July 6, 2016

Nancy Smith
Environmental Health Manager
Florida Department of Health in Seminole County
400 West Airport Boulevard
Sanford, Florida 32773

Re: 1,4-Dioxane in Public and Private Drinking Water

Dear Ms. Smith:

Historical solvent use and disposal at the Siemens-Stromberg hazardous waste site is associated with contamination of on-site and off-site groundwater. Recent testing found 1,4-dioxane in nearby private drinking water wells and the Lake Mary public water system. In this letter, the Florida Department of Health (DOH) assesses the public health threat posed by the highest level of 1,4-dioxane (1.3 µg/L).

Based on a review of available data, DOH concludes that drinking water with the highest level of 1,4-dioxane would not harm people's heath.

This assessment requires the use of assumptions, judgments, and incomplete data. These factors contribute to uncertainty in evaluating the health threat. Assumptions and judgments in this assessment err on the side of protecting public health and may therefore overestimate the risk.

The following paragraphs explain how we assessed the public health threat.

Site Description

The Siemens-Stromberg hazardous waste site is at 400 Rinehart Road in Lake Mary, Seminole County, Florida, 32746 (Figure 1).

In 1968, the Stromberg-Carlson Corporation began operations at the site. Hazardous waste documents suggest chlorinated solvents were used until the early 1980s [DER 1984; Sims 2004]. Starting in the early 1990s, Siemens Information and Communications Networks occupied the site. Site activities included manufacturing commercial telephone system components, telephone transfer stations, and other commercial communication equipment [Sims 2004].

In 2001, contractors investigated groundwater quality under the site. They found chlorinated solvents and 1,4-dioxane, a stabilizer used in chlorinated solvents. In 2007, contractors installed a groundwater pump and treat system to contain the contaminated groundwater and remove contaminants. Levels of

groundwater contaminants under the site have decreased from pre-treatment levels [Brown and Caldwell 2015].

In a 2010 report, DOH reviewed data associated with potential vapor intrusion of contaminants into the Siemens-Stromberg building. DOH concluded that not enough data existed to determine the health risk [DOH 2010].

The U.S. Environmental Protection Agency (EPA) requires some public water systems to sample their water distribution system for unregulated contaminants. In September 2014 and March 2015, the City of Lake Mary sampled their water system and found 1,4-dioxane in the distribution system. Between November 2015 and January 2016, additional sampling by DOH in Seminole County found 1,4-dioxane in two nearby private drinking water wells, the City of Lake Mary municipal wells, and the city water distribution system. Figure 2 shows approximate locations of the city's wells and private wells. Most residences in the area are connected to municipal water.

Demographics
Approximately 4,418 people live within one mile of the site. Eighty-one percent (81%) are white, 10% are Asian, 4% are African-American, and 5% reported more than one race or some other race. Twenty-three percent (23%) are less than 18 years old and 77% are older than 18. About forty percent (40%) make less than $50,000 a year [EPA 2010].

Land Use
Vacant land and Interstate 4 border the site on the west; vacant land and commercial properties border the site to the north. Commercial and residential properties border the site on the east and south (Figure 2).

Exposure Pathways

Completed Exposure Pathways
DOH evaluated two completed human exposure pathways: the Lake Mary public water system and nearby private drinking water wells (Table 1).

For both of these pathways, historical 1,4-dioxane contamination from spilled or improperly disposed of solvents at the Siemens-Stromberg site is the likely source of contamination. Groundwater is the environmental media. Drinking water taps in residences and businesses connected to the public water system or private wells are the points of exposure. The time period of exposure is the past, the present, and the future. Drinking (ingestion) is the route of exposure. DOH did not assess dermal exposure and inhalation of vapors during showering because compared to drinking, these exposure pathways are minimal.

Environmental Data

In September 2014 and March 2015, the City of Lake Mary found 1,4-dioxane levels of 0.54 and 0.55 µg/L, respectively, in its water distribution system [EPA 2016a]. DOH in Seminole County sampled Lake Mary's public water system three times in November 2015 and contractors for the responsible party sampled it in December 2015 and March 2016. 1,4-dioxane levels were found as high as 1.3 µg/L (Table 2). Water in the distribution system is representative of the water that people drink and is a mix of water from several wells.

DOH in Seminole County also sampled two private wells south of the Siemens-Stromberg site, once in December 2015 and twice in January 2016. 1,4-Dioxane was found at levels ranging from less than detection limits to 0.28 µg/L (Table 3). Owners of the other four known private wells in the area either

do not use the wells or did not allow the DOH in Seminole County to take a sample (Joyce Bittle, DOH in Seminole County, personal communication, 2016).

Public Health Implications

DOH makes site-specific public health recommendations based on contaminant levels, exposure pathways, exposure duration, toxicological literature, and characteristics of the exposed population. Whether a person will be harmed depends on the type/amount of contaminant, how they are exposed, how long they are exposed, how much contaminant is absorbed, genetics, and individual lifestyle.

Dose

To calculate the daily doses of each contaminant, DOH uses standard factors [ATSDR 2005; EPA 2011]. DOH assumes that people are exposed daily to the maximum level measured and makes the health protective assumption that 100% of the ingested chemical is absorbed into the body. The percent actually absorbed into the body is likely less. The general formula for estimating a dose is:

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

Where:
D = exposure dose (mg/kg/day)
C = contaminant concentration (various units)
IR = intake rate (amount per day)
EF = exposure factor (unit less)
CF = conversion factor (10^{-6} kg/mg)
BW = body weight (kilograms or kg)

$$EF = F \times ED / AT$$

Where:
EF = exposure factor (unit less)
F = frequency of exposure (days/year)
ED = exposure duration (years)
AT = averaging time (days) (ED × 365 days/year for non-carcinogens; 78 years × 365 days/year for carcinogens)

DOH uses the following standard assumptions to estimate exposure from ingestion of contaminated water:

1) Children ages birth to 1 year drink an average of 0.5 liters and an upper percentile of 1 liter of water per day.
2) Children ages 1 to 2 years drink an average of 0.31 liters and an upper percentile of 0.9 liter of water per day.
3) Children ages 2 to 6 years drink an average of 0.4 liters and an upper percentile of 1 liter of water per day.
4) Children ages 6 to 11 years drink an average of 0.5 liters and an upper percentile of 1.4 liters of water per day.
5) Adolescents ages 11 to 16 years drink an average of 0.6 liters and an upper percentile of 2 liters of water per day.

6) Adolescents ages 16 to 21 years drink an average of 0.8 liters and an upper percentile of 2.4 liters of water per day.
7) Adults over 21 years drink an average of 1.2 liters and an upper percentile of 3 liters of water per day.
8) Average weights vary with age: (birth to 1 year: 7.8 kg), (1 to 2 years: 11.4 kg), (2 to 6 years: 17.4 kg), (6 to 11 years: 31.8 kg), (11 to 16 years: 56.8 kg), (16 to 21 years: 71.6 kg), (above 21 years: 80 kg).
9) The frequency of exposure is 365 days per year.
10) A standard residential occupancy exposure duration is 33 years [EPA 2011].

DOH and the Agency for Toxic Substances and Disease Registry (ATSDR) use the following equation to estimate increased cancer risk:

$$Risk = D \times SF$$

Risk = Cancer risk
D = Age specific non-cancer dose (mg/kg/day)
SF = Slope factor $(mg/kg\text{-}day)^{-1}$

This is a conservative estimate of the increased cancer risk. The actual increased cancer risk is likely lower. Because of large uncertainties in the way scientists estimate cancer risks, the actual increased cancer may be as low as zero.

To put the increased cancer risk into perspective, we use the following descriptors for the different numeric cancer risks:

1 in 10 (10^{-1})	"very high" increased risk
1 in 100 (10^{-2})	"high" increased risk
1 in 1,000 (10^{-3})	"moderate" increased risk
1 in 10,000 (10^{-4})	"low" increased risk
1 in 100,000 (10^{-5})	"very low" increased risk
1 in 1,000,000 (10^{-6}) or less	"extremely low" increased risk

Identifying Contaminants of Concern

DOH compares the maximum levels of contaminants found at a site to ATSDR and other comparison values. Comparison values are specific for the medium contaminated (soil, water, air, etc.). We screen drinking water quality data using these comparison values:

- ATSDR Cancer Risk Evaluation Guides (CREGs)
- ATSDR Environmental Media Evaluation Guides (EMEGs)
- ATSDR Reference Media Evaluation Guides (RMEGs)
- EPA Maximum Contaminant Levels (MCLs)
- EPA Lifetime Health Advisory (LTHA)
- DOH Heath Advisory Levels (HALs)
- Other guidelines

When determining which comparison value to use, DOH follows ATSDR's general hierarchy and uses professional judgment.

Comparing the highest measured levels to screening guidelines, DOH selected 1,4-dioxane as the contaminant of concern in the Lake Mary public water supply. Selection of this contaminant does not necessarily mean there is a public health risk. Rather, DOH selected this contaminant for closer scrutiny. Because levels of 1,4-dioxane in private drinking water wells were below screening guidelines and not likely to cause illness, DOH did not evaluate them further.

1,4-Dioxane

1,4-Dioxane is a clear liquid that mixes easily with water. It does not readily stick to soil particles, and once it mixes with groundwater, it does not break down or volatilize (evaporate) easily. Chemical companies use it for a variety of applications, including as a solvent for chemical processing and as a component of plastics, insecticides, and herbicides. In the past, chemical companies used approximately 90% of the 1,4-dioxane produced in the U.S. as a stabilizer for chlorinated solvents. Since the mid-1990s, use of 1,4-dioxane as a stabilizer has decreased [ATSDR 2012].

The EPA considers 1,4-dioxane a likely human carcinogen. 1,4-dioxane causes hepatic tumors in multiple species of animals and other types of cancers in rats [EPA 2016b]. Long-term exposure to 1,4-dioxane is also associated with renal and liver toxicity [ATSDR 2012].

Cancer risk – DOH estimated doses and increased cancer risk for an individual who drinks Lake Mary water with the highest measured 1,4-dioxane level for a standard residential occupancy exposure duration of 33 years. DOH assumed the dose began at birth for 33 years, rather than 33 years as an adult. This is the more conservative (health-protective) residential exposure assumption because it includes the exposure of children. DOH estimated risk for average (Central Tendency Exposure [CTE]) and high (Reasonable Maximum Exposure [RME]) water intake rates.

People who drink water with the highest 1,4-dioxane levels measured in City of Lake Mary water from birth to 33 years are at an “extremely low” increased estimated risk of cancer. The increased risk at most (using the RME water intake rate) is about 3 in one million (3×10^{-6}) (Table 4). To put this into context, one out of every three Americans (or 333,333 in 1,000,000) will be diagnosed with some form of cancer in their lifetime [Oregon Cancer Foundation 2015]. Adding the greatest estimated increased cancer risk from exposure to 1,4-dioxane in drinking water would increase the cancer incidence from 333,333 in 1,000,000 to 333,336 in 1,000,000.

Site-specific Limitations of Findings

DOH evaluated drinking water exposures based on 1,4-dioxane levels in samples collected between 2014 and 2016. Levels of 1,4-dioxane may have been lower or higher in the past.

Not all nearby private well owners allowed DOH to test their water (Joyce Bittle, DOH in Seminole County, personal communication, 2016). DOH cannot assess the health risk from ingestion of water from untested wells.

Child Health Considerations

In communities faced with air, water, soil, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults might be for certain kinds of exposure to hazardous substances. A child’s lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. Children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children’s health.

DOH considered the cancer risk for children. DOH assessed risk for people consuming 1,4-dioxane in drinking water beginning at birth.

Community Health Concerns

In the past, former site workers were concerned that exposure to chlorinated solvent vapors intruding into the building from contaminated groundwater may have harmed their health. In a 2010 report, DOH concluded that not enough data existed to determine the health risk from vapor intrusion. In addition, in August 2010, DOH distributed a community update to 690 nearby property owners to inform them about the availability of the 2010 health consultation report and to solicit community health concerns. However, no one returned the survey.

At this time, DOH is unaware of any community health concerns about 1,4-dioxane in private drinking water wells or Lake Mary municipal water.

Conclusion

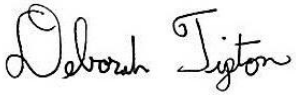
Levels of 1,4-dioxane found in the Lake Mary public water system and private drinking water wells near the Siemens-Stromberg site are not likely to harm people's health. Ingesting water with the highest level of 1,4-dioxane for 33 years would cause, at most, an "extremely low" increased risk of cancer.

Recommendations

DOH has no recommendations at this time.

Please contact me at 877-798-2772 if I can answer any questions about this assessment.

Sincerely,



Deborah Tipton
Health Assessor

DT/dt

This report was supported in part by funds provided through a cooperative agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. The findings and conclusions in these reports are those of the Florida Department of Health and do not necessarily represent the views of the Agency for Toxic Substances and Disease Registry or the U.S. Department of Health and Human Services. This document has not been revised or edited to conform to ATSDR standards.

References

[ATSDR 2005] Agency for Toxic Substance and Disease Registry. Public Health Assessment Guidance Manual (Update). U.S. Department of Health and Human Services, Atlanta, GA. January 2005.

[ATSDR 2012] Agency for Toxic Substances and Disease Registry. Toxicological Profile for 1,4-Dioxane. Atlanta: U.S. Department of Health and Human Services; April 2012.

[Brown and Caldwell 2015] Brown and Caldwell. Annual Report, Former Siemens Site, Lake Mary FL.WCU Site ID: COM_22379. March 2015.

[DER 1984] Florida Department of Environmental Regulation. Hazardous Waste Inspection Report. April 27, 1984.

DOH 2010] Florida Department of Health. Health Consultation, Former Siemens-Stromberg Site, Lake Mary Seminole County, Florida. June 10 2010.

[EPA 2010] U.S. Environmental Protection Agency. EJSCREEN Environmental Justice Geographic Assessment Tool, U.S. Census Bureau American Community Survey 2008-2010. Washington, DC. [Accessed January 16, 2016]. Available from: http://ejscreen.epa.gov/mapper/.

[EPA 2011] U.S. Environmental Protection Agency, Office of Research and Development. Exposure Factors Handbook: 2011 Edition. EPA/600/ R-090/052F.

[EPA 2016a] U.S. Environmental Protection Agency. Occurrence Data for the Unregulated Contaminant Monitoring Rule, UCMR 3 (2013 -2015). [Updated January 2016; Accessed February 17, 2016]. Available from: https://www.epa.gov/dwucmr/occurrence-data-unregulated-contaminant-monitoring-rule#3

[EPA 2016b] U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS), 1,4-Dioxane Quickview. [Updated January 21, 2016; Accessed January 21, 2016]. Available from: http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0326.

[Oregon Cancer Foundation 2015] Oregon Cancer Foundation. [Accessed June 2, 2016]. Available from: http://www.oregoncancerfoundation.org/.

[Sims 2004]. L.S. Sims and Associates. Contamination Assessment Report, Siemens Facility, Lake Mary, Florida. September 2004.

Table 1. Completed Human Exposure Pathway

Completed Pathway Name	Completed Exposure Pathway Elements					Time
	Source	Environmental Media	Point of Exposure	Route of Exposure	Exposed Population	
Lake Mary Public Water System	Historical solvent use and disposal at the Siemens-Stromberg site	Groundwater	Drinking water taps in nearby homes and businesses served by public water system	Ingestion	Lake Mary public water system users	Past, present, future
Private Wells	Historical solvent use and disposal at the Siemens-Stromberg site	Groundwater	Drinking water taps in nearby homes served by private wells	Ingestion	Private drinking water well users	Past, present, future

Table 2: 1,4-Dioxane Levels in Lake Mary Public Water

Contaminant	Concentration Range (µg/L)	Screening Guideline* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/Total #
1,4-Dioxane	0.49 - 1.3	0.35	HAL; CREG	8/8

CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
HAL = State of Florida Health Advisory Level
µg/L = micrograms per liter
* Screening guidelines used only to select chemicals for further scrutiny, not to the judge the risk of health impact.

Sources of data: (DEP, unpublished data, 2016); (DOH Water Program, unpublished data, 2016); [EPA 2016a].

Table 3: 1,4-Dioxane Levels in Nearby Private Wells

Contaminant	Concentration Range (µg/L)	Screening Guideline* (µg/L)	Source of Screening Guideline	# Above Screening Guideline/Total #
1,4-Dioxane	<0.02 – 0.28	0.35	HAL; CREG	0/6

CREG = ATSDR cancer risk evaluation guide for 10^{-6} excess cancer risk
HAL = State of Florida Health Advisory Level
µg/L = micrograms per liter
* Screening guidelines used only to select chemicals for further scrutiny, not to the judge the risk of health impact.

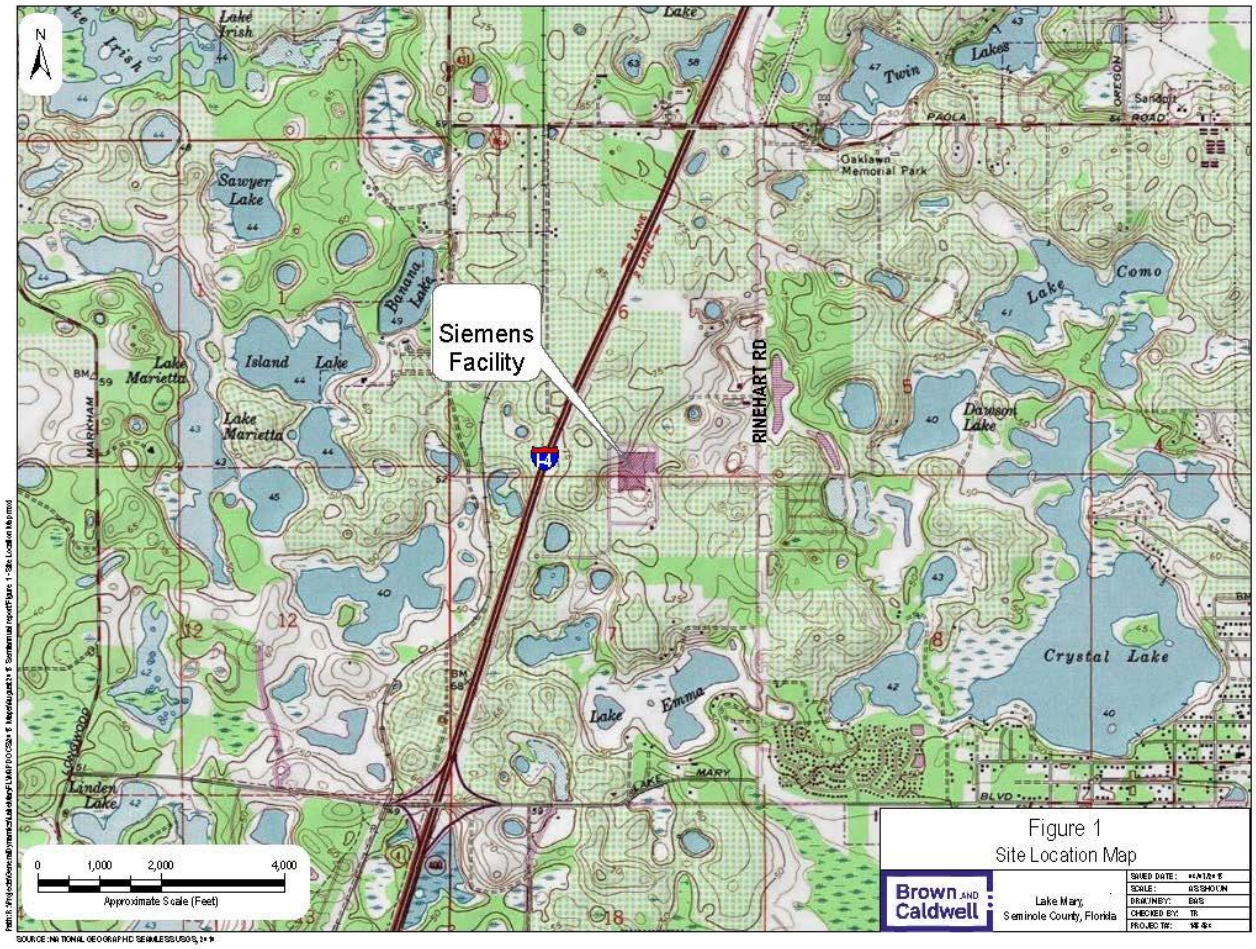
Source of data: (DOH Water Program, unpublished data, 2016).

Table 4. Estimated Dose (Birth to 33 Years) and Increased Cancer Risk from Ingestion of 1,4-Dioxane, Lake Mary Public Water System

Maximum 1,4-Dioxane Concentration in Drinking Water (µg/L)	Estimated Dose (mg/kg/day) (CTE)	Estimated Dose (mg/kg/day) (RME)	Oral Slope Factor $(mg/kg/day)^{-1}$	Source of Oral Slope Factor	Estimated Increased Cancer Risk (CTE)	Estimated Increased Cancer Risk (RME)
1.3	9×10^{-6}	3×10^{-5}	1.1×10^{-1}	EPA IRIS	9×10^{-7} (extremely low)	3×10^{-6} (extremely low)

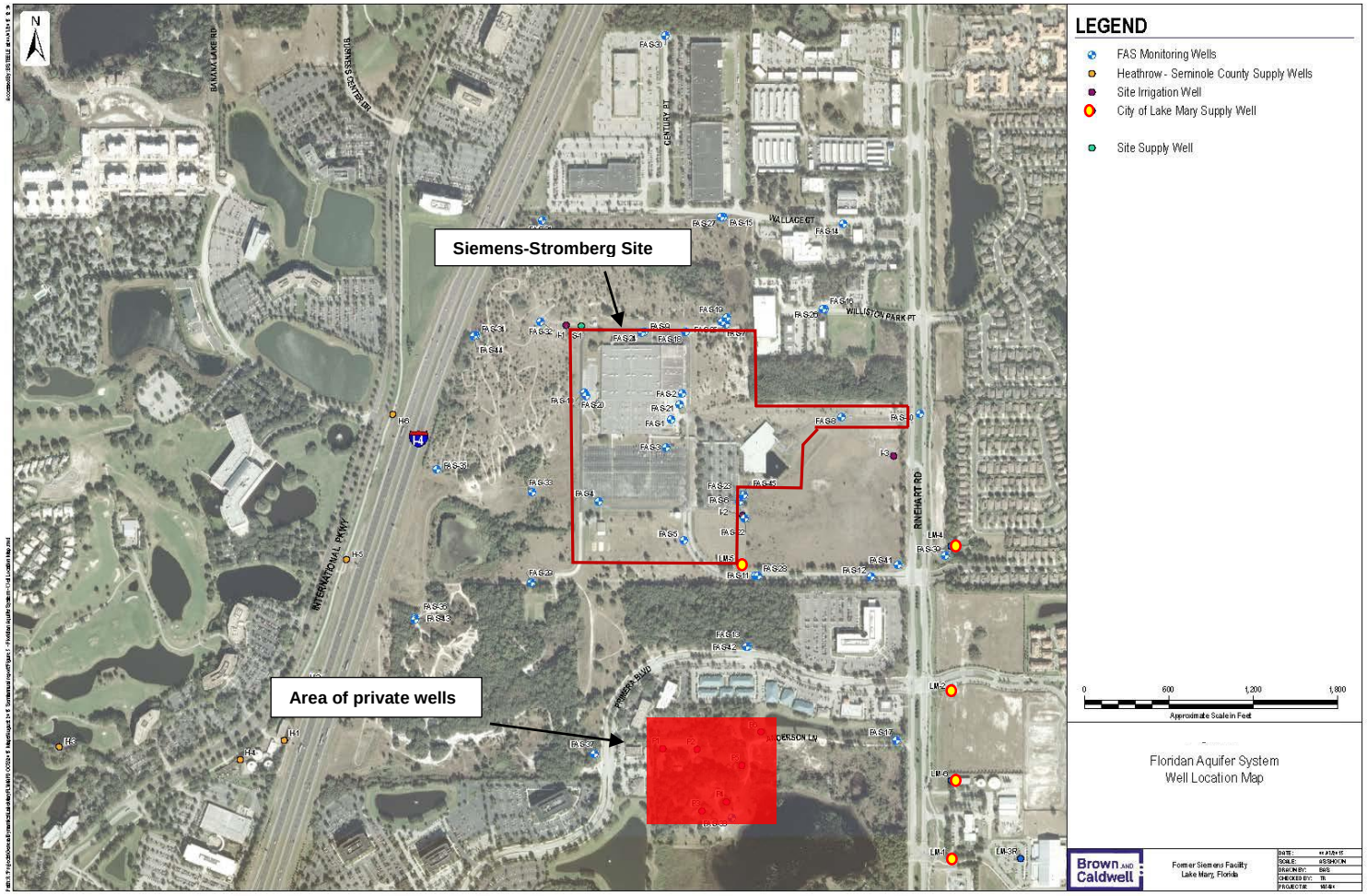
µg/L = micrograms per liter
mg/kg/day = milligrams per kilogram per day
CTE = Central Tendency Exposure
EPA = Environmental Protection Agency
IRIS = Integrated Risk Information System
RME = Reasonable Maximum Exposure

Figure 1. Location of Siemens-Stromberg Site



From [Brown and Caldwell 2015].

Figure 2. Locations of City of Lake Mary Public Supply Wells and Private Wells



Adapted from [Brown and Caldwell 2015]