Massachusetts
Department of
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Health Consultation: Evaluation of Vinyl-Lined Asbestos Cement Pipes Salisbury, MA

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Introduction

In response to a request from the Town of Salisbury Director of Public Health, the Community Assessment Program (CAP) of the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) investigated concerns of some Salisbury residents of a possible association between potential exposure to vinyl-lined asbestos cement (VLAC) pipes in Salisbury's water distribution system and the occurrence of cancer in the community (Morris 2012 a and b).[1] CAP staff reviewed available information on VLAC pipes as well as environmental data obtained from the Salisbury Water Department and the Massachusetts Department of Environmental Protection (MassDEP) to best address these concerns.

Background

History of Asbestos Cement and Vinyl-Lined Asbestos Cement Pipes

Asbestos cement pipe, also known as transite, became available for water distribution systems beginning in the mid-1940s (Williams GE and VonAspern K 2011). According to Williams and Von Aspern, it was used extensively in water and storm drainage systems built between 1950 and 1969. In the late 1960s, asbestos cement pipes were found to produce high alkalinity and poor-tasting water. To address the taste problem, vinyl-lined asbestos cement pipe was developed. VLAC pipe was manufactured by thinning a resin with the solvent PCE and then spraying the mixture onto the inside surface of the asbestos cement pipe. In the late 1970s, it was discovered that VLAC pipe was capable of leaching PCE into the water carried by the pipes.

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This problem was found to be most pronounced in pipes that were flushed infrequently (such as dead end or low-flow pipes). Although the manufacture of VLAC pipes ceased in 1980, one thousand and fifty miles of pipe had been sold to New England communities, approximately half of which was in Massachusetts (MDPH 1997). Ninety-one communities in Massachusetts reported having VLAC pipes at the time, including Salisbury.

In 1980, the Massachusetts Department of Environmental Quality Engineering (now the MassDEP) made recommendations to public water suppliers in Massachusetts about how to control PCE concentrations in VLAC pipes (MDEQE 1982). The agency recommended, and then required, that all dead end and low-flow areas served by VLAC pipes be tested for PCE according to an established schedule, to monitor the effectiveness of the remedial measures at keeping the PCE concentrations below drinking water guidelines or standards (MDPH 1997). In 1982, MDEQE issued a comprehensive report in which Salisbury was reported as one of 33 communities whose water supply met the PCE drinking water standard without any corrective action needed (MDEQE 1982).

Evaluation of Vinyl-Lined Asbestos Cement Pipes

To best address this request, CAP staff first researched the possibility of the release of any potential cancer-causing substances from asbestos cement pipes, in general, and then evaluated available sampling data for Salisbury's public drinking water supply to determine if any drinking water standards for potential cancer-causing substances from asbestos cement pipes have been violated. For a contaminant in drinking water to increase the risk of developing cancer, an individual or population actually has to be exposed to the contaminant by consuming the water. The risk of developing cancer is also dependent on the amount of water consumed, the

concentration of the contaminant in the water, and the frequency and length of time that an individual consumes the water. Drinking water standards for potential cancer-causing substances are developed to prevent unusual cancer risks from daily lifetime exposure.

Staff in the CAP contacted the Salisbury Department of Public Works, the Pennichuck Water Service Company, and the Massachusetts Department of Environmental Protection's (MassDEP) Drinking Water Program to obtain information on the asbestos cement pipes in Salisbury's water distribution system and on the quality of the drinking water in Salisbury[2]. Since 2001, the Pennichuck Water Service Company has been under contract to the town of Salisbury to operate the town's water supply system. CAP learned that Salisbury's water distribution system contained some asbestos cement pipe (reportedly constituting less than one-third of the distribution system) and some vinyl-lined asbestos cement (VLAC) pipes (approximately 6% of the distribution system). Therefore, in reviewing drinking water quality data for Salisbury, CAP focused on asbestos and PCE (or tetrachloroethylene; a chemical used in the manufacture of VLAC pipes) to assess the potential for exposure of Salisbury residents to these contaminants. Both asbestos and PCE are potential cancer-causing substances.

According to the Pennichuck Water Service Company, Salisbury historically had 16.92 miles of asbestos cement pipes which were installed between 1950 and 1973 (Rousseau B. 2013). In 1972 and 1973, VLAC pipes were installed in three locations in Salisbury (Salisbury Water Supply Company 1989):

[2] CAP also reviewed archival microfiche at MassDEP's Boston office in search of historical sampling data.

1. North End Boulevard – from hydrant #60 to the Seabrook line, a distance of 4,804 feet
2. Ferry Road – south from Pleasant Street, a distance of 3,347 feet
3. Beach Road – east from Ferry Road to hydrant #45 (approximately 1,848 feet from North End Blvd.), a distance of 8,799 feet

The entire water distribution system in Salisbury measures approximately 52 miles in length (Levesque D. 2012). In 2010-2011, approximately 1.5 miles of asbestos cement pipe in an industrial park in Salisbury were replaced with plastic pipe because of increased usage and the need to meet higher demand (Levesque D. 2012). Therefore, approximately 15 miles of asbestos cement pipes are currently in Salisbury's water distribution system.

Analysis of Sampling Data

Water samples from various points in the Salisbury water distribution system have been tested for the presence of asbestos and PCE following required water quality sampling schedules established by MassDEP. For PCE, annual sampling occurs at the three locations in Salisbury where VLAC pipes are in place. For asbestos, one sample is required to be analyzed every nine years. Tables 1 and 2 contain the sampling results for PCE and asbestos, respectively.

Table 1 contains available sampling data for fifty-one water samples, dating back to 1980, that were collected and analyzed for the presence of PCE. PCE was not detected in nearly 90% of the samples analyzed (45 of 51 samples). In six samples, the maximum detected concentration of PCE was 1.3 µg/L, which is below the drinking water standard (or Massachusetts Maximum Contaminant Level (MMCL))for PCE of 5 µg/L. According to the Pennichuck Water Service Company and MassDEP records, the MMCL for asbestos has never been exceeded in Salisbury's drinking water (Rousseau, B. 2012). Table 2 shows that asbestos

was not detected in 7 of 8 samples collected between 1996 and 2005; in one sample, asbestos was detected at 0.2 million fibers per liter (MFL), which is below the MMCL of 7 MFL.

Analysis of Cancer Incidence Data

Asbestos is known to cause cancer by inhalation (i.e., breathing in asbestos fibers). However, the health effects from swallowing asbestos are unclear. According to a report by the World Health Organization on asbestos in drinking water, neither studies in people or animals support the hypothesis that an increased cancer risk is associated with the ingestion of asbestos in drinking water (WHO 2003). The panel of experts who prepared the WHO report concluded that there is no consistent, convincing evidence that ingested asbestos is hazardous to health.

Tetracholorethylene is considered to be a cancer-causing chemical both through inhalation and ingestion (ATSDR 1997). According to the ATSDR Toxicological Profile for tetrachloroethylene, this chemical has been shown to cause liver tumors in mice and kidney tumors in rats. Some studies of people exposed to tetracholoroethylene at work, at levels typically much higher than in a residential setting, have found more cases of other types of cancer than expected. According to the American Cancer Society (ACS), however, these studies had several limitations and did not always agree. Because of the strength of animal evidence of the association between exposure to tetrachloroethylene and an increased risk of liver and kidney tumors, MDPH/BEH evaluated the incidence of these two types of cancer in Salisbury.

The incidence of liver and intrahepatic bile duct cancer in Salisbury was evaluated over a 25-year period from 1982 through 2008. During this entire time period, the incidence in Salisbury was approximately as expected based on comparisons to the statewide experience.

The incidence of kidney and renal pelvis cancer in Salisbury was also evaluated throughout this time period. Among females, the incidence of this type of cancer was generally as expected throughout the 25 years. Among males, the incidence of kidney and renal pelvis cancer was approximately as expected throughout most of the time period with the exception of a statistically significant elevation during the 5-year period 2004-2008. As part of another report prepared by MDPH/BEH for Salisbury (MDPH 2014), closer examination of this elevation in males suggested that smoking and occupational exposures appear to have contributed, at least in part, to the increased incidence of kidney and renal pelvis cancer in males. No unusual spatial or temporal patterns were noted when residence at diagnosis and date of diagnosis were examined for these males. Also, no unusual long-term trend in the incidence of this type of cancer was seen in Salisbury males.

Discussion

Toward the end of the lifespan of asbestos cement pipes, it is possible for the asbestos to become friable and enter the water system. For the asbestos in these pipes to be friable, the pipes must have deteriorated or been damaged. Asbestos cement pipes that are in good condition would not be expected to release asbestos fibers. According to the Pennichuck Water Service Company that manages Salisbury's water system, it adheres to a strict corrosion control strategy and pH monitoring program that preserve the integrity of the pipes. Potassium hydroxide is added to the water to control the pH and a phosphate product is added as a corrosion inhibitor; both additives result in less corrosive water. Because asbestos cement pipes contain a lot of calcium (a major component of concrete), it is important to prevent leaching of calcium from the interior of the pipes. If there is no leaching of calcium, then the asbestos fibers remain tightly

bound in the concrete. The pH and corrosion control both result in stronger pipes by minimizing leaching (Rousseau B. 2012).

As stated earlier, PCE had been used by pipe manufacturers as a solvent for the vinyl resin liner. In the coating process, the solution had been sprayed onto the interior walls of the pipe and allowed to dry. In some cases, traces of the solvent remained in the resin lining or in the pores of the pipe walls up to the time the pipes were installed as water mains (MDEQE 1982). PCE concentrations in VLAC pipes would have been at their highest level in the time following installation (in the case of Salisbury, in 1972 and 1973) and in dead end and low-flow situations. Levels would be expected to drop significantly over time. According to MDEQE (1982), the average level of PCE was found to be less than 40 ppb (the standard at the time) in pipe that was 5 years or older. As was true for other communities in Massachusetts with VLAC pipes, water testing did not occur in the early years of their installation because the potential for leaching of PCE from the pipes was not known. As stated previously, in the early 1980s, when Salisbury's water was first tested, it was reported that the level of PCE was below the drinking water standard and that Salisbury's water distribution system did not require any corrective action (MDEQE 1982).

Drinking water sampling results from Salisbury's public water system indicate that, based on over 30 years of data (from 1980 to 2012), the vast majority of samples showed no detectable PCE and, for all samples, no exceedances of the drinking water standards. In addition, samples from 1996-2005 for asbestos showed either no detections or levels well below the drinking water standard for asbestos.

The VLAC pipes were installed in 1972 and 1973, or about 7- 8 years before the first water samples for PCE. Thus, there is uncertainty in what levels of PCE may have been present during this time period, which is also the time that PCE would have been most likely to leach from the pipes, if any leaching occurred. Based on MDEQE's reporting that levels would be below 40 ppb in pipes five years or older, then one could reasonably assume that PCE levels in Salisbury were below 40 ppb by at least 1977 or 1978 if not earlier. Only about six percent of the entire Salisbury distribution system contained these VLAC pipes, and hence, any potential leaching of PCE would have likely been diluted by mixing within the water distribution system. As discussed earlier, however, dilution would be expected to be less in dead end and low-flow situations. CAP checked with both the Salisbury Department of Public Works and the Pennichuck Water Service Company on possible dead end or low-flow situations within the Salisbury distribution system, particularly the North End Boulevard and Beach Road sampling points. Based on a review of the size of the water mains and the number of interconnecting pipes in these locations, they reported that neither location constitutes a static water concern (Levesque D. 2013).

It is important to point out that drinking water quality standards are based on the assumption that individuals may receive a daily lifetime exposure to a contaminant, but in this case, the data gap for water quality data is approximately 5 or 6 years during which documentation of historical levels of PCE do not exist. Given the many years of low or no detectable PCE concentrations, the progressive decline in PCE levels expected to have occurred during the early years, and the likely general dilution in the distribution system of PCE that may have leached in early years after installation, it seems unlikely that exposure opportunities to PCE would have resulted in unusual cancer risks.

With respect to asbestos, more limited data are available, showing no asbestos drinking water standard exceedances during the years 1996-2005. Asbestos cement pipes were installed in Salisbury between 1950 and 1973, and for much of this time, water quality data for asbestos do not exist. However, the pipes have been in good condition according to the Pennichuck Water Service Company and therefore the release of asbestos fibers would not be expected. Given the current good condition of these pipes, significant deterioration of pipes during the early years of their use would not be expected. Salisbury water officials have reported on the stringent steps they have taken for many years to control corrosion and hence minimize the potential for release of any friable asbestos fibers. Further, the most recent testing from 2005 showing no detections of asbestos in the water indicates that the pipes are in good condition. Finally, as with VLAC pipes, not all of Salisbury pipes are asbestos cement pipes; only about 28 percent are of this type. Thus, based on available information, the data do not suggest exposure opportunities to asbestos in Salisbury's drinking water.

Conclusions

Based on all available water sampling data, Salisbury's drinking water supply has been in compliance with Massachusetts' drinking water standards for PCE and asbestos. These standards are set to protect individuals assuming daily lifetime exposure to a contaminant. Although sampling data are not available for the early years when the asbestos cement and VLAC pipes were installed in Salisbury, it does not appear from available information that opportunities for exposure to either substance would have been expected to result in unusual cancer risks. Furthermore, an evaluation of the incidence of liver and kidney cancer (the types of cancer most

strongly associated with exposure to PCE) in Salisbury over a 25-year period did not identify any long-term unusual trends in the incidence of these types of cancer.

Recommendations

The sampling results for the Salisbury drinking water supply did not reveal any violations in the water standards for PCE or asbestos, hence, no specific recommendations or follow-up activities are recommended at this time.

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Table 1. PCE Concentrations in Samples Taken from Salisbury Distribution System

Sampling Location	Date of Sample Collection	PCE Concentration in Sample (µg/L)	Sample Detection Limit (µg/L)	Mass. Drinking Water Standard (µg/L)
Beach Road	3/7/80	0.6	NA	5
Beach Road	1981	≤ 1.3	NA	
Ferry Road	1981	≤ 1.3	NA	
North End Blvd.	1981	≤ 1.3	NA	
Beach Road	1988	ND[1]	NA	
Ferry Road	1988	ND	NA	
North End Blvd.	1988	1.0	NA	
Beach Road	8/3/98	ND	NA	
Beach Road	5/11/99	ND	NA	
Ferry Road	5/11/99	ND	NA	
North End Blvd.	5/11/99	ND	NA	
Main St.	5/3/00	ND	0.5	
Small business	5/3/00	ND	0.5	
North End Blvd.	5/3/00	ND	0.5	
Gas station	5/3/00	ND	0.5	
Ferry Road	5/3/00	ND	0.5	
Small business	5/3/00	ND	0.5	
Beach Road	11/28/01	ND	0.5[2]	
Ferry Road	11/28/01	ND	0.5[2]	
North End Blvd.	11/28/01	ND	0.5[2]	
Beach Road	4/9/02	0.5	0.5	
Beach Road	6/23/03	ND	0.5	
Ferry Road	6/23/03	ND	0.5	
North End Blvd.	6/23/03	ND	0.5	
Beach Road	4/23/04	ND	0.5	
Ferry Road	4/23/04	ND	0.5	
North End Blvd.	4/23/04	ND	0.5	
Beach Road	5/17/05	ND	0.5	
Ferry Road	5/17/05	ND	0.5	
North End Blvd.	5/17/05	ND	0.5	
Beach Road	6/5/06	ND	0.5	
Ferry Road	6/5/06	ND	0.5	
North End Blvd.	6/5/06	ND	0.5	
Beach Road	5/15/07	ND	0.5	
Ferry Road	5/15/07	ND	0.5	
North End Blvd.	5/15/07	ND	0.5	
Beach Road	6/2/08	ND	0.5	
Ferry Road	6/2/08	ND	0.5	
North End Blvd.	6/2/08	ND	0.5	
Beach Road	6/9/09	ND	0.5	

Sampling Location	Date of Sample Collection	PCE Concentration in Sample (µg/L)	Sample Detection Limit (µg/L)	Mass. Drinking Water Standard (µg/L)
Ferry Road	6/9/09	ND	0.5	5
North End Blvd.	6/9/09	ND	0.5	
Beach Road	5/11/10	ND	0.5	
Ferry Road	5/11/10	ND	0.5	
North End Blvd.	5/11/10	ND	0.5	
Beach Road	5/10/11	ND	0.5	
Ferry Road	5/10/11	ND	0.5	
North End Blvd.	5/10/11	ND	0.5	
Beach Road	5/7/12	ND	0.5	
Ferry Road	5/7/12	ND	0.5	
North End Blvd.	5/7/12	ND	0.5	

[1]ND = not detected

[2] Sample detection limit not provided; method detection limit was 0.5 µg/L

NA = not available

Table 2. Asbestos Concentrations in Samples Taken from Salisbury Distribution System

Sampling Location or Sampling ID	Date of Collection and/or Filtering	Asbestos Fiber Count (million fibers per liter; MFL)	Sample Detection Limit (MFL)	Mass. Drinking Water Standard (MFL)
Lafayette Road	5/9/96	0.2	0.2	7
Forrest Road Hydrant #108	7/31/97	ND[1]	0.1798	
Lafayette Road	7/31/97	ND	0.1798	
0311-00477-001	11/19/03	ND	0.193	
0311-00477-002	11/19/03	ND	0.193	
Ferry Road	5/17/05	ND	0.189	
Ferry Road	10/28/05	ND	0.178	
Ferry Road	10/28/05	ND	0.178	

[1]ND = not detected