Health Consultation

Chemically Contaminated South Minneapolis Residence

City of Minneapolis, Hennepin County, Minnesota

March 2002

Prepared By:

The Minnesota Department of Health
in Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

FOREWORD

This document summarizes potential public health concerns associated with a house suspected to be contaminated by chemicals used and stored on-site in Minneapolis, Minnesota. This document is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). A number of steps are necessary to do such an evaluation, and include the following:

- Evaluating exposure: MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is found on the site, and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, businesses, and the general public.

- Evaluating health effects: If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. The report focuses on public health—the health impact on the community as a whole—and is based on existing scientific information.

- Developing recommendations: In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site, and offers recommendations for reducing or eliminating human exposure to contaminants. The role of MDH in dealing with hazardous waste sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. However, if there is an immediate health threat, MDH will issue a public health advisory warning people of the danger and will work to resolve the problem.

- Soliciting community input: The evaluation process is interactive and ongoing. Typically, MDH begins by soliciting and evaluating information from various government agencies, the organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the groups and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. *If you have questions or comments about this report, we encourage you to contact us*.

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In the spring of 1998, the City of Minneapolis (Minneapolis) requested that the Minnesota

Department of Health Site Assessment and Consultation Unit (MDH) review environmental data collected at a private residence in South Minneapolis. A health consultation dated June 11, 1999 (MDH, 1998), was written at that time to describe details of the original investigation and the cleanup of toxic chemicals at this site. This current document, written about 3½ years after the cleanup, contains a short review of events and 1998 data, as well as the results of follow-up sampling events in July 2000 and August 2001.

Background

In April 1998, a Minneapolis inspector and neighbor had symptoms consistent with an environmental exposure to hazardous chemicals upon entering the basement of a single family house in South Minneapolis. A resident who died in 1997 had used the basement and garage as a chemical laboratory for many years prior, and had recovered precious metals from discarded wastes which contained metal alloys. The cleanup manifest, listing chemicals removed from the house, was 99 pages long. The use of most of the chemicals found at this site are not known. Elemental mercury and cyanide were known to be used in both the house and garage for reclaiming precious metals from discarded metals, including silverware.

The United States Environmental Protection Agency (EPA) cleaned up the house at the request of Minneapolis in May 1998. Cleanup included gutting the basement and garage, scraping and washing floors and foundation walls, and remodeling the basement (EPA, 1998).

Cyanide air sampling conducted in the house immediately following cleanup registered 0.0086 milligrams per cubic meter (mg/m^3). This decreased to below the detection limit of 0.0006 mg/m^3 within a month. Both of these concentrations are below levels of health concern for cyanide, and together these data demonstrate a reduction in air contamination in the house over a relatively short period of time. It may be inferred that the air concentrations of other contaminants, without additional uncleaned and/or unsealed exposed sources, would also decrease over time.

Sampling of air in the house following cleanup showed levels of mercury (no detect - 0.0040 mg/m^3) at up to 13 times the EPA reference concentration (RfC; 0.0003 mg/m^3). The RfC is considered to be protective of human health for long-term exposures. The highest concentrations were found in the basement which was being used for laundry and storage. However, elevated mercury was also found in living areas (see below).

Despite years of possible exposure to elevated levels of hazardous chemicals in the house, the remaining resident did not exhibit any adverse health effects, nor did she have elevated biomarkers (whole blood) of mercury, arsenic, or lead exposure. Additionally, since the house was thoroughly cleaned by EPA, it was expected that concentrations in air would decrease as cleaner outdoor air exchanged with indoor air over time. Therefore, the house was not condemned, and the owner continued to occupy the house (Faryan, 1998).

MDH involvement

In June 1998, MDH identified nine issues of health concern at the site:

1. health of the current resident
2. cyanide contamination on surfaces
3. cyanide in the air
4. mercury in the air
5. buried hazardous waste
6. soil contamination
7. possible health risk from unknown hazardous chemicals
8. exposure of children and pregnant women
9. future use of the site

These issues are discussed thoroughly in the previous health consultation (MDH, 1998). However, an updated review of them is included, along with a discussion of the new data.

The health of the current resident (issue 1) is of concern to MDH; however, it is probable that current exposures to all contaminants at the site are significantly decreased from levels two or more years ago. Therefore, any current adverse health effects (none noted) would probably be related to prior exposure to contaminants. Concerns expressed by the resident during follow-up visits in the summers of 2000 and 2001 were unrelated to her health and focused on her deceased husband's possible exposures to chemicals.

Issues 2-3 (above) addressed cyanide contamination and were discussed in-depth in the previous MDH health consultation (MDH, 1998). These issues are of negligible concern for the future. Mercury contamination in air (issue 4) is discussed in detail in a later section of this document.

Issues addressed in numbers 5-9 remain, but MDH is confident that the 1998 environmental investigation and cleanup were conducted with a reasonable amount of attention to these concerns. MDH still has some concern that: buried wastes remain on the site; some soil may be contaminated with mercury or other hazardous chemicals; not all chemicals of concern were identified; sensitive individuals may be exposed to chemicals on-site; and, future use of the site, including use as a residence, may uncover other contaminants or exposure concerns. However, the scope of the investigation in the house, the yard and the garage, as well as the thorough cleanup by the EPA Emergency Response Team (EPA, 1998), provides reasonable assurance that the current and future risks related to issues 5-9 are minimal.

MDH issued the following recommendations in 1998 (MDH, 1998):

- Attempts be made to identify the source of the recorded mercury contamination.
- The City of Minneapolis continue to monitor mercury concentrations in the air of the house, quarterly, for the next 2 years or until conclusions can be inferred as to the potential for human health effects from exposure to mercury at this site. MDH resources are available for consultation.

- Deed restrictions, notations, or other institutional controls be made in accordance with

the potential for exposure of a sensitive population to mercury on-site.

It is our understanding that these recommendations were not carried out. This is due, to some extent, to the lack of technical resources available at that time to sample for low concentrations of mercury in ambient air.

Analysis of trace concentrations of mercury vapor is difficult; however, in the summer of 2000, MPCA acquired a sensitive mercury vapor analyzer. Using this instrument, MDH has been able to reexamine mercury vapor concentrations in the house.

Mercury vapor analyses

Three different methods have been used to sample air at this South Minneapolis house.

EPA contracted for sampling of the house in June 1998 using OSHA method ID-140. This method involves drawing a large sample (~ 200 liters; L) through a hopcalite or Hydrar tube containing a solid sorbent over a 6-8 hour period. The tubes are then analyzed in an analytical laboratory where the sorbent is digested and the solute analyzed using cold vapor-atomic absorption spectrometry. The detection limit for this method is dependent on the amount of air sampled. For samples from this house, the detection limit was about 300 nanograms per cubic meter ($ng/m^{3)}$.

In July 2000, MDH and Minnesota Pollution Control Agency (MPCA) staff used a portable mercury vapor analyzer (Tekran 2537A Mercury Vapor Analyzer) housed in a trailer to sample air in the house. Sampling time for the Tekran is 300 seconds with 7.5 L of air sampled per minute through a 50 foot teflon tube. The Tekran utilizes a gold mercury trap and cold vapor atomic fluorescence spectrometry to reach a detection limit of < 0.1 ng/m^3. While this instrument is extremely accurate and can be moved to any site, sampling speed is limited by the continuous 5 minute sampling periods and 10 minute cycle time of the two mercury traps. Adsorption and release of residual mercury by the teflon tube (memory) does appear to occur, but has not been a large problem with the Tekran to-date.

In August 2001, MDH surveyed the house using a handheld portable Lumex RA-915^+ Mercury Vapor Analyzer (OhioLumex, Cleveland, OH). The Lumex uses atomic absorption spectroscopy, has an air flow rate of 20 L/min, and a sampling time of 10 seconds. The detection limit of this instrument is about 2 ng/m^3. Typically, MDH uses the mean of 3-10 second samples as a single data point, and 10 ng/m^3 as a quantitation limit for the Lumex. Since this instrument is handheld, has a low detection limit, and has a rapid response time, it is possible to record accurate data at any location within 30 seconds. The Lumex's Tygon® (vinyl) intake tube appears to retain some mercury when the Lumex is used in highly contaminated environments. This contamination memory, retaining and outgassing of mercury at a later date, has been noted on numerous occasions by MDH. It is assumed that the contribution from the contaminated hose offsets the actual concentration; therefore, the Lumex readings are adjusted by the difference between outdoor measurements before and after sampling, and typical outdoor concentrations. Monitoring of urban air in the Twin Cities with the Tekran has demonstrated typical ambient

outdoor air mercury vapor concentrations are about 3 ng/m^3 (MPCA, 2001).

Mercury Vapor Sampling Data

Following cleanup in 1998, sampling of the South Minneapolis house was conducted. Using OSHA ID-140 methods, 2 mercury samples were taken in the basement and one sample was taken in the basement stairwell on June 10, 1998. The samples contained 4,000 ng/m^3 (front basement), 3,700 ng/m^3 (back basement) and 1,800 ng/m^3 (stairwell) of mercury. The detection limit was 300 ng/m^3. Prior samples, showed less contamination in the basement (1,900 ng/m^3; May 29), main floor (400 ng/m^3; May 29) and on the second floor (no detect; May 29). Further information about sampling conducted in 1998 is included in the previous health consultation on this residence (MDH, 1998). A review of data from all sampling events at the house is compiled in Table 1.

Table 1: Mercury vapor concentrations (# samples recorded)

	June 10, 1998	**July 2, 2000**	**August 24, 2001 ***	
Method / Instrument	OSHA ID-140 - detection/reporting limit 300 ng/m^3 (# of samples)	Tekran 2537A Mercury Vapour Analyzer - reporting lim. 1 ng/m^3 (# of samples)	Lumex RA-915$^+$ Mercury Vapor Analyzer - reporting limit 10 ng/m^3 (# of samples)	
Location	**Unknown**	**4' above floor**	**4' above floor**	**6" above floor**
Outside		2 ng/m^3 (2)	<10 ng/m^3 (2)	<10 ng/m^3 (1)
5' S & 5' W of NE corner		161 ng/m^3 (3)	89 ng/m^3 (1)	83 ng/m^3 (1)
Back basement	3,700 ng/m^3 (1)		107 ng/m^3 (4)	110 ng/m^3 (3)
Front basement	4,000 ng/m^3 (1)		98 ng/m^3 (4)	176 ng/m^3 (4)
Basement maximum			119 ng/m^3 (1)	** 554 ng/m^3 (1)
Living Room	*** 400 ng/m^3 (1)	22 ng/m^3 (2)	<10 ng/m^3 (2)	<10 ng/m^3 (1)
Garage (inside vent hole - SE)		290 ng/m^3 (4)	131 ng/m^3 (2)	
Garage (inside door - S)		533 ng/m^3 (3)	138 ng/m^3 (1)	
		3" above soil		
Grass below garage vent		12 ng/m^3 (1)		

* Elevated baseline subtracted (37 ng/m^3) - see text

** 3' north & 3' west of SE corner - hotspot sample, not included in front basement mean

*** sample collected 5/29/1998

In July 2000, MDH arranged with technical staff from MPCA to conduct follow-up sampling with the Tekran mercury vapor analyzer. Weather conditions at the time of sampling were cloudy, windy (gusts 20 - 25 mph) and humid, with occasional mist. Outside temperature was about 71° F, and the barometric pressure was measured at 970 millibars. Locations for sampling were restricted by the length of the sampling hose. Samples were taken about 5 feet south and west of the northeast corner of the basement, in the center of the living room, as well as in and near the garage. Basement samples (3) recorded a mean of 161 ng/m^3 mercury vapor with a standard deviation (SD) of ±8.1. Living room samples (2) measured mercury concentrations of

20.7 and 22.7 ng/m^3. Access to the garage was not available, but a 6 inch vent hole in the southeast corner of the garage provided a portal for the sampling tube. The mean concentration (4 samples) measured through the vent hole was 290 ng/m^3 (±59). Additional samples (3) were taken through a crack in the garage door on the south side of the structure. The mean concentration measured through the garage door was 533 ng/m^3 (±27). Additionally, a mercury vapor sample was taken in the grass below the vent hole. The mercury vapor concentration measured was 12 ng/m^3.

In August 2001, MDH staff conducted a mercury vapor survey of this house with a Lumex handheld mercury vapor analyzer. Temperature was about 75° F; it was very humid; with a 7-10 mile per hour wind. The mean of 3 outdoor readings on the Lumex was 36.7 ng/m^3 (±2.3). Experience suggests that elevated outdoor readings recorded are due to the contamination of the Lumex intake hose during a previous use. Following sampling, inquiries were made of MPCA staff about the use history of the Lumex. MDH was informed that the Lumex had elevated baseline readings during 2 prior uses, and that concentrations measured during the second most recent use were extremely high (58,000 ng/m^3). Lumex data reported in Table 1 are adjusted concentrations that reflect a 37 ng/m^3 offset.

Since the Lumex is handheld and portable, mercury vapor samples were taken throughout the basement and first floor of the house. Samples were also taken at the same locations sampled during the previous visit. Additionally, samples were taken at 2 heights above the floor: at about 4 feet, to sample air in the 'breathing zone'; and at 6 inches, to identify areas where there may be some floor contamination. Table 1 contains a summary of the sample data, including sample locations and the number of samples at each location. Samples taken for the purpose of characterizing potential exposure to mercury vapor in the front and back sections of the basement were reasonably consistent. The mean of breathing zone concentrations for the front section (4 samples) was 98 ng/m^3 (standard deviation, ±21 ng/m^3), and for the back section (4) was 107 ng/m^3 (± 8). While measurements at 6 inches above the floor in the back of the basement (3 samples; 110 ng/m^3, ± 5) were similar to measurements in the breathing zone, mercury vapor concentrations found near the floor in the front room were elevated and variable (4 samples; 176 ng/m^3, ±133). The location of the maximum concentration (554 ng/m^3), at 6 inches above the floor and about 3 feet north and west of the SE corner, suggests that some floor contamination remains in the front room.

Two mercury vapor measurements in the living room were below the reporting limit of 10 ng/m^3. A similarly low reading was recorded in the kitchen.

Access to the garage was again restricted to inserting the sampling hose into holes on the SE corner and through the door. Mercury vapor concentrations of 105 and 156 ng/m^3 were recorded through the vent hole, and 138 ng/m^3 was measured through the crack in the garage door.

Discussion

Mercury vapor concentrations in the house

Mercury vapor measurements were performed in this house on 3 occasions over 3 years. There

are distinct differences in the levels found in the basement versus the living quarters of the house. Mercury vapor concentrations in the living room measured 400 ng/m^3 following reoccupancy on June 10, 1998. By July 2, 2000, concentrations had decreased to 22 ng/m^3 (1/18th). By August 24, 2001, they had decreased further to below 10 ng/m^3.

Recorded mercury concentrations in the basement of the house following cleanup in June 1998 (4,000 ng/m^3) decreased 25 times by July 2, 2000 (161 ng/m^3, mean). This concentration was further decreased to 86 ng/m^3 in the following 14 months (mean of samples from 4 feet and 6 inches, at approximately the same location) . These data demonstrate a relatively rapid decrease in mercury vapor concentrations in these 2 areas of the house following the cleanup. In addition, these data demonstrate similar rates of decrease in the basement as in the living room. In fact, modeling (below) confirms this.

Decreasing concentrations of mercury vapor in the front room of the basement after June 1998 fit the relationship $3437.5 * e^{-0.1047*(\text{time in months})}$ ($R^2 = 0.9642$). Using this model, the calculated concentrations in the basement in July 2000 and August 2001 were 251 ng/m^3 and 64 ng/m^3, respectively. Using the same rate constant ($k= -0.1047$, $[Hg]_t = 400 * e^{-kt}$), living room concentrations were expected to decrease from 400 ng/m^3 to 29 ng/m^3 and 7.5 ng/m^3 in July 2000 and August 2001, respectively. These model predictions are very similar to the actual measured concentrations.

The initial rapid decrease in mercury vapor concentrations in ambient air in the basement (slightly greater than the 1st order model values) may suggest that most large sources of the contamination were eliminated during the cleanup, and that the number or contribution from small sources has decreased. It is also possible that the flux from remaining sources has decreased due to chemical or physical encapsulation. The slower decline in concentrations over the last year suggests that there may still be a mercury source remaining in the basement. Data from the August 2001 survey of the basement identified a possible area of contamination near the southeast corner of the basement.

In August 2001, mercury vapor concentrations near the floor in a small area near the southeast corner of the front basement were over 4 times the concentrations found in the breathing zone (~ 4 feet above the floor). In contrast, measurements near the floor in other areas of the basement were very similar to breathing zone concentrations. This suggests that the primary source of mercury vapor found throughout the basement may be in the southeast corner. Additionally, the consistent, slightly elevated mercury vapor readings throughout the basement suggest that there appears to be reasonable mixing of the air in the basement, and that there is limited air exchange with the outside.

Potential exposures

The current resident of the house has lived at this location for many years. Her husband refined and recycled precious metals, and used a large number of hazardous chemicals in the house and the garage to generate income. The resident may have been exposed to many hazardous

chemicals over the years. Following the EPA emergency cleanup in 1998, mercury concentrations remained elevated above levels of concern.

Mercury vapor measurements on the first floor of the house suggest that the current resident may have been exposed, in the living quarters of the house, to mercury above levels of concern for a short period following the cleanup in 1998. According to the modeled decreases in mercury concentrations, this exceedance of the EPA RfC of 300 ng/m^3 probably lasted about 3 months. The RfC is a mercury vapor concentration that is considered a safe exposure level for the general public, including sensitive subpopulations. Individuals may be exposed to mercury at the RfC for long periods of time and not expect to suffer adverse health effects. Exposure to mercury vapor in the basement would have increased the resident's total exposure to mercury. While the model (above) predicts that ambient air mercury vapor concentrations in the basement may have remained above the RfC for about 2 years, sample data suggests that the concentration may have decreased below general levels of concern months before July 2000.

The highest concentrations measured in the house in July 2000 were about one-half of the RfC. Therefore, ambient air in the house after July 2000 does not, by itself, present a health hazard. Additionally, since the resident of this house spends only a limited amount of time in the basement, her exposure to these elevated mercury concentrations is limited.

Measurements of mercury in ambient air in the garage at the South Minneapolis house in July 2000 were about twice the RfC. Concentrations remained elevated in August 2001. Given the lack of access to the garage and the amount of regular ventilation through holes in the walls of the structure, it is not possible to estimate potential exposures related to mercury sources that may be in the garage. However, the relatively high concentration measured in a small structure (about 4000 cubic feet) with large holes to the outside (>130 square inches) implies that there may be a significant existing source of mercury vapor in the garage. Direct inhalation of air immediately above the contaminated area in the garage, could have potential health effects. However without renovation, it is unlikely that mercury vapor concentrations in the breathing zone throughout most of the garage will be elevated above the measured levels. Further, it is unlikely that anyone will be in the garage for a long enough time for exposure to mercury in ambient air to become a significant health issue.

Normal biomarkers of mercury exposure and the lack of symptoms of exposure in the resident (May1998) suggest that her exposure to mercury vapor was below levels of concern. However, any mercury exposure will increase one's overall mercury body burden.

Mercury in ambient air in other Minnesota residences

Measurements of mercury in ambient air have also been made in 5 additional houses in the Twin Cities (see Table 2, below). Two of the houses were built in 1912, one in 1915, one in 1926, and one in 1997. None of the houses had known mercury contamination (broken thermometers or fluorescent light bulbs). Mercury concentrations in these sampled houses ranged from 5.7 ng/m^3 to 31.4 ng/m^3. These data suggest that while mercury concentrations in the contaminated house were above typical concentrations in 1998, concentrations on the first floor had moderated, and were normal by July 2000.

Table 2

Residential Mercury (July, October 2000)

House Built	Average Mercury Concentration	Standard Deviation
1997	5.7 ng/m^3	1.02
1926	6.5 ng/m^3	0.06
1912	5.2 ng/m^3	0.22
1912	31.4 ng/m^3	2.81
1915	18.5 ng/m^3	0.22

MDH also has mercury vapor data from a house where 4 medical thermometers were broken. Visible mercury was carefully collected from the carpet where the thermometers broke. The homeowner then vacuumed the carpet with a standard upright vacuum cleaner. The maximum concentration measured in a flux chamber above the carpet where the thermometers broke was 3680 ng/m^3. Air throughout the house was between 720 and 790 ng/m^3. Further discussion of the data from this house can be found elsewhere (MDH, 2001).

Conclusions

As expected, mercury concentrations in ambient air in the contaminated house in South Minneapolis have decreased over the past 3 years. Currently, mercury concentrations in the living quarters of the house are similar to concentrations found in other houses in the Twin Cities. Concentrations in the basement remain elevated; however, they have been below levels of concern for over a year. While long-term exposure to mercury at concentrations found currently in the house could contribute significantly to an individual's total mercury exposure / accumulation, no adverse health effects are expected from exposure to a single source of mercury at this concentration. The current resident is the widow of the individual responsible for the hazardous chemicals and wastes found on-site in 1998. She has demonstrated no known health effects which may be associated with exposure to mercury. Additionally, her whole blood mercury levels were considered normal by her physician and his lab. Mercury concentrations in ambient air in the garage suggest that there remains significant mercury contamination in the garage. Therefore, this site is categorized as posing "no apparent public health hazard" by ATSDR.

MDH requested that Minneapolis review of the deed for this property and determine if it contained any notifications about the chemical contamination and the cleanup. Minneapolis did not find any notifications on the deed and is currently discussing options available to them.

Recommendations

- MDH recommends that the floor near the southeast corner of the basement be sealed with an epoxy sealer.
- MDH recommends that the garage be inspected for areas of possible mercury contamination, and that it be cleaned if sources are identified or potential exposures are found to be significant.
- MDH recommends that notifications describing the contamination and cleanup of this residence be attached to the deed for the property. Even though the house does not present a health hazard to occupants, owners should be aware that:
    - there still may be a significant source of mercury vapor in the basement
    - the garage may contain residual mercury contamination
    - the yard may have additional buried, uncontained waste.

Public Health Action Plan

This house is classified as posing no apparent public health hazard as defined by the Agency for Toxic Substances and Disease Registry (ATSDR). As part of a Public Health Action Plan, MDH will recommend to the City of Minneapolis and the resident that a 10' X 10' area in the SE corner of the basement floor be epoxied. Furthermore, MDH will request that a description of the contamination and the EPA cleanup be recorded on the deed to the house.

This consultation was prepared by:

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CERTIFICATION

This Chemically Contaminated South Minneapolis Residence Health Consultation was prepared by the Minnesota Department of 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, SPS, SSAB, DHAC, ATSDR

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

Chief, State Program Section, SSAB, DHAC, ATSDR.