not penetrate the skin readily. For organic manganese, dermal exposure

is most likely where occupational workers are likely to handle large quantities of maneb and mancozeb. That exposure pathway is not likely at this site. Thus, it is unlikely that people will experience dermal effects from showering with water at the highest manganese dose found in a monitoring well (ATSDR, 2000b).

Air – Keene Road Air Monitoring

Between August 31, 2005 and September 26, 2005, a consultant for landfill owner Waste Management Inc, sampled the air around Keene Road landfill and in the Lake Jewel neighborhood for hydrogen sulfide. They used a Jerome meter with a detection range of 3 ppb to 50,000 ppb and a resolution of 1 ppb. Samples were collected in the early morning and afternoon on a random day schedule (Grove Scientific &Engineering, 2005).

The hydrogen sulfide concentrations ranged from below the detection limit to 12 ppb. These measurements are all below ATSDR screening values. However, these levels are not 24-hour ambient air samples and actual levels may fluctuate throughout the day and season. This is more of a snapshot rather than a rigorous sampling effort.

Based on the available data there is not a risk of cancer or non-cancer based illness due to exposure to hydrogen sulfide. However, air monitoring data are limited.

Child Health Considerations

In communities faced with air, water, or food 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. 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.

In recognition of these concerns, the federal ATSDR developed the chemical screening values for children's exposures that DOH used in preparing this report.

Susceptible populations may have different or enhanced responses to toxic chemicals than will most persons exposed to the same levels of that chemical in the environment. Reasons may include genetic makeup, age, health, nutritional status, and exposure to other toxic substances (like cigarette smoke or alcohol). These factors may limit a susceptible persons' ability to detoxify or excrete harmful chemicals or may increase the effects of damage to their organs or systems.

Conclusions

1. Current exposures are **no apparent public health hazard** for residents now hooked up to city water. All but three nearby residences are on city water; current exposures for these residents are an **indeterminate public health hazard** because of insufficient data for these wells.

2. Past exposures might be a concern for residents that used groundwater from private wells because of ammonia and manganese levels found in monitoring wells. Private wells were not sampled for those contaminants though, so it is unknown if residents were exposed to contaminants at the same level as the monitoring wells. We evaluated monitoring well results because groundwater connects private wells and monitoring wells. However, private wells tend to be deeper than monitoring wells and often have lower levels of contaminants.

Recommendations

1. Do not allow people to drill new private wells in the area around Keene Road landfill due to the contaminant levels found in some groundwater monitoring wells.
2. In order to more accurately assess the public health threat to ammonia and manganese from the groundwater, retest the three remaining private wells for ammonia and manganese (both organic and inorganic).

Public Health Action Plan

- In March 2006, Orange CHD sampled eight private wells for VOCs. In May 2006, the three remaining wells were sampled (6 had been removed) for VOCs, semi-VOCs and primary metals. The Florida DOH will review the test results from these three wells.
- Florida DOH will notify the water management district of its recommendation not to allow new wells in this area.
- DOH will share the results of this Health Consultation with the community.

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References

[ATSDR] Agency for Toxic Substances and Disease Registry. 1989. Toxicological profile for Bromodichloromethane. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1990. Toxicological profile for Acrylonitrile. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1999a. ToxFAQs ™ for Mercury. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1999b. ToxFAQs ™ for Acrylonitrile. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2000a. Toxicological profile for Arsenic. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2000b. Toxicological profile for Manganese. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2001a. ToxFAQs ™ for Manganese. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2001b. Case study in environmental medicine. Nitrate/Nitrite Toxicity. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2004a. ToxFAQs ™ for Ammonia. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2004b. Toxicological profile for Ammonia. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005a. Public Health Assessment Guidance Manual. Update. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005b. Toxicological profile for Arsenic. Draft for Public Comment. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005c. Water Comparison Values. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005d. ToxFAQs ™ for Benzene. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005e. ToxFAQs ™ for Bromoform and Dibromochloromethane. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005f. Toxicological profile for Bromoform and Dibromochloromethane. Atlanta: U.S. Department of Health and Human Services.

[FDEP] Florida Department of Environmental Protection. 2005.Drinking water standards, monitoring and reporting for public drinking water systems. Chapter 62-550, Florida Administrative Code (F.A.C.). Tallahassee, Florida.

US Bureau of the Census. 2000. LandView®5 Software on DVD, A Viewer for EPA, Census and USGS Data and Maps. Washington, DC: US Department of Commerce.

[US EPA] United States Environmental Protection Agency. 2006a. Integrated Risk Information System (IRIS) database. Nitrate. http://www.epa.gov/iris/subst/0076.htm accessed 6/26/06.

[US EPA] United States Environmental Protection Agency. 2006b. Integrated Risk Information System (IRIS) database. Ammonia. http://www.epa.gov/iris/subst/0422.htm accessed 7/3/06.

Grove Scientific & Engineering. 2005. Keene Road Landfill: Hydrogen Sulfide Monitoring Baseline Results.

Robert Wayne. 2006. Personal communication.

Appendix A. Figures and Tables

Table 1: Contaminants of Concern in Private Wells

*Contaminant of Concern***	*Lowest Concentration ppb*	*Average Concentration**** *ppb*	*Highest Concentration ppb*	*Comparison Value ppb*	*Source of Comparison Value*	*Number of Water Samples Above Comparison Value*
Acrylonitrile	Not analyzed	Not analyzed	Not analyzed	0.06	CREG	Not analyzed
Ammonia	Not analyzed	Not analyzed	Not analyzed	30,000	LTHA	Not analyzed
Arsenic	Undetected	*	10	0.02	CREG	1/2
Benzene	Undetected	Undetected	Undetected	0.6	CREG	0/13
Bromodichloromethane	Undetected	*	9.6	0.6	CREG	1/13
Dibromochloromethane	Undetected	*	3.5	0.4	CREG	1/13
Nitrate	Undetected	4,300	9,000	10,000	MCL	0/13
Manganese	Not analyzed	Not analyzed	Not analyzed	300	LTHA	Not analyzed
Mercury	Undetected	Undetected	Undetected	2	MCL	0/2

*Only 1 of the total samples was above the detection limit. In this case, an average is not meaningful.
** Florida DOH uses Comparison Values to select chemicals for further scrutiny, not for determining the possibility of illness.
*** Average is of all samples above the detection limit.
CREG – ATSDR Cancer Risk Evaluation Guide
EMEG – ATSDR Environmental Media Evaluation Guide
MCL – EPA Maximum Contaminant Level
LTHA – EPA Lifetime Health Advisory Level
ppb – parts per billion
Source of data: FDEP and Orange CHD.

Table 2: Contaminants of Concern in Groundwater Monitoring Wells

*Contaminant of Concern***	*Lowest Concentration ppb*	*Average Concentration**** *ppb*	*Highest Concentration ppb*	*Comparison Value ppb*	*Source of Comparison Value*	*Number of Water Samples Above Comparison Value*
Acrylonitrile	Undetected	12.9	250	0.06	CREG	109/211
Ammonia	Undetected	4,300	100,000	30,000	LTHA	5/473
Arsenic	Undetected	13.6	206.2	0.02	CREG	152/238
Benzene	Undetected	1.9	25	0.6	CREG	173/269
Bromodichloromethane	Undetected	1.3	25	0.6	CREG	129/231
Dibromochloromethane	Undetected	1.8	25	0.4	CREG	126/228
Nitrate	Undetected	2060	35,000	10,000	MCL	4/345
Manganese	Less than 10	1,009§	103,000	300	LTHA	12/187
Mercury	Undetected	0.4	9.9	2	MCL	5/230

** Florida DOH uses Comparison Values to select chemicals for further scrutiny, not for determining the possibility of illness.
*** Average is of all samples above the detection limit.
§ Average is of all samples above “less than 10.”
CREG – ATSDR Cancer Risk Evaluation Guide
EMEG – ATSDR Environmental Media Evaluation Guide
MCL – EPA Maximum Contaminant Level
LTHA – EPA Lifetime Health Advisory Level
ppb – parts per billion
Source of data: FDEP and Orange CHD

Table 3: Estimated Doses from Oral Exposure to Groundwater

Contaminant of Concern	***ATSDR Oral MRL (mg/kg/day)***	***Estimated Drinking Water Ingestion Dose (mg/kg/day)***	
		Child	Adult
Acrylonitrile *	0.04 Chronic	0.02	0.007
Ammonia *	None	7	3
Arsenic	0.0003 Chronic	0.0007	0.0003
Benzene	0.004 †	Undetected	Undetected
Bromodichloromethane	0.02 Chronic	0.0007	0.0003
Dibromochloromethane	0.09 Chronic	0.0002	0.0001
Nitrate	1.6 †	0.6	0.3
Manganese *	0.05 †	7	3
Mercury	None	Undetected	Undetected

† No ATSDR Oral MRL available. EPA's Chronic Oral Reference Dose (RfD) used instead. Units are mg/kg/day (milligrams per kilograms per day).
* Acrylonitrile, ammonia and manganese were not analyzed for in private wells, so the drinking water ingestion dose is from drinking the highest level found in a monitoring well.
Note: These are conservative estimates protective of human health and actual lifetime exposures will probably be lower because the Oral Average Daily Dose during the exposure period was used rather than the Oral Lifetime Daily Dose.
MRL = Minimal Risk Level

Table 4: Estimated Doses from Inhalation Exposure to Groundwater

Contaminant of Concern	***Inhalation MRL (ppm)***	***Estimated Showering Inhalation (ppm)***
		Child and Adults
Acrylonitrile *	0.1 Acute	1.1
Ammonia *	0.1 Chronic	1141
Arsenic	---	†
Benzene	0.003 Chronic	Undetected
Bromodichloromethane	None	0.015
Dibromochloromethane	None	0.004
Nitrate	---	†
Manganese *	---	†
Mercury	0.0002 mg/m^3 Chronic	Undetected

* Acrylonitrile, ammonia and manganese were not analyzed for in private wells, so the estimated showering inhalation dose is from using water with the highest level found in a monitoring well.
† Arsenic, nitrate and manganese are not volatile. Thus, they are not an inhalation problem while showering.
Note: These are conservative estimates protective of human health and actual lifetime exposures will probably be lower because the Oral Average Daily Dose during the exposure period was used rather than the Oral Lifetime Daily Dose.
MRL = Minimal Risk Level
ppm = parts per million
mg/m^3 = milligrams per meter cubed

Table 5: Estimated Doses from Dermal Exposure to Groundwater

Contaminant of Concern	***Dermal MRL (mg/kg/day)***	***Estimated Showering Dermal Exposure (mg/kg/day)***	
		Child	Adults
Acrylonitrile *	None	0.00009	0.00006
Ammonia *	None	0.03	0.02
Arsenic †	None	0.000001	0.0000007
Benzene	None	Undetected	Undetected
Bromodichloromethane	None	0.00003	0.00002
Dibromochloromethane	None	0.00001	0.000007
Nitrate	None	0.0009	0.0006
Manganese * †	None	0.01	0.007
Mercury	None	Undetected	Undetected

* Acrylonitrile, ammonia and manganese were not analyzed for in private wells, so the estimated showering dermal dose is from using water with the highest level found in a monitoring well.
† Arsenic and inorganic manganese are metals. Metals are poorly absorbed through the skin and thus do not constitute a health risk through dermal exposure while showering.
Note: These are conservative estimates protective of human health and actual lifetime exposures will probably be lower because the Oral Average Daily Dose during the exposure period was used rather than the Oral Lifetime Daily Dose.
MRL = Minimal Risk Level
mg/kg/day – milligrams per kilogram per day

Figure 1: Orange County in Florida

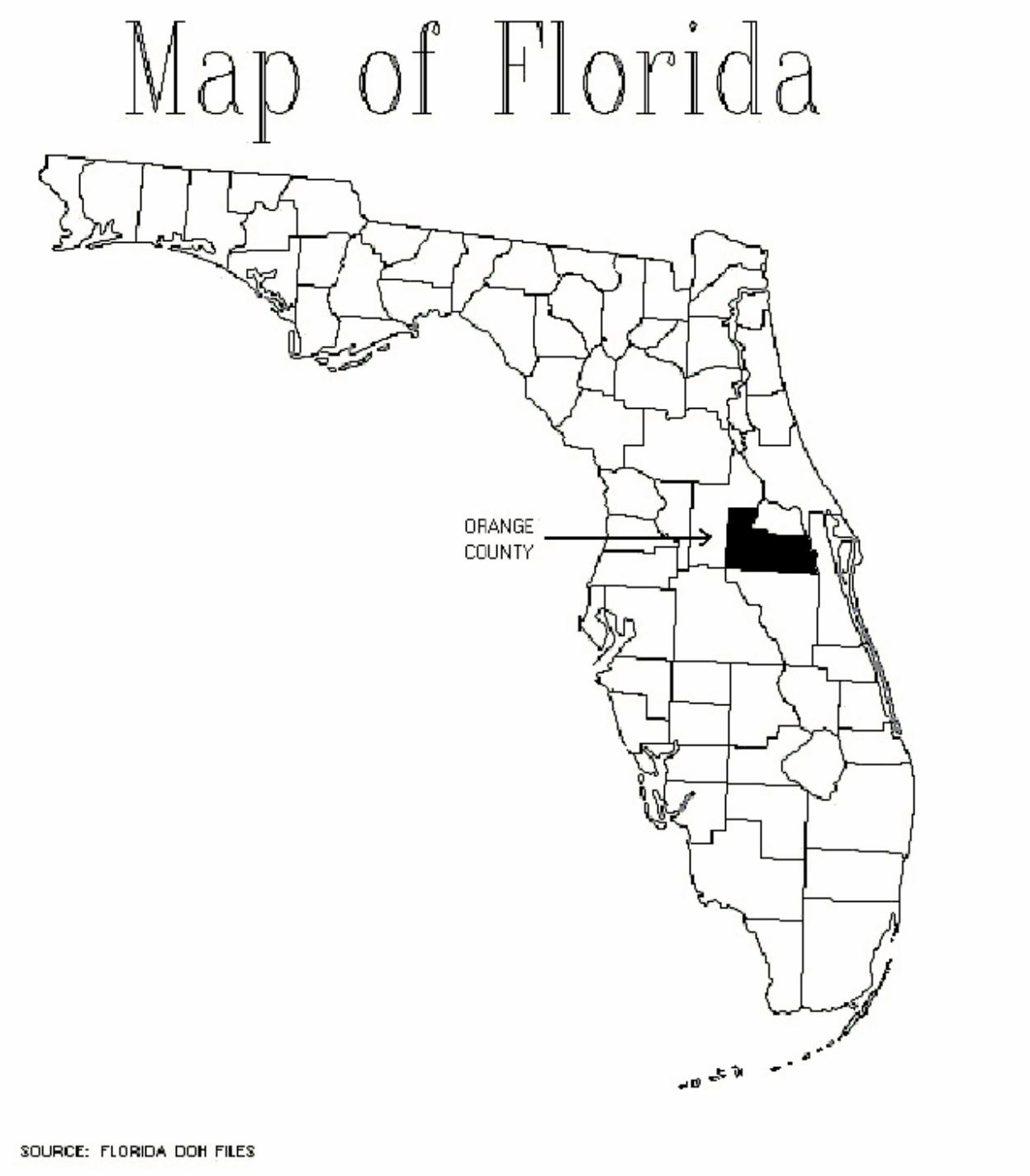


Figure 2: Keene Road landfill area

Figure 3: Private wells around Keene Road Landfill

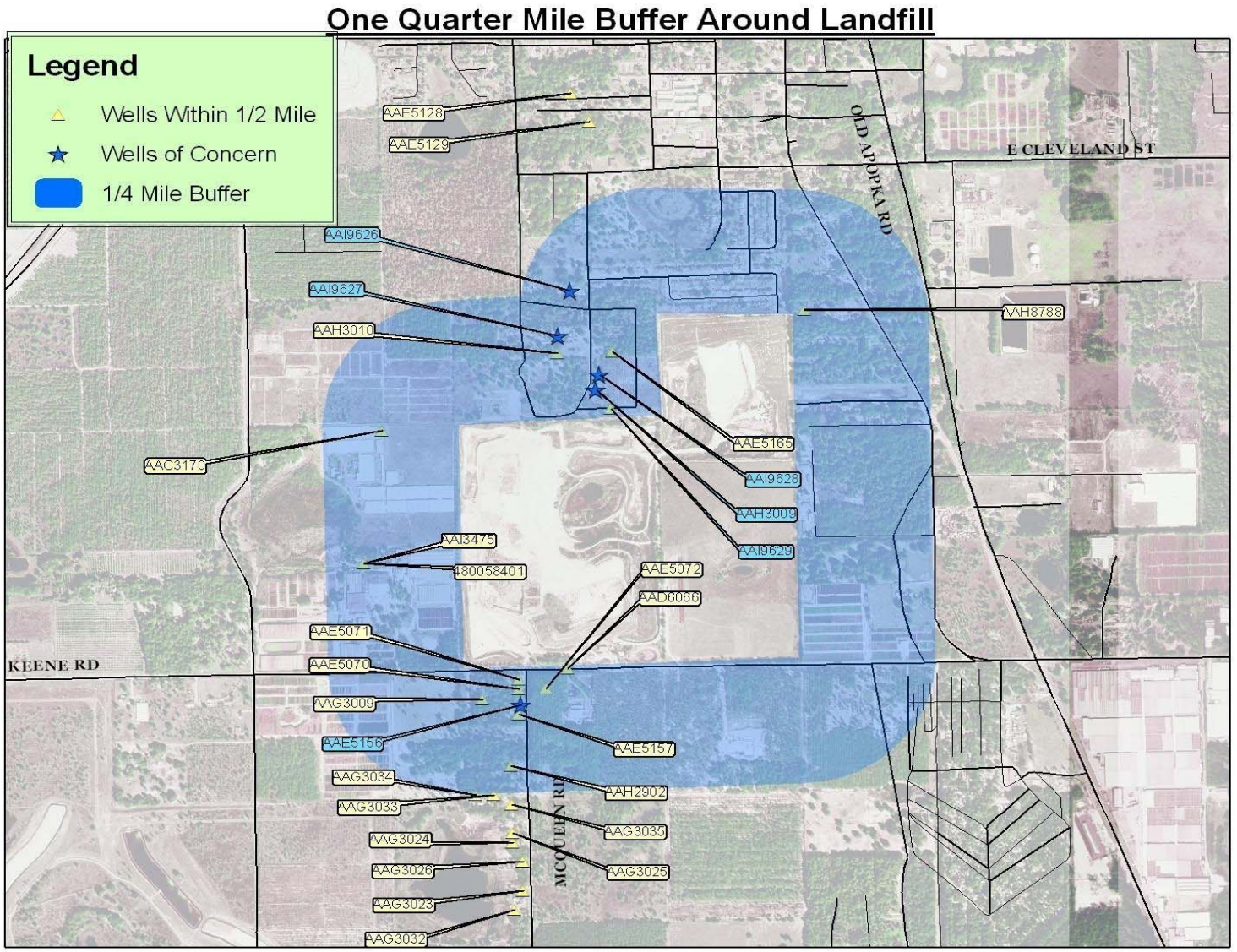
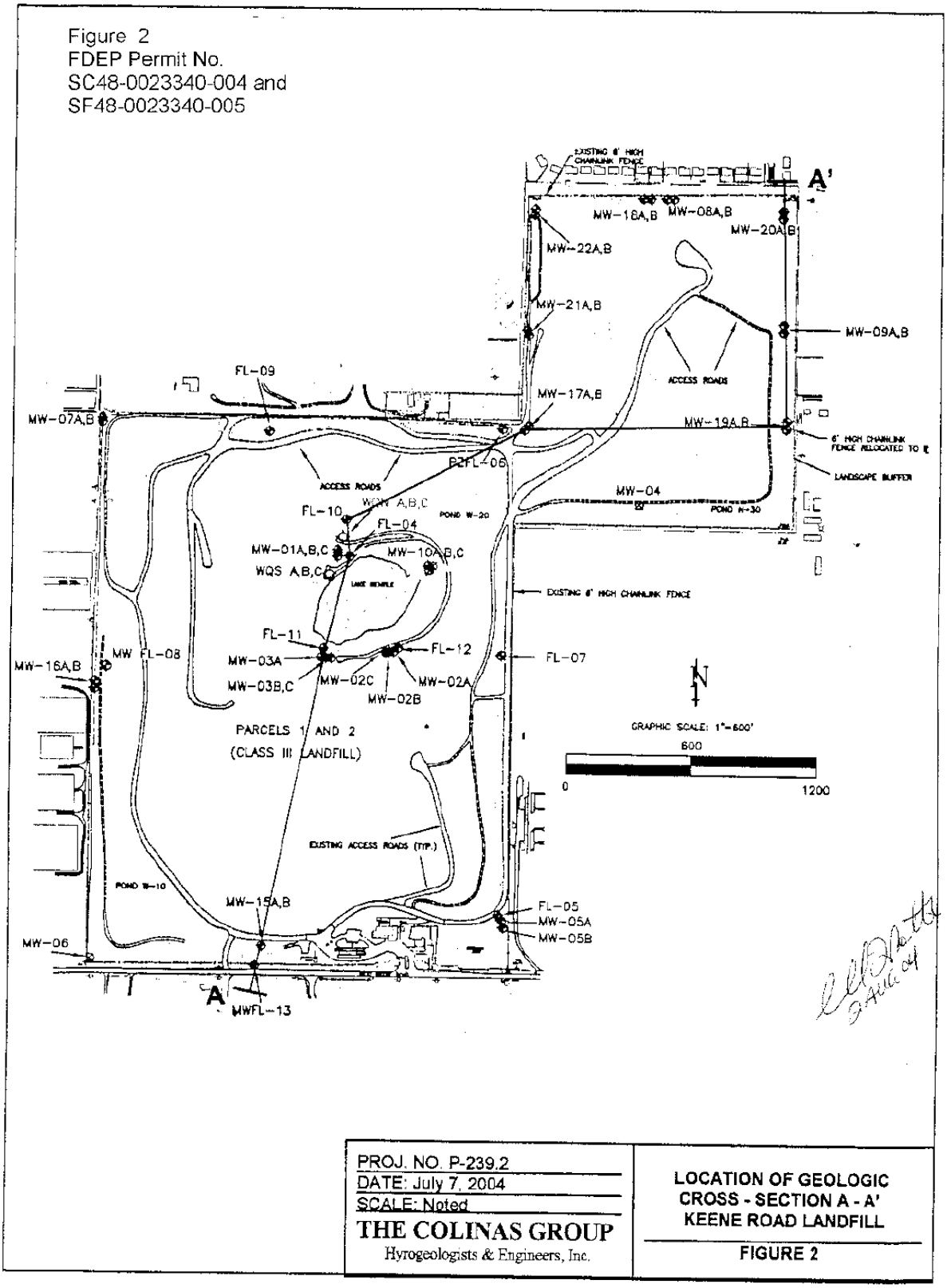


Figure 4: Monitoring wells in Keene Road landfill



Appendix B. ATSDR Glossary of Environmental Health Terms

This glossary defines words used by the Agency for Toxic Substances and Disease Registry (ATSDR) in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-422-8737.

Absorption
The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

Acute
Occurring over a short time [compare with chronic].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with antagonistic effect and synergistic effect].

Adverse health effect
A change in body function or cell structure that might lead to disease or health problems

Aerobic
Requiring oxygen [compare with anaerobic].

The Agency for Toxic Substances and Disease Registry (ATSDR)
The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances.

Ambient
Surrounding (for example, *ambient* air).

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is **less** than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

CAP [see Community Assistance Panel.]

Cancer
Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of

cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)

A group of people from a community and from health and environmental agencies who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

Comparison value (CV)

Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment and health consultation process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment and health consultation process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 CERCLA)

CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. This law was later amended by the Superfund Amendments and Reauthorization Act (SARA).

Concentration

The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant

A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Delayed health effect

A disease or an injury that happens as a result of exposures that might have occurred in the past.

Dermal

Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact

Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology

The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit

The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Dose (for chemicals that are not radioactive)

The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a

measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)

The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship

The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media

Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism

Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

EPA

United States Environmental Protection Agency.

Epidemiologic surveillance [see Public health surveillance].

Epidemiology

The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Exposure

Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

Exposure assessment

The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction

A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation

The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway

The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or

touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Exposure registry

A system of ongoing follow up of people who have had documented environmental exposures.

Feasibility study

A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Groundwater

Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Hazard

A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)

The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste

Potentially harmful substances that have been released or discarded into the environment.

Health investigation

The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to evaluate the possible association between the occurrence and exposure to hazardous substances.

Indeterminate public health hazard

The category used in ATSDR’s public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence

The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].

Ingestion

The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation

The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure

Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro

In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

Lowest-observed-adverse-effect level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual's exposure could negatively affect that person's health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

Minimal risk level (MRL)
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or **NPL)**
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

National Toxicology Program (NTP)
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Plume

A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure

The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population

A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)

A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb

Parts per billion.

ppm

Parts per million.

Public availability session

An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public comment period

An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action

A list of steps to protect public health.

Public health advisory

A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)

An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health.

Public health hazard

A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories

Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public health surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

RfD [see reference dose]

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or an environment.

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette

smoking). Children, pregnant women, and older people are often considered special populations.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Superfund [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see public health surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and

progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor

Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard

A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Volatile organic compounds (VOCs)

Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, and methylene chloride.

CERTIFICATION

The Florida Department of Health, Bureau of Community Environmental Health prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. It followed approved methodology and procedures existing at the time it began. The Cooperative Agreement Partner completed editorial review.

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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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