HEALTH CONSULTATION

ANCHOR ROAD SOLVENT SITE
CASSELBERRY, FLORIDA

Florida Department of Environmental Protection Waste Cleanup Site Identification Number:

COM-275457

Final
September 20, 2016

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

Foreword

The Florida Department of Health (DOH) evaluates the public health threat of hazardous waste sites through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry in Atlanta, Georgia. This public health assessment is part of an ongoing effort to evaluate health effects associated with contaminated groundwater at the Anchor Road Solvent Site. We evaluate site-related public health issues through the following processes:

Evaluating exposure: DOH scientists began by reviewing available information about environmental conditions. We find out how much contamination is present, where it is on the site, and whether human exposures might occur. The Florida Department of Environmental Protection (DEP) and DOH provided the information for this assessment.

Evaluating health effects: When we find evidence that exposures to hazardous substances might occur, we determine whether that exposure could be harmful to human health. We focus this report on public health; that is, the health impact on the community as a whole, and base it on existing scientific information.

Developing recommendations: In this report, we outline our conclusions regarding potential health threats posed by contaminated groundwater, and offer recommendations for reducing or eliminating human exposure to contaminants. The role of the DOH in dealing with hazardous waste sites is primarily advisory. If we had found an immediate health threat existed or was imminent, we would have issued a public health advisory warning people of the danger, and we would have worked to resolve the problem.

Soliciting community input: The evaluation process is interactive. The 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 conclusions about the site with the groups and organizations providing the information, then we seek feedback from the public.

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

Please write to: Division of Disease Control and Health Protection
Public Health Toxicology
Florida Department Health
4052 Bald Cypress Way, Bin # A-12
Tallahassee, FL 32399-1720
Or call us at: 850 245-4444×2316 or toll-free in Florida: 1-877-798-2772

Summary

INTRODUCTION

At the Anchor Road Solvent site, the Florida Department of Health's (DOH) top priority is to ensure nearby residents have the best information to safeguard their health.

This site in Casselberry consists of two adjacent properties: the 1.89-acre former Lawton Printers property and the 1.15-acre former Naturally Fresh property. Florida Department of Environmental Protection (DEP) sampled groundwater on both properties while investigating potential sources of volatile organic compounds (VOCs) in Casselberry public water supply wells. Testing found VOCs in groundwater above Florida drinking water standards on both properties. Businesses and residences are on city water and septic systems. Because they found VOCs in groundwater but not in surface soil, DEP determined the source of contamination was likely solvents disposed of in the on-site septic tanks.

DOH reached the following three conclusions.

CONCLUSION #1

In the future, use of contaminated groundwater from on-site wells for more than 2 weeks for drinking, showering or other household uses could cause harm to health.

BASIS FOR CONCLUSION #1

Use of contaminated well water could increase the risk of heart defects, immune system decrements, and could decrease weight gain in babies born to women using well water with 1,800 to 11,000 micrograms per liter (µg/L) trichloroethene (TCE).

Over a lifetime of residential use of well water with these levels of TCE could also result in a moderate to very-high increased risk of kidney cancer and non-Hodgkin's lymphoma. Similarly, exposure to 1,1-dichloroethene at 11 µg/L could cause a very low to moderate increased cancer risk.

NEXT STEP #1

We recommend site owners not use groundwater until it is cleaned up. Our August 2016 Community Update mail out for this site offered private well testing. Two nearby residents responded to this offer. DOH staff in Seminole County has tested and will continue to test private wells within one-quarter mile of the site upon request.

CONCLUSION #2

The Anchor Road Solvent Site is not a current public health hazard.

BASIS FOR CONCLUSION #2	Although businesses disposed of solvent in their septic systems in the past, no one is currently using this contaminated groundwater.
CONCLUSION #3	We are unable to evaluate the risk of harm to past workers' health.
BASIS FOR CONCLUSION #3	In the past, site workers may have been exposed to TCE by breathing fumes, by getting solvents on their skin, and by accidentally swallowing solvents from hand-to-mouth activities. We lack data for such exposure levels and so are unable to evaluate the risk of harm to their health.
LIMITATIONS OF FINDINGS	All risk assessments, to varying degrees, require the use of assumptions, judgments, and incomplete data. These contribute to the uncertainty of the final risk estimates. Some more important sources of uncertainty in this health consultation include environment sampling and analysis, exposure parameter estimates, use of modeled exposure doses, and present toxicological knowledge. We may have overestimated or underestimated the health risk because of these uncertainties. This public health assessment does not represent an absolute estimate of risk to persons exposed to chemicals at or near the Anchor Road Solvent site.
PUBLIC COMMENTS	Appendix C addresses questions and comments received by DOH on the Anchor Road Solvent site Health Consultation Public Comment draft. The public comment period was from July 29, 2016 to September 2, 2016.
FOR MORE INFORMATION	If you have concerns about your health or the health of your children, you should contact your health care provider. For further information about the Anchor Road Solvent site, you can contact DOH at (850) 245-4444 × 2316.

Acronyms and Abbreviations

ADAF	Age Dependent Adjustment Factor
ATSDR	Agency for Toxic Substances and Disease Registry
BMDL	Bench Mark Dose Level
CREG	Cancer Risk Evaluation Guide
CTE	Central Tendency Exposure (average)
CV	Comparison Value
1,1-DCE	1,1-dichloroethene
cis-1,2-DCE	*cis*-1,2-dichloroethene
DEP	Department of Environmental Protection
DOH	Department of Health
EPA	Environmental Protection Agency
IRIS	Integrated Risk Information System
LOAEL	Lowest Observable Adverse Effect Level
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
mg/L	milligram per liter
MRL	Minimal Risk Level
POE	Point of Entry
PPA	Prospective Purchase Agreement
RfC	Reference Concentration
RfD	Reference Dose
RME	Reasonable Maximum Exposure
RMEG	Reference Dose Medial Evaluation Guide
SP	Screen Point
TCE	Trichloroethylene (or Trichloroethene)
µg/L	Microgram per liter
$\mu g/m^3$	Microgram per cubic meter
VOC	Volatile Organic Compound

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Purpose and Health Issues

This health consultation evaluates the public health threat at the Anchor Road Solvent Site. This site consists of the former Lawton Printers (185 Anchor Road) and Naturally Fresh (175 Anchor Road) properties in Casselberry, Seminole County (Figure 1). Florida DOH initiated this evaluation. It is the first evaluation of the site by Florida DOH. We reviewed available environmental data, ways in which people could come in contact with contaminants, and community health concerns. The assumptions, judgments, and data we used limit the scope and certainty of this report.

Figure 1: The Anchor Road Solvent Site from Pine Street looking east

[Google Earth 2016]

Public Comment

DOH released a public comment draft of this HC on July 29, 2016. The document was also available for viewing or downloading from the DOH web site. The public comment period was open from July 29, 2016 through September 2, 2016.

DOH announced the public comment period online and via a community update distributed to nearby property owners through direct mail. Both forms of outreach summarized the findings of the draft report and solicited public review and comments. We address the public comments we received in Appendix C.

Background

Site Descriptions, History, and Features

The Anchor Road Solvent Site consists of two properties: the 192- by 429-foot former Lawton Printer property and the 250 by 250-foot former Naturally Fresh property. The site is in a mixed commercial, light industrial, and residential area of Casselberry. The site is relatively flat. The elevation is about 90 feet above sea level and increases about 5 feet in elevation from east to west. It has well-drained, fine-grained sandy soil and a water table that varies from 2 to 6 feet below land surface. The site has no surface water (Figure 2).

West of the site are Anchor Road, three large storm water retention ponds, and neighborhoods. The Anchor Road Commerce Center borders the site to the north and east. Sunnytown Park is to the south. Kids First Steps, a day care center, is one-quarter mile east-southeast of the site. Apostolic Church of Jesus Christ and Peaceful Zion Baptist Church are one-quarter mile west. Third Millennium Ministries is one-quarter mile southeast of the site [Google Maps 2016].

Figure 2: Anchor Road Solvent Site location

[DEP 2010, Google Earth 2016]

DEP sampled groundwater on the site while investigating potential sources of volatile organic compounds (VOCs) in the Casselberry North Plant public water supply wells. The North Plant has three wells. In August 2002, tests first detected *cis*- and trans-1,2-dichloroethene in the two more shallow production wells (with 350- and 388-foot depths). Tests have not shown contamination in the 1,200-foot deep well. Although DEP investigated this and other sites, they were unable to identify the source of contamination of the Casselberry wells [DEP 2007, 2010, 2014].

Testing on the site found VOCs in groundwater above Florida drinking water standards. Because they found VOCs in groundwater but not in surface soil, DEP determined the source was likely solvents disposed of in septic tanks. Businesses and residences in this part of Casselberry are on septic systems [DEP 2010].

The red star in Figure 3 marks the shallowest point (8 to 12 feet below land surface) where DEP found TCE at 2.1 µg/L. The red triangle marks the spot just north of the septic drain field where DEP found the highest level of TCE—11,000 µg/L—at 44 to 48 feet below land surface [DEP 2010].

The blue star in Figure 3 marks the shallowest point (34 feet below land surface) about 50 feet north of the northeast corner of the former Naturally Fresh building where DEP found TCE (75 µg/L). The blue triangle marks the spot 25 feet north of the Naturally Fresh septic tank drain field where DEP found the highest level of TCE—6,600 µg/L—at 37 to 47 feet below land surface [DEP 2010].

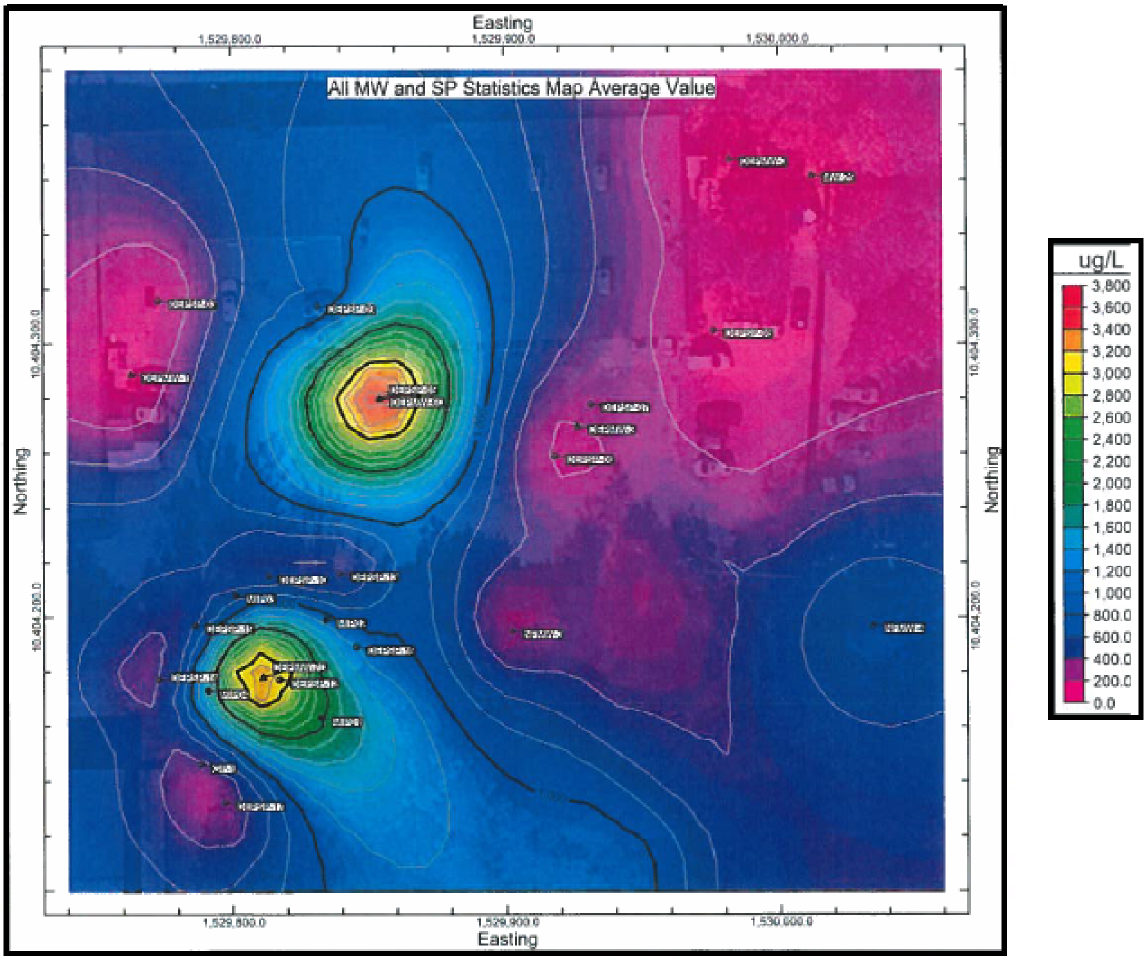
Figure 3: Anchor Road Solvent Site septic tank drain fields

[DEP 2010]

TCE and its breakdown products are denser than water and tend to sink after they enter groundwater. At their closest, the two septic tank drain fields at the rear of the properties are only about 100 feet apart. Figure 4 shows each drain field is a source of groundwater contamination.

The owners of both properties dispute their business was the sources of solvent contamination. Naturally Fresh sold fresh fruit [DEP 2010]. Although Lawton Printers used a press wash containing TCE from 1993 to 1997, the printing-press area reportedly had no floor drains or sinks and therefore no connection to the septic tank [Pence 2012]. Workers stored press-plate cleaning rags with spent solvents in plastic bags inside a large garbage can. A cleaning service picked up these rags for off-site laundering and delivered clean rags. The press wash they used on the 4-color printer they purchased in 1998 did not contain TCE [Pence 2012].

Figure 4. Anchor Road Solvent Site TCE groundwater contamination sources



[Stillwater Technologies 2013]

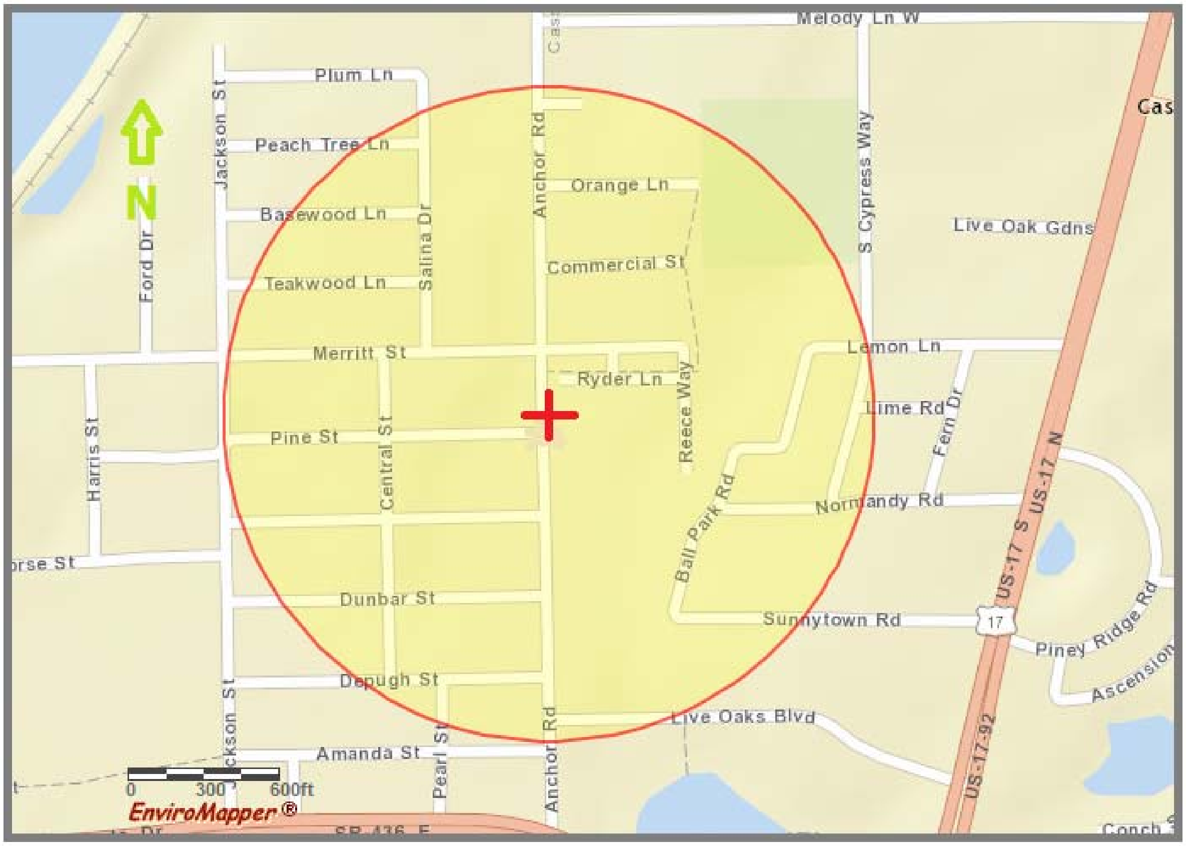
Both properties had prior businesses that might have used solvents [Pence 2012, Ardaman and Associates 2008]. The Lawtons purchased the 185 Anchor Road property in 1992 from Mr. Decker who built the 25,000 square-foot building on the site in 1969. Mr. Decker operated Dektronics, an electronics manufacturing and assembly plant there until 1982 [DEP 2010, Historicalaerials 2016]. Electronics businesses use solvents to remove fluxing agents that remain on components after workers solder parts together. The site was vacant 10 years prior to Mr. Lawton's purchase in 1992. The Casselberry city directory lists a Metallic and Brushless Motor Electronics business for 175 Anchor Road (the former Naturally Fresh site) in 1967 and 1969. This business may have used solvents to degrease motor parts.

Both properties are currently for sale. DEP will likely require a restrictive covenant prohibiting use of contaminated groundwater under the site when the owners sell the properties.

Demographics

In 2010, 460 people lived within one-quarter mile of the site (Figure 5). Forty-nine percent were male and 51% were female. Ninety-seven percent reported as one race. They identified themselves as 52% black, 40% white, 2% Asian, and 3% other. Hispanic population can be of any race, 12% reported as such. Annual household incomes reported were: 16% greater than $75,000, 14% from $50,000 to $75,000, 23% from $25,000 to $50,000, 23% from $15,000 to $25,000, and 24% less than $15,000 [EPA 2016a]. Sensitive populations were children aged 4 and younger (4%) and adults 65 and older (14%).

Figure 5: Anchor Road Solvent Site quarter-mile radius



[EPA 2016a]

Discussion

We evaluated available soil and groundwater data from on and near the site [DEP 2007, 2010, 2014; Ardaman and Associates 2008; Stillwater Technologies, Inc. 2013]. These included test results for 5 soil samples from the former Lawton Printers property and 159 groundwater samples at 43 locations.

Evaluation Process

In this section, we describe the process we use to evaluate the potential for site contaminant exposure to harm health.

- We use EPA's exposure assumptions to determine concentrations of chemicals in the environment (air, water, or soil) below which they do not expect harm to health. They call these *comparison values* (CVs) [ATSDR 2015]. We retain for further evaluation contaminants that are higher than their CVs: 1,1-dichloroethene (1,1-DCE), *cis*-1,2-dichloroethene (*cis*-1,2-DCE) and TCE (Appendix B, Table 1).

- Next we focus on identifying which chemicals and exposure situations could harm health. For exposures occurring by inhalation, we compare the air concentration of the contaminant directly with health guideline air concentrations such as an ATSDR Minimal Risk Level (MRL), if available, or an EPA Reference Concentration (RfC). For other pathways, we calculate *exposure doses*—estimated amounts of a contaminant that people contact and get into their bodies, on an equivalent body weight basis (Appendix A).

- We calculate doses for specified exposure situations, typically starting with "worst case" type assumptions to obtain the highest dose that could be expected using the highest values measured for each chemical. For this report, we also calculate doses for two additional exposure levels. To determine if future off-site wells might contain TCE at levels of health concern, we calculated doses for the highest TCE value—1,800 µg/L—measured at the site boundary and the highest TCE value measured off site—3.2 µg/L. Tests did not find other VOCs above their CVs off the site. The Risk Assessment Guidelines are the source of the Reasonable Maximum Exposure (RME) values [EPA 2004, 2011]. The Central Tendencies Exposure (CTE) values are the same as for RMEs, with the exposure amounts halved to cover the contingencies of people who may spend less time outside, or who may use less tap water

- We compare each calculated exposure dose to chemical-specific health guidelines, typically an ATSDR MRL or EPA Reference Dose (RfD), for that chemical. We consider these health guidelines safe doses; that is, if the concentration or calculated dose is at or below the health guideline, we do not expect harm to health. We then compare these doses to known health effect levels (for both cancer and non-cancer effects) identified in ATSDR's toxicological profiles or EPA's Integrated Risk Information System (IRIS). We use these comparisons as the basis for stating whether or not an exposure could harm health.

- We estimate an increased risk of developing cancer from exposure to carcinogens by multiplying the estimated cancer exposure dose by the cancer slope factor (Appendix A). The result is an estimate of the increase in lifetime risk of developing cancer from exposure. The actual increased risk of cancer may be lower, perhaps by 10 to 1,000 times, than the calculated number due to factors that overestimate the risk.

Pathway Analyses

We determine whether people may have contacted chemicals from a site by examining *exposure pathways*. Exposure pathways consist of five elements which all must be present (in the past, now, or in the future) for exposure to occur: a contamination *source*; *transport* of the contaminant through an *environmental medium* like air, soil, or water; an *exposure point* where people can come in contact with the contaminant; an *exposure route* whereby the contaminant can be taken into the body; and an *exposed population* of people actually coming in contact with site contaminants.

Completed exposure pathways are those for which all five pathway elements are evident. This indicates that exposure to a contaminant has occurred in the past, is now occurring, or will occur in the future. If one or more elements is missing or has been stopped—for example by removal of the exposed population from coming in contact with the contaminant—the pathway is *incomplete*, and exposure cannot occur. *Potential* exposure pathways are those for which exposure seems possible, but one or more of the elements is not clearly defined. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future.

The identification of an exposure pathway does not necessarily mean that health effects will occur. Even if exposure has occurred, is now occurring, or is likely to occur in the future, human health effects might not result. Further evaluation is necessary to determine the likelihood for health effects from exposure.

For the following potential and eliminated exposure pathways (Tables 2 and 3), the *source* of contamination is chemicals from septic tank drain fields on both properties (Figure 3).

Completed Exposure Pathways

We did not identify any completed exposure pathways [DEP 2007, 2010, 2014]. DOH's private well surveys and DEP's investigations show that most nearby residents and businesses use municipal water [DOH 2016]. Surface soil is not contaminated [DEP 2010].

Figure 6 shows the nearest private wells are one-quarter mile south of the site. Although DOH found benzene in private wells one-half mile southwest of the site, it is likely from two active petroleum cleanup sites. The VOC levels and the groundwater gradient to the east suggest contamination from this site is unlikely to be found in private wells to the south and southwest.

Potential Exposure Pathways

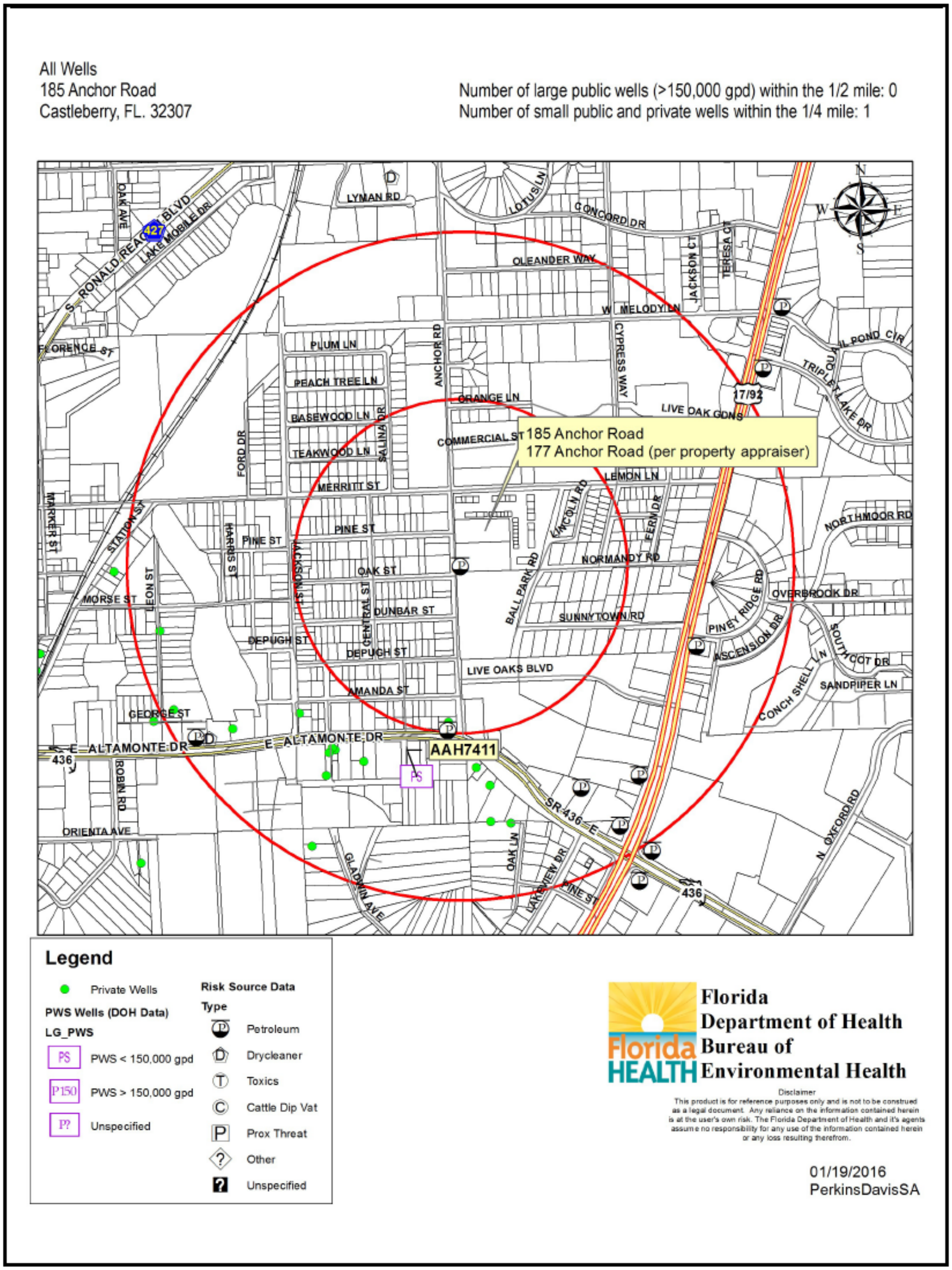
Private Wells Pathway

Our August 2016 Community Update mail out for this site offered private well testing. Two nearby residents responded to this offer. DOH staff in Seminole County has tested and will continue to test private wells within one-quarter mile of the site.

New private wells are a potential exposure pathway as future site owners or nearby property owners could install new wells in the area of groundwater contamination (Table 2).

In the future, *source transport* could move solvents from the on-site septic tank drain fields via groundwater, the *environmental media*, to off-site locations. In groundwater, some TCE can degrade to 1,1-DCE, *cis*-1,2-DCE, and other chemicals. Future *exposure points* could be household taps and showerheads that dispensed well water. Nearby residents and workers who might drink this water and/or use it for cleaning, showering, and other household uses could be the *exposed population*. These actions might result in ingestion, inhalation, and dermal contact *exposures routes.* In the following sections we describe the health risks for potential exposure.

Figure 6. Anchor Road Solvent Site: one-quarter and one-half mile surveys for private and public supply wells, respectively.



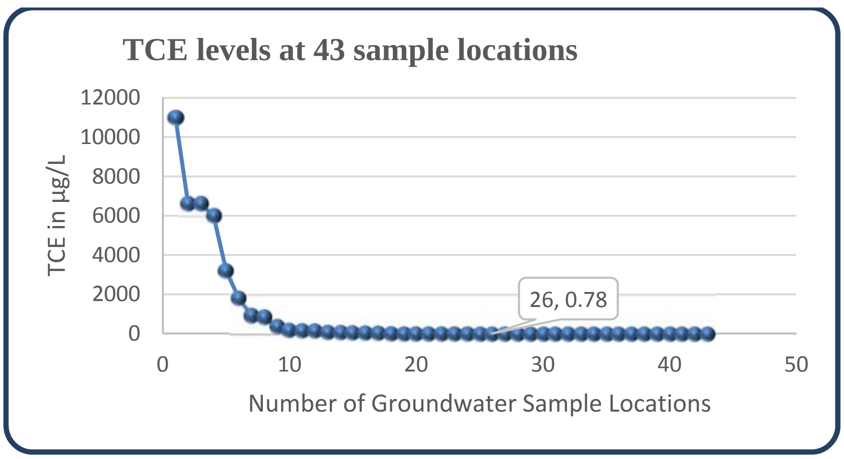
[DOH 2016]

Trichloroethene (TCE)

TCE slows the central nervous system following either oral or inhalation exposure. In the past, doctors used TCE as an anesthetic, as high concentrations causes sleepiness and loss of consciousness. Workers with lower-levels of TCE exposure experienced neuromotor function effects including balance problems and tremors. Some workers who got TCE on their skin developed skin rashes. Health scientists believe these skin disorders have an immunological component [ATSDR 2014a]. In addition to slowed central nervous system responses, TCE-exposed workers experienced higher rates of death from asthma and damage to their facial nerves. High TCE exposure levels in workers caused changes in heartbeat and liver/kidney damage. Workers also experienced a significant increased risk of death from ischemic heart disease (reduced blood flow to the heart) [ATSDR 1997, 2014a].

DOH reviewed groundwater test results from 43 different locations. Twenty-six of these 43 locations had TCE levels above the Cancer Risk Evaluation Guide (CREG) of 0.75 µg/L and 22 had levels above the Florida Maximum Contaminant Level (MCL) of 3 µg/L (Figure 7).

Figure 7: Number of sample locations with TCE levels greater than 0.76 µg/L



[DEP 2007, 2010, 2014; Ardaman and Associates 2008]

We evaluated potential TCE exposures using three different levels: the highest level on site (11,000 µg/L), the highest level at the site boundary (1,800 µg/L), and the highest level found off-site (3.2 µg/L) (Tables 4, 5, and 6). We used an ATSDR model to estimate exposures from showering, drinking, and other household uses.

Noncancer Effects from Future Exposures to TCE in Private Well Water
Our dose estimates show the potential for harm to health from residential use of contaminated groundwater. Although the most-distant monitoring well with TCE is about 200 feet from the eastern site boundary, off-site testing has not delineated groundwater contamination. Therefore, DOH recommends property owners not install private wells on or within one-quarter mile east of the site. The following table summarizes dose ranges we calculated for future residential groundwater use at three TCE levels (Tables 4 through 6 in Appendix B).

Dose Ranges for Potential Average and Maximum TCE Exposure Assumptions

Comparison Value is 0.76 µg/L, MRL is 0.0005mg/kg/day

TCE Levels in Wells	Average Dose Range (CTE, mg/kg/day)	Maximum Dose Range (RME, mg/kg/day)
11,000 µg/L (Table 4)	0.4 to 1.1	1.6 to 20.3
1,800 µg/L (Table 5)	0.06 to 0.2	0.3 to 3.3
3.2 µg/L (Table 6)	0.0001 to 0.0003	0.0005 to 0.006

CTE = Central Tendency Exposure RME = Reasonable Maximum Exposure µg/L = micrograms per liter
mg/kg/day = milligrams per kilogram per day

The following are potential health effects based upon the calculated doses in the above table.

- Future residential use of on-site groundwater contaminated with 11,000 and 1,800 µg/L TCE increases the risk of many illnesses. These include babies born with heart defects, lowered resistance to infection, and lowered ability to gain weight normally with age (Table 7).

- All age groups with 11,000 µg/L TCE in their well water would be at increased risk of reduced thymus weight and delayed development of the immune system.
    - One to 16 year-olds and those older than 21 with 1,800 µg/L TCE in well water and maximum exposure would share these risks.
    - Children 1 to 2 years old with 11,000 µg/L TCE in their well water would be at increased risk of more serious immune system effects, suppressed cell-mediated immune response, and inhibited bone marrow growth. Immune system effects increase the risk of infections.

- For exposures lasting longer than one year, children 1 to 16 with 11,000 µg/L TCE and children 1 to 2 with 1,800 µg/L TCE in well water and maximum exposure would be at increased risk of weight loss and immune system effects.

- The 11 to16 year-old age group with maximum exposure exceeded the 0.00051 mg/kg/day Benchmark Dose Level ($BMDL_{01}$) for risk of fetal heart defects. Therefore, if in the future women 11 to 16 years old use off-site groundwater with 3.2 µg/L TCE, they could have a 1% increased chance of having a baby with a heart defect.

Increased Cancer Risk from Future Exposures to TCE in Private Well Water
The following table summarizes the increased cancer risks at three TCE levels for 33-year exposures.

Future Increased Cancer Risk at Average and Maximum TCE Exposures

TCE Level (µg/L)	Increased cancer risk at CTE (average dose)	Increased cancer risk at RME (max. dose)
11,000 µg/L (Table 4)	2 in 100	3 in 10
1,800 µg/L (Table 5)	4 in 1,000	5 in 100
3.2 µg/L (Table 6)	7 in 1,000,000	9 in 100,000

CTE = Central Tendency Exposure RME = Reasonable Maximum Exposure µg/L = micrograms per liter

For exposures to TCE in future drinking water wells, the estimated increased cancer risk for on-site exposures is high to very high for 11,000 µg/L and moderate to very high for 1,800 µg/L. The estimated increased cancer risk for off-site exposures is very low to low for 3.2 µg/L.

Although a positive association does not necessarily mean causation, epidemiologic studies associate TCE exposure with kidney cancer and non-Hodgkin's lymphoma. Weaker epidemiologic studies associate TCE with liver and biliary tract cancers. The biliary tract is the pathway of bile from the gallbladder to the small intestine. Other human epidemiologic studies find weak associations between TCE exposure and cancer of the bladder, esophagus, lung, prostate, cervix, breast, and childhood leukemia. EPA extrapolates a cancer slope factor from kidney cancer in TCE-exposed animals [EPA 2016b].

1,1,-Dichloroethene (1,1-DCE)

1,1-DCE occurs in groundwater as a breakdown product of TCE. 1,1-DCE slows the central nervous system following either oral or inhalation exposure. Animal studies showed high level ingestion or inhalation exposures damaged livers, kidneys and lungs [ATSDR 1994, 2009]. Exposure also decreased the average body weight in animals, caused immunosuppressive effects likely due to liver and kidney tissue damage, and caused heart birth defects. Exposed animals also experienced skin sensitization [ATSDR 2009].

We evaluated future 1,1-DCE exposures using an ATSDR model to estimate exposures from showering with and drinking well water with 11 µg/L 1,1,-DCE (Table 8).

Noncancer Effects from Future Exposures to 1,1-DCE in Private Well Water
Table 8 in Appendix B lists our dose estimates by age for residential groundwater use of well water with 11 µg/L 1,1-DCE. While doses for children 1 to 6 years old with maximum exposure were above the MRL, none were within a factor of 10 of the $BMDL_{10}$ for the critical effect level: fatty changes in the liver observed in rat chronic drinking water studies (4.6 mg/kg/day). Therefore, non-cancer illness from exposure to 1,1-DCE is unlikely.

Increased Cancer Risk from Future Exposures to 1,1-DCE in Private Well Water
For exposures to 11 µg/L 1,1-DCE in future on-site drinking water wells, the estimated cancer risk is very low to moderate. We calculated these risks for 33-year exposures.

1,1-DCE is a possible human carcinogen. Male mice developed kidney tumors in a lifetime bioassay [EPA 2016c]. This finding was tempered by the absence of similar results in female mice or male or female rats and by enzymatic differences between male and female mice, male and female rats, and human kidney cells [Speerschneider and Dekant 1995, Amet et al. 1997, Cummings et al 2000].

cis-1,2-Dichloroethene (cis-1,2-DCE)

cis-1,2-DCE is a manufactured chemical used to produce solvents and in chemical mixtures, it also forms as TCE breaks down. It can enter the body through the skin, through the lungs via inhalation or through the gastrointestinal tract via drinking water. Breathing high levels of *cis*-1,2-DCE causes sleepiness and nausea. In animal studies, *cis*-1,2-DCE decreases the numbers of red blood cells and adversely affects the liver. One animal study suggests *cis*-1,2-DCE causes slower fetal growth [ATSDR 1996].

We evaluated future *cis*-1,2-DCE exposures using an ATSDR model for showering and drinking well water with 200 µg/L *cis*-1,2,-DCE.

Noncancer Effects from Future Exposures to cis-1,2-DCE in Private Well Water
Table 9 in Appendix B lists dose estimates by age groups for future residential use of well water with 200 µg/L *cis*-1,2,-DCE. All doses were above the chronic MRL (0.002 mg/kg/day) and 1 to 2 year-olds (maximum exposure scenario) were above the intermediate MRL (0.3 mg/kg/day). None, however, were within a factor of 10 of the $BMDL_{10}$ for the critical effect level (5.1 mg/kg/day) for increased liver weight and 10% decreased body weight in exposed male rats (intermediate exposure equivalent). Therefore non-cancer illness from exposure to *cis*-1,2-DCE is unlikely.

Available studies have not determined whether *cis*-1,2-DCE exposures cause cancer in people or animals [EPA 2016d].

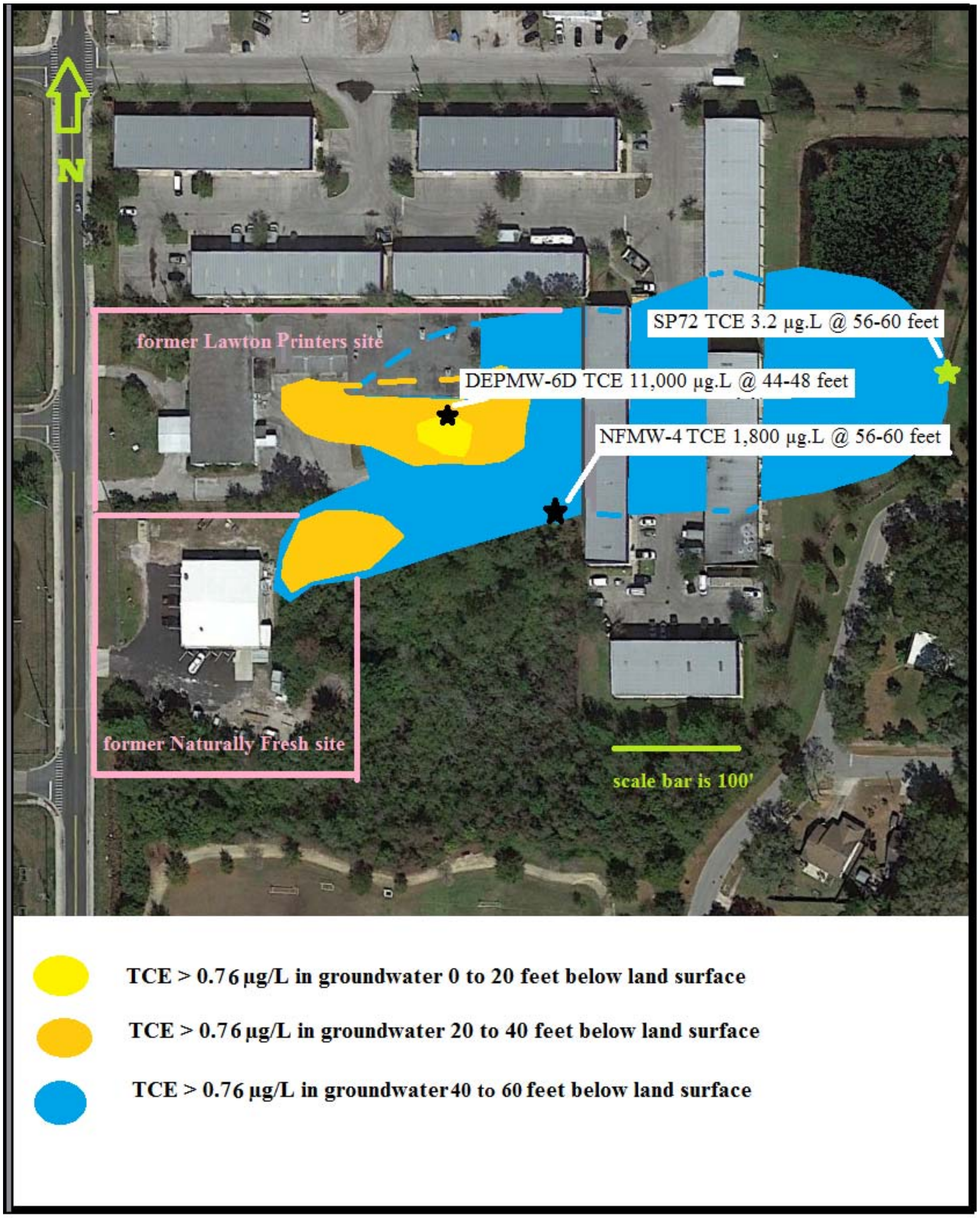
Eliminated Exposure Pathways

Indoor Air Pathway from Vapor Intrusion

We eliminate the past, present, and future <u>on-site</u> indoor air exposure from vapor intrusion due to a lack of buildings above the shallow septic tank drain field source (yellow contour on Figure 8). Figure 8 shows TCE concentrations at three different depths. *Only one on-site sample had solvents in shallow groundwater*. Also, the very low level measured in this shallow groundwater (2.1 µg/L) would not likely be a significant source for vapor intrusion (Table 3).

We eliminate the past, present, and future <u>off-site</u> indoor air exposure from vapor intrusion due to *environmental media* parameters (Table 3). Off site, VOCs are present in groundwater but only at depths greater than 50 feet below land surface. This is far below the water table which is about 3 feet below land surface. VOCs must be present at or above the water table to move into soil gas and buildings via vapor intrusion. Because they sink in groundwater when VOCs are below the water table, only a special aquifer characteristic called artesian flow can bring them up. Artesian flow does not occur at this site.

Figure 8: Anchor Road Solvent Site: TCE in groundwater by depth



[Google Earth 2016, DEP 2007, 2010, 2014; Ardaman and Associates 2008]

Surface Soil Pathway

Tests did not find VOCs in on-site or off-site surface soil [DEP 2007, 2010; Ardaman and Associates 2008]. Therefore, we eliminate the surface soil pathway as it lacks a *source* and *points of exposure* (Table 3).

On-site Well Pathway

We eliminate on-site well exposure because this pathway lacks a *point of exposure* (Table 3). The site businesses use municipal water. All of the current on-site wells are for monitoring groundwater contamination [DEP 2007, 2010; Ardaman and Associates 2008].

Surface Water Pathway

The site has no surface water features. Therefore, it lacks all the components of an exposure pathway (Table 3).

Site Specific Limitation of Findings

We do not have any air-monitoring or work-practices data from previous business. Therefore we are unable to evaluate past worker exposures.

Child Health Considerations

We recognize that infants and children might be more vulnerable than adults to exposures in communities with contaminated air, water, soil, or food. This potential vulnerability results from the following factors: 1) children are more likely to play outdoors and bring food into contaminated areas; 2) children are shorter and therefore more likely to contact dust and soil; 3) children's small sizes result in higher doses of chemical exposure per kg of body weight; and 4) developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Because children depend completely on adults for risk identification and management decisions, we are committed to evaluating their special interests at these sites.

Of the chemicals in the groundwater, TCE might pose greater health risks for children than adults. Based on animal studies, the developing fetal heart may be susceptible to the toxic effects of TCE. In addition, an epidemiologic study showed that maternal age at delivery and TCE exposure might be factors in increasing the risk of congenital health defects. The fetal immune system may also be susceptible to the toxic effects of TCE. A study with mice showed that a single TCE exposure resulted in increased thymocyte cellularity, a condition associated with altered immune system regulation and increased risk of infections [ATSDR 2014a].

Community Health Concerns

On July 29, 2016, DOH released a draft of this HC for public comment. The document was also available for viewing or downloading from the DOH web site. The public comment period was open until September 2, 2016. At the time of release of the public comment draft, DOH was unaware of any community health concerns, but we address concerns collected in Appendix C.

Conclusions

DOH reached the following conclusions:

1. In the future, use of contaminated groundwater from on-site wells for more than 2 weeks for drinking, showering or other household uses could cause harm to health. Such use could increase the risk of heart defects and infections in babies born to women using well water with 1,800 to 11,000 µg/L TCE. It could also decrease weight-gain in babies born to women using this well.

   Over a lifetime, residential use of well water with these levels of TCE could also result in a moderate to very high increased risk of kidney cancer and non-Hodgkin's lymphoma. Exposure to 1,1-DCE at 11 µg/L in this well water could cause a very low to moderate increased cancer risk.

2. The Anchor Road Solvent Site is not a current public health hazard. Although in the past businesses disposed of solvent in their septic systems, no one is currently using this contaminated groundwater.

3. In the past, site workers may have been exposed to TCE by breathing fumes, by getting solvents on their skin, and by accidentally swallowing solvents from hand-to-mouth activities. We lack data for such exposures and so are unable to evaluate the risk of harm to their health.

Recommendations

Florida DOH recommends site owners not use groundwater until it is cleaned up.

Public Health Action Plan

Actions Undertaken

DOH private well surveys and DEP investigations found that most residents and business on and near the Anchor Road Solvent site use municipal water [DOH 2016, DEP 2007, 2010, 2014]. Our August 2016 Community Update mail out for this site offered private well testing. Two nearby residents responded to this offer. DOH staff in Seminole County has tested and will continue to test private wells within one-quarter mile of the site upon request.

DOH solicited public comments and addresses them in this final report in Appendix C.

Actions Planned

DEP plans on requiring a restrictive covenant prohibiting use of contaminated groundwater under the site when the owners sell the properties.

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Appendices

Appendix A: Explanation of Evaluation Process

Screening Process

In evaluating these data, we used comparison values (CVs) to determine which chemicals to examine more closely. CVs are health-based contaminant concentrations found in a specific media (air, soil, or water) and are used to screen contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone might inhale or ingest each day.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and noncancer health effects. Noncancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children and adults are exposed every day. Cancer levels are based on a one-in-a-million excess cancer risk for exposure to contaminated soil or drinking contaminated water every day for 33 years, this exposure is extrapolated to a 78-year lifespan. For chemicals for which both cancer and noncancer CVs exist, we use the lower level to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

CVs used in preparing this document are listed below:

Cancer Risk Evaluation Guides (CREGs) are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a lifetime. CREGs are calculated from EPA cancer slope factors.

Maximum Contaminant Levels (MCLs) are enforceable standards set by EPA for the highest level of a contaminant allowed in drinking water. MCLs are set as close to MCL goals (the level of a contaminant in drinking water below which there is no known or expected risk to health) as feasible using the best available treatment technology and taking cost into consideration.

Estimation of Exposure Dose

The next step is to take those contaminants present at levels above the CVs and further evaluate whether those chemicals may be a health hazard given the specific exposure situations at this site. For exposures occurring by inhalation, the air concentration of the contaminant can be compared directly with health guideline air concentrations. For other pathways, we estimate the *exposure dose*, or the amount of contaminant that gets into a person's body. The exposure dose is typically expressed as milligrams of contaminant per kilogram of body weight of the person exposed, per day (mg/kg/day). This allows comparison with toxicological studies which express dose in the same units.

To do these estimates, we make assumptions about weight and other body characteristics of children and adults exposed, how they may be exposed, and how often they may be exposed to estimate site-and pathway-specific exposure doses. We explain the exposure assumptions and dose calculations for the pathways evaluated in this report in the following sections.

Inhalation of VOCs during Showering

We assumed all future private wells contaminated with VOCs would be used for showering and drinking. ATSDR's showering model calculates inhalation during showering and adds this dose to the drinking water dose. There are several steps in estimating the equivalent 24-hour air concentration, which will be discussed below.

ATSDR first used a model developed by Andelman [Andelman 1990] to estimate the peak TCE concentration occurring in the bathroom as a result of showering. The equation is given below.

$$Peak\ Conc.\left(\frac{\mu g}{m^3}\right) = \frac{C_W(\frac{\mu g}{L}) \times k \times F_W(\frac{L}{min}) \times T_s(min)}{V_a\ (m^3)}$$

Where

C_w	=	Concentration of the volatile compound in water, in µg/L
k	=	Volatilization coefficient, unitless (default is 0.6)
F_w	=	Flow rate of water through showerhead, in L/min (default is 8 L/min)
T_s	=	Time of shower, in min (varies with age, found in [EPA 2011])
V_α	=	Volume of air in shower in m^3 (default is 10 m^3)

For example, a 10-year-old takes a 15-minute shower in water containing 11,000 µg/L TCE. The peak concentration of TCE in the bathroom is:

$$\text{Peak Conc. } (\mu g/m^3) = \frac{11{,}000\ \mu g/L) \times 0.6 \times (8\ L/min) \times 15\ min}{10\ m^3}$$
$$= 79{,}200\ \mu g/m^3$$

The peak air concentration will be breathed in during the shower and during any time stayed in the bathroom after the shower. ATSDR used shower stay times listed in Volume I of the Risk Assessment Guidelines [EPA 2004]. The intake of contaminant due to inhalation is given by the following:

$$Intake_{Inhalation} = \text{Peak Conc. } (\mu g/m^3) \times IR_{st}\ (m^3/min) \times (T_s + T_b)\ (min),$$

Where

IR_{st} = Short term inhalation rate in m^3/min (varies with age, found in [EPA 2011], assumed to reflect "light intensity" activity)

T_s = Time of shower and/or bath, in min (varies with age, found in [EPA 2011])

T_b = Time in bathroom after shower/bath, in min (varies with age, found in [EPA 2011])

For example, the inhalation intake for the 10-year-old in the previous example, who has an average short term inhalation rate of 0.011 m^3/min and remains in the bathroom for 5 minutes after a 15-minute shower is:

$$Intake_{Inhalation}(\mu g) = 79{,}200\ (\mu g/m^3) \times 0.011\ (m^3/min) \times (5+15)\ (min) = 17{,}424\ \mu g\ TCE$$

The total intake from showering is the sum of inhalation doses.

The shower model results reported in Tables 5 through 10 do not take into account the additional exposures in a family from breathing indoor air from showers from other family members. They do include continued indoor inhalation exposure to contaminant air levels from each individual's shower during showering and for the rest of the day. The inhalation model assumes children under one year old will bathe and does not calculate a shower dose for this age-group.

To evaluate total exposure, shower model calculations add the shower time to the time that someone stays in the bathroom after a shower. The Exposure Factors Handbook reports both 50th and 95th percentile for shower time and after-shower bathroom time [EPA 2011]. While the 50th percentile shower time and after-shower bathroom time are similar (i.e., 5 to 15 minutes), the 95th percentile for these parameters is much greater (i.e., 20-50 minutes). Therefore, the Reasonable Maximum Exposure (RME) values can be 5 to 20 times greater than the Central Tendency Exposure (CTE) values, depending on the age group. To mitigate this difference, ATSDR modified the RME estimates so that most of the rest of the parameters they used in the spreadsheet are CTE parameters. When appropriate, they did use

Table A1. Private Well Pathway, Anchor Road Solvent source site, Casselberry, Florida
Exposure Assumptions for Estimating TCE Inhalation Exposures from Showering

Group	Short Term Inhalation Rate, m^3/min	Long Term Inhalation Rate, m^3/day	Time in Shower, min	Time in Bathroom after shower, min
Children from Birth Up to 1 Year Old	0.0076	3.5	10*	5
Children from 1 Year Old Up To Age 2	0.012	8	10	5
Children from 2 Years Old Up To Age 3	0.012	8.9	10	5
Children from 3 Years Old Up To Age 6	0.011	10.1	12	5
Children from 6 Years Old Up To Age 11	0.011	12	15	5
Children from 11 Years Old Up To Age 16	0.011	15.2	15	5
Children from 16 Years Old Up To Age 21	0.012	16.3	15	5
Adults Greater Than 21 Years Old	0.012	15.1	15	5

Sources: We used weighted averages to obtain short term inhalation rates obtained from Table 6-2 of [EPA 2011], for recommended short-term exposure values for inhalation (males and females combined), and light intensity activity level. Long term inhalation rate obtained from Table 6-1 of [EPA 2011], recommended long-term exposure values for inhalation (males and females combined).
cm^2 = square centimeters m^3/min = cubic meter per minute m^3/day = cubic meter per day

RME estimates to calculate RME parameters. For example, ATSDR used the 95th percentile shower time for the RME shower time and the 95^{th} percentile of the bathroom stay times for the RME bathroom stay parameter.

Ingestion of VOCs in Drinking Water

ATSDR estimated exposure doses for users of private well water assuming the average weights and drinking water ingestion rates listed in Table A2 below. The 24-hour equivalent PCE and TCE concentrations calculated using the showering and drinking water equations are listed in Appendix B in Tables 5 thorough 10.

To calculate the dose resulting from the drinking water component of the exposure containing a certain concentration of a chemical, the concentration is used with exposure assumptions as listed in Tables A1 and A2.

For example, a child younger than one year old (average weight 7.8 kg), drinking 1.1 liters of

Table A2. Private Well Pathway, Anchor Road Solvent source site, Casselberry, Florida
Estimates for Body Weight and Drinking Water Ingestion

Group	Body Weight in Kilograms (Weight in Pounds)	Ingestion of Drinking Water in Liters per Day (Approximate 8-ounce glasses per day)	
		High-end	Average
Children from 6 weeks to 1 Year Old	9.2 kg (20 lb.)	1.1 L/day (5 glasses/day)	0.5 L/day (2 glasses/day)
Children from 1 Year Old up to Age 2	11.4 kg (25 lb.)	0.9 L/day (4 glasses/day)	0.4 L/day (2 glasses/day)
Children from 2 Years Old Up To Age 3	13.8 kg (30 lb.)	0.9 L/day (4 glasses/day)	0.5 L/day (2 glasses/day)
Children from 3 Years Old Up To Age 6	18.6 kg (41 lb.)	1.0 L/day (4 glasses/day)	0.6 L/day (2.5 glasses/day)
Children from 6 Years Old Up To Age 11	31.8 kg (70 lb.)	1.4 L/day (6 glasses/day)	0.5 L/day (2 glasses/day)
Children from 11 Years Old Up To Age 16	56.8 kg (125 lb.)	2 L/day (8 glasses/day)	0.6 L/day (2.5 glasses/day)
Children from 16 Years Old Up To Age 21	71.6 kg (158 lb.)	2.5 L/day (11 glasses/day)	0.8 L/day (3.5 glasses/day)
Adults Greater Than 21 Years Old	80 kg (176 lb.)	3.0 L/day (13 glasses/day)	1.2 L/day (5 glasses/day)
Sources: Weight for children and adults obtained from Table 8-1 of [EPA 2011], recommended values for body weight (males and females combined). (Weighted averages used to obtain body weight for specific age ranges listed in this table.) -Ingestion rates obtained from Tables 3-1 and 3-3 of [EPA 2011], consumers-only ingestion of drinking water, High-end=95th percentile, Average=mean. (Weighted averages used to obtain ingestion for specific age ranges listed in this table.) kg = kilogram, lb = pound, L/day = liters per day			

water (about 5 8-ounce glasses), containing the highest concentration of TCE (11,000 µg/L or 11.0 mg/L), every day will receive a dose of:

$$Dose = (11.0\ mg/L \times 1.1\ L/day)/\ 7.8\ kg = 1.6\ mg/kg/day$$

The doses for children less than one are all calculated using these parameters [ATSDR 2014b]. The doses for those older than one are added to the showering dose calculated for that age group using average or maximum exposure assumptions. This model adds the central tendency values from EPA's Exposure Factors handbook for shower time and after shower bathroom time, therefore the RME dose may be 5 to 20 times the CTE dose depending on the age group measured. We list our calculated doses by age group in Tables 4 through 9.

Evaluating Noncancer Health Effects

The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, and/or the use of the lowest study doses that resulted in harmful health effects (rather than the highest dose that did not result in harmful health effects). For noncancer health effects, the following health guideline values are used.

Minimal Risk Level (MRLs) – Developed by ATSDR

An MRL is an estimate of daily human exposure—by a specified route and length of time—to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls/index.html.

Reference Concentration (RfC) – Developed by EPA

The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfC considers both toxic effects of the respiratory system (portal-of-entry) and effects peripheral to the respiratory system (extra respiratory effects).

Reference Dose (RfD) – Developed by EPA

The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime

Maximum Contaminant Level (MCL) – Developed by EPA

The MCL is the highest level of a contaminant that is allowed by the EPA in public drinking water systems. MCLs are enforceable standards set as close as feasibly possible to levels below which there is no known or expected risk to health, using the best available treatment technology and taking cost into consideration.

If the estimated exposure dose for a chemical is less than the health guideline value, then the exposure is unlikely to cause a noncancer health effect in that specific situation. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared to known toxicological values for that chemical and is discussed in more detail in the public health assessment. These toxicological values are doses derived from human and animal studies that are summarized in the ATSDR *Toxicological Profiles* and in current scientific literature. A direct comparison of site-specific exposure and doses to study-derived exposures and doses that cause adverse health effects is the basis for deciding whether health effects are likely or not.

Evaluating Cancer Health Effects

The estimated risk of developing cancer resulting from exposure to the contaminants was calculated by multiplying the site-specific estimated cancer dose by an appropriate cancer slope factor or inhalation unit risk (EPA values can be found at http://www.epa.gov/iris). The result estimates the increase in risk of developing cancer after 33 years of continuous exposure to the contaminant averaged over a lifetime.

If a substance causes cancer by a mutagenic mode of action, there is a greater risk for exposures that occur in early life. For these substances, age-dependent adjustment factors (ADAFs) are applied to the risks estimated as follows: An ADAF of 10 is applied for exposures taking place from birth up to 2 years old, and an ADAF of 3 is applied for exposures taking place from age 2 up to age 16. No adjustment is applied for exposures at age 16 or above [EPA 2004]. Our model uses an ADAF to calculate increased cancer risk for TCE.

The actual increased risk of cancer may be lower than the calculated number, which gives an estimated risk of excess cancer. The methods used to calculate cancer slope factors assume that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The methods also assume that no safe level exists for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, most methods compute the upper 95th percentile confidence limit for the risk. The actual cancer risk can be lower, perhaps by orders of magnitude [ATSDR 2005].

Because of uncertainties involved in estimating cancer risk, ATSDR employs a weight-of-evidence approach in evaluating relevant data [ATSDR 1993]. Therefore, the increased risk of cancer is described in words (qualitatively) rather than giving a numerical risk estimate only. Numerical risk estimates must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions.

Lifetime Cancer Risk Calculation (we assume 21 years at various childhood weights and 12 years at the 21 to 65 year old adult weight for our calculations)

$$\text{Dose} = (C \times IR \times EF \times CF)/BW$$

$$EF = (F \times ED)/AT$$
$$\text{Cancer Risk} = CSF \times \text{Dose}$$

Assumptions:
C = Concentration = 11.0 mg/L
IR = see Table A2 for child and young adult ingestion rates
BW = see Table A2 for child and young adult body weights
EF = Exposure Factor = 0.45
F = Frequency =350 days per year
ED = Exposure Duration = 33 years
CF = Conversion factor (10^{-6} kg/mg)
AT = Averaging Time = 25,500 days (78 years)
CSF = Cancer Slope Factor = 0.0046 $(mg/kg/d)^{-1}$

Dose = (11 mg/L × various amounts apportioned by age × 0.45 × 10^{-6} kg/mg)/ various amounts apportioned by age = **see Table 4 for CTE and RME Doses by age** (model also apportions age dependent adjustment factor for mutagenic chemicals like TCE)

Cancer Risk = (0.0046 $(mg/kg/d)^{-1}$) × CTE and RME Estimated Cancer Ingestion Doses by age group) when added together give

- 1 in 100 or a “high” increased risk for CTE exposures, and
- 3 in 10 or a “very high” increased risk for RME exposures.

For these lifetime cancer risks, we sum the apportioned risks for children and the cancer risk for all adults multiplied by 0.3 because only 12 (ages 21 to 33) of the 44 adult years (ages 21 to 65) are included in the exposure time for cancer.

Appendix B: Tables

Table 1: Contaminants of concern in groundwater at the Anchor Road Solvent Site

Contaminants of Concern	**Concentration Range (µg/L)**	**Screening Guideline* (µg/L)**	**Source of Screening Guideline**	**# Above Screening Guideline/Total #**
Trichloroethene	<0.22 to 11,000	0.76	ATSDR CREG	42/136
1,1-Dichloroethene	<0.75 to11	7	ATSDR CREG	1/83
cis-1,2-Dichloroethene	<0.5 to200	20	ATSDR RMEG	6/83

ATSDR–Agency for Toxic Substances and Disease Registry
CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
RMEG = ATSDR reference dose media evaluation guide. A reference dose is an estimate, with uncertainty spanning perhaps 10 times, of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
µg/L = micrograms per liter
* Screening guidelines only used to select chemicals for further scrutiny, not to the judge the risk of health impact.
Source of data: [DEP 2007, 2010, 2014; Ardaman and Associates, 2008]

Table 2. Potential human exposure pathways for the Anchor Road Solvent Site

Pathway Name	Exposure Pathway Elements					Time Frame
	Source	**Environmental Media**	**Point of Exposure**	**Route of Exposure**	**Potentially Exposed Population**	
Private wells	Solvent discharged to on-site septic tanks	Groundwater	Residential taps, showerheads, and indoor air	Ingestion, inhalation, and dermal contact	Residents in areas of groundwater contamination	Future

Table 3. Eliminated human exposure pathways for the Anchor Road Solvent Site

Pathway Name	Exposure Pathway Elements					Time
	Source	**Environmental Media**	**Point of Exposure**	**Route of Exposure**	**Exposed Population**	
Indoor air	Solvents discharged to on-site septic tanks	Indoor air	Air in on-site businesses and in nearby businesses and residences	Inhalation	On-site workers and nearby workers and residents	---
Surface soil	Solvents discharged to on-site septic tanks	Soil	On-site unpaved areas, residential yards, and nearby businesses	Ingestion, ingestion, and dermal contact	Site workers, nearby residents, and nearby workers	---
On-site well	Solvents discharged to on-site septic tanks	Groundwater	On-site water taps	Ingestion	Workers	---
Surface water	Solvents discharged to on-site septic tanks	On- and off-site surface water	Surface water bodies	Ingestion and dermal contact	On-site workers and nearby residents and workers	---

Table 4: Estimated doses and increased lifetime cancer risks for future residential use of TCE-contaminated well water at the Anchor Road Solvent Site—concentration 11,000 µg/L.

Age Group (years)	Body Weight (kg)	Ground-water Concentra-tion (µg/L)	Estimated Non-cancer Dose (mg/kg/day)		EPA RfD/ ATSDR MRL (mg/kg/ day)	Oral Cancer Slope Factor $(mg/kg/d)^{-1}$	Estimated Cancer Dose (mg/kg/day)		Estimated Increased Lifetime Cancer Risk	
			RME	CTE			RME	CTE	RME	CTE
0.5 to <1	9.2	11,000	1.6*	0.7*	0.0005/ 0.0005 int. and chr.	.046	2×10^{-2}	9×10^{-3}	2×10^{-2}	9×10^{-3}
1 to <2	11.4		20.3	1.1			3	1×10^{-1}	1×10^{-1}	7×10^{-3}
2 to <6	17.4		12.6	0.8			2	1×10^{-1}	9×10^{-2}	5×10^{-3}
6 to <11	31.8		4.8	0.7			9×10^{-1}	1×10^{-1}	4×10^{-2}	6×10^{-3}
11 to <16	56.8		4.4	0.5			9×10^{-1}	9×10^{-2}	4×10^{-2}	4×10^{-3}
16 to <21	71.6		2.0	0.4			1×10^{-1}	2×10^{-2}	6×10^{-3}	9×10^{-4}
≥21	80		2.1	0.4						

Children's summed cancer risk 0.5 year to <21 year................3×10^{-1} 2×10^{-2}

Adults' cancer risk ages 21 to 33...5×10^{-5} 9×10^{-4}

Lifetime Cancer Risk, Children + Adults...............................3×10^{-1} 2×10^{-2}

Estimates include drinking and showering with this water. Shower exposures include vapor inhalation.

µg/L = micrograms per liter,

RME = Reasonable Maximum Exposure,

CTE = Central Tendency Exposure

*Doses for children under one are for drinking (ingestion) only.

EPA RfD = Reference Dose A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

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.

[shaded box] Shaded doses exceed the EPA RfD and or ATSDR MRL

Table 5: Estimated doses and increased lifetime cancer risks for future residential use of TCE-contaminated well water at the eastern boundary of the Anchor Road Solvent Site—concentration 1,800 µg/L.

Age Group (years)	Body Weight (kg)	Ground-water Concentra-tion (µg/L)	Estimated Non-cancer Dose (mg/kg/day)		EPA RfD/ ATSDR MRL (mg/kg/ day)	Oral Cancer Slope Factor $(mg/kg/d)^{-1}$	Estimated Cancer Dose (mg/kg/day)		Estimated Increased Lifetime Cancer Risk	
			RME	CTE			RME	CTE	RME	CTE
0.5 to <1	9.2	1,800	0.3*	0.1*	0.0005/ 0.0005 int. and chr.	.046	3×10^{-3}	2×10^{-3}	3×10^{-3}	2×10^{-4}
1 to <2	11.4		3.3	0.2			4×10^{-1}	2×10^{-2}	2×10^{-2}	1×10^{-3}
2 to <6	17.4		2.1	0.1			3×10^{-1}	2×10^{-2}	1×10^{-2}	9×10^{-4}
6 to <11	31.8		0.8	0.1			2×10^{-1}	2×10^{-2}	7×10^{-3}	1×10^{-3}
11 to <16	56.8		0.7	0.08			1×10^{-1}	2×10^{-2}	6×10^{-3}	7×10^{-4}
16 to <21	71.6		0.3	0.07			2×10^{-2}	3×10^{-3}	1×10^{-3}	1×10^{-4}
≥21	80		0.4	0.06						

Children's summed cancer risk 0.5 year to <21 year................5×10^{-2} 4×10^{-3}
Adults' cancer risk ages 21 to 33..8×10^{-5} 1×10^{-4}
Lifetime Cancer Risk, Children + Adults.................................5×10^{-2} 4×10^{-3}

Estimates include drinking and showering with this water. Shower exposures include vapor inhalation.
µg/L = micrograms per liter,
RME = Reasonable Maximum Exposure,
CTE = Central Tendency Exposure
*Doses for children under one are for drinking (ingestion) only.
EPA RfD = Reference Dose A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
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.
[shaded box] Shaded doses exceed the EPA RfD and or ATSDR MRL

Table 6: Estimated doses and increased lifetime cancer risks for future residential use of TCE-contaminated well water off-site, east of the Anchor Road Solvent Site—concentration 3.2 µg/L.

Age Group (years)	Body Weight (kg)	Maximum Ground-water Concentra -tion (µg/L)	Estimated Non-cancer Dose (mg/kg/day)		EPA RfD/ ATSDR MRL (mg/kg/ day)	Oral Cancer Slope Factor $(mg/kg/d)^{-1}$	Estimated Cancer Dose (mg/kg/day)		Estimated Increased Lifetime Cancer Risk	
			RME	CTE			RME	CTE	RME	CTE
0.5 to <1	9.2	3.2	0.0005*	0.0002*	0.0005/ 0.0005 intermediate and chronic exposures	.046	5×10^{-4}	2×10^{-4}	6×10^{-6}	3×10^{-6}
1 to <2	11.4		0.006	0.0003			8×10^{-4}	4×10^{-5}	3×10^{-5}	2×10^{-6}
2 to <6	17.4		0.004	0.0002			6×10^{-4}	3×10^{-5}	3×10^{-5}	2×10^{-6}
6 to <11	31.8		0.001	0.0002			3×10^{-4}	4×10^{-5}	1×10^{-5}	2×10^{-6}
11 to <16	56.8		0.001	0.0001			2×10^{-4}	3×10^{-5}	2×10^{-6}	1×10^{-6}
16 to <21	71.6		0.0006	0.0001			4×10^{-5}	6×10^{-6}	5×10^{-7}	3×10^{-7}
≥21	80		0.0006	0.0001						

Children's summed cancer risk 0.5 year to <21 year..............9×10^{-5} 7×10^{-6}
Adults' cancer risk ages 21 year to 33....................................5×10^{-5} 3×10^{-7}
Lifetime Cancer Risk, Children + Adults...............................9×10^{-5} 7×10^{-6}

Estimates include drinking and showering with this water. Shower exposures include vapor inhalation.
µg/L = micrograms per liter,
RME = Reasonable Maximum Exposure,
CTE = Central Tendency Exposure
*Doses for children under one are for drinking (ingestion) only.
EPA RfD = Reference Dose A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
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.
Shaded doses exceed the EPA RfD and or ATSDR MRL

Table 7: Comparison of TCE levels from Tables 4 and 5 with the Lowest Observable Adverse Effect Levels (LOAEL).

	TCE level in µg/L	
Intermediate (2 weeks to one year) Exposure Health Effects	**11,000**	**1,800**
LOAEL 0.048 mg/kg/day, increased incidence of congenital heart abnormalities [Johnson et al. 2003]	all doses for women of child-bearing age are greater than this LOAEL	all doses for women of child-bearing age are greater this LOAEL
LOAEL - 0.35 mg/kg/day, immune system effects: decreased thymus weight, increased levels of selected antibodies [Keill et al. 2009]	all doses are greater than this LOAEL	RME exposures for 1 to 16 year-olds and those older than 21 are greater than this LOAEL
LOAEL - 0.37 mg/kg/day, decreased response in an assay that measures the function of the immune system response called the plaque-forming cell response, in male and female pups, increased hypersensitivity response in male pups, another measure of the immune system's response, 18% decreased body weight in 3-week-old pups [Peden-Adams et al. 2006]	all doses are greater than this LOAEL	RME exposures for 1 to 16 year-olds and those older than 21 are greater than this LOAEL
LOAEL 18 mg/kg/day, suppressed cell-mediated immune response, inhibited bone marrow stem cell colonization [Wang et al. 2007]	RME exposures for children 1 to 2 years old are greater than this LOAEL	none
Chronic (longer than one year) Exposure Health Effects		
LOAEL 3.3 mg/kg/day, 12% depressed mean terminal body weight, 29% decreased thymic cellularity (loss of thymus cells), decreased thymus weight is often one of the first noted measures of immune system toxicity [Peden-Adams 2008]	RME exposures for children 1 to 16 years old greater than this LOAEL	RME exposures for children 1 to 2 years old equal this LOAEL

CTE = Central Tendency Exposure RME = Reasonable Maximum Exposure
µg/L = micrograms per liter mg/kg/day = milligrams per kilogram per day

Table 8: Estimated doses and increased lifetime cancer risks for future residential use of 1,1-Dichloroethene contaminated well water at the eastern boundary of the Anchor Road Solvent Site—concentration 11 µg/L.

Age Group (years)	Body Weight (kg)	Maximum Ground-water Concentra-tion (µg/L)	Estimated Non-cancer Dose (mg/kg/day)		EPA RfD/ ATSDR MRL (mg/kg/ day)	Oral Cancer Slope Factor $(mg/kg/d)^{-1}$	Estimated Cancer Dose (mg/kg/day)		Estimated Increased Lifetime Cancer Risk	
			RME	CTE			RME	CTE	RME	CTE
0.5 to <1	9.2	11	0.002*	0.0007*	0.05/ 0.009 chronic	0.6	2×10^{-5}	9×10^{-6}	1×10^{-5}	6×10^{-6}
1 to <2	11.4		0.02	0.001			3×10^{-4}	1×10^{-5}	2×10^{-4}	9×10^{-7}
2 to <6	17.4		0.01	0.0008			6×10^{-4}	4×10^{-5}	4×10^{-4}	2×10^{-6}
6 to <11	31.8		0.005	0.0007			3×10^{-4}	5×10^{-5}	2×10^{-4}	3×10^{-6}
11 to <16	56.8		0.004	0.0005			3×10^{-4}	3×10^{-5}	2×10^{-4}	2×10^{-6}
16 to <21	71.6		0.002	0.0004			1×10^{-4}	2×10^{-4}	8×10^{-5}	2×10^{-6}
≥21	80		0.002	0.0004						

Children's summed cancer risk 0.5 year to <21 year................1×10^{-3} 1×10^{-5}
Adults' cancer risk ages 21 to 33...2×10^{-4} 4×10^{-6}
Lifetime Cancer Risk, Children + Adults...............................1×10^{-3} 1×10^{-5}

Estimates include drinking and showering with this water. Shower exposures include vapor inhalation.
µg/L = Micrograms per liter
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
*Doses for children under one are for drinking (ingestion) only.
EPA RfD = Reference Dose A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
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.
Shaded doses exceed the EPA RfD and or ATSDR MRL

Table 9: Estimated doses for future residential use of cis-1,2-Dichloroethene contaminated well water at the eastern boundary of the Anchor Road Solvent Site—concentration, 200 µg/L.

Age Group (years)	Body Weight (kg)	Maximum Groundwater Concentration (µg/L)	Estimated Non-cancer Dose (mg/kg/day)		EPA RfD/ ATSDR MRL (mg/kg/ day)
			RME	CTE	
0.5 to <1	9.2	200	0.03*	0.01*	.002/0.3 intermediate MRL
1 to <2	11.4		0.4	0.02	
2 to <6	17.4		0.2	0.01	
6 to <11	31.8		0.09	0.01	
11 to <16	56.8		0.08	0.009	
16 to <21	71.6		0.04	0.008	
≥21	80		0.04	0.007	

cis-1,2-Dichloroethene is not a carcinogen.
Estimates include drinking and showering with this water. Shower exposures include vapor inhalation.
µg/L = Micrograms per liter
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
*Doses for children under one are for drinking (ingestion) only.
EPA RfD = Reference Dose A reference dose is an estimate of a daily oral exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
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.
Shaded doses exceed the EPA RfD and or ATSDR MRL

Appendix C: Response to Health Concerns

We received feedback in response to our Anchor Road Solvent site community update mailed in late July 2016. We identified one family who still uses well water east of the site. Seminole County DOH staff sampled this well for solvents in July 2016. We also identified another well user who lives north of the site (not in the direction of groundwater flow from of the site) who uses groundwater delineated for ethylene dibromide, a pesticide. Seminole County DOH staff sampled this well for ethylene dibromide in July 2016. Florida has a Water Supply Restoration program that will provide an alternate water source or whole house filtering system if a follow-up confirmation sample shows the groundwater source for the well is contaminated.

A woman who received our community update phoned us. She said she had lived near the area in the late 1960s when the Dektronics and Metallic and Brushless Motor Electronics businesses operated at the site. She said they drank and used well water as their household water source. She said she, her son, and her sister all had skin rashes. I asked if she knew what kind of rash they had, she said eczema.

We do not have an address for where this woman lived in the late 1960s, nor do we know if their well water had contamination at that time. Therefore, we are unable to establish if any family members were exposed to solvents via ingestion of groundwater that may have caused their rashes.

We found the following information on eczema [Mayo Clinic, 2016]. Another name for eczema is atopic dermatitis, a condition that makes your skin red and itchy. It is common in children but can occur at any age. Atopic dermatitis is long lasting (chronic) and tends to flare periodically and then subside. It may be accompanied by asthma or hay fever.

Mayo clinic authors advise seeing your doctor if your atopic dermatitis symptoms distract you from your daily routines or prevent you from sleeping. No cure has been found for atopic dermatitis. Treatments and self-care measures can relieve itching and prevent new outbreaks. For example, it helps to avoid harsh soaps and other irritants, apply medicated creams or ointments, and moisturize your skin.

Atopic dermatitis (eczema) signs and symptoms vary widely from person to person and include:

- Itching, which may be severe, especially at night
- Red to brownish-gray patches, especially on the hands, feet, ankles, wrists, neck, upper chest, eyelids, inside the bend of the elbows and knees, and, in infants, the face and scalp
- Small, raised bumps, which may leak fluid and crust over when scratched
- Thickened, cracked, dry, scaly skin
- Raw, sensitive, swollen skin from scratching.

Atopic dermatitis most often begins before age 5 and may persist into adolescence and adulthood. For some people, it flares periodically and then clears up for a time, even for several years.

Healthy skin helps retain moisture and protects you from bacteria, irritants and allergens. Eczema is likely related to a mix of factors:

- Dry, irritable skin, which reduces the skin's ability to be an effective barrier
- A gene variation that affects the skin's barrier function
- Immune system dysfunction
- Bacteria, such as Staphylococcus aureus, on the skin that creates a film that blocks sweat glands
- Environmental conditions

Treatments and drugs

Atopic dermatitis can be persistent. You may need to try various treatments over months or years to control it. And even if you respond to treatment, your signs and symptoms may return (flare). It is important to recognize the condition early so you can start treatment. If regular moisturizing and other self-care steps don't help, your doctor may suggest the following treatments and drugs:

Creams that control itching and inflammation. Your doctor may prescribe a corticosteroid cream or ointment. Talk with your doctor before using any topical corticosteroid. Overuse of this drug may cause skin irritation or discoloration, thinning of the skin, infections, and stretch marks.

- **Creams that help repair the skin.** Drugs called calcineurin inhibitors — such as tacrolimus (Protopic) and pimecrolimus (Elidel) — affect your immune system. Applied to the skin, they help maintain normal skin, control itching and reduce flares of atopic dermatitis. Due to possible side effects, these prescription-only drugs are used only when other treatments have failed or if someone can't tolerate other treatments. They are approved for children older than 2 and for adults.
- **Drugs to fight infection.** You may need antibiotics if you have a bacterial skin infection or an open sore or cracked skin caused by scratching. Your doctor may recommend taking oral antibiotics for a short time to treat an infection. Or he or she may suggest you take it for a longer time to reduce bacteria on your skin and to prevent another infection.
- **Oral anti-itch drugs.** If itching is severe, oral antihistamines may help. Diphenhydramine (Benadryl, others) can make you sleepy and may be especially helpful at bedtime.
- **Oral or injected drugs that control inflammation.** For more severe cases, your doctor may prescribe oral corticosteroids — such as prednisone — or an injected corticosteroid. These drugs are effective but cannot be used long term because of potential serious side effects. Continue moisturizing and using other self-care remedies to prevent a flare-up after you stop taking the corticosteroids.

Therapies

- **Wet dressings.** An effective, intensive treatment for severe atopic dermatitis involves wrapping the affected area with topical corticosteroids and wet bandages. It has proven to control signs and symptoms within hours to days. Sometimes it is done in a hospital because it is labor intensive and requires nursing expertise. Or, ask your doctor about learning how to do this technique at home.

- **Light therapy.** The simplest form of light therapy (phototherapy) involves exposing your skin to controlled amounts of natural sunlight. Other forms use artificial ultraviolet A (UVA) and narrow band UVB either alone or with medications.
- Though effective, long-term light therapy has harmful effects, including premature skin aging and an increased risk of skin cancer. For these reasons, phototherapy is not used for infants and young children. Talk with your doctor about the pros and cons of light therapy in your situation.
- **Treatment for stress.** Counseling may help children and young adults who are extremely embarrassed or frustrated by their skin condition.
- **Relaxation, behavior modification or biofeedback.** These approaches may help you with habitual scratching.

Infantile eczema

Treatment for infantile eczema includes:

- Identifying and avoiding skin irritations
- Avoiding extreme temperatures
- Lubricating your baby's skin with bath oils, lotions, creams or ointments

See your baby's doctor if these measures do not improve the rash or if the rash looks infected. Your baby may need a prescription medication to control the rash or to treat an infection. Your doctor may recommend an oral antihistamine to help lessen the itch and to cause drowsiness, which may be helpful for nighttime itching and discomfort.

Glossary

Absorption
The process of taking in. For a person or 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]**.

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

Age Dependent Adjustment Factor (ADAF)
A factor used to account for age-related differences in toxicity of cancer-causing chemicals which allows integration of varying toxicity and exposures over relevant age intervals.

Aquifer
A layer of underground porous rock, gravel, sand, or silt containing enough groundwater to supply springs or wells.

Association
In statistics, a relationship between two measured quantities that means changes in one quantity can predict changes in the other. The relationship is not necessarily causal; that is, changes in one quantity do not necessarily cause the changes observed in the other quantity.

Cancer
A group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

Cancer risk
A theoretical risk of 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.

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

Chronic
Occurring over a long time (more than 1 year) [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**].

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 process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

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

Demographic
Pertaining to statistical characteristics of human populations.

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**].

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

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

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.

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

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

EPA
United States Environmental Protection Agency.

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 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**.

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.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with **public health assessment**].

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**].

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.

mg/kg
Milligram per kilogram.

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**].

Mutagen
A substance that causes **mutations** (genetic damage).

Percentile
The value of a variable below which a certain percent of observations fall. For example, 95 out of 100 observations are expected to fall below the 95^{th} percentile.

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).

ppb
Parts per billion.

ppm
Parts per million.

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.

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.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see **exposure registry** and **disease registry**].

RfD
See reference dose.

Risk
The probability that something will cause injury or harm.

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].

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.

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**.

Sensitive 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.

Substance
A chemical.

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

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.

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.

Vapor Intrusion

Vapor intrusion is a way that volatile chemicals in the ground or groundwater can get into indoor air. Volatile gases, or vapors, can move up from the groundwater into pockets of air underground. Then the vapors can travel through the ground. Vapors can enter homes through cracks in foundations, dirt floors, sump pump pits, utility conduits, floor drains, and damaged or poorly constructed plumbing. Once vapors are in the home, they may not be able to leave if the home is airtight and does not get fresh air. In some cases, the vapors can build up to harmful levels inside a home.

Volatile organic compounds (VOCs)

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