HEALTH CONSULTATION

DEPARTMENT OF MANAGEMENT SERVICES SITE

STARKE, FLORIDA

DEP Site #56SL

September 27, 2018

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 (FDOH) evaluates the public health threat through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry in Atlanta, Georgia. This health consultation is part of an ongoing effort to evaluate potential health effects associated with contaminated groundwater at the Department of Management Services site. FDOH evaluates site-related public health issues through the following processes:

The cooperative agreement program is not regulatory (meaning the program does not oversee nor direct programs that oversee the control of environmental standards that are designed to protect public health). The cooperative agreement program is advisory and can suggest that regulatory programs or responsible parties look at certain issues of public health concern. Each program (within FDOH or outside the FDOH) is governed by its own statutes, rules, and policies for directing clean up or mitigation of a chemical once an issue is found. The risk levels, concentrations, and inputs for these health consults represent a snapshot in time that may not be the same as what a regulatory program uses to direct their cleanup or mitigation efforts

Evaluating exposure: FDOH begins by reviewing available information about environmental conditions at the site. It finds out how much contamination is present, where it is on the site, and how human exposures might occur. The Florida Department of Environmental Protection (DEP) provided the information for this assessment.

Evaluating health effects: If FDOH finds evidence that exposures to hazardous substances are occurring or might occur, it determines whether that exposure could be harmful to human health. This report focuses on public health, based on existing scientific information.

Developing recommendations: FDOH outlines its conclusions regarding potential health threats posed by contaminated groundwater, and offers recommendations for reducing or eliminating human exposure to contaminants. If it finds an immediate health threat exists or is imminent, it issues a public health advisory warning people of the danger, and works to resolve the problem.

Soliciting community input: The evaluation process is interactive. Once FDOH prepares an evaluation report, it seeks feedback. It shares its conclusions about the site with the groups and organizations who provided the information and it asks about the concerns of those living in communities near the site.

If you have questions or comments about this report, please contact FDOH.

Please write to: Division of Disease Control and Health Protection
Bureau of Environmental Health, Public Health Toxicology
Florida Department Health
4052 Bald Cypress Way, Bin # A-08
Tallahassee, FL 32399-1720
Or call: Toll free at 877-798-2772

Summary

INTRODUCTION

At the Department of Management Services (DMS) site, the top priority of the Department of Health (FDOH) and the Agency for Toxic Substances and Disease Registry (ATSDR) is to ensure nearby residents have the best information to safeguard their health. ATSDR funds and assists FDOH's health assessment program.

The 25-acre DMS site is at 14281 U.S. Highway 301, Starke, Florida. A DMS predecessor began storing and auctioning surplus federal property on the site in the early 1960s.

In 2001, FDOH found trichloroethene (TCE) in Deerwood subdivision private wells. The Department of Environmental Protection (DEP) found three source areas on the DMS site. Between 2011 and 2014, DEP's contractor treated the contaminated groundwater.

In 2002 and 2003, FDOH tested private drinking water wells one-half mile north and one-quarter mile south of the site and found TCE in 18 wells. Eleven wells exceeded the TCE drinking water standard. DEP provided public water to nine homes, a filter to one home, and the owner abandoned one well.

FDOH reached four conclusions:

CONCLUSION #1

The vapor intrusion exposure pathway is currently incomplete, but surficial aquifer contamination is a potential source.

BASIS FOR CONCLUSION #1

Although there are currently no buildings above the southern source areas, any *new* unventilated buildings could trap vapors from contaminated groundwater. FDOH recommends DMS workers keep the bay doors open when using the vehicle maintenance building near the northern source area.

NEXT STEP #1

FDOH recommends DMS determine the risk of vapor intrusion in any *new* buildings built directly over the source areas and have a mitigation plan in place to reduce exposure and risk. If risk was identified prior to construction of a new building, immediate mitigation is recommended as well as continuous seasonal monitoring (winter and summer) of sub-slab soil gas and 8-hour indoor air samples for TCE and other volatile chemicals. It also recommends DMS continue to keep the vehicle maintenance building bay doors open when workers are inside.

FDOH will inform DMS of its recommendations that they test new on-site buildings for vapor intrusion and continue to ventilate the vehicle maintenance building when it is in use.

CONCLUSION #2	Between 1970 and 2001, the long-term use of the one private drinking water well with the highest level of TCE, 31 µg/L, could have contributed to potential health effects of young children.
BASIS FOR CONCLUSION #2	FDOH evaluated drinking water (ingestion) and inhalation of vapors from showering. FDOH found: ▪ Babies of exposed mothers could have a slight increased risk (1%) of a heart defect. ▪ 1 to 2-year olds could have an increased risk of infections due to decreased thymus weight.
CONCLUSION #3	Use of the one private drinking water well with the highest TCE level may have resulted in an increased cancer risk.
BASIS FOR CONCLUSION #3	For the well with the highest TCE level (31 µg/L), the estimated increased cancer risk varied from 7 in 100,000 (for average exposures) to 8 in 10,000 (for maximum exposures). For the other wells, the increased cancer risk is lower.
CONCLUSION #4	FDOH cannot tell if past potential exposures to solvents affected the health of on-site workers.
BASIS FOR CONCLUSION #4	Although 2002 and 2003 soil tests did not find solvents in surface soil, the Department lacks exposure data.
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 environmental sampling and analyses, exposure parameter estimates, modeled exposure doses, and toxicological knowledge. FDOH does not know when contamination first reached nearby drinking water wells or how levels varied over time. Because of these uncertainties, FDOH may have either overestimated or underestimated the risk. Therefore, this public health assessment does not represent an absolute estimate of risk

to persons exposed to chemicals at or near the Department of Management Services site.

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 health information about the DMS site, you can contact FDOH at 850-901-6494, or call toll free 877-798-2772

Table of Contents

Statement of Issues

In 2001 and 2007, FDOH found trichloroethene (TCE) in private wells north and south of the Department of Management Services (DMS) site. The Department of Environmental Protection (DEP) connected homes with contaminated wells to public water and in one case provided a well filter. FDOH initiated this evaluation of the public health risk.

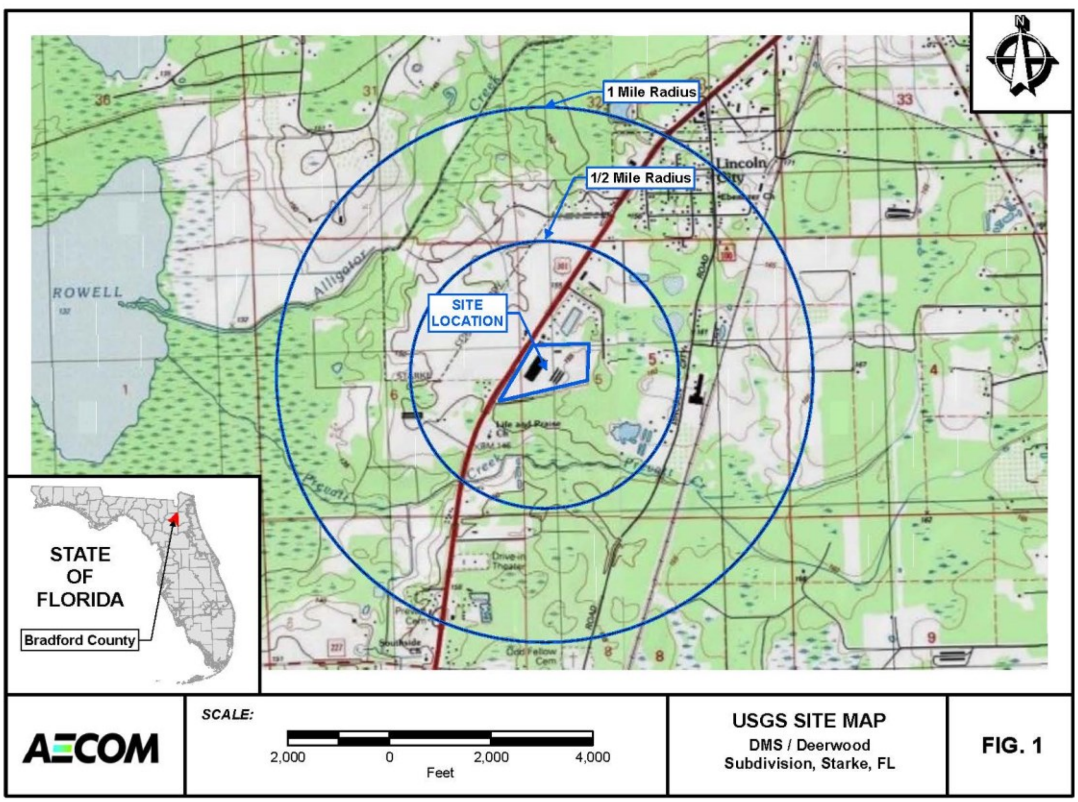
FDOH prepared this report with assistance and funding from the Agency for Toxic Substances and Disease Registry (ATSDR), part of the United States Department of Health and Human Services. FDOH reviewed available environmental data, exposure pathways, and community health concerns to evaluate the public health threat. The assumptions, judgments, and data in this report are sources of uncertainty.

Background

Site Description

The 25-acre DMS site is at 14281 U.S. Highway 301, two miles southwest of Starke in Bradford County, Florida (Figure 1).

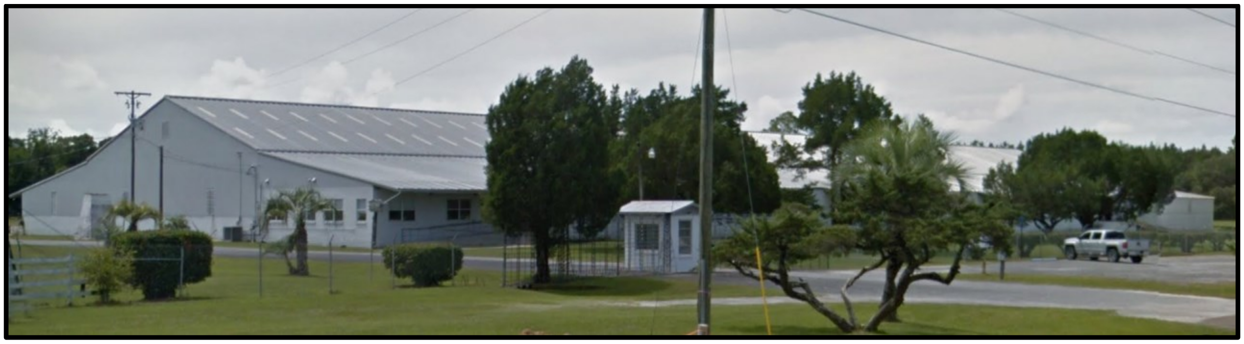
Figure 1. Department of Management Services site



[AECOM 2012a]

The DMS site buildings include a large metal-clad warehouse, a vehicle maintenance shed, and three pole barns (Figures 2 and 3).

Figure 2. Department of Management Services site, looking southeast from US 301.



[Google Maps 2017]

Figure 3. Department of Management Services site and Deerwood Subdivision

[AECOM 2015]

Site Visit

Department staff from the Bureau of Environmental Health visited the site on March 3, 2017. Staff observed a perimeter fence, a lockable gate, and a guard house which restricts after-hours public access. Most of the site was flat and landscaped with grass and trees. The vehicle maintenance and office buildings had metal exteriors, roll-up bay doors, and concrete floors. Two to four prison trustees currently work on the site 3 days a week (Dave Phillips, personal communication, December 12, 2017).

Site History and Operations

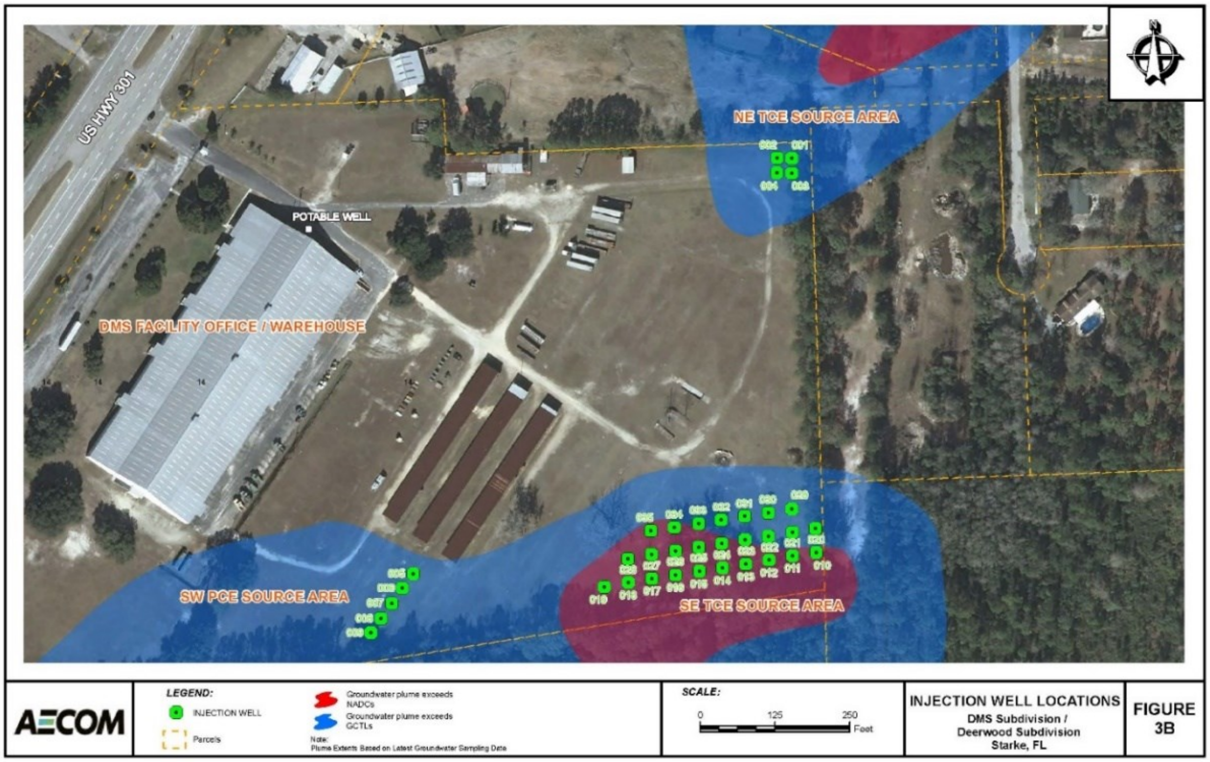
The site was part of a farm until the late 1950s [USGS 1948]. While DEP identified this site as a likely source property, they were unable to determine how solvents got in the groundwater. There are, however, anecdotal reports of indiscriminate dumping in a low-lying area prior to the state's purchase of the property. Discovery of buried waste supports these reports (Dave Phillips, personal communication, August 8, 2017).

In 1960 the State of Florida purchased the site and DMS now uses it to store and auction surplus federal property [DEP 2003]. DMS uses the large warehouse as an office and for storage. They use a small shed on the northern boundary for vehicle maintenance. They park heavy equipment and vehicles for display and resale on the east side of the site and in three pole barns in the center of the site (Figure 3).

Site Remediation

In 2001, FDOH found chemicals in private drinking water wells in the Deerwood subdivision north of the site. At FDOH's request, DEP tested site soil and groundwater [DEP 2003]. DEP found trichloroethene (TCE) under the northeast part of the site. In 2006, they found tetrachloroethene (PCE, perchloroethylene) under the south part of the site. In 2009, they discovered TCE under the southeast part of the site (Figure 4).

Figure 4. Groundwater injection wells on the Department of Management Services site



[AECOM 2015]

During monitoring well construction, DEP's contractor found buried paint and metal wastes in the southeastern TCE source area (Figure 4). They dug up and disposed of 98.73 tons of soil, 13.61 tons of paint and dye waste, and metal debris. They also disposed of 2,095 gallons of groundwater [AECOM 2012b]. The discovery of the buried waste lends credibility to anecdotal reports of improper waste disposal before the state purchased the site.

DEP's contractor installed 35 injection wells for bioremediation (green symbols in Figure 4) [AECOM 2012b]. This bioremediation uses bacteria to break down the TCE and PCE. DEP's contractor pumped chemicals into these wells to raise the groundwater pH, then they pumped in bacteria, food, and nutrients. They treated contaminated groundwater in the source areas between December 2011 and January 2014.

In 2016 DEP's contractor tested groundwater under the site and found "an overall reducing contaminant concentration trend" [AECOM 2017].

Land Use

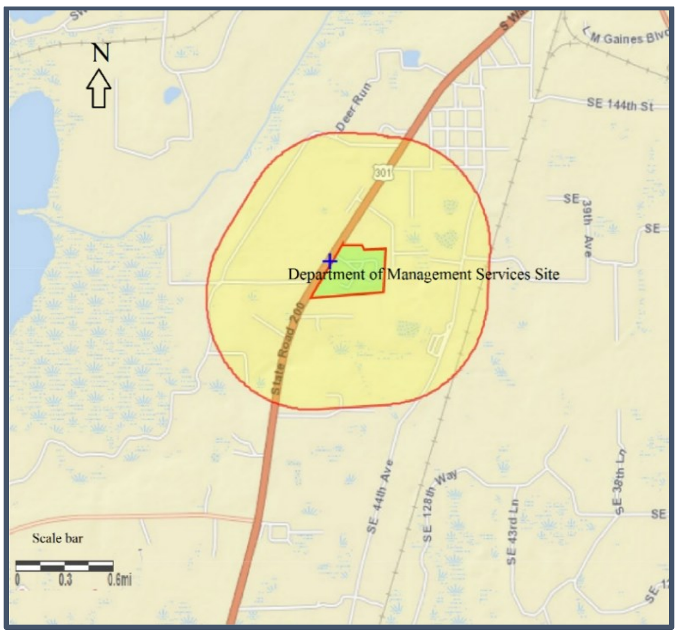
The Deerwood subdivision is north of the DMS site (Figure 3) and was developed in the 1970s [DEP 2003, USGS 1948]. In 2004, developers built a Walmart and smaller retail stores on US 301 northwest of the site. A large cattle farm surrounds the Walmart property. A tree farm is south of the DMS site. Residential, agricultural, silvicultural, conservation, and commercial and light industrial

properties are southwest of the site along U.S. 301. The southern end of the new U.S. 301 bypass is nearing completion just west of the site [DEP 2003, Google Maps 2017].
Many residents of the Deerwood subdivision now use a public water supply, however there are some residents who use private wells and many residents south of the site also use private wells that FDOH periodically tests through the well surveillance program within the department.

Demographics

In 2010, 213 people lived within one-half mile of the site (Figure 5). Of the total, 46% were white, 42% were black, 12% reported two or more races, and 1% reported as Hispanic, a Spanish cultural association that does not reflect race [EPA 2017a]. FDOH found no preschools or churches within one-half mile of the DMS site [Google Maps 2017].

Figure 5. Area within one-half mile of the Department of Management Services site



[EPA 2017a]

Discussion

Evaluation Process

To evaluate the risk of harm to public health from site-related chemicals, FDOH determines the contaminated media and the relative contamination levels. It screens the site-related data using ATSDR's comparison values (CVs) [ATSDR 2017]. Each CV is a concentration for a chemical in the environment (air, water, or soil) below which FDOH does not expect harm to health. FDOH identifies contaminants higher than their CVs for further evaluation, as well as the ones with carcinogenic concerns (Appendix A) and lists the contaminant ranges (Appendix B).

Next FDOH looks at ways people could be exposed to contaminated media, called exposure pathways. Because the DMS facility is still operating, FDOH also considers exposure pathways on the site. FDOH looks for additional testing that could be done to help evaluate exposure pathways.

Finally, FDOH discusses completed exposure pathways in the Public Health Risk section.

Environmental Data

After FDOH found TCE in Deerwood subdivision private drinking water wells in 2001, DEP began testing soil and groundwater at the DMS site [DEP 2001]. In the following sections, FDOH discusses on-site and off-site contamination separately. Figure 6 shows on-site and off-site groundwater contamination together.

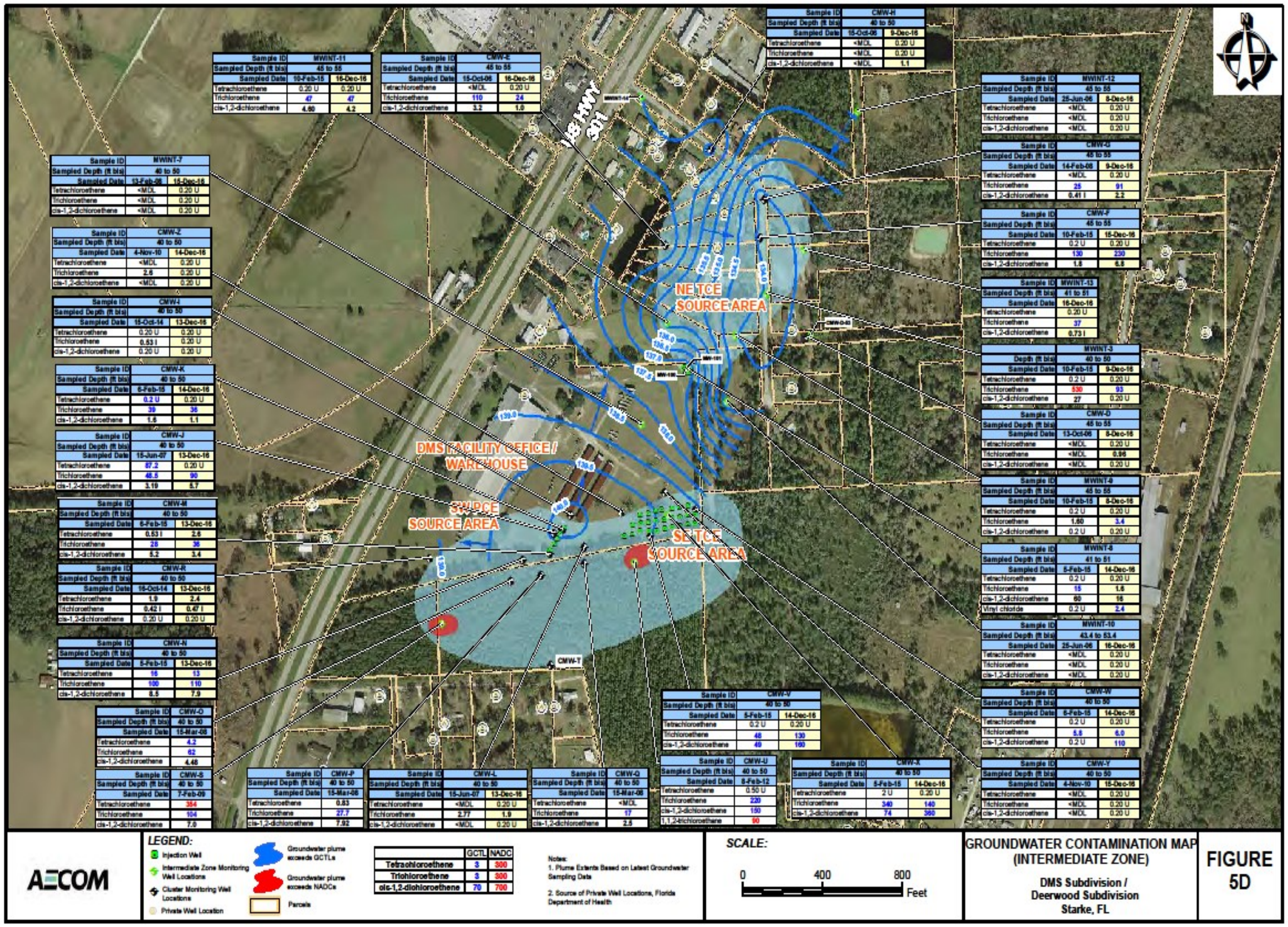
On-site Groundwater

Initially, DEP tested groundwater in the northeastern part of the site and found TCE [DEP 2003]. DEP's remediation contractor later sampled groundwater in the southeastern and southern parts of the site and found TCE and PCE [Metcalf & Eddy 2006, 2007, AECOM 2011, 2012a, and 2017]. DEP's contractor also found other volatile organic compounds (VOCs) related to the breakdown of PCE and TCE (Table B4 to B6).

PCE, TCE, and their breakdown products are denser than water and sink in groundwater. Tests found the highest contamination levels in the intermediate aquifer (35 to 55 feet deep).

Figure 6 shows areas of groundwater contamination in 2016. Blue shading estimates areas with TCE above 3 µg/L. Red shading estimates areas with PCE and TCE above 300 µg/L. These data show an overall decrease in contaminant levels following groundwater treatment [AECOM 2017].

Figure 6. PCE and TCE groundwater contamination, Department of Management Services site



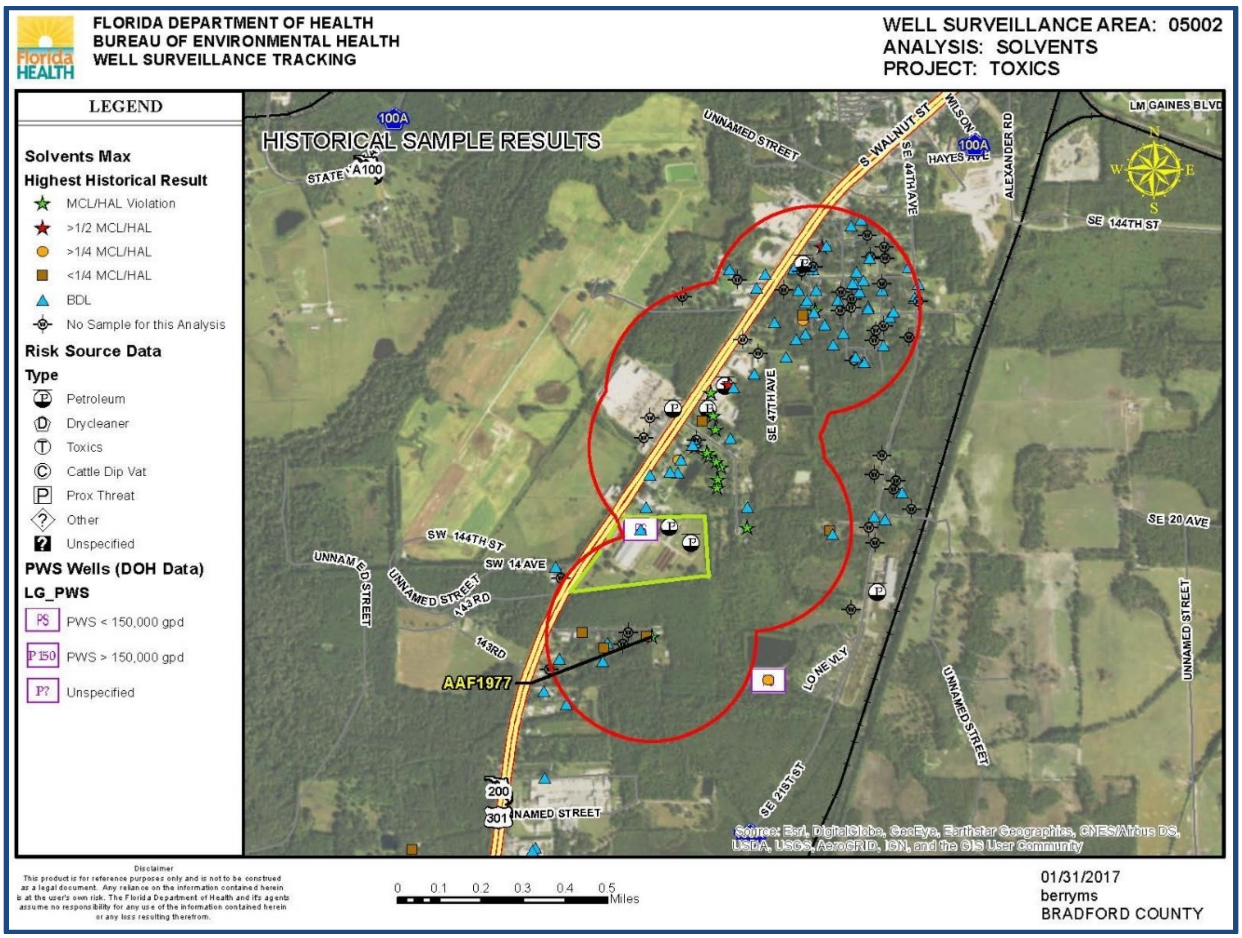
[AECOM 2017]

On-site Soil
DEP contractors found no surface soil contamination (sampled from 0 to 6 inches) on the site above ATSDR CVs [DEP 2003, Metcalf & Eddy 2006, 2007; AECOM 2011].

Off-site Groundwater
Monitoring well tests show groundwater contamination moved off-site (Figure 6). Contaminated groundwater moved southwest, south, and east from the sources areas in the southern part of the site [Metcalf & Eddy 2006, 2007, AECOM 2011, 2012a, 2017] and northeast from the northeast source area [DEP 2003].

Figure 7 shows the 74 private wells FDOH tested [DOH 2017a].

Figure 7. Compilation of private well test results.



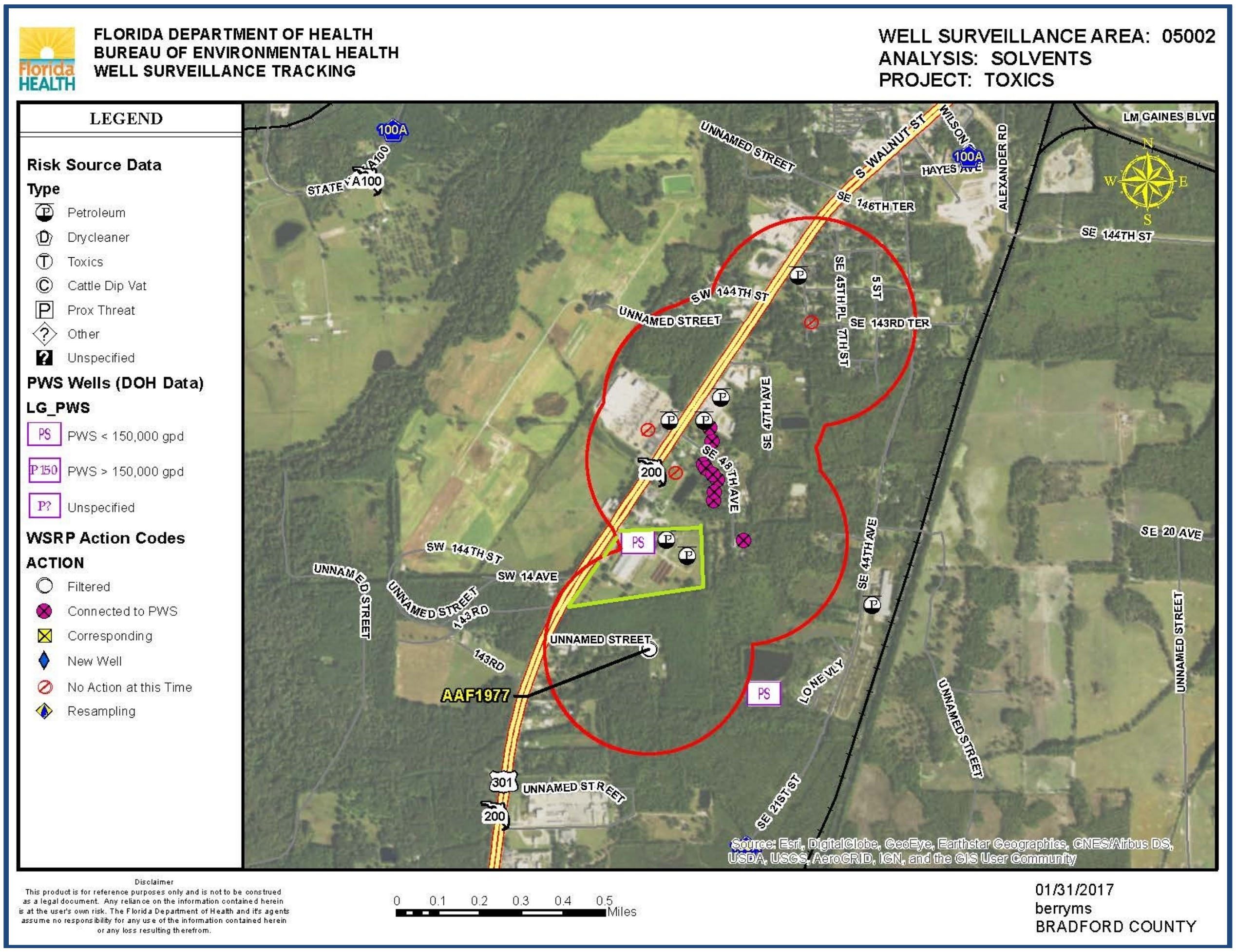
[DOH 2017a]

In 2002 and 2003, FDOH found 10 private drinking water wells northeast of the site which had TCE exceeding the 3.0 µg/L drinking water standard (Maximum Contaminant Level or MCL) [DEP 2003, AECOM 2011]. Several private drinking water wells had TCE levels slightly below the MCL.

Between December 2011 and January 2014, DEP's contractor treated the on-site groundwater. In 2016, tests showed that the on-site contaminant levels had decreased [AECOM 2017].

FDOH periodically sampled private drinking water wells south of the site. None had TCE above the MCL until 2016 [DOH 2016]. DEP connected wells north of the site to the public water supply (purple circles) and installed a filter on the one well south of the site (white circle) (Figure 8).

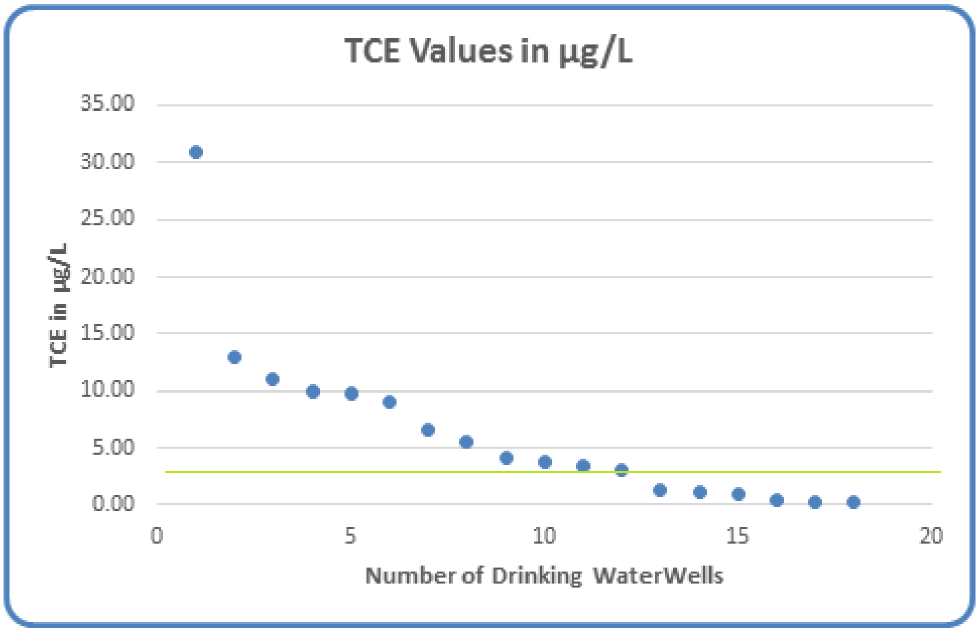
Figure 8. Contaminated private drinking water wells near the Department of Management Services site



[DOH 2017]

Figure 9 shows the test results for 18 wells where testing found TCE prior to water supply restoration in 2001. Only 11 had TCE above 3.0 µg/L.

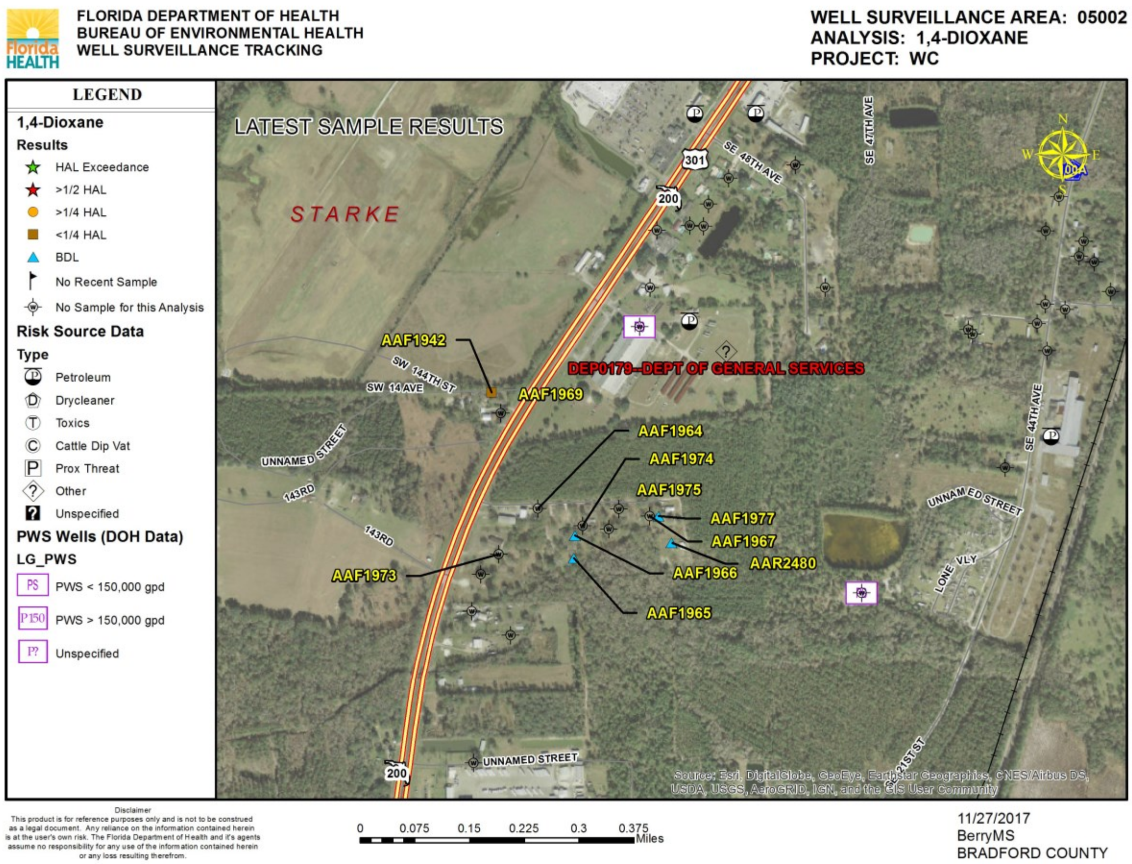
Figure 9. Distribution of TCE levels in private drinking water wells near the DMS site.



[DOH 2017a]

In October and November 2017, the Alachua County Health Department sampled five private drinking water wells near the site (Figure 10). In the well west of the site, the 1,4-dioxane level was 0.062 µg/L, which is below the health advisory level of 0.35 µg/L. In the four wells south of the site, 1,4-dioxane levels were below detection limits.

Figure 10. 1,4-Dioxane below health advisory levels in private drinking water wells near the Department of Management Services site



[DOH 2017b]

Soil

DEP did not test off-site surface soil. On-site surface soil is not contaminated and it is unlikely that stormwater runoff carried solvent contamination off-site.

Pathway Analyses

Chemical contamination in the environment can harm your health but only if you have contact with those contaminants (exposure). Without contact or exposure, there is no harm to health. If there is contact or exposure, how much of the contaminants you contact (concentration), how often you contact them (frequency), for how long you contact them (duration), and the hazard level of the contaminant (toxicity) all determine the risk of harm.

Knowing or estimating the frequency people could have contact with contaminants is essential to assessing the public health concerns of these contaminants. The method for assessing whether a public health hazard exists is to determine whether there is a completed exposure pathway from a contaminant source to a population and whether exposures to contamination are high enough to be of health concern.

Exposures occur if a *contamination source* has all of the following*:*

- an *environmental medium* to hold or transport it; like air, soil, or water
- an *exposure point* where people contact it
- an *exposure route* through which it enters the body
- an *exposed population* who contact it

Solvents found on three areas of the site are the potential *source* of contamination for the following completed, potential, and eliminated exposure pathways. The identification of an exposure pathway does not necessarily mean that harm to health will occur.

Completed exposure pathways

Past residential use of groundwater from off-site wells contaminated with TCE was a complete exposure pathway (Table B1, Figures 7 and 8). *Source transport* involved movement of TCE into groundwater, the *environmental media*, and movement of contaminated groundwater off-site. The *exposure points* were household taps and showerheads that dispensed groundwater from private wells in the past. The year groundwater contamination began is unknown. The exposure timeframe for nearby residents using private wells could extend as far back as 1970 when developers built the Deerwood subdivision. The potential exposure period extends to 2001 when FDOH discovered TCE MCL exceedances in 9 wells north of the site.

People who drank and used this water in their homes, and breathed indoor air were the potentially *exposed population*. These actions resulted in potential ingestion and inhalation *exposure routes.* VOCs in groundwater are the *contamination sources*.

Potential exposure pathways

Private Wells

New and existing private wells near the site are potential pathways. Some off-site areas with contaminated groundwater (Figure 6) are undeveloped. New property owners could drill household wells in these areas. Although FDOH samples existing wells, groundwater contamination moves and people may use contaminated groundwater in-between testing. People might also use contaminated groundwater if they refuse any of the following: private well testing, groundwater treatment such as filters for short-term fixes, or the opportunity to hook-up to a public drinking water source water for long-term fixes (Table B2).

Surface Soil

In the past, workers *could have been* exposed to TCE via on-site surface soil and air. As early as 1960, site workers could have been the *exposed population*. Workers could have touched soils resulting in direct dermal exposures and could have had incidental ingestion exposures from smoking, eating, or other hand-to-mouth activities. Workers could have breathed solvents that evaporated from the soil. Ingestion and inhalation could have been *exposure routes* (Table B2). FDOH is unable to evaluate past exposures because no data are available. Surface soil testing found no chemicals above their CVs [DEP 2003].

Vapor Intrusion

VOCs in the surficial aquifer on the site *could be* the source for vapor intrusion if the vehicle maintenance shed is ever used with the bay doors shut. Without ventilation, and depending on parameters of the heating and air-conditioning system, VOCs can become trapped in indoor air. Workers, *the exposed population, could* breathe this air, making indoor air inhalation the *exposure route* (Table B2).

Other on-site areas with VOCs at elevated levels in the surficial aquifer could be *potential source areas* for vapor intrusion if the owner constructs new buildings there (Appendix A).

Vapor intrusion can occur when VOCs in soil gas enter a building through plumbing access openings and cracks in concrete floors. Buildings in areas with elevated VOCs in a shallow surficial aquifer may be subject to vapor intrusion. On the site, such areas could include the TCE source area in the northeastern and southeastern parts of the site and the PCE source area in the southern part of the site. FDOH discusses the potential for vapor intrusion as an exposure pathway in Appendix A.

Eliminated exposure pathways

Vapor Intrusion into Existing Offsite Buildings

Currently, no off-site buildings are near on-site source areas (areas with VOCs in the surficial aquifer). Tests of the off-site surficial aquifer did not find contamination (Figure 6). Therefore, FDOH eliminates vapor intrusion into existing off-site buildings as an exposure pathway (Table B3).

Vapor Intrusion into Large On-site Office Building

FDOH eliminates past, present, and future on-site indoor air exposure from vapor intrusion into the central (large) office building (Table B3). Tests did not find contamination in the shallow groundwater near this building.

Surface Soil

Tests of surface soil did not find contamination. Therefore, FDOH eliminates incidental ingestion of surface soil as an exposure pathway (Table B3).

On-site Well

FDOH eliminates on-site well exposure because testing of the existing well has not found contamination (Table B3). The state owns and is remediating the site. Therefore, now and in the future, it is unlikely anyone will install a new well in the area of known on-site groundwater contamination.

Surface Water

The site has no surface water and no off-site drainage pathways (Table B3).

Public Health Risk

Contaminants of Concern

FDOH identified 10 contaminants of concern (COCs) in groundwater that exceed ATSDR CVs and are considered carcinogenic (Table B4 to B6): benzene; 1,1-dichloroethene; 1,1,2-trichloroethane;1,1,2,2-tetrachloroethane; 1,2-dichloroethane; cis-1,2-dichloroethene; 1,4-dioxane; trichloroethene (TCE); perchloroethene (PCE); and vinyl chloride (VC).

Completed Exposure Pathway*: *Private Wells

This section evaluates the health risk from the highest level of trichloroethene (TCE) found in nearby private drinking water wells. Levels of the other nine contaminants of concern were either not detected or below drinking water standards in private wells.

FDOH evaluated past TCE exposures using 31 µg/L, the highest level measured in a private well northeast of the site). FDOH used the ATSDR model described in Appendix B to estimate TCE exposures from household uses of well water. FDOH discusses TCE's chemical properties and toxicity in Appendix E.

FDOH compared the calculated doses with substance-specific health guidance values called minimal risk levels (MRLs). MRLs are likely to be without appreciable risk of adverse noncancer health effects over a specified length of exposure time [ATSDR 2017]. As all the calculated doses for 31 µg/L were above the MRL for TCE of 0.0005 mg/kg/day, FDOH compared these doses to the MRL study Lowest Observable Adverse Effect Levels (LOAEL) doses and health effects. The average dose for the maximum TCE concentration of 31 µg/L ranges between 0.001 and 0.003 mg/kg/day; the maximum dose ranges between 0.006 to 0.06 mg/kg/day. Table B7 in Appendix B presents a more in-depth overview about the estimated dose by age groups.

Only maximum exposure assumption doses exceed critical effects levels modeled from animal studies:

- Pregnant women who drank and used water with 31 µg/L TCE had a slight increased risk (1% above what is found in unexposed populations) that their babies could have been born with a heart defect. The calculated exposure levels for women of child-bearing age, 0.006 mg/kg/day, slightly exceeds the 1% Benchmark Dose Level of 0.0051 mg/kg/day for disruption of cardiac valve formation.
- Children 1 to 2 years old who drank and used water with 31 µg/L TCE (0.06 mg/kg/day) exceeded the 1% increased risk of having low thymus weight, which could suppress their immune systems, causing more frequent infections [ATSDR 2014a].

Increased Cancer Risk from Past Exposures to TCE in Private Well Water

For an average exposure assumption TCE dose, the increased cancer risk is 7 in 100,000. For a maximum exposure assumption TCE dose, the increased cancer risk is 8 in 10,000. Table 7 in Appendix B presents a more in-depth overview about the cancer risk by age groups.

Epidemiologic studies associate TCE occupational exposures (at much higher concentrations then expected at this site) with kidney cancer and non-Hodgkin's lymphoma. Less statistically significant occupational studies associate TCE with liver and biliary tract cancers [EPA 2017b]. EPA calculates a cancer slope factor from which FDOH estimates cancer risk from kidney cancer in TCE-exposed animals [EPA 2017b].

Site Specific Limitation of Findings

FDOH does not have workplace air-monitoring data. Therefore, it is unable to evaluate workers' past exposure. In addition to the most important direct exposure from handling full strength cleaning solvents in the workplace, workers who also lived near the site and drank contaminated groundwater could have been exposed by multiple pathways.

FDOH may have overestimated the cancer risk. It assumed people would be using contaminated water for 33 years and calculated increased cancer risks for 78-year lifespans. The earliest that people could have been drinking this water would have been the early 70s, because that is when the Deerwood subdivision was built. DEP connected residences with TCE in the wells to municipal water supplies after 2001, so people may have used this water 30 or fewer years. Reducing the exposure time would reduce the exposure factor, and the lifetime cancer risk. Additionally, levels of TCE in well water could have been lower in the past, making lifetime cancer risk levels lower.

Community Health Concerns

FDOH is unaware of any community health concerns.

Conclusions

FDOH reached four conclusions:

1. The vapor intrusion exposure pathway is currently incomplete, but surficial aquifer contamination is a potential source. Although there are currently no buildings above the southern source areas, *new* unventilated buildings could trap vapors from contaminated groundwater. DEP reports DMS workers keep the bay doors open when using the vehicle maintenance building near the northern source area.

2. Between 1970 and 2001, long-term use of the one private drinking water well with the highest level of TCE, 31 µg/L, could have harmed the health of young children. FDOH evaluated drinking water (ingestion) and inhalation of vapors from showering. FDOH found:

    - Babies of exposed mothers could have a slight increased risk (1%) of a heart defect.
    - 1 to 2 year olds could have an increased risk of infections due to decreased thymus weight.

3. Use of the one private drinking water well with the highest TCE level may have caused an increased cancer risk. For the well with the highest TCE level, the increased cancer risk varied from 7 in 100,000 (for average exposures) to 8 in 10,000 (for maximum exposures). For the other wells, the increased cancer risk is lower.

4. FDOH cannot determine if past exposures to solvents affected the health of on-site workers. Although 2002 and 2003 soil tests did not find solvents in surface soil, FDOH has limited exposure data.

Recommendations

1. FDOH recommends DMS to determine the risk of vapor intrusion in any *new* buildings built directly over the source areas and have a mitigation plan in place to reduce exposure and risk. If risk was identified prior to construction of a new building, immediate mitigation is recommended as well as continuous seasonal monitoring (winter and summer) of sub-slab soil gas as well as 8-hour indoor air samples for TCE and other volatile chemicals. It also recommends DMS continue to keep the vehicle maintenance building bay doors open when workers are inside.

Public Health Action Plan

Actions Undertaken

1. FDOH identified 74 private wells north and south of the site and tested them, if the owner's permission was obtained. FDOH found 11 wells with TCE above 3.0 μg/L.

2. 11 potables wells were identified in the proximity of the DMS Starke Site. Nine contaminated wells north of the site were connected to a public water source between 2002 and 2003. In 2003, a filter system was provided to one household south of the site. Their well was never connected to a public water supply. The 11th well supplied a business. The business stopped using the well as water source entirely.

3. FDOH visited the site in March 2017.

Actions Underway

1. FDOH routinely resamples wells near the site with chemical levels slightly below the drinking water standard.

Actions Planned

1. FDOH will inform DMS of its recommendations that they test any *new* on-site buildings for vapor intrusion and continue to keep the existing vehicle maintenance building doors open when it is in use.

2. FDOH will solicit public comments on this draft report and will address public comments in the final report.

3. FDOH will consider reviewing additional data upon request.

References

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[AECOM 2011] Supplemental Site Assessment Report, Department of Management Services (Deerwood Subdivision), 14281 US Highway 302 South, Starke, FL, FDEP Site #56SL, May 2011.

[AECOM 2012a] Remedial Action Plan, Department of Management Services (Deerwood Subdivision), 14281 US Highway 302 South, Starke, FL, FDEP Site #56SL, June 29, 2012.

[AECOM 2012b] Remedial Action Report, Department of Management Services (Deerwood Subdivision), 14281 US Highway 302 South, Starke, FL, FDEP Site #56SL, June 29, 2012.

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Appendices

Appendix A. Explanation of Evaluation Process

Screening Process

In evaluating these data, FDOH used comparison values (CVs) to determine which chemicals to examine more closely. It used CVs to screen contaminants for further evaluation. They are health-based contaminant concentrations found in a specific media (soil or water). 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 in a residential-type exposure.

As health-based thresholds, ATSDR sets CVs at concentrations below which they expect known or anticipated adverse human health effects to occur. ATSDR develops different CVs for cancer and noncancer health effects. For chemicals for which both cancer and noncancer CVs exist, FDOH uses the lower CV 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:

Cancer Risk Evaluation Guides (CREGs)—ATSDR and EPA base cancer screening values on a one-in-a-million excess cancer risk for exposure to contaminated soil or drinking contaminated water every day for 33 years. They extrapolate this exposure to a 78-year lifespan. CREGs are calculated from EPA cancer slope factors.

Children's Environmental Media Evaluation Guidelines (Child EMEGS)—ATSDR bases noncancer levels on valid toxicological studies for a chemical, with appropriate safety factors included, and they assume daily exposure for small children and adults. ATSDR estimates EMEGs as contaminant concentrations (by media) without adverse noncancer health effects. ATSDR derives EMEGs from their minimal risk level (MRL). FDOH uses children's EMEGs because they are the most protective.

Maximum Contaminant Levels (MCLs)—EPA sets enforceable drinking water standards for the highest level of a contaminant allowed. They set MCLs 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 pathways other than air, FDOH estimates 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, FDOH makes 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 allow estimation of site-and pathway-specific exposure dose. The following sections detail the exposure assumptions and calculation of exposure dose for the pathways evaluated in this report.

Inhalation of VOCs during Showering

The Department assumed all private wells contaminated with VOCs were used for showering and drinking. ATSDR's showering model calculates inhalation during showering and adds this dose to the drinking water dose. FDOH discusses the several steps this model uses in estimating equivalent 24-hour air concentrations 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 27 µg/L TCE. The peak concentration of TCE in the bathroom is:

$$\text{Peak Conc. } (\mu g/m^3) = \frac{27\ \mu g/L) \times 0.6 \times (8\ L/min) \times 15\ min}{10\ m^3} = 194\ \mu g/m^3$$

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

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

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:

$$\text{Intake}_{\text{Inhalation}}\ (\mu g) = 194\ (\mu g/m^3) \times 0.011\ (m^3/min) \times (5+15)\ (min) = 42.6\ \mu g\ \text{TCE}$$

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

The shower model results reported in Table A1 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 EPA's 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.

***Table A1. Private** well pathway**, DMS site, Starke, 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: The Department 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
* The model assumes children under one year old will bathe and does not calculate a shower dose for this 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 RME estimates to calculate RME parameters. For example, ATSDR used the 95th percentile shower time for the RME shower time and the 95th 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. Table 7 (Appendix C) lists the 24-hour equivalent TCE concentrations calculated using the showering and drinking water equations.

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.

Table A2. Private *well pathway****, DMS site, Starke, 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			

FDOH calculated the doses for children less than one using the highest concentration, the ingestion rate and the average body weight. parameters of [ATSDR 2014b]. The shower model calculates the doses for those older than one by adding to the showering dose calculated to the drinking water for that age group. 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. Table 7 lists calculated doses by age group.

Evaluating Noncancer Health Effects

FDOH then compares the calculated exposure doses to an appropriate health guideline for that chemical, in this case TCE, MRL.

Evaluating Cancer Health Effects

TCE causes cancer by a mutagenic mode of action, that is, there is a greater risk for exposures that occur in early life. For TCE, the EPA applies age-dependent adjustment factors (ADAFs) to the estimated cancer risks. They apply an ADAF of 10 for exposures taking place from birth up to 2 years old and an ADAF of 3 for exposures taking place from age 2 up to age 16. No adjustment is applied for exposures at age 16 or above [EPA 2005]. The shower 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 (assuming 21 years at various childhood weights and 12 years at the 21- to 65-year-old adult weight)

Dose = (C × IR × EF ×CF)/BW
EF = (F × ED)/AT
Cancer Risk = CSF × Dose

Assumptions:
C = Concentration = 0.18 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 = 0.0021 $(mg/kg/d)^{-1}$

Dose = (0.031 mg/L × various amounts apportioned by age × 0.046 × 10^{-6} kg/mg)/ various amounts apportioned by age = **see Table 7 for CTE and RME Doses by age**

Cancer Risk = (0.0021 $(mg/kg/d)^{-1}$) × CTE and RME Estimated Cancer Ingestion Doses by age group) when added together give 7 in 100,000 increased risk for CTE exposures, and 8 in 10,000 for RME exposures. ATSDR considers both increased risks low.

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

Public Health Evaluation of Potential for Vapor Intrusion from Contaminated Surficial Aquifer Groundwater [ATSDR 2016b]

FDOH used ATSDR's air CVs, EPA's recommended screening attenuation factors [EPA 2015], and the following equation to derive a screening level for TCE in surficial aquifer groundwater to evaluate its vapor intrusion potential.

$CV_{gw} = CV_{air} / (H' * \alpha_{gw})$,

Where CV_{gw} = screening level in groundwater

CV_{air} = ATSDR's air CV

H' = unitless Henry's Law constant for TCE (0.403) [EPA 2016a]

α_{gw} = EPA's recommended screening groundwater attenuation factor 0.001 [EPA 2015]

$CV_{gw} = (0.22\ ug/m^3) * 4.2^{\dagger} / (0.403 * 0.001)$

$CV_{gw} = 0.9240\ ug/m^3/0.000403$

$CV_{gw} = 2{,}293\ ug/m^3$

Groundwater concentrations must be in µ/L, so multiply by 0.001 m^3/L:

$CV_{gw} = 2{,}293\ ug/m^3 * 0.001\ m^3/L = 2.29\ \mu g/L$ TCE in surficial groundwater

†Workers could be exposed 40 hours a week, while someone who stayed at home might be exposed 168 hours a week, so FDOH multiplies the air CV by 4.2 to compensate for fewer workers' exposure hours.

Appendix B. Tables

Table B1. Completed human exposure pathways, Department of Management Services site

Pathway Name	Exposure Pathway Elements					Time Frame
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Private wells - existing	Solvents buried or discharged before or after the state occupied the site	Groundwater	Water taps, showerheads, and indoor air of nearby (off-site) residences using existing private wells	Ingestion and inhalation	Nearby residents with private wells in the area of contaminated groundwater	1970s to 2001

Table B2. Potential human exposure pathways, Department of Management Services site

Pathway Name	Exposure Pathway Elements					Time Frame
	Source	Environmental Media	Point of Exposure	Route of Exposure	Potentially Exposed Population	
Private wells	Solvents from the Department of Management Services site	Groundwater	Water taps, showerheads, and indoor air of residences using private wells	Ingestion and Inhalation	Residents in areas of future groundwater contamination	Future
Surface soil	Solvents from the Department of Management Services site	Surface soil and air	On-site source areas	Ingestion and inhalation	Past on-site workers	Past
Vapor intrusion – northern source area	Solvents from the Department of Management Services site	Indoor air	Inside the on-site vehicle maintenance building near the northern site boundary	Inhalation	On-site workers	Past, present, and future
Vapor intrusion – southern source area	Solvents from the Department of Management Services site	Indoor air	Inside new on-site buildings on or near the southern source area	Inhalation	On-site workers	Future
Vapor intrusion - offsite	Solvents from the Department of Management Services site	Indoor air	Inside new off-site buildings near the northern and southern property lines	Inhalation	Residents and workers	Future

Table B3. Eliminated human exposure pathways, Department of Management Services site

Pathway Name	Exposure Pathway Elements					Time
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Vapor intrusion	None known: solvents not found in off-site soil or surficial aquifer within 100 feet of existing buildings.	Indoor air	Existing nearby off-site buildings	Inhalation	Residents and workers	Present
Vapor intrusion	None known: solvents not found in soil or surficial aquifer within 100 feet of this building.	Indoor air	Existing large on-site office building	Inhalation	DMS employees	Present
Surface soil	None known: solvents not found in surface soil on site or off site.	Soil	On-site source areas	Ingestion	DMS employees	Present and future
On-site well	None known: solvents not found in the on-site well.	Groundwater	Water taps	Ingestion and inhalation	DMS employees	Past, present, and future
Surface water	No surface water	No surface water	none	none	none	Past, present, and future

Table B4. Contaminants of concern in private drinking water wells near the Department of Management Services site

Contaminants	Concentration Range (µg/L)	Screening Guideline* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/Total #
benzene	<0.02	0.44	ATSDR CREG	0/74
1,1,dichloroethene	<0.02	63	ATSDR C# EMEG	0/74
1,1,2-trichloroethane	<0.02	0.43	ATSDR CREG	0/74
1,1,2,2-tetrachloroethane	<0.02	0.12	ATSDR CREG	0/74
1,2-dichloroethane	<0.02	0.27	ATSDR CREG	0/74
cis-1,2-dichloroethene	<0.02	14	ATSDR C# EMEG	0/74
1,4-dioxane	<0.02 to 0.062	0.24	ATSDR CREG	0/5
TCE	<0.02-31	0.43	ATSDR CREG	33/74
PCE	<0.02	12	ATSDR CREG	0/74
vinyl chloride	<0.02	0.0086	ATSDR CREG	0/74

ATSDR = Agency for Toxic Substances and Disease Registry
C# = Screening level for children
CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
EMEG = ATSDR Environmental Media Evaluation Guide
PCE = tetrachloroethene or perchloroethene
TCE = trichloroetheene
µg/L = micrograms per liter
* Screening guidelines only used to select chemicals for further scrutiny, not to judge the risk of health impact.
Sources of data: [DEP 2003], [AECOM 2011] [DOH 2017a] [DOH 2017b]

Table B5. Contaminants of concern in groundwater under the Department of Management Services site

Contaminants	Concentration Range (µg/L)	Screening Guideline* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/Total #
benzene	<0.02 – 2.2	0.44	ATSDR CREG	5/274
1,1,dichloroethene	<0.02 – 170	63	ATSDR C# EMEG	3/274
1,1,2-trichloroethane	<0.02 – 51	0.43	ATSDR CREG	2/274
1,1,2,2-tetrachloroethane	<0.0 – 74	0.12	ATSDR CREG	9/274
1,2-dichloroethane	<0.02 – 46	0.27	ATSDR CREG	11/274
cis-1,2-dichloroethene	<0.02 – 930	14	ATSDR C# EMEG	15/274
1,4-dioxane	<0.02 – 8.2	0.24	ATSDR CREG	5/12
TCE	<0.02 – 5,500	0.43	ATSDR CREG	174/274
PCE	<0.02 – 1,210	12	ATSDR CREG	20/274
vinyl chloride	<0.02 – 3.4	0.0086	ATSDR CREG	5/274

ATSDR = Agency for Toxic Substances and Disease Registry
C# = Screening level for children
CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
EMEG = ATSDR Environmental Media Evaluation Guide
PCE = tetrachloroethene or perchloroethene
TCE = trichloroethene
µg/L = micrograms per liter
* Screening guidelines only used to select chemicals for further scrutiny, not to judge the risk of health impact.
Sources of data: [DEP 2003], [Metcalf and Eddy 2007], [AECOM 2012b], [AECOM 2015]

Table B6. Contaminants of concern in off-site monitor wells near the Department of Management Services site

Contaminants	Concentration Range (µg/L)	Screening Guideline* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/Total #
benzene	<0.02	0.44	ATSDR CREG	0/141
1,1,dichloroethene	<0.02 – 7	63	ATSDR C# EMEG	0/141
1,1,2-trichloroethane	<0.02 – 1.1	0.43	ATSDR CREG	5/141
1,1,2,2-tetrachloroethane	<0.02 – 63	0.12	ATSDR CREG	2/141
1,2-dichloroethane	<0.02	0.27	ATSDR CREG	0/141
cis-1,2-dichloroethene	<0.02 – 150	14	ATSDR C# EMEG	9/141
1,4-dioxane	<0.02 – 1.0	0.24	ATSDR CREG	1/1
TCE	<0.02 – 1,600	0.43	ATSDR CREG	55/141
PCE	<0.02 – 31.7	12	ATSDR CREG	3/141
vinyl chloride	<0.02 – 1.21	0.0086	ATSDR CREG	0/141

ATSDR = Agency for Toxic Substances and Disease Registry
C# = Screening level for children
CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
EMEG = ATSDR Environmental Media Evaluation Guide
PCE = tetrachloroethene or perchloroethene
TCE = trichloroethene
µg/L = micrograms per liter
* Screening guidelines only used to select chemicals for further scrutiny, not to judge the risk of health impact.
Sources of data: [DEP 2003], [Metcalf and Eddy 2007], [AECOM 2012], [AECOM 2015]

Table B7. Estimated doses and increased cancer risk for residents near the Department of Management Services site using well water contaminated with the highest TCE level.*

Age Group (years)	Body Weight (kg)	Maximum Private Drinking Well Water Concentration (µg/L)	Estimated Noncancer Dose (mg/kg/day)		ATSDR MRL (mg/kg/day)	Oral Cancer Slope Factor $(mg/kg/d)^{-1}$	Estimated Cancer Dose (mg/kg/day)		Estimated Increased Cancer Risk	
			RME	CTE			RME	CTE	RME	CTE
birth to <1	7.8	31	0.004**	0.002**	0.0005 chronic	.046	6×10^{-5}	3×10^{-5}	3×10^{-5}	1×10^{-5}
1 to <2	11.4		0.05	0.002			7×10^{-3}	4×10^{-4}	3×10^{-4}	2×10^{-5}
2 to <6	17.4		0.03	0.002			5×10^{-3}	3×10^{-4}	2×10^{-4}	1×10^{-5}
6 to <11	31.8		0.01	0.002			3×10^{-3}	4×10^{-4}	1×10^{-4}	2×10^{-5}
11 to <16	56.8		0.01	0.001			2×10^{-3}	3×10^{-4}	1×10^{-4}	1×10^{-5}
16 to <21	71.6		0.006	0.001			4×10^{-4}	6×10^{-5}	2×10^{-5}	3×10^{-6}
≥21	80		0.006	0.001			4×10^{-3}	7×10^{-4}	9×10^{-6}	5×10^{-6}

Child cancer risk birth to <21 year..8×10^{-4} 7×10^{-5}
Adult cancer risk ages 21 to 33..1×10^{-6}*** $2x10^{-6}$***
Cancer Risk, Child + Adult…..8×10^{-4} 7×10^{-5}

* Estimates include drinking this water and breathing vapors from showering.
µg/L = micrograms per liter
RME = Reasonable Maximum Exposure
CTE = Central Tendency Exposure
**Doses for children under one are for drinking (ingestion) only.
***Adult cancer risk is for ages 21-33.
MRL = Minimal Risk Level: 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 ATSDR MRL

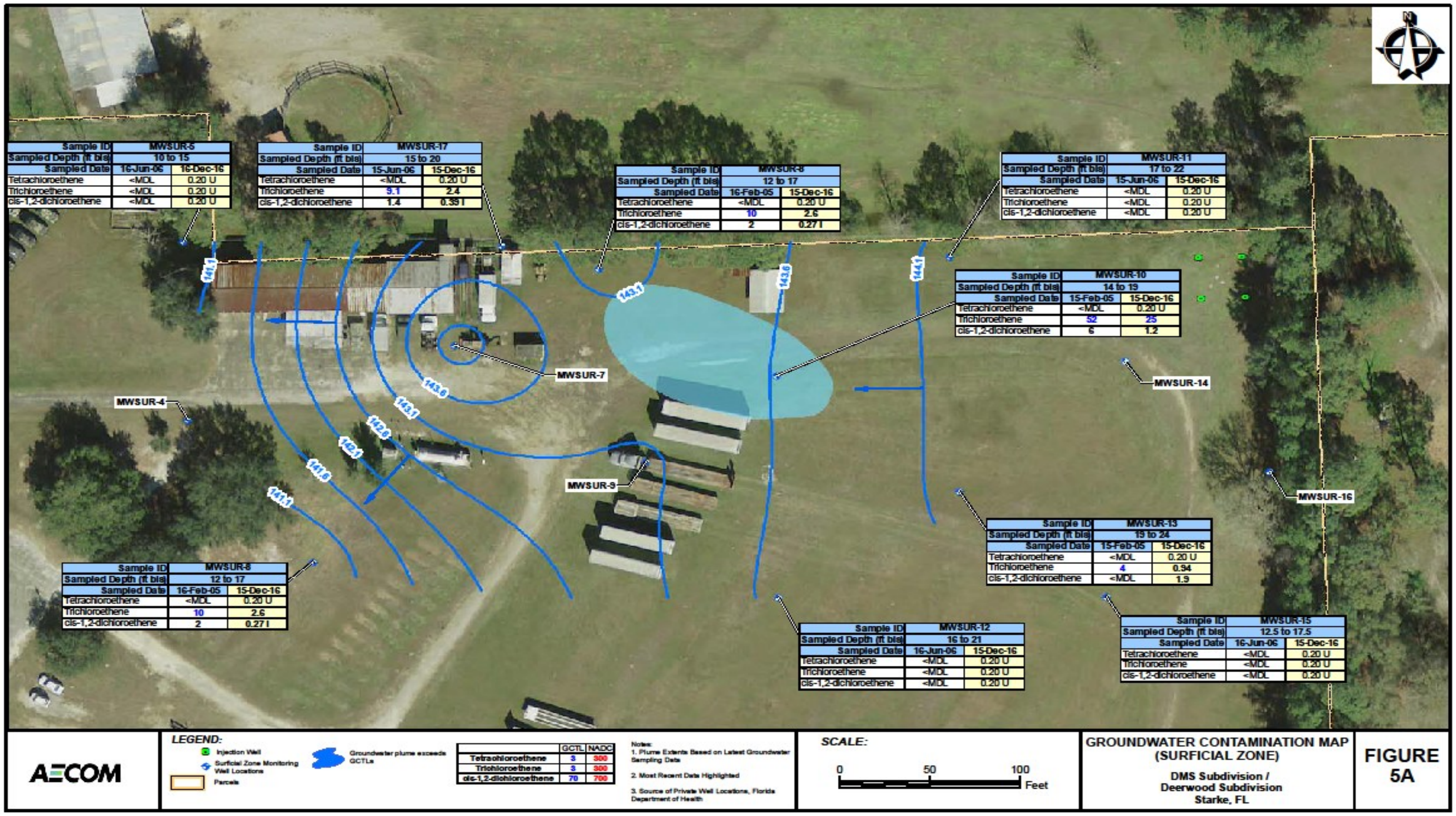
Appendix C: Vapor Intrusion Potential Exposure Pathway

If workers used the vehicle maintenance shed in the northern part of the site with the bay doors closed, they could breathe TCE in indoor air. Figure C1 shows areas adjacent to the vehicle maintenance building where DEP's contractor measured TCE levels in the surficial aquifer in 2016 [AECOM 2017]. FDOH evaluated these TCE levels and found that although TCE levels in groundwater have decreased, they still might result in vapor intrusion (Appendix B).

DEP reports workers leave the vehicle maintenance building bay doors open when they use it (Dave Phillips, DEP, personal communication, 2017). FDOH recommends if workers use this building they continue to leave the bay doors open because of the potential for vapors to collect inside a closed building.

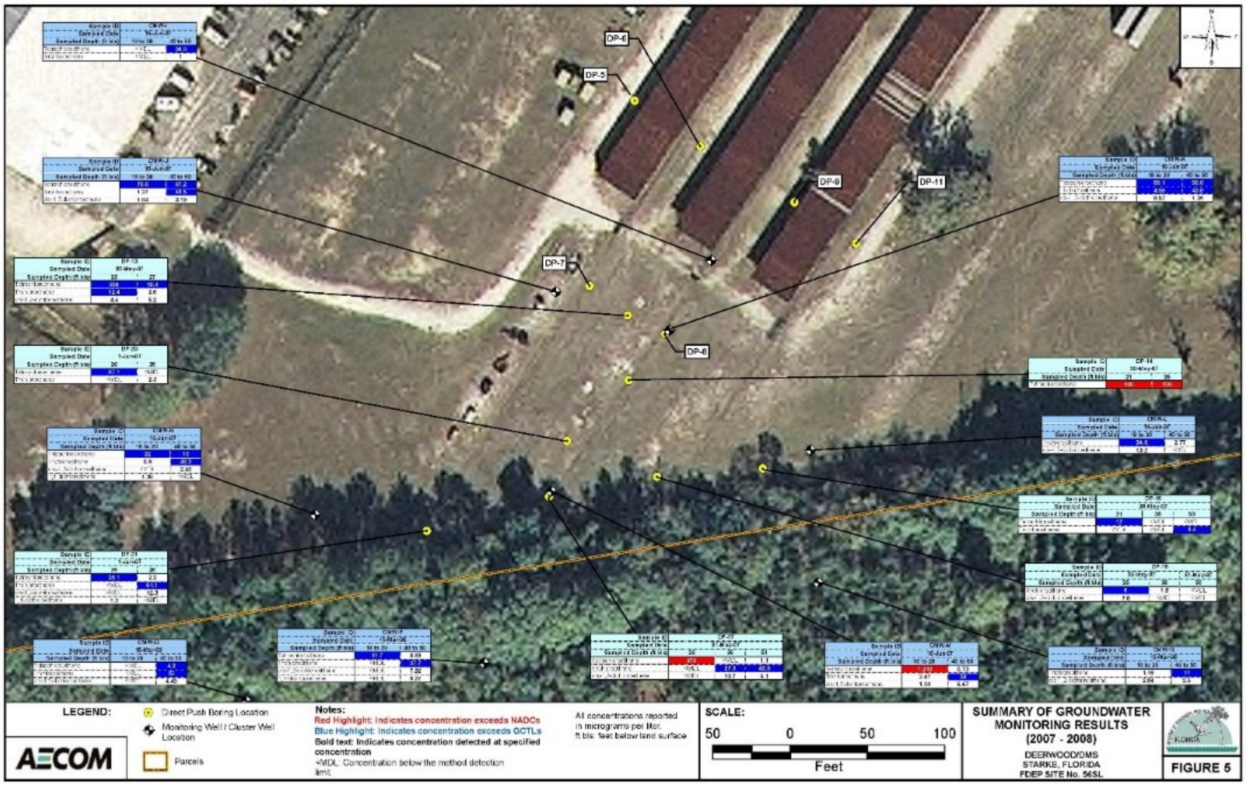
If DMS builds any *new* buildings over site source areas (Figures C1 and C2), workers might breathe TCE and PCE in indoor air. For the reported surficial aquifer levels, ATSDR would recommend testing soil gas simultaneously with indoor air, during hot and cold weather conditions to approximate daily exposure for unventilated buildings [ATSDR 2016b].

Figure C1. Vehicle maintenance building location on northern DMS site boundary



[AECOM 2016]

Figure C2. Potential vapor intrusion areas in the southeast corner of the DMS site



[AECOM 2011]

Appendix D: Chemical Toxis Information

Trichloroethene

TCE slows the central nervous system (CNS) following either oral or inhalation exposure. In the past, doctors used TCE as an anesthetic, as high concentrations cause sleepiness and loss of consciousness. In addition to slowed CNS responses, TCE-exposed workers experienced higher rates of death from asthma. They also experienced damage to their facial nerves. High TCE exposure levels in workers resulted in changes in heartbeat, and liver and kidney damage. Exposed workers experienced a significantly increased risk of death from ischemic heart disease (reduced blood flow to the heart) [ATSDR 1997, 2014a]. Workers with lower-levels of TCE exposure showed 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].

Health scientists know these TCE health effects from workers with high levels of exposure. FDOH does not apply these health effects to off-site residential exposure to well water associated with the DMS site. It compared the doses calculated to health effects known from animal studies at comparable TCE-exposure levels.