HEALTH CONSULTATION

SPRINGFIELD PROPERTY

SPRINGFIELD, CALHOUN COUNTY, MICHIGAN

Prepared by

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

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Abbreviations and Acronyms

$\mu g/m^3$	micrograms per cubic meter
AIAC	MDEQ Acceptable Indoor Air Concentration
ATSDR	Agency for Toxic Substances and Disease Registry
EPA	U.S. Environmental Protection Agency
FID	flame ionization detector
IR	infrared ambient air analyzer
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
ng/m^3	nanograms per cubic meter
PCE	perchloroethylene
PID	photoionization detector
ppb	parts per billion
ppm	parts per million
SVOC	semivolatile organic compound
TIC	Tentatively Identified Compound
TCE	trichlorethylene
VOC	volatile organic compound

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Summary

A homeowner reported the she and one of her children suffered from headaches and seizures that they felt were associated with suspected environmental contamination on their property. Ambient- and indoor-air sampling indicated that there was no environmental source of contamination. The chemicals detected are not likely to cause the symptoms reported. The site poses no apparent public health hazard.

Additionally, a neighbor of the homeowner described above was concerned that there appeared to be an elevated rate of cancer diagnoses on her street. There is no epidemiological evidence indicating an increased cancer incidence rate in this area.

Purpose and Health Issues

The Michigan Department of Community Health (MDCH) became involved at this site at the request of the U.S. Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry (ATSDR).

The purposes of this health consultation are to determine if environmental contamination could be scientifically linked to seizures experienced by two members of the same household and to respond to another citizen's concerns regarding a perceived increase rate of cancer incidences in the vicinity of the contamination.

Background

In June 2003, the Michigan Department of Environmental Quality (MDEQ) contacted MDCH regarding a citizen's health complaints. The citizen and one of her children were experiencing seizures that they felt were attributable to environmental contamination they suspected on their property. MDCH contacted the citizen to get more information.

The property consists of a manufactured home set on an approximately quarter-acre lot in the Battle Creek/Springfield area of Calhoun County, Michigan (Figure 1). The occupants had moved into the newly-built structure two years previously. The property is about one city block west of an asphalt plant. The property also is situated immediately south of an industrial facility where trichloroethylene (TCE) and perchloroethylene (PCE) have been found in the groundwater. Local residents apparently used the property as an unregulated dump for many years. The current occupants had found pieces of dry, rusted 55-gallon drums and chunks of asphalt when excavating their property.

The mother first experienced tremors one month before the family moved into the new home. (The family members had regularly visited the property during construction and had entered the building several times.) The woman described her symptoms as initially being headaches, which progressed over time to tremors and seizures. Occasionally she can sense the onset of a seizure, but other times she is caught unaware. There is no consistency as to when the tremors happen. Her oldest son experienced more intense

seizures until he moved out of the house. Her next younger son complained of headaches that were severe enough to prompt him to ask to be taken to the hospital.

The mother and her oldest son reportedly underwent extensive testing, including blood and urine testing for heavy metals and cholinesterase (with negative findings), and magnetic resonance imaging. They were eventually diagnosed with an Arnold-Chiari malformation, also known as tonsillar ectopia, a herniation of the cerebellum. The woman asked MDCH if exposure to environmental contamination could cause or exacerbate the symptoms. After researching the topic, MDCH replied that there was insufficient scientific information regarding tonsillar ectopia and suggested that she confer with an occupational health specialist to address her concerns of exposure to environmental contaminants.

The citizen subsequently contacted the EPA and requested further assistance, asking that her property be examined for possible contamination. EPA notified ATSDR and requested guidance regarding the public health perspective of the situation. ATSDR, in turn, asked MDCH to re-evaluate the site. (MDCH conducts public health assessments in Michigan under a cooperative agreement with ATSDR.)

Discussion

Environmental Characterization

On July 2, 2003, EPA staff went to the property to conduct on-site analyses of the air and soil with two photo-ionization detectors (PIDs), a flame-ionization detector (FID), and an infrared ambient air analyzer (IR). A PID is capable of measuring total volatile organic compounds (VOCs) in air, in real time, with a detection limit of about 0.1 ppm (parts per million). An FID detects organic compounds and is most sensitive for alkanes and alkenes. An IR can identify compounds fairly accurately, if they are in its database, however further testing in a lab is needed for confirmation and quantitation.

Upon determining background ambient-air concentrations, the samplers proceeded with sampling indoors. In the home belonging to the family with the reported health effects, the two PIDs reported a range of 0.2 to 4.5 ppm VOCs. FID readings in this house ranged from 0.5 to 2.1 ppm hydrocarbons. Field staff sampled indoor air in the neighbor's house as well, also a manufactured home, installed at the same time as the first house and on the same parcel of land. (The occupants of this home were suffering from headaches.) The PIDs reported a range of 0.0 to 3.2 ppm VOCs, and the FID reported 1.2 to 7.6 ppm hydrocarbons. The IR detected compounds in the indoor air of both homes but could not match any of the samples with compounds in its library (TetraTech EMI 2004).

During this site visit, field staff also sampled for gases volatilizing from the soil at the main residence. They placed a soil sample in a zip-locking baggie, sealed the bag and let it sit in the sun for five minutes, and sampled the headspace. The two readings from the front yard reported 150 ppm and 2.2 ppm VOCs with the PID and 2.5 and 35 ppm hydrocarbons with the FID. The two readings from the backyard were 17.9 and 200 ppm

with the PID and 2.5 for both locations with the FID. The highest PID reading occurred at the southwest corner of the house, close to the building, whereas the highest FID reading occurred in the front yard and corresponded with the lowest PID reading. Field staff sent the soil sample with the highest PID reading to a contract laboratory for VOC and semivolatile organic compound (SVOC) analysis (EPA Methods 8260 and 8270, respectively). The analysis report indicated no detections, with detection limits of 50-100 ppb for the majority of VOCs and 330 ppb for the majority of SVOCs (TetraTech EMI 2004).

It is unclear from the TetraTech report (2004) which readings were associated with which PIDs in the indoor air sampling, and whether one or two PIDs were used when testing the headspace from the soil samples. It is possible that one machine might have reported consistently high readings. It is also possible that the fluctuating readings were accurate depictions of total VOCs in the soil and air. Nonetheless, EPA Methods 8260 and 8270 analyzed for 59 individual VOCs and 58 individual SVOCs, respectively, and these methods are a more precise measurement of these chemicals.

Following this air-monitoring event, EPA decided to sample both the indoor and the outdoor air over a 24-hour period to determine average daily exposure to specific VOCs (EPA Method TO-15). According to MDEQ, there is TCE and PCE contamination of the groundwater in the area, gases from which could potentially enter the home's indoor air via the vapor intrusion pathway. (Typically, investigators conduct soil-gas testing first, to determine the likelihood of vapor intrusion. However, EPA chose to sample indoor air immediately due to the acute nature of the complainants' reported health effects.) Samplers placed four 6-liter Summa canisters in the following locations in each house: living room, master bedroom, crawl space, and backyard.

At the same time, EPA also decided to determine if aldehydes were present (EPA Method TO-11A). Formaldehyde can off-gas from manufactured homes and some building and furniture materials. Only the main house of concern was tested for aldehydes; adsorbent tubes were placed in the same locations as the Summa canisters for an 8-hour collection period.

The results for the TO-15 and TO-11A analyses are listed in Tables 1 and 2. The VOCs that exceeded their respective MDEQ Acceptable Indoor Air Concentrations (AIACs) were benzene (in the living room of the main house of interest and in all rooms tested as well as outside air at the neighbors' house), 1,2-dichloroethane and 1,1-dichloroethene (both in the living room of the main house of interest). Values reported for benzene were qualified as estimates because the mass spectra (peaks on the readout) indicated that two or more compounds were co-eluting (being detected simultaneously) at the point where benzene would be detected. The values reported for 1,2-dichloroethane and 1,1-dichloroethene were less than twice the respective AIACs for those compounds (TetraTech EMI 2004). The living room in the main house of interest was the sampling location with the most TO-15 chemicals detected.

The analytical results reported the TO-11A data in concentrations (micrograms per cubic meter [$\mu g/m^3$]) as well, however these data were not validated. (Table 2 reports the findings in micrograms only.) Nonetheless, the concentrations are discussed here because the laboratory compared them with the chemicals' respective AIACs, when available. (Only four of the TO-11A chemicals have AIACs: acetaldehyde, acetone, formaldehyde, and methyl ethyl ketone/butyraldehydes.) The compounds that exceeded their respective AIACs were formaldehyde and acetaldehyde. Formaldehyde was detected at all sampling locations at concentrations ranging from 2.8 $\mu g/m^3$ (outside), to 19.3 $\mu g/m^3$ (crawlspace), to 61.6 $\mu g/m^3$ (living room) (TetraTech EMI 2004). The AIAC for this compound is 1.9 $\mu g/m^3$ (MDEQ 2003). Acetaldehyde was detected in the crawlspace and indoors at concentrations ranging from 23 to 28 $\mu g/m^3$, respectively. The outside concentration for this chemical was 2.5 $\mu g/m^3$ (TetraTech EMI 2004). The AIAC for acetaldehyde is 9.4 $\mu g/m^3$ (MDEQ 2003). These results suggest that the contamination is arising from an indoor, rather than an environmental, source.

The laboratory also reported on Tentatively Identified Compounds (TICs) found in the VOC analysis (Table 3). According to the *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual* (EPA 1989), although a laboratory may estimate TIC concentrations, these estimates "are highly uncertain and could be orders of magnitude higher or lower than the actual concentration(s). For TICs, therefore, assigned identities may be inaccurate, and quantitation is certainly inaccurate." Therefore, MDCH chose not to report the estimated concentrations for the TICs reported in the analytical results, choosing instead only to report the match quality percent. ("Match quality percent" indicates the extent to which, as estimated by the laboratory, the analytical spectrum matches the standard for that chemical.) The most commonly reported TIC was acetaldehyde (also detected in the TO-11A scan), found in seven of the eight testing locations, with a match quality ranging from 64 to 90 percent. Pentanal and alpha-pinene were each found in four of the testing locations. The living room in the main house of interest was the sampling location with the most TICs detected.

Acting on a request from the ATSDR Region 5 office, MDCH conducted mercury-vapor testing in ambient and indoor air July 18 and August 12, 2003. Although biomarker testing had not indicated elevated mercury levels in the woman and her son, the neurological nature of the symptoms were suggestive of mercury toxicity. MDCH staff used a Lumex RA915+ real-time mercury-vapor analyzer, capable of detecting mercury vapors in the nanogram-per-cubic-meter (ng/m^3) range, and tested ambient air in the back and front yards and indoor air in the entryway, kitchen, and living room of the main house of interest. Average outside readings ranged from 0-10 ng/m^3, with peak readings at less than 10-20 ng/m^3. Indoor peak readings ranged from 30-50 ng/m^3. The indoor readings were indicative of minimal mercury contamination.

During the July visit, the MDCH staff person walked on the property, noting any unusual characteristics, and investigated the area that neighbors had used previously as a dump. In the yard, only scant grass covered the lawn, due to the homeowner making attempts to grade the land with a front-end loader so that rainwater would drain off better. Occasional pieces of rusty metal, such as crushed paint cans or pieces of metal drums,

were evident in the sandy soil in the backyard of the main house of interest. There were several railroad ties by the detached garage and the smell of creosote was detectable. In the neighbors' yard, the soil berm behind the house contained a black gravelly substance similar to crumbled asphalt shingles. The dump area was in the woods behind the houses. Several large appliances had been disposed of there. Older refuse included cans labeled for antifreeze and motor oil. More recent items included tires, paint cans, and brush.

As mentioned previously, there is an asphalt plant approximately 150 yards to the west of the property. Asphalt plants are known for odorous emissions that can include VOCs, sulfur, nitrogen oxides, and polycyclic aromatic hydrocarbons. (Odors might trigger headaches in some people, especially if duration is significant.) The MDCH staff person readily detected odors when driving downwind of the plant. Prevailing winds in the Battle Creek/Springfield area are from the southwest quadrant, which would carry emissions toward the property of interest. There are other houses as well as a credit union closer to the asphalt plant than the property of interest is, however there are no records of odor complaints regarding the plant.

On September 29, 2003, EPA conducted a geophysical survey of the property to determine if there were buried drums. Field staff surveyed the front and back yards of both residences and located two anomalies, one in each front yard. The anomaly in the yard of the main house of interest was a buried metal stake. That in the other yard was a layer of cinder-like material. Therefore, EPA concluded that no drums had been buried on the site (TetraTech EMI 2004).

Likelihood of Exposure

According to MDEQ, the Clark Equipment Company, now Ingersoll-Rand, and the former Eaton Corporation are the responsible parties for the TCE and PCE groundwater contamination (2004, D. Heywood, MDEQ-Remediation and Redevelopment Division, personal communication). The companies' properties are located immediately across the street, north of the home of interest. Company buildings are situated more to the north and west boundaries of the properties. Closer to the home of interest, the Clark property consists of open field. It is unlikely that there is a preferential pathway for volatilized TCE or PCE to migrate toward the home. Historic records do not indicate that the plumes were beneath the residential property in question (Figure 2). Groundwater flow is to the north, discharging to the Kalamazoo River. The house is served by municipal water. Therefore, it is unlikely that the occupants are experiencing exposure to TCE or PCE originating at the Clark Equipment Company or Eaton Corporation via vapor intrusion or drinking water pathways.

The geophysical survey did not indicate any buried drums on the property. If there were contamination up-gradient of this site and it was migrating underneath the property, one might expect the monitoring wells at the Clark Equipment Company or Eaton Corporation, further down-gradient, to detect such contamination. Therefore, it is unlikely that any VOCs that might be in the groundwater under the property of interest

are migrating through the soil and entering indoor or ambient air to a degree that adverse health effects would be expected.

The TO-11A sampling results indicated that formaldehyde and acetaldehyde were present in the indoor air during the sampling event. To determine if there is ongoing exposure, longer term indoor air monitoring is necessary.

Plausibility of Connection to Reported Health Effects

Of the compounds tested for in this investigation, the chemicals most likely to elicit the headaches reported by the woman and her son are VOCs. However, there were no significant exceedances of indoor air criteria for these compounds. Rather, formaldehyde and acetaldehyde concentrations were greater than their respective criteria, by as much as 30 times. However, these chemicals act as mucous membrane irritants, causing a sore throat, runny nose, and watery eyes.

Mercury is a known neurotoxin and can cause tremors and seizures if exposure is substantial. However, testing for mercury vapors did not reveal that high concentrations were present.

As mentioned previously, there is little information on tonsillar ectopia. It is possible that persons with this malformation are more susceptible to the effects of environmental exposures. Also, because the cerebellum is herniated, central nervous system effects might predominate over other body systems in these individuals when responding to chemical stimuli. Again, this information is not known.

ATSDR Child Health Considerations

Children may be at greater risk than adults from exposure to hazardous substances at sites of environmental contamination. Children engage in activities such as playing outdoors and hand-to-mouth behaviors that could increase their intake of hazardous substances. They are shorter than most adults, and therefore breathe dust, soil, and vapors closer to the ground. Their lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures are high enough during critical growth stages. Even before birth, children are forming the body organs they need to last a lifetime. Injury during key periods of growth and development could lead to malformation of organs (teratogenesis), disruption of function, and premature death. Exposure of the mother could lead to exposure of the fetus, via the placenta, or affect the fetus because of injury or illness sustained by the mother (ATSDR 1998). The obvious implication for environmental health is that children can experience substantially greater exposures than adults to toxicants that are present in soil, water, or air.

It is unlikely that the average child would experience the same symptoms reported by the woman and her son. It is more likely that a child would experience irritant effects from exposure to formaldehyde and acetaldehyde. The child might show symptoms of exposure before an adult would.

Community Health Concerns

The questions asked by the woman in the main home of interest are addressed above in the Plausibility of Connection to Reported Health Effects section.

Additionally, EPA referred another area resident to MDCH regarding the resident's concerns over a perceived increased incidence rate of cancers in the area. This resident had been talking with the occupants of the homes that EPA had investigated. She reported to MDCH that her mother and two other women, all of whom had lived in the area for more than 10 years, were diagnosed with breast cancer in their 40s. Another older woman had been diagnosed with lung cancer. The resident felt that, because these women all lived on the same street, the incidences were associated with environmental contamination. The MDCH toxicologist discussed the resident's concerns, asked her if she wanted a cancer cluster investigation conducted, and told her what information would be necessary. (To date, the resident has not followed up with MDCH.) Following the conversation with this person, MDCH contacted the county health department to inquire about cancer cluster investigations for this area. There is no indication that there is an abnormal incidence rate of cancers near this site (2003, A. Lathem, Calhoun County Health Department, personal communication).

Conclusions

Based on environmental and toxicological data, this site poses *no apparent public health hazard*. The TO-11A results indicate that formaldehyde and acetaldehyde contamination likely is arising from an indoor, not an environmental, source. Such a situation does not come under the purview of regulatory agencies. MDCH can provide advice to the homeowners (see Recommendations section) but cannot make clean-up recommendations to the EPA or MDEQ in such circumstances. Formaldehyde can be found in building materials, insulation, and furniture. However, it should be noted that both homes on this property house cigarette smokers. Tobacco smoke contains formaldehyde, among other chemicals detectable via Methods TO-15 and TO-11A. It may not be possible to ascertain the source of the formaldehyde and acetaldehyde.

Recommendations

1. The occupants of the main house of interest should consult with an Indoor Air Quality consultant to determine if formaldehyde and acetaldehyde concentrations in the home remain elevated in the long term. If concentrations do remain elevated, the occupants should try to determine the source of chemicals and mitigate exposure. (The occupants have since moved.)
2. The persons diagnosed with the Arnold-Chiari malformation should continue seeing their medical care provider to address and monitor their condition.
3. The woman affected with seizures should discuss with her doctor whether it is safe for her to operate a vehicle, since these seizures cannot always be predicted.

Public Health Action Plan
MDCH will remain available to assist in this case as necessary.

If any citizen has additional information or health concerns regarding this health consultation, please contact the Michigan Department of Community Health, Environmental and Occupational Epidemiology Division, at 1-800-648-6942.

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TetraTech EMI. 2004. Data summary final results letter regarding Technical Direction Document No. S05-0306-014. Southfield, Michigan: TetraTech EMI.

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Table 1. EPA Method TO-15 results in main house of concern and neighbors' house at Springfield Property, Calhoun County, Michigan, and comparison to MDEQ Acceptable Indoor Air Concentrations.

		Main house of concern				Neighbors' house				Maximum
Chemical	**AIAC**	**LR**	**MB**	**CS**	**BY**	**LR**	**MB**	**CS**	**BY**	**RL**
Acetone	6,200	120	71	49	12	46	87	37	61	4
Benzene	2.9	8.2 J	1.8 J	1.2 J	1.5 J	4.7 J	4.3 J	3.4 J	2.3 J	1.1
Bromomethane	5.2					1.3	1.5	0.92 J	1.5 J	1.3
Butadiene, 1,3-	NV					3.6	3.4			3.8
Chloroform	10	1.8				0.67 J				1.7
Chloromethane	38	1.4	1.9	1.3	1.8	4.9	4.7	1.7	1.5	0.7
Dichlorobenzene, 1,2	1,600	3.9							2.2	2
Dichlorobenzene, 1,4-	3.5	0.94 J								2
Dichloroethane, 1,1-	520	0.95								1.4
Dichloroethane, 1,2-	0.94	1.1								1.4
Dichloroethene, 1,1-	0.49	0.8								1.4
Dichloroethene, cis-1,2-	36	13 J								1.4
Dioxane, 1,4-	NLV	8.7								6.1
Ethanol	NLV	240 J	310 J	100	13	500 J	360 J	86	21	3.2
Ethyl Benzene	79	14			0.81	1.8	1.5	3.5	5.6	1.5
Ethyltoluene, 4-	NV	12							8.3	8.4
Freon 11	59,000	1.6		1.6	1.6	1.8	1.8	2.4	1.6	1.9
Freon 12	52,000	2.9	2.7	2.9	3	2.9	3.1	12	3.1	1.7
Hexane	210							7.9		6
Hexanone, 2-	42	7.1							9.1	7
Methyl Ethyl Ketone	1,000	130	6.9	9.7	2.8	12	11	13	35	5
Methyl Isobutyl Ketone	2,100	64							110	7
Methylene Chloride	52	5.1						5.7		2.4
Propanol, 2-	NLV	56	39	16	3.6	8.4	6.9	84	8.3	4.2
Styrene	43	2.3 J				2	1.7	3.2	1.4 J	1.4
Tetrachloroethene	42	11						2.9	6	1.8
Tetrahydrofuran	6,200	9.1						3.4 J		5
Toluene	420	86	8.2	4.9	5.4	15	14	61	22	1.3
Trichloroethane, 1,1,1-	1,000	2.7								1.8
Trichloroethene	14	10		0.78	1.2	1.7 J	2	2	2.3	1.8
Trimethylbenzene, 1,2,4-	1,300	16	2.0 J	0.94	1.2	3.1 J	2.8 J	3	11	1.7
Trimethylbenzene, 1,3,5-	1,300	3.4							2.8	1.7
Xylene, m,p-	4,600	79	2.7	2	2.7	5.5	4.4	10	33	1.5
Xylene, o-	4,600	33		0.67	0.91	1.4	1.1	3	14	1.5

Abbreviations:

AIAC Acceptable Indoor Air Concentration
LR Living Room
MB Master Bedroom
CS Crawl Space
BY Back Yard
NV no AIAC value listed
NLV not likely to volatilize
RL Reporting Limit

Qualifier:

J estimated value

Notes:

1. Units are ug/m^3.
2. Only TO-15 chemicals for which at least one value was reported are listed.
3. Values in grey boxes exceed the MDEQ AIAC for that chemical.
4. Blank boxes indicate the chemical was not detected at that sampling location.

Table 2. EPA Method TO-11A results in main house of concern at Springfield Property, Calhoun County, Michigan.

	Main house of concern				Maximum
Chemical	**LR (duplicate)**	**MB**	**CS (duplicate)**	**BY**	**RL**
Acetone	6.4 J (5.3 J)	5.8 J	11 (11)	2.0 J	0.5
Crotonaldehyde	1.3 (0.96)	1.1	0.25 J (0.26 J)	ND	0.5
Formaldehyde	35 (31)	36	10 (10)	1.6	0.1
Hexanal	24 (22)	26	11 (11)	0.61	0.5
Isopentanal	ND (0.61 J)	0.62 J	0.27 J (0.35 J)	ND	0.5
MEK/Butyraldehydes	3.1 (3.4)	3.2	2.3 (2.5)	0.37	0.5
Benzaldehyde	4 (3.6)	4.4	1.7 (1.7)	ND	0.5
Pentanal	8.0 J (9.9 J)	10 J	4.1 J (4.9 J)	1.1 J	0.5
Propanal	3.8 (3.6)	3.4	1.6 (1.6)	0.5	0.5

Abbreviations:

LR Living Room — CS Crawl Space — ND not detected

MB Master Bedroom — BY Back Yard — RL Reporting Limit

Qualifier:

J estimated value

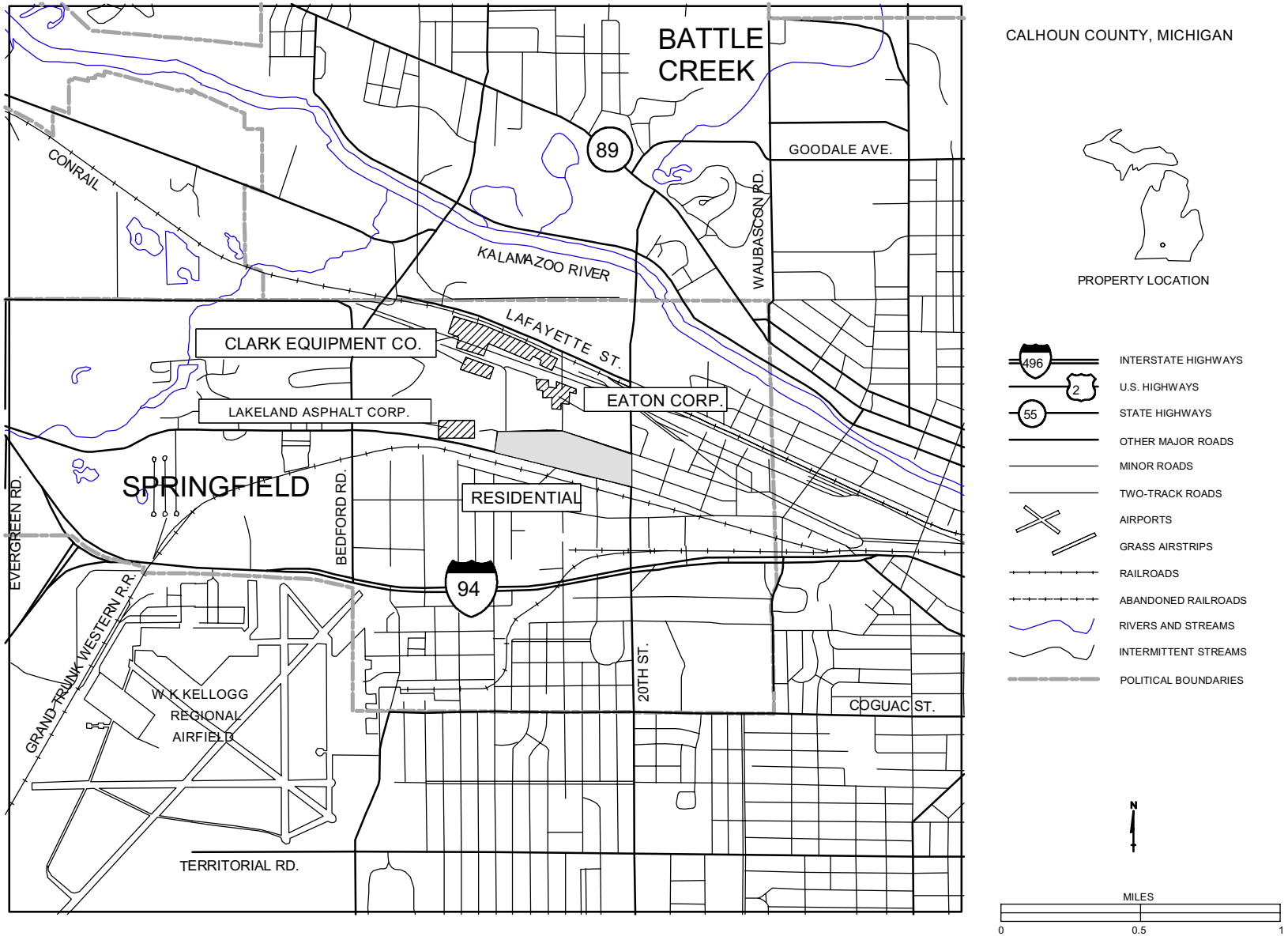
Notes:

1. Results given in ug.
2. Formaldehyde detected in trip blank at 0.058 ug.

Table 3. Tentatively Identified Compounds (TICs) and match quality percent reported in EPA Method TO-15 results in main house of concern and neighbors' house at Springfield Property, Calhoun County, Michigan.

	Main house of concern				Neighbors' house			
TIC	LR	MB	CS	BY	LR	MB	CS	BY
Acetaldehyde	80	74	86	64	86	90		64
Benzene, 1-ethyl-2-methyl-	91							
Benzo[b]thiophene		91						
Bicyclo[2.2.1]hept-2-ene, 1,7,7-trimethy							94	
Bicyclo[3.1.0]hexane, 4-methylene-1-(1-m	91							
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-me						94		
Butadiene, 3-methyl-1,2-		93		94		96		
Butane, 2-methyl-				72	72		78	
Butanol, 1-	90							86
Butanol, 2-	83							
Butenal, (E)-2-							72	
Butenoic acid, 3-					78			
Cyclohexadiene, 1,3-		89						
Cyclohexane, butyl-	50							
Cyclohexanone, 3,3,5-trimethyl-								91
Cyclohexene, 1-methyl-4-(1-methylethenyl						90		
Cyclohexene, 1-methyl-5-(1-methylethenyl	83							
Cyclopentadiene, 5-methyl-1,3		58						
Ethane, 1,1,1,2-tetrafluoro-							59	
Ethene, ethoxy-			59					
Hexanal	62							
Hexane, 2,2,5,5-tetramethyl-								59
Hexanol, 2-								56
Limonene					94			
Methane, chlorodifluoro-					91			
Naphthalene		94						
Octatriene, 3,7-dimethyl-1,3,6-					87			
Oxirane, ethyl-				59				
Pentanal	87		72		86	74		
Pentane							59	
Pentane, 2,3,3-trimethyl-								90
Pentane, 2-methyl-				64			58	
Pentane, 3-ethyl-								78
Pentanone, 2,2,4,4-tetramethyl-3-								91
Pinene, alpha-	95		94	94			94	
Pinene, beta-					91			
Propanal			56					
Propene, 1-						53		

Figure 1.



Michigan Department of Community Health

7/20/2004

Historic TCE and PCE Groundwater Plumes at Clark Equipment Co. and Eaton Corp., Battle Creek/Springfield Area, Calhoun County, Michigan

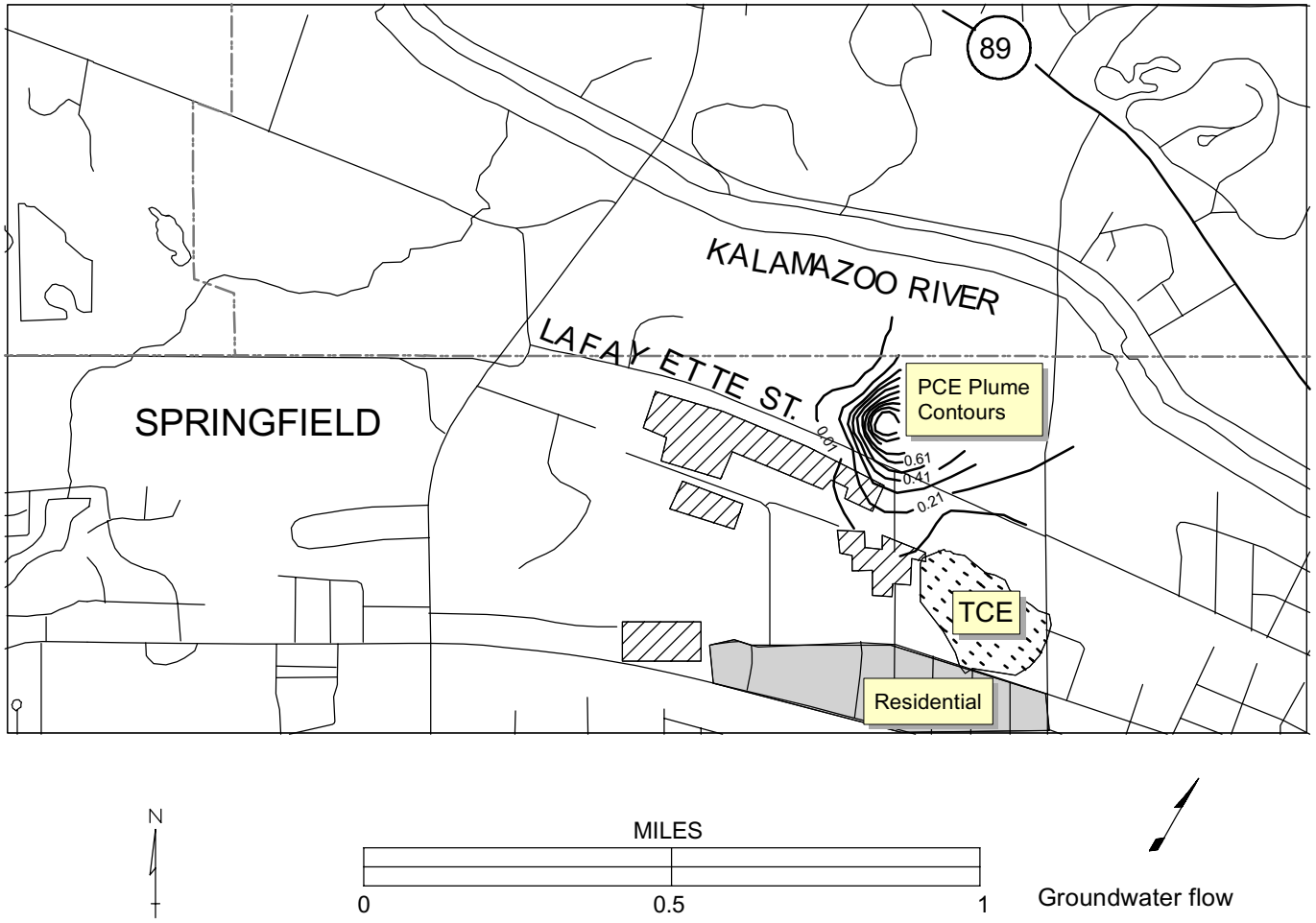


Figure 2.

Certification

This **Springfield Property** Health Consultation was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

Technical Project Officer, Cooperative Agreement Team, SPAB, DHAC, ATSDR

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

for Team Leader, Cooperative Agreement Team, SPAB, DHAC, ATSDR