Health Consultation

VAN WATERS & ROGERS SITE

CITY OF MINNEAPOLIS, HENNEPIN COUNTY, MINNESOTA
EPA FACILITY ID: MND054497052

APRIL 4, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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Prepared by:

Minnesota Department of Health
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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March 14, 2005

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U.S. Department of Health and Human Services

FOREWORD

This document summarizes public health concerns at a hazardous waste site in Minnesota. It is based on a formal site evaluation prepared by the Minnesota Department of Health (MDH). For a formal site evaluation, a number of steps are necessary:

- *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. Rather, MDH relies on information provided by the Minnesota Pollution Control Agency (MPCA), the US Environmental Protection Agency (EPA), and other government agencies, private 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. MDH's report focuses on public health— that is, the health impact on the community as a whole. The report 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. If, however, an immediate health threat exists, MDH will issue a public health advisory to warn people of the danger and will work to resolve the problem.

- *Soliciting community input*: The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the individuals or organizations responsible for cleaning up the site, and community members living near the site. Any conclusions about the site are shared with the individuals, 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.*

Please write to: Community Relations Coordinator
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Summary

Because of the extent of contamination in soil and groundwater at the Van Waters & Rogers site in Minneapolis, Minnesota, and concerns over the potential for subsurface vapor migration from the contaminated soil, soil gas and groundwater towards nearby structures, MDH staff were requested to review site information in order to develop conclusions and recommendations regarding the potential public health concerns from the site. The Van Waters & Rogers site currently represents no apparent public health hazard. Groundwater is severely impacted by past solvent leaks at the site, and the extent of groundwater contamination has not been fully defined. Available data suggests limited use of groundwater in the area, but its use in private wells (such as in nearby Gluek Park) cannot be conclusively determined. While indoor air in neighboring buildings appears to be only minimally impacted, only one set of samples has been collected. Additional samples would be useful. If groundwater contamination proves to be more extensive that currently thought, additional indoor air sampling may be needed. The installation of three additional SVE systems at the site and in adjacent Bottineau Park should reduce contaminant levels in soil, soil gas, and groundwater, and lessen the potential for sub-surface vapor migration.

I. Site Background and History

The Van Waters & Rogers site is located at 111 - 22nd Avenue Northeast in Minneapolis, Minnesota. The site is located in a mixed commercial and residential neighborhood (the Bottineau neighborhood) of Northeast Minneapolis. The site consists of a two-acre lot, occupied by a large warehouse with associated outdoor storage areas and an office. The property was occupied by a chemical warehouse and distribution center from 1955 until 1987 (Geomatrix 1999). To the north of the site is a commercial building, to the west railroad tracks and commercial buildings, to the south a city park (Bottineau Park), and to the east are single and multi-family homes and apartments. The site is now leased by a roofing materials company, which is not believed to have caused or contributed to contamination at the site in any way. The location of the site is shown in Figure 1, and the original site features are shown in Figure 2.

The McKesson Chemical Company (owners of the site from 1958 to 1986) submitted a notification and a Resource Conservation and Recovery Act (RCRA) permit application to EPA in 1980. The permit application was for operation of two chemical container storage areas on the site for storage of spent halogenated and non-halogenated solvents. A RCRA hazardous waste storage facility permit for the site was issued by EPA in 1986, allowing storage of up to 8,800 gallons of liquid hazardous waste for greater than 90 days. The Van Waters & Rogers Company operated the site in 1986 and 1987. After bulk chemical operations ceased in 1987, the site was used by Van Waters & Rogers until 1991 for the temporary storage of containerized hazardous wastes, when the permit expired and site operations were moved to a facility in St. Paul, Minnesota. Formal site closure under RCRA took place in 1992. The potential for a release of hazardous substances at the site was first identified during a post-closure visual inspection in 1992, and a release was confirmed in 1998 when soil samples showed the presence of volatile organic compounds (VOCs; Geomatrix 1999). This initial investigation, as well as all

subsequent investigations, were conducted under the oversight of the Minnesota Pollution Control Agency's (MPCA) RCRA program.

Historical air photos from the 1950s through the 1980s show the original chemical warehouse (which was expanded in the 1960s), drums of chemicals stored on the ground, and groups of above-ground storage tanks (ASTs) in two locations along the western edge of the site. A railroad spur (shown in Figure 2) served one of the AST locations. Railroad tank cars, as well as boxcars are visible on the spur in some of the aerial photographs, indicating that bulk and containerized chemical transfer were part of the site operations. The ASTs (typically 10,000 gallon capacity) reportedly were used for solvent storage, although specific information as to what solvents were stored is unavailable.

Investigations at the site indicate that soils at the site and groundwater across a wide area in the vicinity of the site are contaminated with tetrachloroethene (also known as perchloroethylene, or PCE), trichloroethene (TCE) and other chlorinated VOCs. PCE is a common dry cleaning solvent, and TCE was a common industrial solvent that can also be a breakdown product of PCE. VOCs have also been detected in soil gas samples collected at and around the site. The VOC contamination appears to be from spillage or leakage of solvents from the former AST locations (see Figure 2). The south AST area was outdoors, and lacked a concrete liner. Leakage or spillage from other solvent storage and handling areas at the site may have contributed to the contamination as well.

Because of the extent of VOC contamination in soil and groundwater at the site, and concerns over the potential for subsurface vapor migration from the contaminated soil, soil gas and groundwater towards nearby structures, in the spring of 2004 the MPCA RCRA program staff requested that MDH review site documents prepared to date, the results of indoor air monitoring conducted in nearby buildings, and other documents in order to develop conclusions and recommendations regarding the potential public health concerns from the site.

Geology/Hydrogeology

In general, the surface soils at the site consist of a thin layer of localized fill materials. Beneath the fill materials lie sand and gravel deposits that extend to approximately 20 feet below grade and may also contain small deposits of silt, loam, or organic soils. Below the sand deposits is a thick interbedded layer of silt, clay, and fine sand that is less permeable than the sand deposits. It has been proposed by Geomatrix, a consultant for the former site operator, that the sand unit (termed the "A-Zone") is in essence 'surrounded' by the less permeable silt and clay unit (the "B-Zone"), which rises towards the ground surface to the west of the site, and to the east of Bottineau Park (see Figure 4; Geomatrix 2003). The deepest area of sand and gravel is thought to be in Bottineau Park (Geomatrix 2004a). This soil configuration would act to confine and channel the shallow groundwater flow, although an extensive investigation of the soil and groundwater characteristics in the area has not been conducted to confirm this. The uppermost bedrock is expected to be the Prairie du Chien group at approximately 180 feet below grade.

The surficial groundwater is approximately 12 to 15 feet below grade in the sand deposits, and flows south-southeast towards the Mississippi River. Regional groundwater flow in the lower units is likely to the west or southwest.

Soil Data

Soil samples were initially collected from approximately 20 borings drilled in the north end of the site, and in the former AST areas on the west edge of the site as shown in Figure 3 (Geomatrix 1999). Soil samples were collected from depths of between six inches and 17 feet below ground and analyzed for VOCs. Four VOCs were detected: PCE, TCE, and low levels of cis-1,2-dichloroethene (in one sample) and 1,1,1-trichloroethane (in two samples). PCE was found in soil at concentrations as high as 800,000 milligrams per kilogram (mg/kg) of soil, or 80%, at a depth of 3 feet below grade in the former south AST area. Levels of TCE ranged from non-detectable to 1,100 mg/kg, also in the former south AST area. Levels of PCE were much lower in the north storage area. The soil data are shown in Table 1. The concentrations of TCE and the two other chlorinated VOCs, which may all be breakdown products of PCE, are low in comparison to the PCE contamination.

The horizontal extent of the VOC contamination in soil does not appear to be large, and is mainly beneath the former south AST area. It may extend under the building somewhat, but is not laterally extensive based on the low levels found in borings SB-2, SB-4, and SB-5. PCE concentrations in shallow soils (0-2 feet below grade) exceeded the applicable MPCA Tier I (residential) Soil Reference Value (SRV) for PCE of 72 mg/kg and the Tier II (industrial) SRV of 131 mg/kg in two of four samples (SS-11 and SB-1), indicating that exposure to PCE in shallow soils could represent a human health risk. The SRV is a soil evaluation criterion based on the protection of human health from direct contact with contaminated soil through ingestion, skin contact, and inhalation of vapors and/or contaminated dust particles.

Groundwater Data

Since investigation activities at the site began, a total of eight permanent monitoring wells have been installed at and around the site to evaluate groundwater quality. The locations of the monitoring wells are shown in Figure 4. The monitoring wells are all completed in the shallow sand unit. The monitoring well identifications, depth, and general locations are as follows:

Well ID	Well Depth (feet)	Monitoring Well Location
MW-1	17	East side of site
MW-2	17	Northwest area of site
MW-3	16	West side of site in south AST area
MW-4	15	East side of Bottineau Park, SE of site
MW-5	16	SE corner of Bottineau Park, SE of site
MW-6	20	Northwest area of site
MW-7	17	North central area of site
MW-8	17	North central area of site

Groundwater samples were collected quarterly from the site monitoring wells from 1999 to 2003. The groundwater data are presented in Table 2. During the December 2003 sampling event, PCE was detected in all site monitoring wells (with the exception of MW-6) at concentrations ranging from 0.51micrograms per liter (µg/L, in MW-1) to 13,000 µg/L (MW-4). TCE was also detected in the monitoring wells (with the exception of MW-1 and MW-6), at concentrations ranging from 44 µg/L to 1,400 µg/L. High levels of 1,1,1-trichloroethane, another solvent found at the site, were present in MW-7 and MW-8 in the former north AST area. Much lower concentrations of other VOCs that are common breakdown products of PCE and TCE, such as 1,2-dichloroethene, have been found in some monitoring wells. Vinyl chloride, the most toxic breakdown product of PCE, was not found. The laboratory detection limits for vinyl chloride were quite high for some samples; however, due to interference from the high levels of PCE.

PCE and TCE were detected at high concentrations in monitoring wells, at levels well in excess of their Health Risk Limits (HRLs). The HRL for PCE is 7 µg/L; MDH uses an interim recommended exposure limit for TCE of 5 µg/L. The HRLs represent levels of contamination in drinking water that MDH considers safe for daily (about 2 liters per day) human consumption over a lifetime. Levels of VOC contamination have historically been highest in monitoring wells MW-7 and MW-8, which are located near the suspected contamination source areas, and in MW-4 along the eastern edge of Bottineau Park.

The results of groundwater monitoring to date indicate that the contamination plume may be extensive. Figure 4 shows an outline of the extent of PCE concentrations in excess of 2,000 µg/L at and downgradient of the site. The full extent of the groundwater contamination, both vertically and horizontally, is unknown. A well receptor survey of the area was conducted by Geomatrix (Geomatrix 1999). While 140 possible wells were identified within a 1-mile radius of the site, many of the wells are no longer in existence, or are used strictly for monitoring or industrial purposes. Homes and businesses in the area are served by the Minneapolis municipal water supply. Only one well, located at Gluek Riverside Park approximately 1,200 feet west-southwest of the site, was identified as an operable well in use as a potable water source. The Gluek Riverside Park well is 156 feet in depth.

In April of 2004, the MPCA collected a water sample from the Gluek Riverside Park well for analysis for VOCs as part of the investigation of a different contaminated site in Northeast Minneapolis. Three VOCs, cis-1,2-dichloroethene, trans-1,2-dischloroethene, and vinyl chloride were detected in the water sample from the well. The concentration of vinyl chloride (2.8 µg/L) exceeded both the federal Maximum Contaminant Limit (MCL) for public water supplies of 2.0 µg/L, and the MDH HRL of 0.2 µg/L. The well was subsequently closed by the Minneapolis Parks and Recreation Board, and MDH has recommended that the well be permanently sealed. It is difficult at this time to determine the possible contribution from the Van Waters & Rogers site to the contamination found at the Gluek Riverside Park well. This is because the plume that originates at the Van Waters & Rogers site has not been fully defined, and there are other potential sources of similar VOCs in Northeast Minneapolis.

Soil Gas Data

Because of the high concentrations of VOCs in shallow groundwater at and around the site and the porosity of the shallow sand and gravel formation, the possibility that VOCs were vaporizing from the groundwater into the overlying pore spaces in the soil (and possibly into neighboring utilities or buildings) needed to be investigated. The first step in the investigation involved the screening of underground utilities (storm and sanitary sewers) with an organic vapor meter capable of detecting VOCs. Ten locations (sewer grates and manholes) at and surrounding the site were screened at depths of one to seven feet below ground. No VOCs were detected using an organic vapor meter.

In early 2004, Geomatrix collected a series of over 30 soil gas samples at and around the site. The soil gas samples were collected using push-probe borings advanced to a general depth of approximately eight feet below ground. This sample depth was selected because it is below the frost line, above the groundwater surface, and is the approximate depth of basement foundations in the area. The soil gas samples were collected in ½-liter Tedlar® bags, and transferred to a mobile laboratory for analysis for VOCs as soon after collection as possible.
The soil gas sample locations are shown in Figure 5, along with the results of the soil gas analysis for PCE and TCE, the two main contaminants of concern at the site. Other VOCs, including 1,1,1-trichloroethane and various breakdown products of PCE and TCE were also detected. The data are presented in Table 3. The highest concentrations of PCE (200 milligrams per cubic meter, mg/m^3) and TCE (10.3 mg/m^3) were detected at SG1/SG1A, located in the former northern AST area. While the concentrations of VOCs in soil gas generally declined with distance from SG1/SG1A, high concentrations of PCE and TCE were found in soil gas samples collected along 22nd Avenue NE, and south of the site along 2nd Street NE.

The soil gas sample results were compared to screening criteria developed by the EPA for use in investigating potential vapor intrusion sites (EPA 2002). The EPA screening criteria, and the maximum concentrations detected in soil gas at and around the site are as follows:

Chemical	**EPA Screening Level, mg/m^3**	**Maximum Level Detected (mg/m^3) / Sample Location**
PCE	4.1	200 / SG-1
TCE	0.11	10.3 / SG-1
1,1,1-trichloroethane	1,100	33 / SG-4
1,1-dichloroethane	250	1.40 / SG-4
cis-1,2-dichloroethene	18	0.145 / SG-3
1,1-dichloroethene	100	1.20 / SG-4

PCE and TCE also exceeded the screening concentrations in many other sample locations both on and off the site (Figure 5 / Table 3). Exceeding the EPA screening criteria indicates that the soil gas concentrations are high enough that the VOCs could potentially infiltrate overlying structures and be detectable in indoor air at concentrations of long-term human health concern. The multiple exceedances of the EPA soil gas screening criteria for PCE and TCE at and around the site suggested that nearby buildings could be at risk for vapor intrusion.

Indoor Air Data

Due to the presence of high levels of PCE and TCE in soil, groundwater, and soil gas at the site, sampling for VOC vapors in indoor air in the basements of several nearby buildings was conducted in the summer of 2004. As described above, VOCs are capable of migrating in the vapor state through porous soil and into adjacent structures, where they can contaminate indoor air. Exposure to low concentrations of some VOCs in indoor air, including PCE and TCE, at concentrations well below the odor threshold may be of long-term health concern.

This sampling was conducted using six-liter Summa canisters (non-reactive, coated stainless steel canisters placed under a vacuum), which are portable and can be used to collect air samples in a variety of settings. A low-flow restrictor valve was used with the Summa canister to collect air samples over a period of approximately 24 hours. The air samples were analyzed for selected VOCs using EPA Method TO-15. Detection limits below one part-per-billion (generally less than 10 micrograms per cubic meter ($\mu g/m^3$) for most compounds) are possible using this method.

Indoor air samples were collected from 11 locations in seven off-site buildings (five single-family or duplex style houses and two apartment buildings) near the site; permission was not granted for sampling in two other buildings (Geomatrix 2004b). Buildings closest to the site, and to the soil gas sample locations with the highest levels of PCE and TCE were targeted for indoor air sampling. The samples were collected on the lowest occupied level of each building, in living spaces or utility / storage rooms. Consideration was given to placing the Summa canister near sumps, pipe entries, or other potential routes of vapor entry. Prior to collecting the air sample, a building survey was conducted (using a form provided by MDH) to identify the basement construction, heating and ventilation systems in use, and any sources of similar contaminants that could interfere with the sample results. The surveys did not identify any conditions that would appear to contribute to the presence of the contaminants of concern in indoor air.

Three outdoor air samples were also collected at the site to determine if the chemicals ofconcern were present in ambient air, and if so at what levels. All samples were analyzed for PCE, TCE, 1,1,1-trichloroethane, 1,1-dichloroethene, and vinyl chloride. The results of the sampling are presented in Table 4, and the sample locations are shown in Figure 6. Note that the data are in units of micrograms per cubic meter ($\mu g/m^3$). Applicable long-term (or chronic) screening criteria are also shown in Table 4 for comparison.

As can be seen in Table 4, low levels of PCE and TCE were detected in many of the indoor air samples and in two out of three of the ambient air samples. 1,1,1-trichloroethane was only detected in two of the 11 samples, and vinyl chloride and 1,1-dichloroethene were below their respective laboratory detection limits in all of the samples. The concentrations of PCE and TCE in most of the samples were close to levels reported for indoor air as published in a recent Minnesota study (see below), and in many cases were close to the levels observed in the ambient samples. This indicates that the detections of PCE, TCE, and 1,1,1-trichloroethane may not entirely be the result of vapor intrusion, and could be in part a reflection of ambient air quality in the vicinity of the site.
The concentrations of the compounds detected were compared against EPA reference

concentrations (RfCs) for non-carcinogens (1,1,1-trichloroethane), or criteria known as Interim Screening Criteria (ISCs) that have been developed by MDH for carcinogenic compounds (PCE, TCE). Levels of TCE exceeded its ISC in some samples (including an outdoor sample), while no other VOCs exceeded their respective screening criteria. The RfCs and ISCs are health-based criteria and represent levels considered by MDH to be safe exposure levels for the general population, including sensitive sub-populations. In the summer of 2004, letters were sent to the building owners and residents informing them of the results of the indoor air sampling and explaining the potential health risks.

Site Response Actions

Because of the extensive VOC contamination at the site, the current responsible party for the site (Univar USA Inc.) determined that a response action was needed. The response action selected is a technology known as soil vapor extraction (SVE). This involves the placement of soil vapor extraction points (similar to dry wells) in area of contamination at the site, to which a vacuum is applied for extraction of VOC vapors from the pore spaces between soil particles below the ground. This is a proven technology that has been successfully applied at many other VOC and petroleum contaminated sites in Minnesota and elsewhere, and the MPCA agreed with Univar's plan to install an SVE system.

The initial SVE system was installed in the former south AST area, as shown in Figure 7, and became operational in December 2001. Rather than vertical soil vapor extraction points, it consists of a horizontal slotted pipe to increase the area of influence, several vacuum monitoring points, associated piping and vacuum equipment, and a granular activated carbon (GAC) filtration vessel to remove VOCs from the effluent. A pilot study of the initial in-situ SVE system at the site was conducted after installation. The objectives of the SVE pilot study were to establish the relationship between the applied vacuum and the resulting soil vapor flow rate, determine the radius of influence at various applied vacuums, and estimate VOC emission rates from the SVE system. The initial pilot test showed that the system was effective at removing VOCs from the subsurface. To date, the first SVE system (SVE-1) has removed over 2,600 pounds of (primarily) PCE from the soil in the former south AST area (E. Tollefsrud, Geomatrix, personal communication, 2004).

In 2004 three additional SVE systems were installed at and near the site to control the potential migration of VOCs vapors from the contaminated soil and groundwater. The new systems are referred to as the site north SVE system, the site southeast SVE system, and Bottineau Park SVE system. The two additional site SVE systems are shown in Figure 7; the Bottineau Park SVE system is not shown. The site north SVE system consists of one soil vapor extraction well and associated monitoring points, piping, vacuum equipment, and a separate GAC filter to control emissions. The site SE SVE system consists of five soil vapor extraction wells, and is connected to the original SVE system at the site. The Bottineau Park SVE system consists of a single horizontal SVE line (similar to the original site SVE system) that runs along 2nd Street NE in the southeast corner of Bottineau Park, directly across from the apartment building where indoor air samples were collected (units #8, #12-#14). This system also has its own monitoring points, piping, vacuum equipment, and a separate GAC filter to control emissions. Because the three new SVE systems were only recently installed, information as to their performance was not yet

available at the time this report was prepared. Based on their locations, and the performance of the original SVE system, they should be effective at removing VOCs from the soil and groundwater and limit the potential for soil vapor migration.

Site Visits

A number of site visits have been conducted since MDH was first requested to assist with the site in the spring of 2004. Site visits have been conducted to observe site conditions, to become familiar with the layout of the SVE systems and monitoring well locations, to visit neighboring properties to determine the best locations for indoor air samples, to distribute information on the site to neighboring residents, and to attend neighborhood meetings.

The site itself is currently in use as a roofing materials warehouse, and there is little remaining of the original solvent collection and distribution operations. There are no apparent physical hazards, and access is restricted by a fence. The two areas where PCE levels were found to exceed the MPCA SRV at the ground surface have since been covered clean fill or asphalt.

II. Discussion

The main contaminants of concern at the site are PCE, TCE, and to a lesser extent 1,1,1-trichloroethane. This discussion will focus on PCE and TCE. Tetrachloroethylene (PCE) is a synthetic solvent widely used for fabric cleaning and degreasing of metal. It has been the solvent of choice for dry cleaning operators for a number of years because it is nonflammable and volatilizes quickly. In dry cleaning operations, PCE is used as a scouring solvent to remove oils, greases, waxes, and fats from both natural and man-made fabrics (ATSDR 1997a). PCE is also used in water repellents, silicone lubricants, spot removers, adhesives, and wood cleaners.

Trichloroethylene (TCE) is a nonflammable, colorless liquid with a slightly sweet odor and taste (ATSDR 1997b). TCE is extremely volatile, and most TCE released into the environment will evaporate into the air. It can persist in groundwater, however, due to the limited contact between groundwater and air. TCE was used extensively as a degreasing solvent in a variety of industries. While its use as a solvent has been declining, it is also used in the manufacture of other chemical products (ATSDR 1997b). Due to its extensive use, TCE is one of the most common contaminants found at Superfund sites across the United States, especially in groundwater. TCE can be found throughout the environment, and most people are likely to be exposed to it at low levels through ingestion of drinking water, inhalation of ambient air, and ingestion of food.

Exposure to PCE and TCE at high concentrations in air can cause dizziness, headache, nausea, and in some cases, unconsciousness. These effects are primarily seen in cases of extreme occupational or intentional exposure. Skin irritation can also result from repeated contact. Although it has not been conclusively demonstrated to cause cancer in people, the U.S. Department of Health and Human Services has determined that PCE may reasonably be considered as a potential human carcinogen, or cancer causing agent, based on animal studies (ATSDR 1997a). The International Agency for Research on Cancer (IARC) has determined that

TCE is probably carcinogenic to humans, based on limited data in humans and evidence that TCE causes cancer in animals (ATSDR 1997b).

1,1,1-trichloroethane is a colorless liquid with a sweet, sharp odor. It is used in commercial products, mostly to dissolve other chemicals such as in glues or paints, and has many industrial and household uses (ATSDR 1995). It volatilizes easily from soil and water. Exposure to high concentrations of 1,1,1-trichloroethane in air can cause dizziness or lightheadedness, and a loss of coordination. Exposure to high levels over time may cause liver and respiratory system damage. There has been no indication in scientific studies that exposure to 1,1,1-trichloroethane causes cancer in animals or humans.

Based on its volatility and the behavior of PCE in the environment, inhalation is usually the most common exposure pathway (compared to ingestion or dermal exposure from water and soil) (McKone and Daniels 1991). Once it enters the body, PCE is presumed to be metabolized by the liver through a saturable enzymatic path (Bogen and McKone 1988). Because it has similar physical and toxicological properties, TCE likely behaves in a similar fashion.

Once released into the environment, PCE and TCE easily volatilize from soil and water. Factors that can affect the rate of volatilization from soil include soil type, organic matter content of soil, moisture content of soil, and the type of release (e.g. the size of a spill). Volatilization will tend to be higher in sandy soils and lower in denser, more organic soils such as clays where the solvents may be adsorbed onto organic carbon particles. PCE and TCE also tend to move rapidly through soil, and can easily contaminate shallow groundwater. PCE and TCE are denser than water, and, if present in sufficient concentrations in groundwater, may sink to form a pool at the base of the groundwater aquifer. This pool of dense, non-aqueous phase liquid (or DNAPL) can serve as a continuing source of groundwater contamination.

People are commonly exposed to PCE, TCE and other VOCs found at the site through a number of pathways and in a number of situations. They are present in the environment (in ambient air and water), and in our homes and workplaces (in products and building materials). Levels of PCE measured in ambient air in the U.S. have ranged from less than 1 $\mu g/m^3$ to as high as 9.0 $\mu g/m^3$, while levels above 100 $\mu g/m^3$ have been measured in some industrialized areas (ATSDR 1997a). TCE levels in ambient air appear to be lower, ranging from 0.24 to 3.9 $\mu g/m^3$ in samples collected in Portland, Oregon (ATSDR 1997b). In a recent study involving the collection of concurrent outdoor, indoor, and personal air samples from three urban neighborhoods in the Minneapolis-St. Paul area (Sexton et al 2004), PCE was detected in 98% of the samples at a mean concentration of 0.4 $\mu g/m^3$ in outdoor air and 2.9 $\mu g/m^3$ in indoor air. In the same study, TCE was found in 73.5% of outdoor air samples at a mean concentration of 0.2 $\mu g/m^3$, and in 83.9% of indoor air samples at a mean concentration of 0.5 $\mu g/m^3$ in indoor air.

The health-based criterion for PCE in air in a residential setting developed by MDH (the ISC) for screening purposes is 3.33 $\mu g/m^3$. Lifetime estimates of excess cancer risk from exposure to PCE in indoor air have been estimated to be as high as 1.4×10^{-2} based on measured concentrations in homes (Tancrede et al 1987). VOCs in indoor air may also contribute to respiratory hypersensitivity and be capable of triggering asthmatic symptoms, although this

relationship is not well established (Becher et al 1996).

Soil Contamination

There are (or were) several areas of contaminated soil at the site, mainly in the former south AST area. Maximum levels of PCE in soil exceed the MPCA Tier I (residential) and Tier II (industrial) Soil Reference Values (SRVs) by a factor of several thousand. The SRV is a soil evaluation criterion based on the protection of human health from direct contact with contaminated soil through ingestion, skin contact, and inhalation of vapors and/or contaminated dust particles. Because the PCE detections that exceed the SRV of 72 mg/kg are found at significant depth (more than 2 feet below ground) or have been covered by clean soil or asphalt, there is little possibility of regular direct contact with the soil (and therefore exposure to PCE) by workers at the site. The SVE systems installed at the site have undoubtedly reduced the concentrations of VOCs in the soil, as over 2,600 pounds of PCE have been removed since 2001.

Groundwater Contamination

Maximum levels of PCE in the shallow groundwater at the site (13,000 µg/L in monitoring well MW-4 in December of 2003) exceed the HRL of 7 µg/L by a factor of over 1,800. The HRLs represent levels of contamination in drinking water that MDH considers safe for daily human consumption (two liters per day) over a lifetime. Concentrations of TCE above the MDH interim recommended exposure limit of 5 µg/L are also present on the site; the highest level of TCE detected in December 2003 (1,400 µg/L) was also in well MW-4. Levels of 1,1,1-trichloroethane, another solvent found at the site, have exceeded the HRL of 600 µg/L in MW-7 and MW-8 in the former north AST area. The full extent of the groundwater contamination, both vertically and horizontally, is unknown. As determined by groundwater elevation measurements, groundwater in the two aquifers appears to be moving in a south or southeast direction, toward the Mississippi River.

Detectable levels of the breakdown products of PCE and TCE, primarily 1,2-dichloroethylene, have also been detected in monitoring wells on and off the site. Vinyl chloride, perhaps the most toxic breakdown product of PCE, has been detected at levels above the laboratory reporting limit in samples collected at the site in the past. Detection limits have been high for many of the more recent samples, so the possibility of vinyl chloride in the groundwater cannot be ruled out. PCE typically dissolves into the groundwater as it moves downgradient from the source of the contamination. Dissolved PCE has been shown to be easily degraded under anaerobic conditions in the environment by microbes through a process known as reductive dehalogenation (ATSDR 1997a).

Currently, direct exposure to PCE, TCE, and their breakdown products in groundwater is unlikely. A well receptor survey of the area was conducted by Geomatrix (Geomatrix 1999). Only one well, located at Gluek Riverside Park approximately 1,200 feet west-southwest of the site, was identified as an operable well in use as a potable water source. While the concentration of vinyl chloride in the Gluek Park well found by the MPCA exceeded both the MCL and the MDH HRL, it is unclear if the contamination was caused by the release at the Van Waters & Rogers site. The well was subsequently closed by the Minneapolis Parks and Recreation Board,

and MDH has recommended that the well be permanently sealed. The presence of other wells in the area cannot be ruled out.

Indoor Air Quality

Potentially site-related VOCs were detected in basement air samples from four of five single-family / duplex houses and two apartment buildings near the site. VOCs in the indoor air in buildings close to the site represents the current exposure pathway of concern. Based on a review of the site soil, soil gas, and groundwater data, the VOCs detected in indoor air that could be the result of soil vapor intrusion are PCE, TCE, and possibly 1,1,1-trichloroethane. Because PCE and TCE were also detected in outdoor air samples collected at the site, it is difficult to determine the exact contribution from soil vapor intrusion. While potential sources of TCE or PCE were not observed in the buildings during placement of the Summa canisters, they also cannot be ruled out. Something as simple as a person entering the structure wearing recently dry-cleaned clothes could influence the results.

The ISCs used for comparison to levels of PCE and TCE found inside the nearby structures were developed using the most recently available toxicological information and common exposure parameters, and are consistent with MDH risk assessment methodology for calculating other standards for VOCs in air. The excess lifetime cancer risk level used was 1×10^{-5}, or 1 in 100,000, which is the default limit used in Minnesota. Estimated excess lifetime cancer risks below this level are considered to be negligible. The ISCs are intended for simple screening for the identification of potential problem situations and not as actual, long-term health standards.

The fact that concentrations of TCE in some of the indoor air samples exceeded the health-based ISCs indicates that a slight excess lifetime incremental cancer risk could exist for residents who spend a majority of their time in the affected units, in the sampled areas, over a lifetime. To put it another way, if a person spent all day, every day at Unit #8, based on the concentrations of PCE and TCE detected their estimated excess lifetime cancer risk from exposure to the PCE and TCE at these concentrations would be approximately 3 in 100,000. Note that as an incremental risk, this estimate is in addition to the reported lifetime cancer incidence rate of Minnesota citizens, which is approximately 40% (or 40,000 in 100,000).

The ISCs and associated risk estimates were developed using conservative exposure assumptions. The assumptions used likely overestimate the actual exposures that may occur at the buildings. The true health risks are probably lower. Exposures to PCE and TCE in some of the units are likely limited, because the basement use is limited. Because the first and upper floors are located farthest away from the contamination source (assuming vapor intrusion is the primary source), simple dilution and natural ventilation should reduce PCE and TCE concentrations to even lower concentrations.

Contaminant concentrations in indoor air as a result of soil vapor intrusion can vary substantially over time due to changes in air pressure, soil moisture, wind speed and direction, and ventilation (EPA 2002). The presence of frost in the winter months can greatly influence the migration of subsurface gases and vapors. Frost can act as a "cap," preventing VOCs from volatilizing from the soil surface and into the atmosphere, thus increasing migration into buildings through such

routes as foundation cracks, pipe entries or simple diffusion. This diffusion is driven by pressure differences between the building and the surrounding soil. The pressure differential is caused by differences in temperature, wind loading on the building and soil, and unbalanced ventilation systems (Hodgson et al 1992). Also, during winter months windows are typically closed, and basement spaces tend to be underpressurized. These factors can lead to a seasonal increase in VOC concentrations. Only one sampling event has been conducted, so it is not clear if there is a seasonal variation in the levels of VOCs.

The use of Summa canisters has been shown to be an effective method for the collection of ambient air samples for analysis of low levels of VOCs. The stability of collected mixtures of ambient gases can be affected by physical adsorption or absorption processes with the collection vessel, reactions with the chemicals in the collected sample, or instability of the compounds. The stainless steel construction of the Summa canisters minimizes physical adsorption and absorption processes. A study of the accuracy, precision, and storage stability of 194 VOC samples collected in Summa canisters demonstrated percent mean recovery rates of 93.7% and 103.5% for the primary VOCs (PCE and TCE) found in indoor air (Brymer et al 1996). Other potential VOCs of concern fall in the same range.

The SVE systems installed at the site should reduce VOC vapor concentrations in the contaminated soil and groundwater, reducing (or even reversing) the possible migration of VOC vapors towards the surrounding buildings.

Child Health Considerations

ATSDR and MDH recognize that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances at waste disposal sites. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are smaller than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also weigh less, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Children may be exposed to VOC vapors from the infiltration of soil gas into buildings near the site (or from outdoor or other indoor sources), in some cases at levels that could pose a slight long-term health risk. Additional data would be helpful to fully characterize these slight risks.

III. Conclusions

Based on a review of available site information, the Van Waters & Rogers site currently represents no apparent public health hazard. Although groundwater is severely impacted by past solvent leaks at the site, and the extent of groundwater contamination has not been fully defined, available data suggests that groundwater use in the area is limited. In the past, groundwater use

(such as in nearby Gluek Park well) may have occurred. While indoor air in neighboring buildings appears to be only minimally impacted, only one set of samples has been collected. Although MDH has determined that the site presents no apparent public health hazard, in order to be protective of public health, analysis of additional samples would be useful. If the contaminated groundwater plume is shown to be under other buildings, additional indoor air samples should be collected in those buildings as well. The installation of three additional SVE systems at the site and in Bottineau Park should reduce contaminant levels in soil, soil gas, and groundwater, and lessen the potential for sub-surface vapor migration.

IV. Recommendations

1. The full horizontal and vertical extent of the groundwater contamination should be defined through the installation of additional borings or monitoring wells.
2. A second round of indoor air samples should be collected, especially in the units where TCE exceeded its ISC.
3. The indoor air samples should be collected during winter months, and after the SVE systems are fully operational.
4. The SVE systems should be monitored closely, including any emissions.
5. The local community should be updated on a regular basis.

V. Public Health Action Plan

MDH's Public Health Action Plan for the site consists of continued consultation and negotiation with MPCA staff and the responsible party to ensure that air and groundwater monitoring is conducted, to communicate the results to the various property owners and occupants near the site, and to plan or participate in any public outreach activities.

VI. References

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CERTIFICATION

This Van Waters & Rogers Site 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. Editorial review was completed by the Cooperative Agreement partner.

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Jeff Kellam
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.

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Roberta Erlwein
Chief, State Program Section, SSAB, DHAC, ATSDR

Table 1
VOC Soil Analytical Results
Van Waters Rogers Site

Sample ID	Depth (ft bgs)	Tetrachloroethene (PCE) (mg/kg)	Trichloroethene (TCE) (mg/kg)	cis-1,2-Dichlorothene (mg/kg)	1,1,1-Trichloroethane (mg/kg)
MPCA SRV	--	*72*	*29*	*8*	*140*
SS1	3	**100**	<5	<5	<5
SS1	4	**500**	26	<5	<5
SS2	3	**540,000**	**97**	**100**	<5
SS2	4	**520,000**	**190**	<5	<5
SS3	3	**14,000**	11	<5	<5
SS3	4	**1,000**	<5	<5	<5
SS4	3	**190,000**	**110**	<5	<5
SS4	4	**120**	<5	<5	<5
SS5	3	**800,000**	**60**	<5	<5
SS5	4	**660,000**	**100**	<5	<5
SS6	3	**80**	<5	<5	<5
SS7	3	23	<5	<5	<5
SS8	3	25	<5	<5	<5
SS9	3	15	<5	<5	<5
SS10	0.5	11	<5	<5	<5
SS11	0.5	**56,000**	**1,100**	<5	<5
SB1	1.5	**270**	0.850	<0.25	0.063
SB1	12	**35**	<2.5	<2.5	<2.5
SB1	17	3.20	<1.2	<1.2	<1.2
SB2	3	0.012	<0.005	<0.005	<0.005
SB2	9	0.42	0.021	<0.005	<0.005
SB2	14.5	0.12	<0.12	<0.12	<0.12
SB3	1.5	1.5	0.074	<0.12	<0.12
SB3	5.5	1.9	<0.12	<0.25	<0.12
SB3	9	2.8	<0.12	<0.25	<0.12
SB4	3	0.009	<0.005	<0.005	<0.005
SB4	5	0.008	<0.005	<0.005	<0.005
SB4	8	0.12	<0.005	<0.005	<0.005
SB5	3	5.8	0.45	<0.005	0.012
SB5	10	0.58	<0.5	<0.5	<0.5
SB5	10.5	0.65	<0.5	<0.5	<0.5
SB5	16	2.5	0.18	<0.5	<0.5

Bold indicates exceedance of SRV

SRV = MPCA Soil Reference Value, residential land use

ft bgs = feet below ground surface

mg/kg = milligrams-per-kilogram

TABLE 2
SUMMARY OF VOC DATA - MONITORING WELLS
Van Waters Rogers Site

Units are in micrograms per liter (ug/L), except dissolved or total organic carbon, which is in milligrams per liter (mg/l)

Well	Date	1,1,1-Trichloroethane	Tetrachloroethene	Trichloroethene	1,1-Dichloroethane	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl Chloride	1,1-Dichloroethene	Chloroform	Methane	Ethene	Ethane	Dissolved or Total Organic Carbon
HRL		**600**	**7**	**5***	**70**	**70**	**100**	**0.2**	**6**	**60**	**none**	**none**	**none**	**none**
MW7	23-Jul-02	**25,000**	**2,600**	**2,400**	**1,600**	< 50	< 50	< 100	< 50	< 50	5.2	0.140	0.060	2.2
MW7	16-Oct-02	**9,200**	**2,400**	**1,000**	**780**	< 50	< 50	< 100	< 50	< 50	25	0.540	0.081	2.9
MW7	19-Dec-02	**7,700**	**2,800**	**1,000**	**990**	< 50	< 50	< 50	< 50	< 50	6.6	0.150	0.033	NA
MW7	19-Mar-03	**2,300**	**1,900**	**470**	**340**	< 50	< 50	< 50	< 50	< 50	7.4	0.094	0.016	NA
MW7	26-Jun-03	**71,000**	**9,200**	**8,000**	**3,000**	< 50	< 50	< 50	**170**	< 50	34.0	0.420	0.067	NA
MW7	17-Sep-03	**17,000**	**5,800**	**1,900**	**1,000**	< 50	< 50	< 50	**56**	< 50	NA	NA	NA	NA
MW7	15-Dec-03	**6,500**	**4,200**	**1,000**	**770**	< 50	< 50	< 50	< 50	< 50	NA	NA	NA	NA
MW8	23-Jul-02	**19,000**	**2,900**	**1,800**	**1,400**	< 50	< 50	< 100	< 50	< 50	1.4	0.210	0.290	2.5
MW8	16-Oct-02	**9,200**	**2,400**	**1,000**	**760**	< 50	< 50	< 100	< 50	< 50	1.5	0.230	0.031	3.2
MW8	19-Dec-02	**3,400**	**1,900**	**510**	**350**	< 50	< 50	< 50	< 50	< 50	0.38	0.089	0.033	NA
MW8	19-Mar-03	**3,200**	**6,400**	**540**	**390**	< 50	< 50	< 50	< 50	< 50	0.34	0.060	0.018	NA
MW8	26-Jun-03	**7,400**	**4,000**	**890**	**570**	< 50	< 50	<100	< 50	< 50	0.75	0.086	0.029	NA
MW8	18-Sep-03	**6,300**	**4,100**	**1,200**	**710**	< 50	< 50	< 50	< 50	< 50	NA	NA	NA	NA
MW8	16-Dec-03	**1,200**	**3,400**	**280**	**300**	< 50	< 50	< 50	< 50	< 50	NA	NA	NA	NA
MW3	7-Jun-99	5	**1,500**	< 2	< 2	65	9	**3**	< 2	< 2	6.7	< 0.5	< 0.5	< 0.5
MW3	16-Sep-99	6	**1,200**	**240**	1 J	57	12	**7**	< 2	< 2	NA	NA	NA	NA
MW3	17-Dec-99	13 J	**2,200**	**530**	< 25	**100**	18 J	< 25	< 25	< 25	10	0.640	< 0.5	0.8
MW3	9-Jan-01	9.5	**1,900**	**330**	< 5	**88**	20	**4.1**	< 5	< 0.5	NA	NA	NA	1.4
MW3	15-May-01	10	**6,600**	**240**	< 5	27	10	< 0.83	< 5	< 5	2.8	0.031	0.014	1.5
MW3	1-Oct-01	< 5	**200**	**48**	6.8	25	10	< 10	< 5	< 5	8.4	0.072	0.021	2.6
MW3	6-Dec-01	< 5	**450**	**100**	< 5	40	15	< 10	< 5	< 5	3.6	0.056	0.015	2.2
MW3	5-Mar-02	< 5	**590**	**140**	< 5	**78**	32	< 10	< 5	< 5	7.5	0.056	0.010	1.5
MW3	22-Jul-02	< 25	**400**	**52**	< 25	< 25	< 25	< 50	< 25	< 25	4.8	0.063	0.013	1.4
MW3	15-Oct-02	< 25	**500**	**44**	< 25	< 25	< 25	< 50	< 25	< 25	3.6	0.190	< 0.005	1.7
MW3	18-Dec-02	< 25	**350**	**90**	< 25	28	< 25	< 25	< 25	< 25	5	0.056	< 0.005	NA
MW3	19-Mar-03	<10	**320**	**120**	<10	67	24	<10	<10	<10	5.4	0.070	<0.005	NA
MW3	26-Jun-03	<10	**250**	**58**	<10	<10	<10	<10	<10	<10	3.1	0.021	<0.005	NA
MW3	17-Sep-03	<10	R	**100**	<10	60	28	<10	<10	<10	NA	NA	NA	NA
MW3	15-Dec-03	<10	**340**	**120**	<10	**70**	41	<10	<10	<10	NA	NA	NA	NA
MW4	9-Jan-01	5.3	**4,500**	**1,100**	24	68	14	**9.2**	< 5	< 0.5	NA	NA	NA	2.6
MW4	15-May-01	< 5	**2,700**	**510**	14	53	19	**5.3**	< 5	< 5	3.4	0.360	0.012	2.8
MW4	1-Oct-01	5.8	**2,200**	**990**	14	56	14	< 10	**15**	< 5	3.0	0.420	0.016	3.2
MW4	6-Dec-01	< 100	**2,900**	**1,200**	< 100	68	< 100	< 200	< 100	< 100	5.6	0.900	0.042	2.6
MW4	5-Mar-02	< 50	**5,300**	**1,500**	< 50	**90**	< 50	< 100	< 50	< 50	3.9	0.930	0.025	2.7
MW4	22-Jul-02	< 250	**3,700**	**970**	< 250	< 250	< 250	< 500	< 250	< 250	4.2	0.720	0.015	3.3
MW4	15-Oct-02	< 250	**4,800**	**3,800**	< 250	< 250	< 250	< 500	< 250	< 250	4.6	0.710	0.014	3.4
MW4	19-Dec-02	< 100	**3,700**	**790**	< 100	< 100	< 100	< 100	< 100	< 100	4.7	2.400	0.022	NA
MW4	19-Mar-03	<100	**5,000**	**810**	< 100	< 100	< 100	< 100	< 100	< 100	4.6	0.220	0.019	NA
MW4	26-Jun-03	<100	**4,900**	**910**	< 100	< 100	< 100	< 100	< 100	< 100	5.3	0.410	0.015	NA
MW4	17-Sep-03	<50	**5,200**	**1,000**	< 50	**130**	< 50	< 50	< 50	< 50	NA	NA	NA	NA
MW4	15-Dec-03	<50	**13,000**	**1,400**	< 50	**76**	< 50	< 50	< 50	< 50	NA	NA	NA	NA
MW5	15-May-01	< 5	**1,200**	**540**	25	40	< 5	< 0.83	**9.2**	< 5	1.3	0.099	0.023	4.3
MW5	1-Oct-01	< 50	**70**	**610**	**80**	**100**	< 50	< 100	< 50	< 50	2.5	0.270	0.031	13
MW5	6-Dec-01	< 5	**880**	**220**	6.8	19	< 5	< 20	< 5	< 5	0.88	0.160	0.016	3.8
MW5	5-Mar-02	7.5	**1,900**	**640**	49	**81**	< 5	< 10	**13**	< 5	4.1	0.280	0.036	3.3
MW5	22-Jul-02	< 50	**1,600**	**710**	< 50	< 50	< 50	< 100	< 50	< 50	2.8	0.240	0.075	3.4
MW5	15-Oct-02	< 50	**1,200**	**460**	< 50	< 50	< 50	< 100	< 50	< 50	2.2	0.280	0.037	3.8
MW5	18-Dec-02	< 50	**1,200**	**580**	< 50	< 50	< 50	< 50	< 50	< 50	2.2	0.200	0.037	NA
MW5	19-Mar-03	<50	**2,100**	**1,500**	**93**	**240**	< 50	< 50	< 50	< 50	8.7	0.360	0.052	NA
MW5	26-Jun-03	<50	**2,300**	**1,400**	**75**	**130**	< 50	< 50	< 50	< 50	4.7	0.280	0.042	NA
MW5	17-Sep-03	<50	**2,200**	**840**	< 50	**77**	< 50	< 50	< 50	< 50	NA	NA	NA	NA
MW5	15-Dec-03	<50	**1,500**	**460**	< 50	58	< 50	< 50	< 50	< 50	NA	NA	NA	NA
MW2	7-Jun-99	75	**490**	10	40	< 1	< 1	< 1	1	< 1	< 0.5	< 0.5	< 0.5	< 0.5
MW2	16-Sep-99	87	**260**	18	67	< 1	< 1	< 1	5	< 1	NA	NA	NA	NA
MW2	17-Dec-99	220	**260**	**34**	44	< 2.5	< 2.5	< 2.5	1.9	< 2.5	< 0.5	< 0.5	< 0.5	0.6
MW2	9-Jan-01	**1,000**	**200**	**100**	**110**	< 5	< 5	< 0.5	**6.6**	< 0.5	NA	NA	NA	1.8

TABLE 2
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Van Waters Rogers Site

Units are in micrograms per liter (ug/L), except dissolved or total organic carbon, which is in milligrams per liter (mg/l)

Well	Date	1,1,1-Trichloroethane	Tetrachloroethene	Trichloroethene	1,1-Dichloroethane	cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Vinyl Chloride	1,1-Dichloroethene	Chloroform	Methane	Ethene	Ethane	Dissolved or Total Organic Carbon
HRL		**600**	**7**	**5***	**70**	**70**	**100**	**0.2**	**6**	**60**	**none**	**none**	**none**	**none**
MW2	15-May-01	9	**390**	7.4	17	< 5	< 5	< 0.83	< 5	< 5	0.21	< 0.005	0.013	1.7
MW2	1-Oct-01	250	**70**	29	**76**	< 10	< 10	< 20	**15**	< 10	0.53	0.018	0.015	1.5
MW2	6-Dec-01	**1,200**	**86**	**82**	**76**	< 10	< 10	< 20	< 10	< 10	0.20	0.022	0.015	< 1.0
MW2	5-Mar-02	**2,100**	**130**	**140**	**89**	< 5	< 5	< 10	**6.3**	< 5	0.07	0.016	0.013	1.1
MW2	22-Jul-02	< 5	**200**	< 5	< 5	< 5	< 5	< 10	< 5	< 5	1.6	0.012	0.008	1.2
MW2	15-Oct-02	11	**160**	< 5	28	< 5	< 5	< 10	< 5	< 5	1.7	0.210	0.006	1.7
MW2	18-Dec-02	280	**53**	19	69	< 5	< 5	< 5	< 5	< 5	0.091	< 0.005	0.007	NA
MW2	19-Mar-03	**4,500**	**150**	**240**	**180**	< 5	< 5	< 5	**9.8**	< 5	0.66	0.046	<0.005	NA
MW2	26-Jun-03	28	**450**	9.7	13	< 5	< 5	< 5	< 5	< 5	0.37	<0.005	<0.005	NA
MW2	17-Sep-03	220	**140**	**38**	**100**	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	NA	NA	NA	NA
MW2	15-Dec-03	430	**73**	**44**	61	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	NA	NA	NA	NA
MW1	7-Jun-99	< 0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	1.4
MW1	16-Sep-99	< 0.5	0.8	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.2	NA	NA	NA	NA
MW1	17-Dec-99	2.3	**17**	5.7	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.3	< 0.5	< 0.5	< 0.5	2.0
MW1	9-Jan-01	< 5	< 5	< 5	< 5	< 5	< 5	< 0.5	< 5	< 0.5	NA	NA	NA	2.2
MW1	15-May-01	< 5	< 5	< 5	< 5	< 5	< 5	< 0.83	< 5	< 5	0.24	< 0.005	< 0.005	2.2
MW1	1-Oct-01	< 0.5	2.3	1.1	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	0.89	0.021	0.023	2.5
MW1	6-Dec-01	< 0.5	0.97	0.53	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	0.71	0.030	0.033	2.1
MW1	5-Mar-02	< 0.5	0.59	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 5	0.25	0.009	0.013	2.1
MW1	22-Jul-02	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	1.7	0.012	0.008	1.9
MW1	15-Oct-02	< 0.5	1.4	1.1	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	1.9	0.210	< 0.005	2.0
MW1	18-Dec-02	< 0.5	0.69	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.26	< 0.005	0.008	NA
MW1	19-Mar-03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.83	0.042	<0.005	NA
MW1	26-Jun-03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.63	<0.005	<0.005	NA
MW1	17-Sep-03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	NA	NA	NA
MW1	15-Dec-03	< 0.5	0.51	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	NA	NA	NA
MW6	23-Jul-02	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	1.1	0.017	0.009	1.6
MW6	15-Oct-02	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 1.0	< 0.5	< 0.5	2.3	0.260	< 0.005	1.9
MW6	18-Dec-02	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.21	< 0.005	< 0.005	NA
MW6	19-Mar-03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.94	0.030	<0.005	NA
MW6	26-Jun-03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.78	<0.005	<0.005	NA
MW6	17-Sep-03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	NA	NA	NA
MW6	15-Dec-03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	NA	NA	NA	NA

Data presented in descending order of maximum concentration. * Interim Exposure Limit

Concentrations in bold are above the respective HRL.

J = Estimated value

NA = Not applicable

HRL = Minnesota Department of Health (MDH) Health Risk Limit for Groundwater

R = The results are unacceptable due to QC problems.

TABLE 3
SUMMARY OF VOC DATA - SOIL GAS SAMPLES
Van Waters Rogers Site

Units are in milligrams per cubic meter (mg/m^3)

Location	Date	Tetrachloroethene (PCE)	Trichloroethene (TCE)	1,1,1-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	cis-1,2-Dichloroethene
SG1	7-Jan-04	**200 J**	**10.3**	5.80	<0.05	0.475	<0.05
SG1A	30-Apr-04	**200 J**	**10.3**	4.20	<0.1	0.515	<0.1
SG2	7-Jan-04	**13.8 J**	**1.7**	1.10	<0.05	<0.05	<0.05
SG3	8-Jan-04	**52 J**	**3.9**	4.25	0.175	0.37	0.145
SG3A	26-Apr-04	**10.7**	**1.2**	3.70	1.40	0.24	<0.1
SG4	8-Jan-04	**56**	**5.6**	33.00	<0.1	1.20	0.055
SG4A	26-Apr-04	**20.5**	**3.10**	10.75	<0.05	0.625	<0.1
SG5	7-Jan-04	0.980 J	**0.15**	0.35	<0.1	<0.05	<0.05
SG5A	29-Apr-04	0.50	<0.10	0.42	<0.05	<0.1	<0.1
SG6	8-Jan-04	**5.9**	**0.55**	0.13	<0.05	<0.05	<0.05
SG8	7-Jan-04	1.10 J	**0.24**	<0.075	<0.05	<0.05	<0.05
SG9	7-Jan-04	**12.6 J**	**2.35**	<0.075	<0.1	<0.05	<0.05
SG9A	30-Apr-04	**19**	**4.40**	0.145	<0.1	<0.1	<0.1
SG10	8-Jan-04	1.5	**0.11**	0.225	<0.05	<0.05	<0.05
SG11	8-Jan-04	<0.360	<0.05	<0.075	<0.05	<0.05	<0.05
SG12	8-Jan-04	<0.335	<0.05	<0.075	<0.05	<0.05	<0.05
SG14	8-Jan-04	<0.225	<0.05	<0.075	<0.05	<0.05	<0.05
SG15	29-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG16	29-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG17	29-Apr-04	0.16	<0.1	<0.1	<0.1	<0.1	<0.1
SG18	28-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG19	28-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG20	29-Apr-04	0.21	<0.1	<0.1	<0.1	<0.1	<0.1
SG22	29-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG23	29-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG24	27-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG25	30-Apr-04	0.1 J	<0.1	<0.1	<0.1	<0.1	<0.1
SG26	29-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG27	27-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG28	27-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG29	27-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG30	26-Apr-04	0.99	**0.175**	0.28	<0.1	<0.1	<0.1
SG31	27-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG32	27-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG33	26-Apr-04	**6.1**	**0.64**	0.42	<0.1	<0.1	<0.1
SG34	27-Apr-04	0.15	<0.1	<0.1	<0.1	<0.1	<0.1
SG35	27-Apr-04	<0.150	<0.1	<0.1	<0.1	<0.1	<0.1
SG36	30-Apr-04	0.05 J	<0.1	<0.1	<0.1	<0.1	<0.1
EPA Soil Gas Screening Level		4.1	0.11	1100	250	100	18

Concentrations in **bold** are above the EPA screening level.

J = Estimated value

TABLE 4
SUMMARY OF VOC DATA - INDOOR AIR
Van Waters Rogers Site

Units are in micrograms per cubic meter (ug/m^3)

Location	Date	Tetrachloroethene (PCE)	Trichloroethene (TCE)	1,1,1-Trichloroethane	1,1-Dichloroethene	Vinyl chloride
Unit #1	22-Jul-04	0.186	<0.055	<0.055	<0.04	<0.026
Unit #3	3-Aug-04	0.338	**1.310**	<0.061	<0.044	<0.029
Unit #4	22-Jul-04	1.030	**0.470**	<0.067	<0.052	<0.031
Unit #6	22-Jul-04	0.221	0.087	<0.061	<0.044	<0.024
Unit #7	3-Aug-04	<0.13	<0.1	<0.11	<0.077	<0.049
Unit #8	3-Aug-04	2.760	**0.983**	0.444	<0.04	<0.026
Unit #9	4-Aug-04	2.410	<0.05	<0.051	<0.038	<0.024
Unit #10	3-Aug-04	0.103	**1.310**	<0.051	<0.038	<0.024
Unit #11	3-Aug-04	0.407	**0.492**	<0.055	<0.04	<0.026
Unit #12	3-Aug-04	0.076	<0.052	<0.053	<0.039	<0.025
Unit #13	3-Aug-04	1.310	0.279	0.116	<0.048	<0.031
Unit #14	3-Aug-04	0.145	<0.046	<0.047	<0.035	<0.022
(dup of #12)						
Outdoors #1	22-Jul-04	0.207	**0.541**	<0.055	<0.04	<0.026
Outdoors #2	3-Aug-04	<0.055	0.355	<0.044	<0.032	<0.021
Outdoors #3	4-Aug-04	0.448	<0.038	<0.039	<0.029	<0.018
Screening Criteria, type		3.3, ISC	0.4, ISC	2,200, RfC	200, RfC	1.14, ISC

Concentrations in **bold** are above the screening criteria

ISC = MDH Interim Screening Concentration

RfC = EPA Reference Concentration

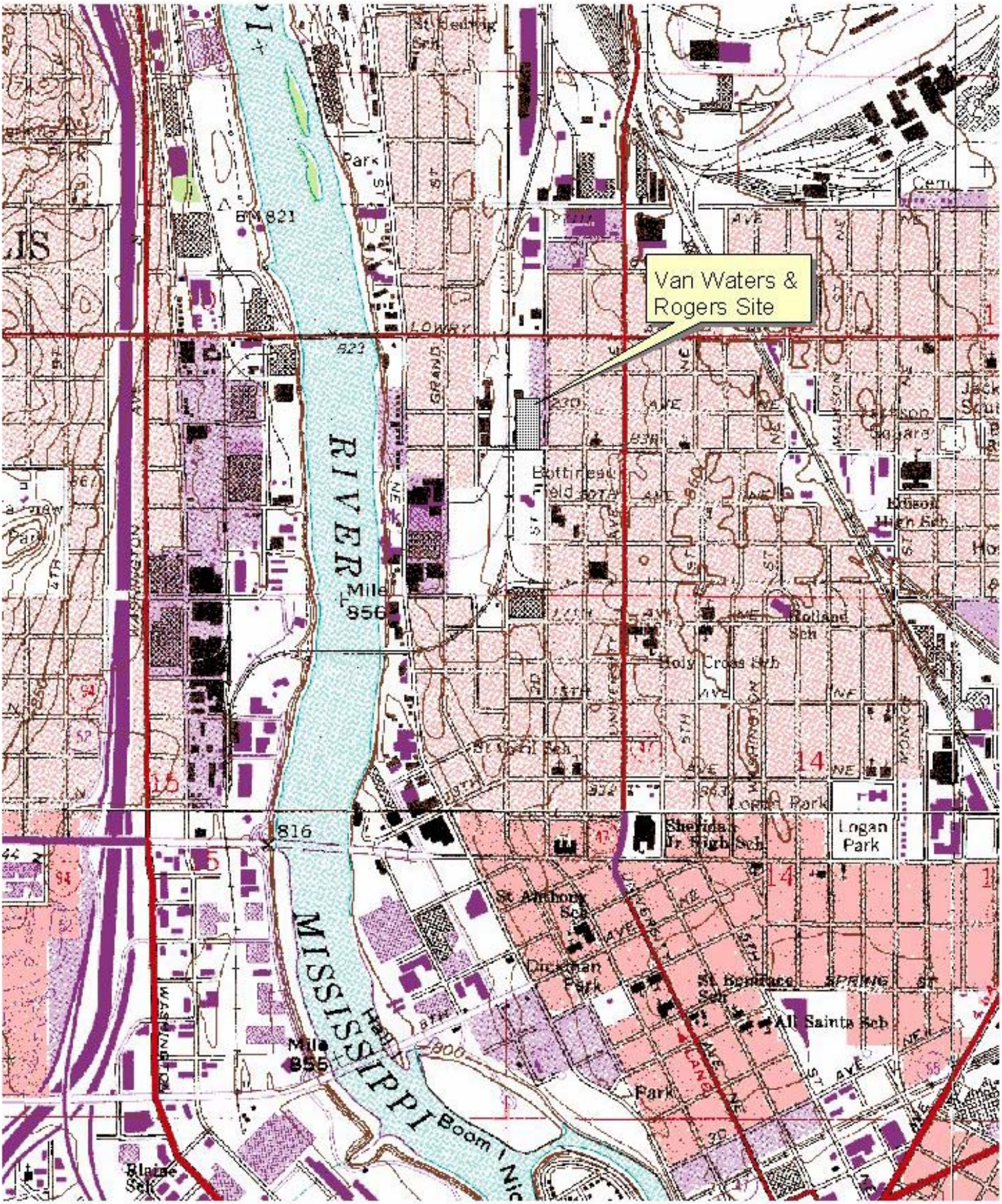

Figure 1: Site Location