Health Consultation

Chrysler Corporation, Phase I Area
Vapor Intrusion Investigation and Mitigation

BEHR VOC PLUME SITE
DAYTON, MONTGOMERY COUNTY, OHIO

EPA FACILITY ID: OHN000510164

SEPTEMBER 30, 2008

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

Health Consultation: A Note of Explanation

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Prepared By:

The Health Assessment Section
of the Ohio Department of Health
Under a cooperative agreement with the
Agency for Toxic Substances and Disease Registry

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BEHR VOC PLUME SITE

SUMMARY

In October, 2006, the Health Assessment Section (HAS) was asked to participate in a multi-agency emergency response team to evaluate the potential health impacts to the community posed by the elevated levels of trichloroethylene (TCE) in shallow groundwater underlying residential properties in the north Dayton area of Montgomery County, Ohio (Figure 1). The Ohio Environmental Protection Agency (Ohio EPA) requested U.S. Environmental Protection Agency (USEPA) and HAS assistance to carry out a time-critical investigation in the neighborhood to address these concerns. The results of groundwater sampling by the Chrysler Corporation for the Behr-Dayton Facility and deep soil gas sampling by the Ohio EPA showed the presence of TCE in the groundwater and soil gas in the McCook Field residential area that exceeded screening levels established by USEPA's Subsurface Vapor Intrusion Guidance (USEPA, 2002). Exceeding these guidance levels indicates that vapor-phase chlorinated solvents emanating from the underlying groundwater might pose an unacceptable risk to area residents through the vapor intrusion pathway.

This public health consultation document evaluates the environmental data collected by Ohio EPA, the USEPA, and the Chrysler Corporation as part of the Phase I vapor intrusion investigation at the Behr VOC (Volatile Organic Compound) Plume site. HAS makes conclusions and recommendations for additional actions that may be necessary to protect the public health.

ATSDR and HAS provided USEPA with health-based indoor air screening levels for residential and non-commercial buildings for trichloroethylene (TCE) and other volatile organic compounds. HAS proposed that interim measures be taken at those properties that exceeded the screening criteria to reduce or eliminate the vapor intrusion route as a pathway of health concern. Initially, indoor air samples were collected by USEPA from eight residences immediately south of the Behr-Dayton facility. This residential area immediately south of the facility was later designated as the Phase I area (See Figure 2) in the USEPA Administrative Order of Consent (USEPA, 2006c).

Chrysler subsequently sampled indoor air and sub-slab soil gas in 19 residences and three businesses in the Phase I area in December 2006 and January 2007. Fifteen homes and two businesses had TCE levels that exceeded HAS indoor air screening levels. Sub-slab vapor abatement systems were installed in all fifteen homes. By January 2008, six homes and one business had indoor air TCE levels remaining above the HAS screening value. A Soil Vapor Extraction (SVE) system was installed in May 2008 in the Phase I area to intercept soil gas and remove TCE before it enters nearby homes. These six homes and one business are currently being monitored to determine whether indoor air and sub-slab TCE levels are being reduced below HAS screening levels.

The Behr VOC Plume site posed an ***Indeterminate Public Health Hazard*** for exposure of nearby residents to contamination via vapor intrusion *in the past.* There are no indoor air data that indicate that nearby residents were breathing site-related contaminants in the air in their homes prior to the Fall 2006 USEPA sampling. There are no soil gas data that indicate that contaminants were at levels in the soil gas that could pose a vapor intrusion hazard to nearby residents. Evidence suggests that area groundwater was contaminated with chlorinated solvents at least since 1999, so some vapor intrusion into area homes likely was occurring at this time.

Based on the 2007-2008 sampling conducted by Chrysler with USEPA oversight, HAS determined that the Behr VOC Plume site poses a ***Public Health Hazard*** to area residents due to exposure to chlorinated solvent contamination via vapor intrusion. Indoor air data collected by Chrysler in 2008 indicate that, *at the present,* nearby residents are likely being exposed to trichloroethylene in indoor air via the vapor intrusion route at levels that may pose a long term health threat.

The Behr VOC Plume site may continue to pose a ***Public Health Hazard*** as a result of exposure of nearby residents to contamination via vapor intrusion *in the future* unless the source or sources of the groundwater contamination in the area can be fully identified and be cleaned up. The installed vapor abatement systems and the soil vapor extraction (SVE) systems are intended to be temporary remedies to prevent or reduce the likelihood of the contaminants entering nearby homes and posing a health threat to the residents. The long term solution to the contaminant exposure issue in the neighborhood is to identify and remove the source(s) of the groundwater contamination underlying the community.

HAS will review any additional environmental data collected in the Phase I neighborhood. At the request of the community, HAS requested a community cancer assessment on November 21, 2007 from ODH's Chronic Disease and Behavioral Epidemiology Section for the residential area around the Behr facility. Working with Public Health of Dayton and Montgomery County and with representatives of the Northeast Priority Board, the local community advocacy group, HAS helped set up two health education activities:

1. August 11, 2008 - Lunch and Learn in Dayton with area physicians and Dr. Michelle Watters M.D., from the ATSDR Region V Office, Chicago.
2. August 21, 2008 – Northeast Priority Board public meeting at Kiser Elementary School for a multi-agency update on site investigation and discussion of health concerns.

STATEMENT OF ISSUES

The Behr VOC Plume site is a vapor intrusion site with vapor-phase contaminants that originate from a chlorinated solvent groundwater contaminant plume whose source is the Behr-Dayton Thermal (formerly Chrysler Air Temp) facility in Dayton, Montgomery County, Ohio. In September 2006, Chrysler notified Ohio EPA that the volatile organic compounds (VOCs) from the Behr-Dayton Thermal facility were migrating off-site in the groundwater under the residential areas south-southwest of the facility. The high concentrations of contaminants detected in the groundwater migrating off-site led to Ohio EPA concerns that vapor-phase chlorinated solvents could migrate from the groundwater and travel up through the soil and into buildings in the neighborhood south of the Behr-Dayton facility. The concentration of the solvent trichloroethylene (TCE) in the groundwater and soil gas exceeded the USEPA's Office of Solid Waste and Emergency Response (OSWER) Subsurface Vapor Intrusion Guidance (USEPA, 2002) screening levels for this chemical.

In October, 2006, the USEPA Emergency Response Branch On-Scene Coordinator (OSC) requested the assistance of the Health Assessment Section (HAS) at the Ohio Department of Health to provide indoor air screening and action levels (based in part on ATSDR health-based comparison values and hereafter referred to as HAS screening or action levels) for the volatile contaminants found in the plume. The Health Assessment Section of the Ohio Department of Health has a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). Under that agreement, HAS undertook the lead in conducting this public health consultation.

This public health consultation document will evaluate the environmental data collected by Chrysler as ordered in the December 2006 Administrative Order of Consent (AOC) between USEPA and Chrysler and will make conclusions and recommendations for additional actions that may be necessary to protect public health of area residents. This public health consultation focuses on Chrysler's sampling and vapor abatement actions in the Phase I area conducted from the Fall 2006 through the Spring 2008. The initial time critical emergency actions taken by the USEPA and Ohio EPA in the Phase I area were evaluated in a previous public health consultation document (HAS, 2008). Additional public health assessment documents will be completed as on-going investigations into the full extent and nature of this contamination in the north Dayton area continue. The Phase I area investigated by Chrysler includes the area south of the Behr-Dayton facility bordered by Leo Street on the north, Milburn Avenue to the east, Lamar Street to the south, and Webster Street to the west (see Figure 3). Sub-slab and indoor air samples from eight homes were initially collected by USEPA and found to have TCE levels above HAS action levels. DaimlerChrysler re-sampled these homes as well as an additional 11 homes and three businesses in this residential community.

BACKGROUND

Site Location

The Behr VOC Plume Site is located in an older mixed urban industrial/commercial and residential portion of north Dayton, Montgomery County, Ohio (See Figures 1 and 2). The site is a groundwater contamination plume originating under the current Behr-Dayton Thermal facility. Following regional groundwater flow, the groundwater contamination is migrating into the adjacent residential areas south and southwest of the facility. The Behr VOC Plume site is about two miles north of downtown Dayton and one mile north of the confluence of the Great Miami River and the Mad River (Figure 1). It is about one mile east of the confluence of the Great Miami River and the Stillwater River and is about one mile south of the City of Dayton's Public water supply wellfield.

Regional Hydrogeology and Groundwater Resources

Natural Resource Use

The Behr VOC Plume site is located in the Great Miami River valley. The Great Miami River flows across a deep bedrock valley that was cut into the limestone and shale bedrock. Ice Age glaciers back-filled these deep bedrock valleys with sand and gravel deposits and an occasional layer of clay. These valley fill deposits range from 150 to 250 feet thick. The sand and gravel deposits are thickest near the present course of the Great Miami River and taper to 25 feet thick on the edges of the bedrock valley.

The bulk of the soils under the site are porous and permeable sand and gravels (Ohio Department of Natural Resources well logs). These sand and gravel deposits comprise a prolific buried valley aquifer system. The buried valley aquifer provides most of the region with an abundant supply of water for drinking and industrial use (Miami Conservancy, 2002). Seventy-six percent of the water used in the area is withdrawn via wells from the buried valley sand and gravel aquifer. Most of the water that is withdrawn from the aquifer (67%) is used for public drinking water supplies (Miami Conservancy District [MCD], 2002). This buried valley aquifer has been designated as a "Sole Source Aquifer" (See Figure 1). The USEPA's Sole Source Aquifer designation is defined as an aquifer that supplies at least 50% of the drinking water consumed in the area overlying the aquifer.

Since 2001, Chrysler has sampled the groundwater from 75 on-site and off-site monitoring wells on an irregular basis. Chrysler reported that groundwater elevations indicated that the flow direction in the vicinity of the facility was from the northwest and turned to the southwest just south of the facility (USEPA, 2006a). Regional groundwater flow in the buried valley aquifer system mimics the regional topographic gradient (Miami Conservancy, 2002). The depth to the water table is relatively shallow, ranging from about 15 to 30 feet below ground surface (ODNR, 1995). The intervening soils consist primarily of unconsolidated permeable, porous sands, gravels, and cobbles (Ohio Department of Natural Resources well logs).

The City of Dayton's Miami well field is located about one mile north of the site. The Miami well field supplies approximately 40 percent of the drinking water supply for the City of Dayton (City of Dayton, 2007 water quality data). A report prepared for Chrysler in 2002 stated that twelve other water wells were located in the Dayton downtown area within one mile of the site (Earth Tech, 2002). Nine of these wells were reported to be domestic wells and two wells were industrial supply wells (Earth Tech, 2002). There is also a public water supply at the Behr-Dayton Thermal Site (Earth Tech, 2002).

Demographics

The Phase I area lies within the McCook Field Neighborhood Planning District of the City of Dayton. In the 2000 census, there were a total of 2,107 people living in this district with 49 percent white, 47 percent African-American, and 4 percent other. In the McCook District at the time of the 2000 Census, 38 percent of the people were 17 years old or younger, 50 percent were between the ages of 18 and 64, and 12 percent were 65 years old or older. There was a total of 1,141 housing units with 836 households and an average of 2.47 persons per household. At the time of the 2000 census, 15 percent of the housing units were owner occupied, 58 percent were rented and 27 percent were vacant (Dayton, 2003). Also from the 2000 Census, but based on 1999 income, 47 percent of the people (of all ages) living in the McCook District were living with incomes below the poverty level (Dayton, 2000). Since the 2000 Census, the Dayton Metro Housing Parkside Homes project, on the west side of Interstate 75, has been incrementally dismantled and this may have significant impact to the demographics of the McCook Field Neighborhood Planning District.

Land Use

The Phase I area (Figure 2) is primarily an area of older, single family residences interspersed with some small commercial properties. The City of Dayton has zoned this area as a "general industrial district." There is a small park located on the south side of Lamar Street on the southern border of the Phase I area called Claire Ridge Park. The Behr facility is at the northern edge of the Phase I area on the north side of Leo Street (Figure 2). The areas to the immediate east and west of the Phase I area are occupied by industrial and commercial properties. The adjacent Phase 2 Behr VOC Plume area to the south consists mostly of general and light industrial properties mixed with older neighborhoods of single-family homes and duplexes. Some larger parks can also be found further to the west along the Great Miami River such as Deeds Park, Triangle Park and the McCook Fields area.

There are numerous industries in addition to the Behr facility near the Phase I area, including, Aramark Uniform Services Inc., DAP Inc., Environmental Processing SVC, Gayston, and GEM City Chemicals Inc. Other than the Aramark facility, existing groundwater data does not indicate that these other facilities are significant sources of contamination in the Phase I area (Ohio EPA; City of Dayton; personal communication, 2007).

There are two elementary schools in the Behr VOC Plume area; the Kiser Elementary School and Van Cleve Elementary School. The Kiser Elementary School is immediately east across the railroad tracks from the Behr Facility on the northeast side of Leo Street. Recent indoor air samples did not detect contaminants at Kiser Elementary School (USEPA, 2007). The Van Cleve Elementary School was located at 1032 Webster Street, roughly 1,600 feet, south of the Behr facility. However, the school was relocated in August 2007 to 132 Alaska Street after indoor air samples detected levels of TCE above the HAS screening levels in and under the Webster Street school building in June and July 2007.

SITE HISTORY

Operational history

The Behr-Dayton Thermal facility manufactures vehicle air conditioning and engine cooling systems. Although the operations at this facility have remained consistent through the history of the site, ownership of the plant has changed several times. The Chrysler Corporation owned and operated the facility from 1937 until 2002. In 1998, Daimler-Benz and Chrysler Corporation, merged forming the DaimlerChrysler Corporation (Chrysler) (USEPA, 2006a). In April of 2002, Behr America became the current owner of the Dayton facility. However, DiamlerChrysler (now Chrysler) Corporation is assuming responsibility for the identification and remediation of the Behr VOC Plume. In the past, TCE was used regularly in the plant's manufacturing processes, primarily as a metal degreaser.

Administrative Order of Consent with Chrysler

Upon obtaining and reviewing the results of initial USEPA sampling (HAS, 2008), USEPA met with Chrysler on November 17, 2006 to discuss the signing of an Administrative Order of Consent (AOC) which included a proposed two phase time-critical removal action to reduce or eliminate exposure of residents to site-related chemicals. The proposed Phase I action included installation of a sub-slab vapor abatement system in each of the eight residences that USEPA had previously determined to have indoor air TCE concentrations greater than 0.4 ppb (USEPA, 2006a). The AOC expanded the scope of the Phase I investigation to include an additional 13 residences in the neighborhood south of facility – bounded by: Leo Street to the north, Lamar Street to the south, Webster Street to the west, and Milburn Street to the east (Figures 2 and 3). On December 19, 2006, the AOC was signed by USEPA and Chrysler (USEPA, 2006a). On December 21, 2006, USEPA approved the Chrysler Phase I Work Plan. By this time, Chrysler had already installed vapor abatement systems in three of the residences (USEPA, 2006a). The following actions were approved by USEPA as part of the Phase I Work Plan:

Phase I Actions:

1. Chrysler would install vapor abatement systems in five remaining residences initially sampled by USEPA.
2. Chrysler would install vapor abatement systems in residences with indoor air TCE concentrations that are greater than 0.4 ppb (initial eight plus the additional 11).
3. Chrysler would take periodic confirmatory air samples following the installation of the vapor abatement systems to ensure effectiveness of

mitigation systems.
4. USEPA would conduct a public meeting in January 2007

Previous Site Investigations

In 2002, Chrysler submitted an application for the Voluntary Action Program (VAP) to the Ohio EPA. As part of the VAP application, Chrysler documented groundwater contamination beneath the facility with contaminant levels exceeding VAP cleanup standards. In response to the groundwater contamination documented in 2002, Chrysler contracted Earth Tech to design, install, and operate two systems for the remediation of on-site contamination, one for the soil cleanup and one for the groundwater contamination under the facility, with TCE as the main contaminant of concern.

On-Site Soil and Groundwater Remediation Systems

Chrysler installed a Soil Vapor Extraction (SVE) system on-site for the removal of contaminants from the soils in October 2003. It continued operating through December 2005. An estimated 900 pounds of VOCs were removed from the soils (Earth Tech, 2006).

In an attempt to remove contaminants from the groundwater, a remediation system consisting of six extraction wells and seven injection wells was installed. The capture zone of the six extraction wells reportedly extends as much as 300 feet to the south and 150 feet east of the Behr facility boundaries. Within this capture zone contaminated groundwater is reportedly recovered and treated by the groundwater remedial system. Sodium lactate solution is injected into this system to break down chlorinated solvents before the groundwater is returned to the aquifer. The remedial groundwater system began operation in June 2004 and an estimated 1031 pounds of VOCs were removed (Earth Tech, 2006).

Up to 75 monitoring wells, on-site and in the surrounding area, were sampled for VOC analyses on an irregular basis by Chrysler between 2003 and 2007. Chrysler summarized the data in a report provided for Ohio EPA in September, 2006.

In 2003, Chrysler groundwater monitoring program discovered wells with elevated levels of TCE; including MW028s (9,600 parts per billion (ppb)), MW029s (16,000 ppb), and MW010s (17,000 ppb) (Table 1 and Figure 4). Monitoring well MW10s is located at the southern edge of the Behr-Dayton facility and monitoring wells MW028s and MW029s are located offsite in the Phase I neighborhood just south of the facility.

Ohio EPA discovery

On September, 2006, Chrysler notified Ohio EPA that a chlorinated solvent contaminant plume from the Behr-Dayton Thermal facility was migrating off-site in the groundwater under the residential area south-southwest of the facility (Figure 4). The high concentrations of these VOCs detected in the groundwater migrating off-site led to Ohio EPA concerns that vapor-phase chemical compounds could migrate from the groundwater and travel through the soil and into inhabited buildings near the Behr-Dayton facility. The concentrations of TCE, vinyl chloride, and cis-1,2-dichloroethene in the groundwater exceeded the USEPA Office of Solid Waste and Emergency Response (OSWER) screening levels (USEPA, 2002) (see Table 1).

Exceeding these guidance levels indicated that there was a potential for an unacceptable risk to area residents due to vapor intrusion. Vapor intrusion is the migration of vapor-phase volatile organic compounds from contaminated groundwater to overlying soils to the indoor air of area homes. The OSWER vapor intrusion evaluation process is designed to screen out sites that do not require further investigation or remediation and to focus attention on those sites that need further consideration of the vapor intrusion pathway.

In response to groundwater levels that exceeded the OSWER guidance levels, Ohio EPA sampled the deep soil gas in the Phase I area south of the facility in October, 2006 (Figure 5). These seven soil gas samples were collected approximately one foot above the water table (17 feet below ground surface). Contaminant concentrations in these deep soil gas samples significantly exceeded the USEPA OSWER screening levels for TCE and cis-1,2-dichloroethene in deep soil gas and TCE, cis-1,2-dichloroethene, trans-1,2-dichloroethene and 1,1-dichloroethene in shallow soil gas. The Ohio EPA soil gas sampling indicated TCE at levels up to 160,000 ppb cis-1,2-DCE at levels up to 11,000 ppb, and 1,1-DCE up to 1,200 ppb under the north Dayton community (Table 2).

Exceeding OSWER screening levels is an indication that there is a potential for an unacceptable risk to area residents due to vapor intrusion, resulting from the migration of vapor phase volatile organic compounds from contaminated groundwater, to soil gas, to indoor air of area properties. The guidance levels are intended to provide recommendations to determine if there is a potential for unacceptable health risk to exposed residents, not to delineate the extent of risk or how to eliminate risk.

USEPA referral

Ohio EPA formally requested assistance from the USEPA Emergency Response Branch on November 6, 2006 to conduct a time-critical removal action at the Behr VOC Plume site (USEPA, 2006a). ATSDR and HAS were asked by the USEPA on scene coordinator (OSC – the Emergency Response Branch site manager) to establish short-term action levels and long-term screening values for contaminants of concern for both residential and commercial sub-slab soil gas and indoor air concentrations at the Behr VOC Plume site (see Appendix A). Short-term HAS action levels and long-term screening values were established for TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, 1,1,1- TCA, and vinyl chloride (see Appendix A). Exceeding a short-term action level would warrant immediate action by Chrysler or USEPA to reduce exposure levels. These short-term HAS action levels were derived from ATSDR's intermediate EMEGs (Environmental Media Evaluation Guides). Exceeding the EMEGs level will not necessarily result in adverse health effects, but prompts further evaluation to determine potential public health threats to residents. Intermediate EMEGs were developed for exposure durations of longer than two weeks but less than one year. Long-term screening levels were taken from the USEPA OSWER Draft Vapor Intrusion Guidance levels at the 10^{-4} cancer risk level. Exceeding the long-term screening values indicates that there is an increased potential to develop adverse health effects due to chemical exposure. Long-term residential indoor air screening value for TCE is 0.4 ppb and the

HAS short-term action level is 100 ppb (see Table 4 and Appendix A).

USEPA Sampling

USEPA began the vapor intrusion investigation by sampling the sub-slab soil gas and indoor air in eight residents in the Phase I neighborhood in November of 2006. The soil gas can accumulate under basement floors or under cement floors of buildings built on slabs. The soil gas can migrate into the homes through cracks in the floor or through the joints between the floors and the wall. Samples of the sub-slab soil gas can be obtained by drilling a small diameter hole in the concrete and installing sample tubing into the hole. A vacuum canister is attached to the tube through a regulator which facilitates sample collection over a 24 hour period. The indoor air is typically collected in the basement using a vacuum canister connected to a pump which is set up to collect a sample over a 24 hour period. Indoor air samples and sub-slab soil gas samples were collected at the same time in the Phase I neighborhood due to the high concentrations of contaminants found in the deep soil gas samples and the shallow depth to the groundwater. Contaminant concentrations in the sub-slab soil gas samples exceeded the OSWER shallow soil gas screening levels (USEPA, 2002) for TCE in all eight homes (see Table 3). Residential sub-slab screening level was set at 4 ppb for TCE. Sub-slab soil gas levels were exceeded in five homes for cis-1,2-dichloroethene, two homes for trans-1,2-dichloroethene, and one home for 1,1-dichloroethene (HAS, 2008).

The indoor air concentrations exceeded the action level of 0.4 ppb established by ATSDR and HAS in all eight homes (see Table 4). TCE levels in the indoor air exceeded the short-term action level of 100 ppb in three homes (HAS, 2008).

Chrysler Phase I Investigation

Chrysler obtained access to sample sub-slab soil gas and indoor air in 19 of the 21 residences in the Phase I area. Chrysler was denied access to two homes and no samples were collected on these properties. Another Phase I home had sub-slab and indoor air TCE levels below detection levels or below HAS screening levels on two baseline sampling events and therefore required no further action. Three additional homes had sub-slab sample results above HAS screening values of 4 ppb TCE, however the indoor air TCE levels were below the HAS indoor screening level. These three homes were sampled four times throughout the year and indoor air levels remained below screening levels. Following four full quarters of sampling, these three homes were also determined to require no further action.

Fifteen Phase I area homes had TCE levels that exceeded HAS indoor air screening levels. Sub-slab vapor abatement systems were installed in all fifteen homes in 2007. The results from the installation and operation of these vapor abatement systems have been inconsistent at best. In seven of these homes, indoor air TCE levels dropped below screening levels. However, only three of these homes had sub-slab TCE levels dropping below screening levels. These seven homes will be monitored to confirm that TCE levels remain below screening levels. One home had the indoor air TCE levels initially drop below the screening level, only to have subsequent sampling indicating levels exceeding screening values. Another home had indoor air levels drop just slightly below the screening value. Six homes had indoor air TCE levels remaining above the HAS screening value as late as August, 2008 (Chrysler Corporation, pers. Comm., 2008).

Commercial

There are six commercial or industrial facilities in the Phase I area. Chrysler was only able to obtain access to three commercial facilities to sample the sub-slab soil gas and indoor air. Samples were collected as part of the Phase II investigation in May-April, 2007. One of the three facilities that granted Chrysler access had indoor air TCE levels below screening levels and sub-slab soil gas TCE levels above commercial screening values (see Appendix A). This facility is now being monitored on a quarterly basis. One commercial facility had initial TCE levels that exceeded both sub-slab and indoor air HAS commercial screening levels. A Sub-slab vapor abatement system was installed in August, 2007 and the sub-slab vapor abatement system lowered the TCE level in the indoor air below the action levels. The third facility had three vapor abatement systems installed, two in May and one in September of 2007. Indoor air TCE levels remained far above the HAS commercial indoor air and sub-slab action levels. This facility is within the area of influence of the SVE system in the Phase I area. The indoor air and sub-slab TCE levels were significantly reduced during the initial operation of the SVE system in May, 2008, although the TCE levels were not lowered below HAS's screening levels.

Sub-Slab Vapor Abatement Systems

Following the installation of the sub-slab vapor abatement system or upgrades made to the systems, indoor air samples were collected at predetermined time intervals. These samples were collected at 10, 30, 60, 90, and 180 day intervals to determine whether TCE levels were lowered below action levels. When TCE levels were not lowered below indoor air action levels, Chrysler installed larger fans in four homes with vapor abatement systems. Chrysler attempted to lower TCE levels in four homes by caulking the cracks in the floors and walls of the basements. Chrysler also attempted to lower indoor air TCE levels by the installation of a second system in three homes.

Six homes and one commercial property had the indoor air TCE levels drop below screening values 30 days following installation of the vapor abatement system. Other Phase I homes had significant decreases in sub-slab and indoor air TCE levels, but sample results were still above screening levels 30 days after installation. After one year of operation, six houses with individual sub-slab vapor abatement systems still had TCE levels above indoor air chronic screening levels.

Off-Site Phase I Soil Vapor Extraction System

In an additional effort to reduce indoor air TCE levels below HAS action levels in these six homes and in one commercial building, a Soil Vapor Extraction (SVE) system was installed by Chrysler in early 2008 in the eastern block of the Phase I area (see Figure 6). A Soil Vapor Extraction (SVE) system applies a vacuum to an area of the subsurface soils (for the Behr site it is between 5 feet to 20 feet below ground surface) to remove vapor-phase contaminants for treatment or collection for later disposal. SVE systems are designed to operate in porous permeable soils above the groundwater in areas with high soil gas contaminant concentrations.

The off-site Phase I SVE treatment system is located on the south side of Leo Street and consists of primarily of a vacuum system (with pumps, valves, controls, etc.) and the treatment system (two granular activated carbon vessels , heat exchanger if needed, air/water separator, etc.) (Chrysler, 2008). The SVE system also has a system of piping (and all that is associated with piping such as valves, meters, etc.) connecting the extraction wells to vacuum pumps, a treatment system, and the vapor extraction wells. For the Behr Phase I off-site system, there are eleven vapor extraction wells (see Figure 6).

In an effort to reduce air TCE levels below HAS action levels in these six homes and in one commercial building, the Soil Vapor Extraction (SVE) system was installed by Chrysler in early 2008 in the eastern block of the Phase I area (see Figure 6). After initial operation of the SVE system in the late Spring of 2008, TCE levels were significantly reduced in both the indoor air and in the soil gas, however the indoor air TCE levels still remain marginally above HAS action levels in five homes (30 days after intermittent operation of the SVE system). The SVE has been connected to permanent power supply and has been operating daily since the end of July, 2008. Chrysler is currently collecting indoor air and sub-slab soil gas samples from impacted houses to measure the initial effectiveness of this SVE system.

COMMUNITY HEALTH EDUCATION ACTIVITIES

HAS staff, in conjunction with the US EPA On-Scene Coordinator and representatives of Public Health of Dayton and Montgomery County (PHDMC), have met repeatedly with residents impacted by the contamination associated with the Behr VOC Plume site. On November 20, 2006 HAS, USEPA, Ohio EPA, and PHDMC met on a one-on-one basis with the eight residents whose homes were sampled by USEPA in November, 2006. Agencies provided each resident with their sub-slab and indoor air sampling results, a short history of the site, an explanation of the vapor intrusion route, and discussion of the toxicology and potential health concerns regarding exposure to the primary contaminant of concern, TCE. Agency staff answered questions from the individual residents and facilitated discussions between representatives from the Chrysler Corporation and the residents to sign access agreements to allow Chrysler to conduct additional sampling in and under their homes. HAS provided residents with fact sheets on Exposure to Toxic Chemicals, the Vapor Intrusion Pathway, and Trichloroethylene (See Appendix B).

Agency staff, along with representatives from Chrysler Corporation, met again with residents on January 18, 2007, on a one-to-one basis to discuss the results of sub-slab and indoor air sampling conducted by Chrysler in December, 2006 and early in January, 2007. Chrysler offered to install sub-slab vapor abatement systems as a short-term solution to limit or eliminate current exposure to TCE through the vapor intrusion route to residents with indoor air levels of TCE exceeding HAS action levels and ATSDR screening values. Agency and Chrysler staff answered questions from residents and solicited signed agreements from residents for the installation of the abatement systems.

HAS staff participated in a US EPA public meeting at the Kiser School February 8, 2007 to provide the community with information about the on-going investigation in their neighborhood.

US EPA provided residents with a short history of the site, a description of contamination issues, a discussion of the vapor intrusion pathway, a description of the in-house sub-slab vapor mitigation systems being installed impacted homes, and a discussion and time-table for additional environmental investigations to be conducted in the community. HAS provided the community with information concerning TCE, the chemical of concern at the site, its toxicology, potential health effects from exposures via the air route, and answered health-related questions from the community. HAS staff participated in a second USEPA public meeting for the Behr site at the Kiser Elementary School on November 15, 2007. This public meeting focused on the Phase II investigation efforts and the dispute between Chrysler and USEPA over the scope of the Phase II area. The USEPA established a command post / office in the community on North Keowee Street to support USEPA's Phase II work in the area in November, 2007.

At the request of the community Northeast Priority Board, Public Health of Dayton and Montgomery County organized a multi-agency public meeting at Kiser Elementary School on August 21, 2008 to discuss site-related health concerns with the community. HAS presented information regarding the August 1, 2008 Public Health Consultation (Behr VOC Plume Site, Initial USEPA Investigation) and help to answer questions from the community.

DISCUSSION

Exposure to Toxic Chemicals

For the public *to be exposed* to the elevated levels of chemical contaminants in and around the Behr VOC Plume site, they must first come into contact with the contaminated groundwater, surface water, soils, soil gas, sediment, or air. In order to come into contact with contamination in the environment, media there must be a *completed exposure pathway*. A completed exposure pathway consists of *five main parts*, which must be present for a chemical exposure to occur. These include:

1) A Source of the Toxic Chemicals of concern;
2) A method of Environmental Transport, which allows the chemical contaminant to move from its source (soil, soil gas, air, groundwater, surface water, sediment);
3) A Point of Exposure where the residents come into direct physical contact with the chemical (on-site, off-site);
4) A Route of Exposure, which is how the residents come into physical contact with the chemical (drinking, breathing, eating, touching); and
5) A Population at Risk which are the people who could possibly come into physical contact with site-related chemicals.

Exposure pathways can also be characterized as to when the exposure occurred or might occur in the *Past, Present, or Future*.

Physical contact with a chemical contaminant, in and by itself, does not necessarily result in adverse health effects. A chemical's ability to affect a resident's health is also controlled by a number of factors, including:

- How much of the chemical a person is exposed to (the *Dose*).
- How long a person is exposed to the chemical (duration of exposure).
- How often a person is exposed to the chemical (frequency).
- The toxicity of chemicals the person is exposed to (how chemicals can make people sick).

Other factors affecting a chemical's likelihood of causing adverse health effects upon contact include the resident's:

- Personal habits
- Diet
- Age and sex
- Current health status
- Past exposures to toxic chemicals (occupational, hobbies, etc.)

The site-related chemicals of concern found in the groundwater plume under the Behr VOC Plume site consist primarily of trichloroethylene (TCE) and cis-1,2-dichloroethene (DCE).

EXPOSURE PATHWAYS

Drinking Water Pathway

Although the Behr VOC Plume site is a known groundwater contamination plume, the focus of this public health consultation is on the health concerns related to the vapor intrusion pathway resulting from this plume. Groundwater collected by the City of Dayton in July, 2007 indicated the presence of low levels of TCE and cis-1,2-DCE in two City of Dayton production wells, roughly one mile to the north of the site. The levels detected were below federal drinking water standards. The source of these contaminants is not known with any certainty. Both TCE and cis-1,2-DCE are chemicals of concern at the Behr VOC Plume site. Ohio EPA and the City of Dayton are continuing to investigate this contamination (Ohio EPA, pers. comm. August, 2008).

Vapor Intrusion Pathway

The contaminants of concern, trichloroethylene (TCE) and cis-1,2-dichloroethene (DCE), are referred to as volatile organic compounds (VOCs). These chemicals are considered sufficiently toxic and sufficiently volatile to pose a threat via the vapor intrusion pathway (USEPA, 2002). Although typically found in the liquid-phase in groundwater, these compounds will readily become a gas on exposure to the air. These vapor-phase contaminants can migrate into the air spaces between soil particles, as soil gas, up through the soils, and then into basements of nearby residences. Once in the basement, these chemical vapors can be distributed throughout the home and into the breathing air. Factors that favor this type of transport of these chemicals at the Behr site are; 1) the shallow depth to the groundwater (less than 25 feet below the ground surface), 2) the highly permeable sand and gravel soils underlying this area, 3) the high concentrations of the contaminants in the shallow aquifer (up to 16,000 ppb TCE), and 4) the short horizontal distance from the source to the nearest residences in the Phase I area. Since the depth to groundwater is shallow, 17 to 25 feet below ground surface at the Behr site, the vertical distance the contaminants will have to travel as a vapor to get into a basement is minimal. The Behr site is located in the Great Miami River valley and soils consist of highly porous and permeable sands and gravel. These soils provide an environment where these organic compounds can readily volatilize from the groundwater to the vapor-phase in the interstitial spaces in the soil and can then migrate as soil gas to areas of lower vapor pressure at or near the ground surface.

Groundwater plumes with higher concentrations of volatile contaminants will typically generate higher concentrations of contaminant vapors in the air spaces in the soils above the plume. The concentrations of the contaminants in the shallow groundwater at the Behr VOC Plume site are locally high as indicated by the levels found in area shallow monitoring wells. TCE levels ranged from 94 to 16,000 ppb (11 out of 15 samples with detections); cis-1,2-dichloroethylene from 16 to 3,800 ppb (6 out of 15 samples with detections); and vinyl chloride from 3 to 730 ppb (5 out 15 samples with detections) (DaimlerChrysler, 2006). Ohio EPA sampling of soil gas over the groundwater contamination plume also reflected this relationship, detecting soil gas levels of TCE as high as 160,000 ppb and cis-1,2-DCE as high as 11,000 ppb under the Phase I neighborhood (Table 2). The sub-slab soil gas sampled collected by USEPA from the eight sampled homes had TCE as high as 62,000 ppb and cis-1,2-DCE levels as high as 7,900 ppb (Table 3). Sub-slab levels in Phase I homes sampled by Chrysler in January and February 2007 had TCE levels as high as 67,000 ppb and indoor air levels as high as 230 ppb, with three homes exceeding HAS short-term action levels (100 ppb TCE). The vapor intrusion pathway to the indoor air in these homes was determined to be complete and poses an unacceptable public health concern to nearby residents (USEPA, 2006a).

Past Exposures

No indoor air data are available prior to the initial USEPA investigation in 2006 to determine whether the public has been exposed to contaminants in the air through inhalation in the past. No soil gas or sub-slab soil gas data are available to determine whether there was a potential for vapor intrusion in the past. Available groundwater data indicates that groundwater in the area was impacted by site-related chemicals as least as far back as 1999 (Geoprobe sampling in 1999; monitoring wells sampled in 2001). These data indicate that past (before indoor air data was collected in 2006) exposure of area residents was at least a possibility.

In 2002, Chrysler submitted a Human Health Risk Evaluation (HHRA) (Earth Tech, 2002). The HHRA was the initial screening of human health risk based on the concentration of VOCs detected in the groundwater at off-site locations. The HHRA evaluated risk from vapor intrusion using the Johnson-Ettinger Model (Johnson-Ettinger, 1991). The HHRA concluded that the risks due to vapor intrusion were marginal for both non-carcinogenic and carcinogenic risks and concluded “that an imminent and substantial health risk is not present” (Earth Tech, 2002).

Current Exposures

USEPA collected indoor air samples over a 24 hour period at eight locations in the Phase I area. TCE was detected at concentrations exceeding the HAS chronic screening level of 0.4 ppb in all eight indoor air samples, with the maximum concentration of 260 ppb at location EPA-05 (See Table 4). HAS’s short-term action level of 100 ppb was exceeded at three residential locations, EPA-02, EPA-03, and EPA-05, all along Daniel Street and Milburn Avenue.

Cis-1,2-Dichloroethene was detected at concentrations exceeding the HAS chronic screening level of 8.8 ppb sampling locations EPA-02 and EPA-05 with a maximum indoor air vapor level of 20 ppb at sample location EPA-05.

Chrysler's sample results from the Phase I area homes indicated TCE levels as high as 230 ppb in the indoor air and 62,000 ppb in the sub-slab soil gas (see Table 5). The highest levels of TCE found in commercial properties in the Phase I area were 111 ppb in the indoor air and 8,550 ppb in the sub-slab soil gas (see Table 8).

Vapor abatement systems were installed in 14 of the 21 residences and two of the six commercial/industrial facilities in the Phase I area. Through operation of these systems, the TCE levels in all the residences were lowered below the short-term action level (=100 ppb). More than one year after installation of vapor abatement systems, the TCE indoor air levels remain above the chronic screening levels in six of the residences and one of the commercial facilities. In April, 2008 Chrysler installed a SVE system in the Phase I area to lower the levels of contaminants in the soil gas before it migrates into near-by buildings. The SVE system was connected to a permanent power source in July, 2008. Indoor air samples collection of Phase I residences at regular intervals will be conducted to evaluate the effectiveness of the SVE system beginning in September, 2008.

CHEMICALS OF CONCERN

TCE and 1,2-DCE are partially soluble in water and are heavier than water. Significant rainfall events usually flushes these chemicals deeper into the soils and then into the groundwater. TCE tends to sink down through the groundwater and accumulate at the bottom of the aquifer. As it travels deeper in the aquifer, TCE enters low oxygen areas and come in contact with bacteria that break TCE down into other chemicals. Under certain conditions TCE breaks down to DCE and VC (Vogel and McCarty, 1985). DCE and VC are typically found at the leading edge of a TCE plume where contaminants have been in the ground for the longest period and where bacteria have had more time to break down TCE. Typically the highest concentrations of TCE will be found in that portion of the plume nearest to the source.

Trichloroethylene (TCE)

The primary use of trichloroethylene has been the degreasing of metal parts and its use has been closely associated with the automotive and metal-fabricating industries from the 1950's through the 1970's. It is an excellent solvent for removing greases, oils, fats, waxes, and tars. As a solvent it was used alone or blended with other solvents. These solvents were also added to adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners. When in surface soils, TCE will transform from a liquid to a gas faster than most other volatile organic compounds. It has been shown that the majority of the TCE spilled on soils close to the surface will vaporize into the air. When TCE is released into the air, it reacts relatively quickly in the presence of sunlight and oxygen, with about half of it breaking down to simpler compounds in about a week. TCE doesn't stick well to soil particles unless the soils have high organic carbon content. TCE is known to be only slightly soluble in water, but there is ample evidence that dissolved TCE can remain in groundwater for a long time. Studies show that TCE in water will rapidly form a gas when it comes into contact with air. In a sand and gravel aquifer, TCE in the groundwater can rapidly vaporize into the air spaces between adjacent soil grains. Studies indicate that it would then disperse by two primary routes; first, diffusion through the soil air spaces and then be re-adsorbed by groundwater or infiltrating rainwater, or second, it would migrate as a gas to the surface and be released to the atmosphere.

The primary means of degradation of trichloroethylene in groundwater is by bacteria, but a breakdown product by this means is vinyl chloride, a known human carcinogen and likely more of a health concern than TCE (Vogel and McCarty, 1985). Very little vinyl chloride has been detected in area groundwater and none has been detected in indoor air of sampled residences.

Acute Health Effects

Occupational studies of workers who use TCE in their work environments and studies of people intentionally inhaling large amounts of TCE (in excess of 100,000 parts TCE per billion parts of air) indicate the potential for impaired heart function, unconsciousness, and death (ATSDR, 1997). Breathing similarly high levels of TCE for longer periods of time may cause permanent nerve, kidney, and liver damage. Breathing lesser amounts of TCE may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. These latter symptoms are reversible and can be addressed by preventing further exposure of the individual to TCE in the indoor air environment. OSHA has set an occupational indoor air limit of 100,000 ppb TCE for an 8-hour workday over a 40-hour work week. ATSDR has established a 2,000 ppb TCE acute minimum risk level (MRL) for TCE in air (ATSDR, 1997).

Exceeding this latter number in the indoor air of homes in the Behr VOC Plume site area might have triggered temporary removal of residents from their homes. However, the highest indoor air level for TCE detected in the Phase I area at the Behr VOC Plume site is 260 ppb, an order of magnitude less than the ATSDR acute MRL value of 2,000 ppb; therefore, we would not expect to see acute adverse health effects.

Short-term Non-Cancer Health Effects

HAS has established a “short-term” exposure comparison value for exposures to TCE in the air that may have durations greater than a week but less than a year (15 to 365 days). This 100 ppb level provides protection from possible neurological effects due to TCE exposure over this “short-term” exposure period (ATSDR, 1997). Three homes sampled by USEPA in November, 2006 had indoor air levels of TCE exceeding this “short-term action level”. One additional home sampled by Chrysler in January, 2007 also exceeded this value, in addition to the homes already sampled by USEPA. Sub-slab vapor abatement systems were installed in all four homes in February, 2007. Ten-day and 30-day confirmation sampling indicated that levels of TCE in the indoor air in these homes were reduced to single-digit parts per billion levels of TCE (below the 100 ppb “short-term action level”) very soon after installation and initial operation of these vapor abatement systems.

Long-term or Chronic Cancer Risk

TCE was most recently classified by USEPA as Class B2 carcinogen – a "probable human cancer-causing chemical". However, the cancer classification of TCE has been withdrawn and is currently under review by USEPA. The National Toxicology Program (NTP), in its 11th Report on Carcinogens (2005), lists TCE as being "reasonably anticipated" to be a human carcinogen based on limited evidence of carcinogenicity from studies of humans and sufficient evidence from studies of lab animals exposed to high levels of the chemical.

Chronic exposure to high levels of TCE in air in the workplace (greater than 100,000 ppb TCE), based on analyses of seven studies of worker populations, was associated with excess incidence of liver cancer, kidney cancer, non-Hodgkin's lymphoma, prostrate cancer, and multiple myeloma in these workers. The strongest evidence for linking cancer in these workers to TCE exposure is for the first three of these cancers (NTP, 2005). Agreement between human and animal studies supports the conclusion that TCE exposure may result in the development of kidney cancer. High doses are needed to cause liver toxicity and cancer in lab animals. Differences with regard to how humans and animals process TCE in the liver suggests that humans would be less susceptible to liver cancer from TCE exposures than the lab animals (National Academy of Sciences NAS, 2006).

The health impacts, including increased cancer risks, from chronic exposure to single digit parts per billion levels of TCE in air and/or drinking water remain poorly documented and largely unknown. For the Behr VOC Plume site, HAS and ATSDR recommended a long-term protective screening level of 0.4 ppb TCE in the indoor air, based on a hypothetical cancer risk scenario that assumes a resident lives in the basement of his or her house and breathes in TCE in the air 24 hours/day for 350 days of the year, for 30+ years.

Indoor air levels of TCE in 14 of the 21 homes in the Phase I investigation area sampled by the USEPA and Chrysler exceeded this long-term screening level. Sub-slab vapor abatement systems were installed in all 14 of these homes in February, 2007. As of February, 2008, eight out of these 14 homes still had indoor air levels of TCE above the 0.4 ppb screening level. USEPA is requiring Chrysler to review the effectiveness of their vapor abatement systems in light of these homes still being out of compliance with regard to indoor air levels of TCE. Chrysler installed an in-ground soil vapor extraction system (SVE) in the Phase I neighborhood in April, 2008 to try and better address the continuing exposure issues in these homes.

As the duration of the TCE exposures via the vapor intrusion pathway at the Behr VOC Plume site remains largely unknown but may have been going on for at least a decade, at the request of HAS, the Chronic Disease and Behavioral Epidemiology Section at the Ohio Department of Health and Public Health of Dayton and Montgomery County Staff, is conducting a community cancer assessment of the impacted neighborhoods in north Dayton to determine cancer incidence in this community.

1,2-Dichloroethene (DCE)

DCE has been manufactured as a chlorinated solvent, but at the Behr VOC Plume site it is believed to be primarily a by-product of the breakdown of the solvent TCE in groundwater by bacteria. There are three different forms of DCE of concern at the Behr VOC Plume site; 1,1-DCE, cis-1,2-DCE, and trans-1,2-DCE. TCE breaks down into 1,1-DCE or trans-1,2-DCE forms through minor transformation pathways and these forms are typically found in lower concentrations than the cis-1,2-DCE form. The major portion of the DCE by-product formed in the TCE breakdown is the cis-1,2-DCE form.

Low concentrations of trans-1,2-DCE and 1,1-DCE have been detected in the groundwater, soil gas, and indoor air at Behr VOC Plume site. Trans-1,2-DCE is classified as having evidence that it does not cause cancer in humans and 1,1-DCE has been identified as a chemical that has suggestive evidence of carcinogenic potential. Trans-1,2-DCE and 1,1-DCE have not been found at concentrations in the indoor air at the Behr VOC Plume site Phase I area that pose a health concern (up to 18 ppb for trans-1,2-DCE and 50 ppb for 1,1-DCE).

At the Behr VOC Plume site, cis-1,2-DCE was detected at significantly higher concentrations than 1,1-DCE and trans-1,2-DCE. Cis-1,2-DCE is classified as a Class D Carcinogen because there is no data to indicate that this chemical promotes tumor formation in the body (ATSDR, 1996). Although there is no human non-cancer exposure data for cis-1,2-DCE, non-cancer health effects are expected to be similar to exposure to trans-1,2-DCE. Exposure to high concentrations of trans-1,2-DCE depresses the central nervous system in humans. Inhalation of 1,700,000 to 2,220,000 ppb for 5 minutes or 1,200,000 ppb for 10 minutes of trans-1,2-DCE has caused nausea, drowsiness, fatigue, vertigo, and intracranial pressure in two human subjects (ATSDR, 1996). Slight burning of the eyes was reported by two humans when exposed to 830,000 and 2,220,000 ppb trans-1,2-DCE for 30 minutes (ATSDR, 1996).

The concentrations of cis-1,2-DCE found at the Behr VOC Plume site in the indoor air (at levels at or below 8.8 ppb) are unlikely to pose a health concern. Two of the eight residences had levels of cis-1,2-DCE in the indoor air above the levels of concern (11.0 and 20 ppb). Sub-slab vapor abatement systems were installed in these two homes in February, 2007 based on elevated TCE levels. USEPA is requiring Chrysler to review the effectiveness of their vapor abatement systems in light of these homes still being out of compliance with regard to indoor air levels of TCE. TCE was found at higher concentrations in the groundwater, soil gas, sub-slab, and the indoor air than DCE and the screening level for TCE (0.4 ppb) is significantly lower than the screening level for DCE (8.8 ppb). The effectiveness of the vapor abatement systems has focused on the goal of getting indoor air levels below the more conservative screening level for TCE.

CHILD HEALTH CONSIDERATIONS

ATSDR and HAS recognize the unique vulnerabilities of children exposed to environmental contamination and hazards. As part of this public health consultation, HAS considered the greater sensitivity of the children who live in the area of the Behr VOC Plume site when drawing conclusions and making recommendations regarding health effects from exposure to chemicals related to the Behr VOC Plume site.

CONCLUSIONS

The Behr VOC Plume site posed an ***Indeterminate Public Health Hazard*** for exposure of residents in the Phase I area to contamination via vapor intrusion prior to the initial USEPA investigation in 2006. There are no historical indoor air data that indicate that nearby residents were breathing contaminants in the air from the Behr facility. There are no soil gas data that indicate that contaminants were at levels in the soil gas that could pose a vapor intrusion hazard to nearby residents.

Based on the 2007-2008 sampling conducted by the Chrysler Corporation, the Behr VOC Plume site poses a ***Public Health Hazard*** for exposure of nearby residents to Trichloroethylene contamination via vapor intrusion pathway *in the present.* Indoor air data collected in 2007, prior to the installation and operation of vapor abatement systems in impacted homes, indicated that some nearby residents were being exposed to TCE in the indoor air at levels that exceeded both short-term (15-365 days) and long-term (30+ years) screening values. The short-term indoor air comparison value provides protection from possible neurological effects from exposure to TCE over this more limited time period. All homes that exceeded the short-term value for TCE in indoor air received vapor abatement systems early in 2007 and none of these residences *currently* exceed this short-term value . A small number of homes in the Phase I area sampled in 2008 continue to have TCE levels in the indoor air above the long-term screening value and this may pose an additional cancer risk to these residents *at the present time.*

The Behr VOC Plume site poses a ***Public Health Hazard*** for exposure of nearby residents to contamination via vapor intrusion *in the future.* The source or sources of the groundwater contamination in the neighborhood needs to be fully identified and cleaned up. The installed vapor abatement systems and SVE system are only intended to be temporary solutions to prevent contaminants entering nearby homes and posing a health threat to the residents. The long-term solution to the contaminant threat to the North Dayton area is identifying and removing the source of the groundwater contamination underlying the community.

RECOMMENDATIONS

1. The nature and extent of the groundwater contamination should be more fully investigated. Details of groundwater flow direction and investigation of possible additional sources of contamination are areas that need further investigation. Dayton's well field, one mile to the north, has a cone of influence very close to the northern edge of the Behr facility. Vigilant monitoring of the groundwater in this area is recommended to ensure that contaminants are not entering Dayton's water supply.

2. Sampled commercial and industrial locations in the Behr VOC Plume area should use action levels that are protective of their workers. OSHA standards should apply only to businesses that manufacture or routinely use the same hazardous chemicals that are chemicals of concern for the Behr site, i.e. businesses that have a written Hazardous Communication and Monitoring Plan in place that ensures that best practices are used to reduce or eliminate worker's exposures coupled with worker education and training. In businesses where the contaminants of concern are not used, it is likely that no protective

measures are taken to monitor or reduce exposure and workers are not educated on the hazards associated with the use of the chemical and are not trained on the appropriate safety measures to be taken to reduce and recognize exposure to the chemical. Although a business may have a written Hazardous Communication and Monitoring Plan, the plan may not be providing adequate protection for the workers if the chemicals in their plan are not the same chemicals of concern as those of the Behr VOC Plume site.

3. The full extent of the TCE contamination associated with the Behr VOC Plume site should be determined. Residences and businesses at risk of exposure via vapor intrusion pathway should have their sub-slab and indoor air sampled for TCE.

4. Residences with indoor air levels of TCE exceeding long term screening value for TCE in indoor air should be provided with sub-slab vapor abatement systems.

5. Installed sub-slab vapor abatement systems should to be monitored at regular intervals to ensure that these systems continue to remove vapor-phase chemicals before they can enter the home.

6. Due to the number of mitigation systems installed in the neighborhood and the concentrations of contaminants expelled by these systems, the ambient air should to be monitored to ensure that the ambient outdoor air is not at concentrations that pose a health concern.

PUBLIC HEALTH ACTION PLAN

Investigations at this site are currently being conducted by Chrysler and the USEPA Emergency Response Branch (ERB) to identify and mitigate environmental impacts to air, soils, and water and evaluate threats to public health in the north Dayton area. Chrysler is conducting investigations and remediation in the Phase I area and a part of the Phase II area. Chrysler is disputing USEPA claims that the Behr VOC Plume area extends into other neighborhoods to the southeast and west of the Van Cleve at McGuffey Schools on Webster Street. The USEPA Environmental Response Branch (ERB) is currently conducting investigations and remediation in the disputed Phase II areas.

HAS will review any additional environmental data collected in the Phase I neighborhood. HAS will to review indoor air data after the installation of the vapor mitigations systems and the operation of the in ground SVE system. HAS will also review environmental data from the Phase II area.

At the request of the community, HAS requested a community cancer assessment on November 21, 2007 from ODH's Chronic Disease and Behavioral Epidemiology Section for the residential area around the Behr facility. Working with Public Health of Dayton and Montgomery County and with representatives of the Northeast Priority Board, the local community advocacy group, HAS helped set up two health education activities:

3. August 11, 2008 - Lunch and Learn in Dayton with area physicians and Dr. Michelle

Watters M.D., from the ATSDR Region V Office, Chicago.

4. August 21, 2008 – Northeast Priority Board public meeting at Kiser Elementary School for a multi-agency update on site investigation and discussion of health concerns.

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TABLES

Table 1. Behr VOC Plume - Phase I
Shallow Groundwater Monitoring Data

Volatile Organic Compound	MCL	OSWER	MW024S	MW025S	MW027S	MW028S	MW029S	MW030S	MW031S
Sample Date	ug/L	ug/L	3/7/2006	3/7/2006	3/7/2006	3/9/2006	11/18/2003	3/8/2006	3/9/2006
1,1,1-Trichloroethane	200	3,100	0.8U	0.8U	0.8U	46	16U	0.8U	0.8U
1,1-Dichloroethene	7	190	0.8U	0.8U	0.8U	4J	16U	0.8U	0.8U
Cis-1,2-Dichloroethene	70	210	0.8U	1J	0.8U	94	3800	0.8U	0.8U
Tetrachloroethylene	5	110	0.8U	1J	0.8U	4U	16U	0.8U	0.8U
Trans-1,2-Dichloroethene	100	180	0.8U	0.8U	0.8U	4U	29J	0.8U	0.8U
Trichloroethylene	5	5	1U	16	1U	3900	16000	1U	1U
Vinyl Chloride	2	2	1U	1U	1U	5U	730	1U	1U

Volatile Organic Compound	MCL	OSWER	MW032S	MW033S	MW034S	MW035S	MW036S	MW037S	MW038S	MW039S
Sample Date	ug/L	ug/L	11/14/2003	3/9/2006	11/17/2003	11/15/2003	11/16/2003	3/8/2006	3/9/2006	11/9/2005
1,1,1-Trichloroethane	200	3,100	6	18J	0.8U	9	2J	3J	12J	6
1,1-Dichloroethene	7	190	0.8U	4J	0.8U	0.8U	0.8U	0.8U	4U	6
Cis-1,2-Dichloroethene	70	210	7	690	16	62	120	3J	810	190
Tetrachloroethylene	5	110	0.9J	4U	1J	3J	0.8U	2J	4U	0.8U
Trans-1,2-Dichloroethene	100	180	0.8U	19J	0.9J	5J	3J	0.8U	19J	10
Trichloroethylene	5	5	250	3800	220	220	720	120	3900	310
Vinyl Chloride	2	2	1U	36	10	1U	1U	1U	18J	3J

(cyan)	Samples collected in 2006.
(yellow)	Concentration exceeds MCL.
(pink)	Concentration exceeds MCL and OSWER guidance levels.
(orange)	Sample quantitation limit is above the MCL.
J	The associated value is an estimated quantity.
U	The analyte was analyzed for, but was not detected. The associated value is a sample quantitation limit
OSWER	Action levels were derived from the USEPA Draft Vapor Intrusion Guidance Document, 2002, based on target groundwater concentrations at the 10-4 risk level

Table 2. Behr VOC Plume Site - Phase I
Ohio EPA Deep Soil Gas Data, Oct. 2006

Volatile Organic Compound	OSWER	OSWER	SG-01	SG-02	SG-03	SG-04	SG-05	SG-06	SG-07
ppb	Shallow	Deep							
1,1,1-Trichloroethane	4,000	40,000	640	**140***	1300	1500	**160***	310	220
1,1-Dichloroethene	500	5000	**300***	**330***	1200	780	10	12	ND
Cis-1,2-Dichloroethene	88	880	10000	11000	5400	4800	410	1200	**400***
Tetrachloroethylene	120	1200	**33***	5	9	8	2	8	6
Trans-1,2-Dichloroethene	180	1800	770	**390***	**460***	**210***	23	**59***	**34***
Trichloroethylene	4.1	41	120000	70000	160000	140000	13000	16000	12000
Vinyl Chloride	110	1100	**92***	**86***	**45***	9	ND	2	ND

* = Value exceeds calibration range.

ND = Indicates not detected at or above the EQL (estimated quantitation limit) value.

[yellow] Concentration exceeds OSWER's shallow soil gas value

[pink] Concentration exceeds OSWER's deep soil gas value

Table 3. Behr VOC Plume Site - Phase I
USEPA Sub-Slab Soil Gas Data, Oct./Nov. 2006

Volatile Organic Compound	Screening	Short-term	EPA-01	EPA-02	EPA-03	EPA-04	EPA-05	EPA-06	EPA-07	EPA-08
ppb	Action Level	Action Level								
1,1,1-Trichloroethane	4,000	7,000	11	260	140	17	140	39	25	900
1,1-Dichloroethene	500	NA	4	52	45	ND	170	ND	ND	540
Cis-1,2-Dichloroethene	88	2000	57	3100	2900	2	7900	170	ND	4200
Tetrachloroethylene	120	2000	ND	37	30	5	23	2.1	0.85	3.8
Trans-1,2-Dichloroethene	180	2000	3	130	130	ND	340	13	0.19	230
Trichloroethylene	4	1000	980	18000	16000	260	62000	3700	49	62000
Vinyl Chloride	110	300	ND	10	14	ND	79	ND	ND	6.7

ND = Indicates not detected at method detection limits.

(Yellow) Concentration exceeds OSWER's Sub-Slab soil gas Screening Action Level were derived from the USEPA Draft Vapor Intrusion Guidance Document, 2002, based on target indoor air concentration at the 10-4 risk level.

(Pink) Concentration exceeds HAS Short-term Sub-Slab soil gas Screening Action Level derived from the ATSDR Intermediate Environmental Media Evaluation Guide for air.

Table 4. Behr VOC Plume Site - Phase I
USEPA Indoor Air Data, Oct./Nov. 2006

Volatile Organic Compound ppb	Screening Action Level	Short-term Action Level	EPA-01	EPA-02	EPA-03	EPA-04	EPA-05	EPA-06	EPA-07	EPA-08
1,1,1-Trichloroethane	400	700	ND	1.4	0.99	0.5	1	4.9	ND	0.89
1,1-Dichloroethene	190	NA								
Cis-1,2-Dichloroethene	8.8	200	ND	11	8.3	0.19	20	0.21	ND	1.9
Tetrachloroethylene	12	200	ND	0.2	0.13	0.24	0.13	0.12	ND	0.17
Trans-1,2-Dichloroethene	18	200	ND	0.5	0.34	ND	0.97	ND	ND	ND
Trichloroethylene	0.4	100	1.9	180	130	13	260	7.5	0.4	49
Vinyl Chloride	11	30	ND	ND	ND	ND	ND	ND	ND	ND

ND Indicates not detected at method detection limits.

(yellow) Concentration exceeds OSWER's Indoor Air Action Level - derived from the USEPA Draft Vapor Intrusion Guidance Document, 2002, based on target indoor air concentration at the 10-4 risk level.

(pink) Concentration exceeds HAS's Short-term Indoor Air Action Level - derived from the ATSDR Intermediate Environmental Media Guide for air.

Table 5. Behr VOC Plume Site - Phase I
Chrysler Initial and One Year Post Vapor Abatement System

Trichloroethylene (TCE) ppb	Screening Value	Short-term Action Level	Locations									
			1	2	3	4	5	6	7	8	9	10
RESIDENTIAL												
Initial Indoor Air	0.4	100	35	24	230	180	76	160	14	7.3	0.34	8.10
IA One Year Post Abatement System*	0.4	100	0.73	0.57	2.2	4.5	<0.20	1.4	17.2	0.23	0.39	0.22
IA Post SVE	0.4	100	0.95	1.1	0.86	0.69	-	0.7	0.16	-	0.12	-
Initial Sub-slab	4	1000	62,000	14,000	55,000	58,000	3,200	67,000	21,000	4.8	71	320
SS One Year Post Abatement System	4	1000	4,730	848	350	110	2.5	2.2	43.1	23.9	19.4	4.9
SS Post SVE	4	1000	410	114	16.7	90.3	-	2.0	5.2	-	6.6	-
			11	12	13	14	15	16	17	18	19	
Initial Indoor Air	0.4	100	8.7	0.55	0.31	0.14	0.22	1.2	1.3	0.06	0.23	
IA One Year Post Abatement System*	0.4	100	1.6	<0.2	0.17	<0.20	<0.20	<0.20	<0.20	0.31	<0.20	
IA Post SVE	0.4	100	NS	-	-	-	-	-	-	-	-	
Initial Sub-slab	4	1000	12,000	240	130	44	3.8	38	140	29	4.7	
SS One Year Post Abatement System	4	1000	70.8	4.9	2.9	<1.6	<1.6	1.1	78	<1.6	<1.6	
SS Post SVE	4	1000	NS	-	-	-	-	-	-	-	-	

NS	Indicates no sample results or no sample collected.
*	Sample collected one year post installation of Vapor Abatement System or last sample collected before installation of SVE system.
(yellow)	Concentration exceeds OSWER's action levels (USEPA, 2002) based on target concentrations at 10-4 risk levels.
(pink)	Concentration exceeds HAS's Short-term Action Level - derived from ATSDR Intermediate Environmental Media Guide for air.

Table 6. Behr VOC Plume Site - Phase I Chrysler Residential Summary

Trichloroethylene (TCE) ppb	Screening Value	Short-term Value	Locations									
			1	2	3	4	5	6	7	8	9	10
Initial Indoor Air	0.4	100	35	24	230	180	76	160	14	7.3	0.34	8.10
Abatement System			2/07	2/07	2/07	2/07	2/07	12/06	2/07	1/07	9/07	2/07
Larger Fan			6/07	7/07	5/07	8/07	-	4/07*	6&9/07*	-	-	-
Caulked Basement			Yes	-	8/07	-	11/07	9/07	8/07	-	-	-
2nd System			9/07	10/07	-	-	-	12/07	-	-	-	-
Continued Elevated IA			Yes	Yes	Yes	Yes		Yes	Yes			
Continued Elevated SS										Yes	Yes	Yes
Within SVE Area			Yes	Yes	Yes	Yes		Yes	Yes		Yes	
Post SVE Monitoring			Yes	Yes	Yes	Yes		Yes	Yes		Yes	
Last Indoor Air			0.95	2.4	0.86	0.69	<0.20	0.70	0.16	0.23	0.12	0.22
Post Abatement Monit.							Yes			Yes		Yes

Locations			11	12	13	14	15	16	17	18	19
Initial Indoor Air	0.4	100	8.7	0.55	0.31	0.14	0.22	1.2	1.3	0.06	0.23
Abatement System			12/06	2/07	-	-	-	1/07	2/07	12/06	-
Continued Elevated IA			Yes								
Continued Elevated SS				Yes					Yes		
Within SVE Area			Yes								Yes
Post SVE Monitoring			Yes								
Last Indoor Air			1.6	<0.2	0.17	<0.20	<0.20	<0.20	<0.20	0.31	<0.20
No Further Action					Yes	Yes	Yes				Yes
Quarterly Monitoring				Yes				Yes	Yes	Yes	

* Vapor abatement system upgrades.

(yellow) Concentration exceeds OSWER's Indoor Air Action Level - derived from the USEPA Draft Vapor Intrusion Guidance Document, 2002, based on target indoor air

(pink) Concentration exceeds ATSDR's Intermediate Indoor Air Action Level - derived from the ATSDR Intermediate Environmental Media Guide for air.

Table 7. Behr VOC Plume Site - Chrysler Phase I Commercial Summary

Trichloroethylene (TCE) ppb	Screening Value	Locations		
		1	2	3
Commercial				
Initial Indoor Air	1.7	<0.20	100	2.6
IA One Year Post Abatement System*		-	8.1	0.14
IA Post SVE		-	-	NA
Initial Sub-slab	17	222	2,900	680
SS One Year Post Abatement System		-	3,790	<1.6
SS Post SVE		-	18.9	NA
1st Abatement System			5/07	8/07
2nd Abatement System				
3rd Abatement System				
SVE System			5/08	
Quarterly Monitoring		Yes 5/07		
Post Abatement Monitoring		9/07		Yes
Post SVE Monitoring			Yes	

NA Not applicable.
Sample collected one year post installation of Vapor Abatement System
or last sample collected before installation of SVE system.

(yellow) Concentration exceeds OSWER's Indoor Air Action Level - derived from the USEPA Draft Vapor Intrusion Guidance Document, 2002, based on target indoor air concentration at the 10-4 risk level.

FIGURES

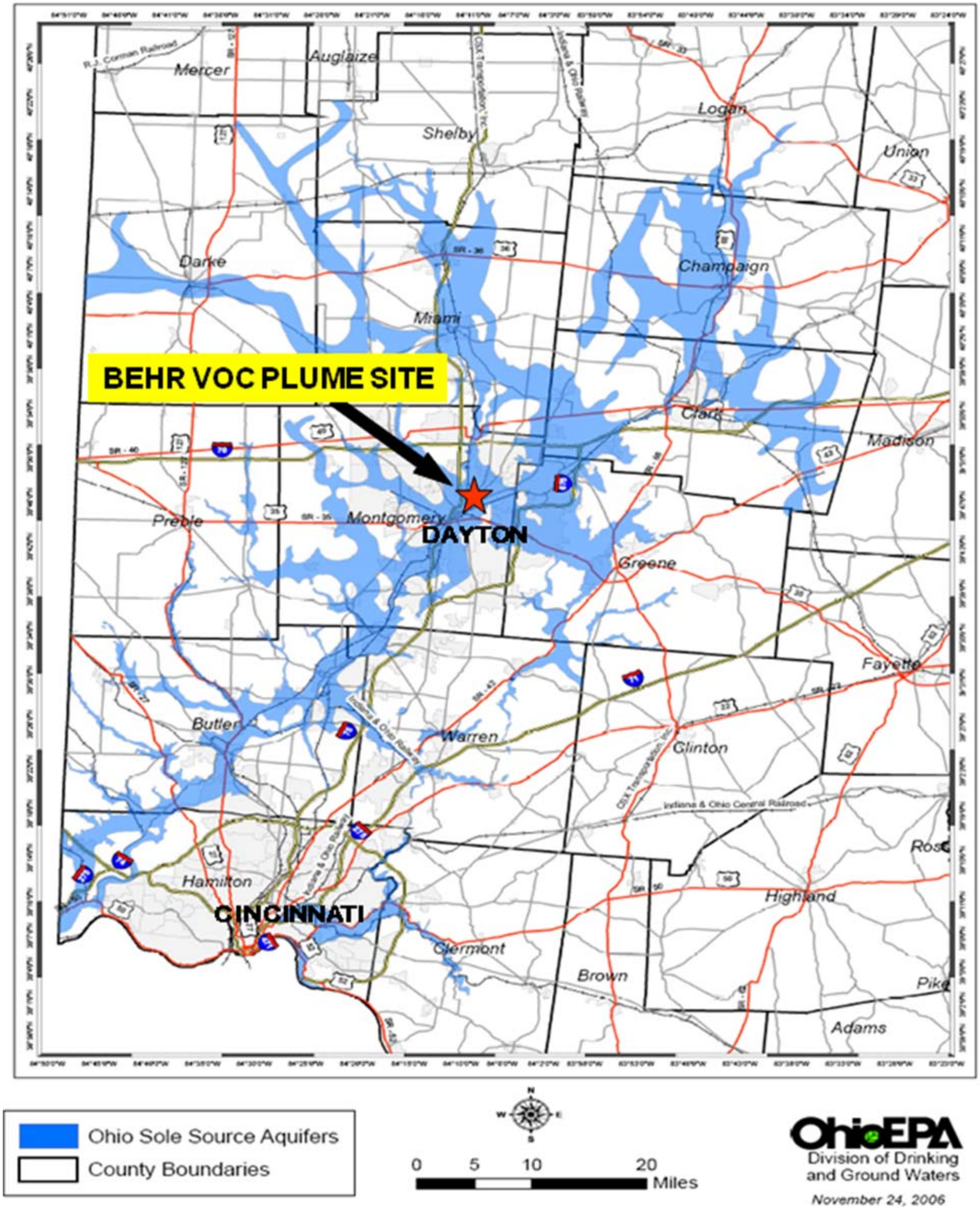


FIGURE 1 –BEHR VOC PLUME LOCATION AND GREATER MIAMI SOLE SOURCE AQUIFER

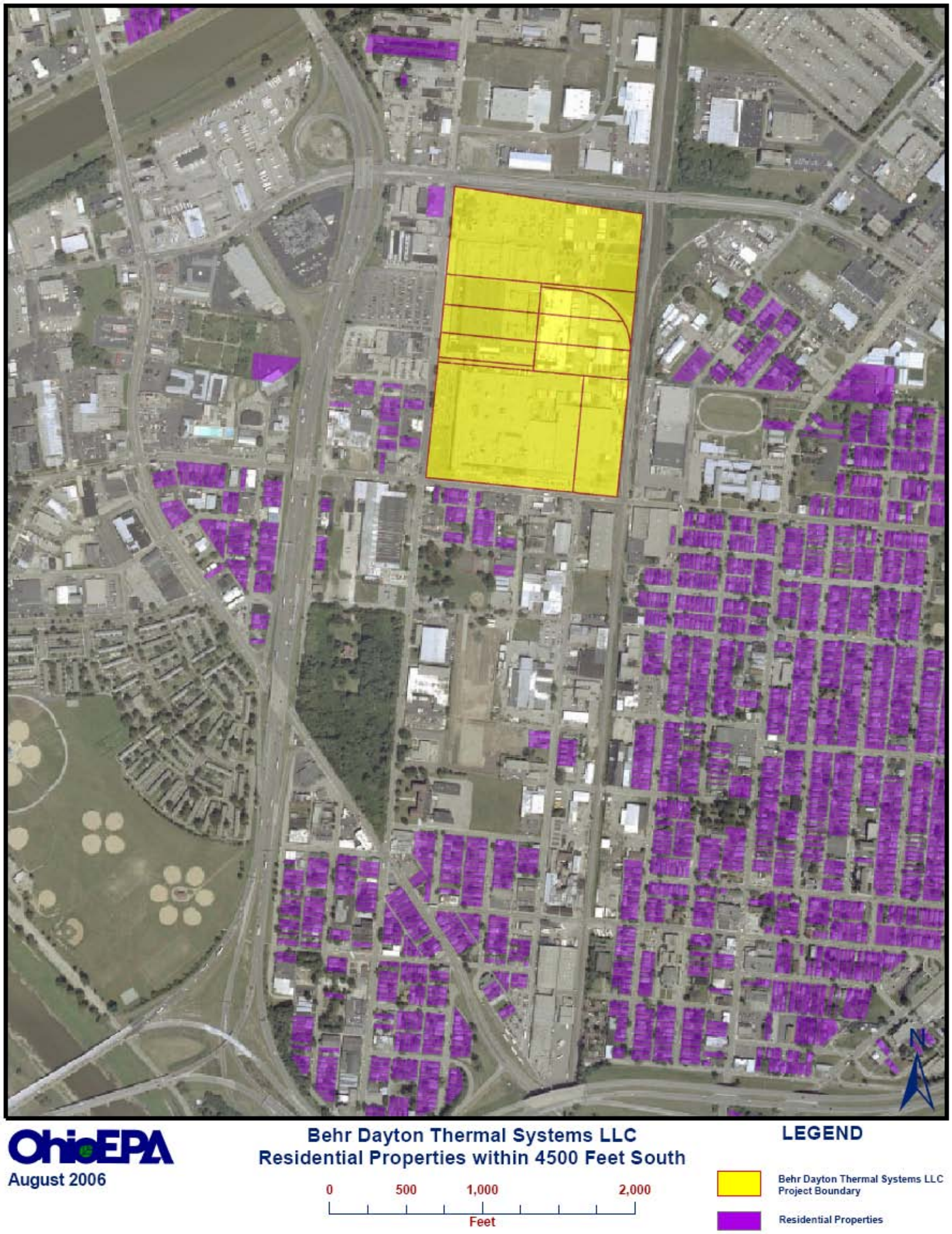


Figure 2 Residential Properties South of the Behr Dayton Facility

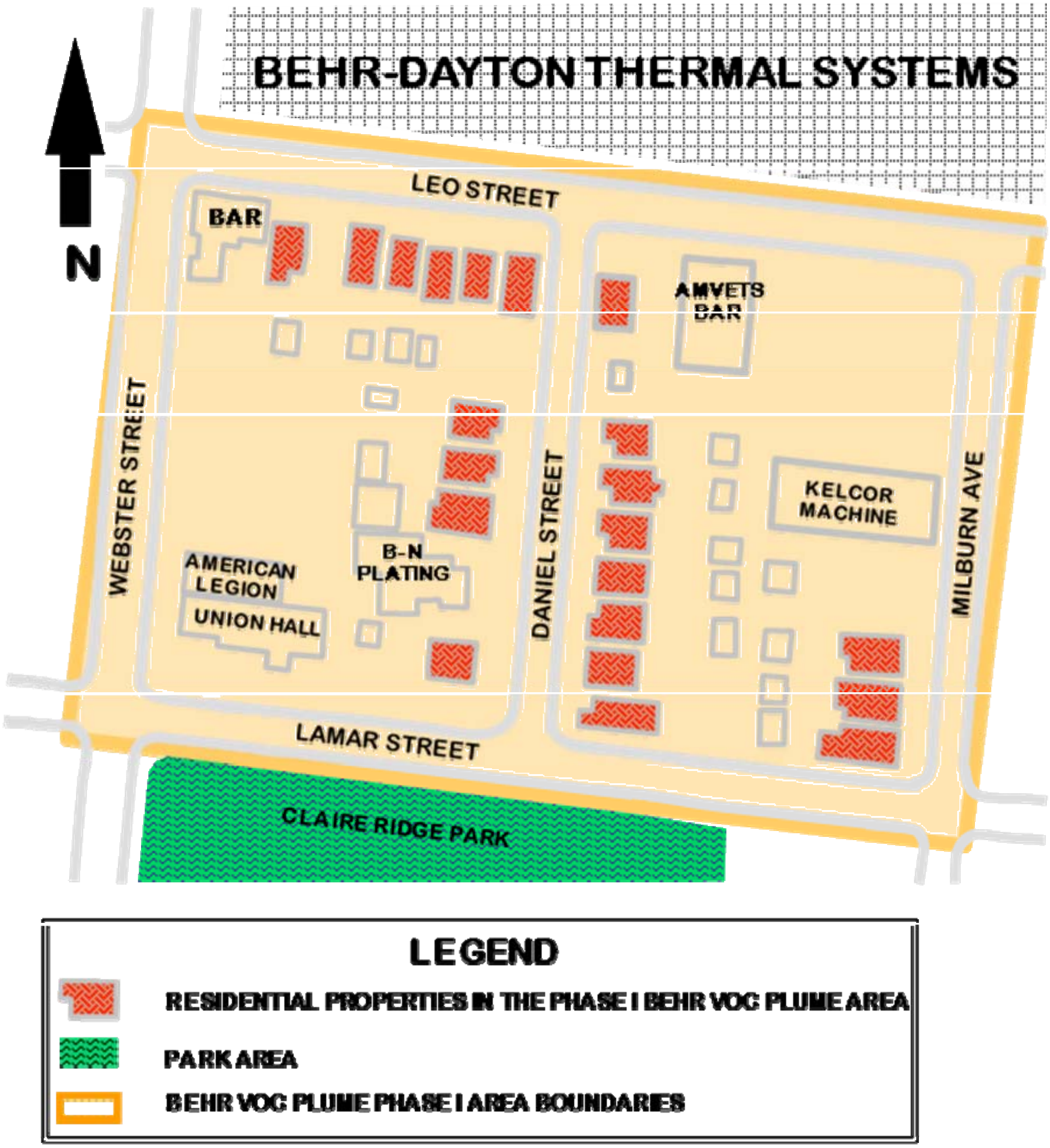
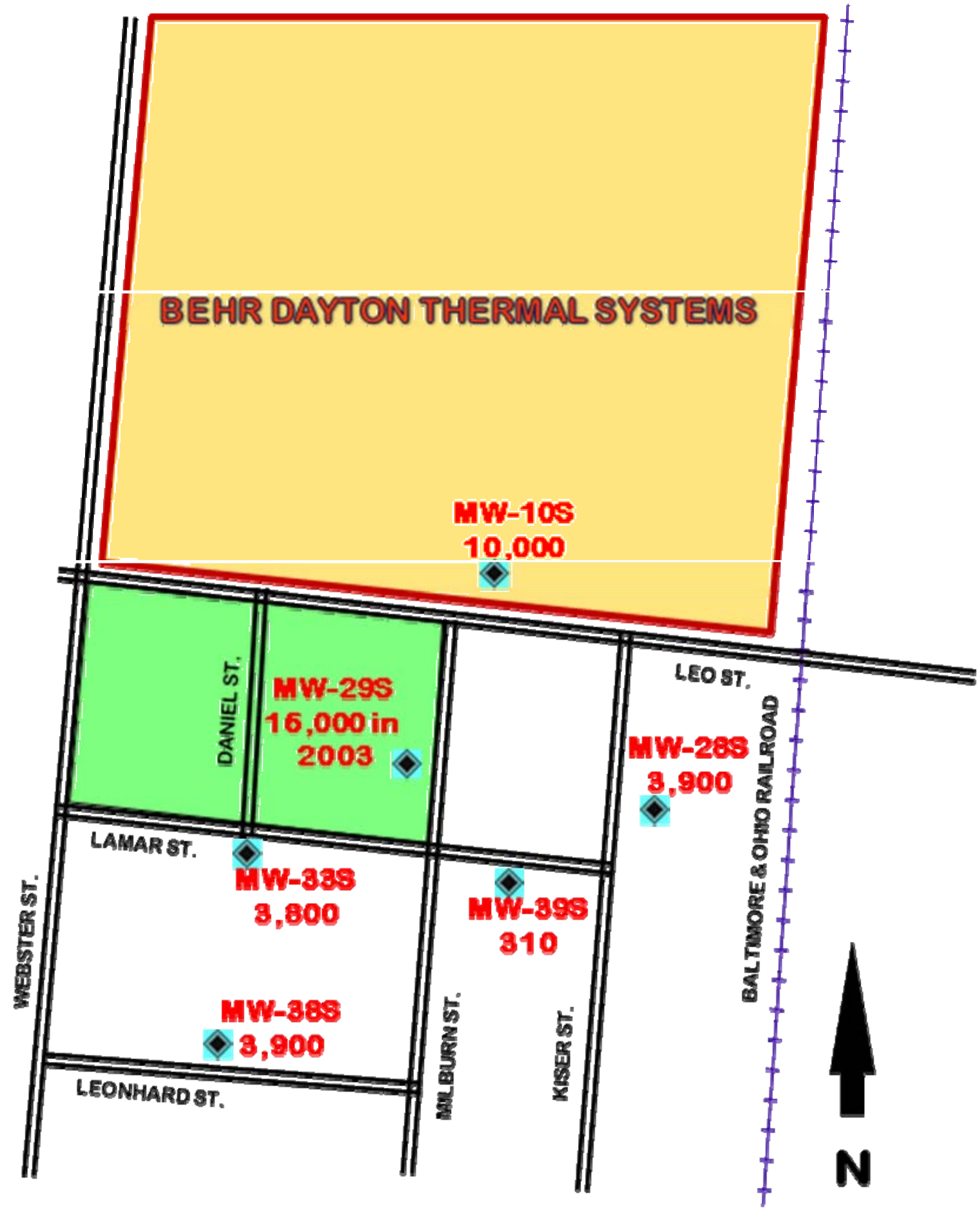


FIGURE 3 – RESIDENTIAL PROPERTIES IN THE BEHR VOC PLUME – PHASE I AREA



LEGEND

GROUNDWATER MONITORING WELL LOCATION

PHASE I LOCATION

MONITORING WELL & TCE LEVELS IN PPB

FIGURE 4 – TCE LEVELS IN GROUNDWATER 2006
BEHR VOC PLUME AREA

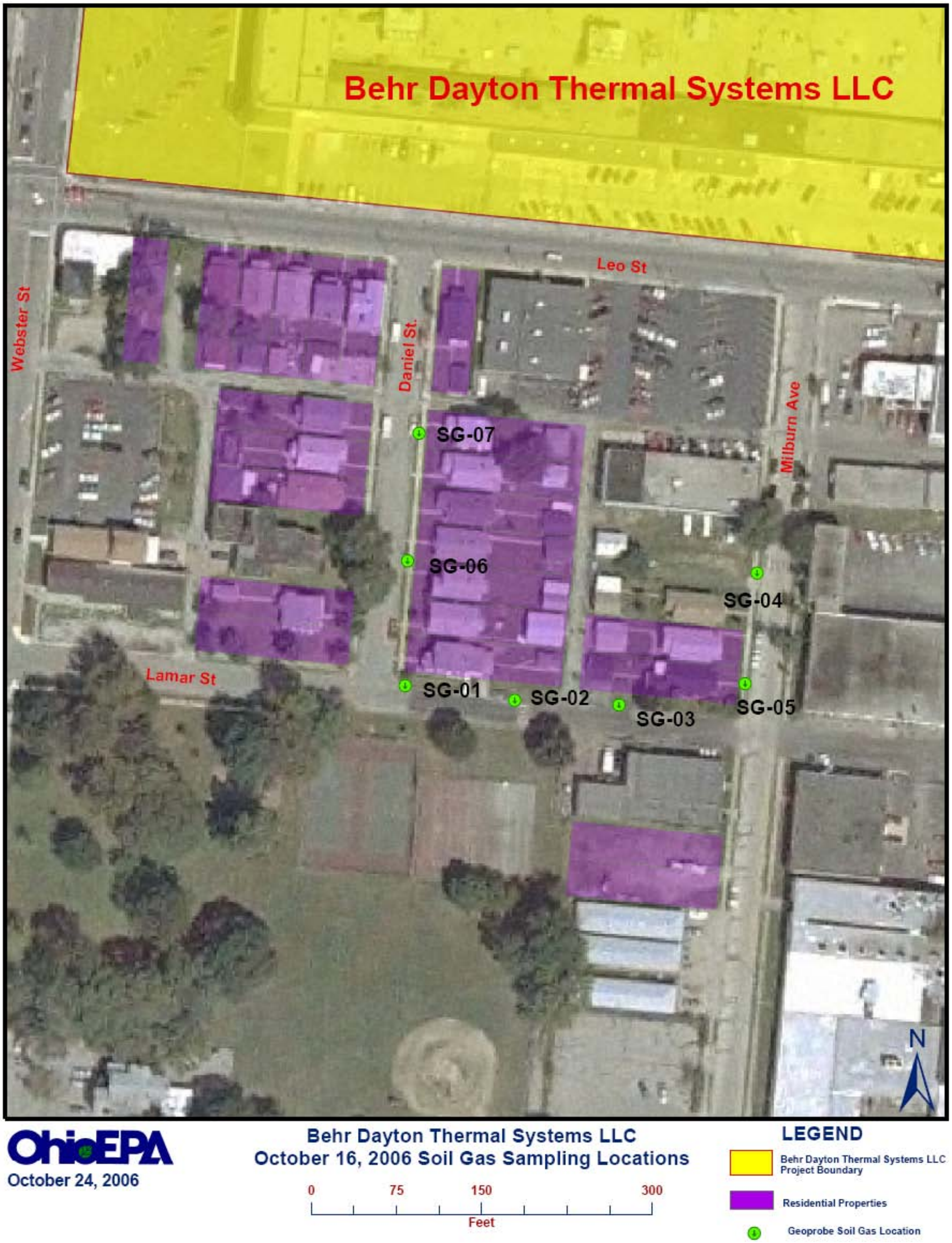


Figure 5 Ohio EPA Soil Gas Sample Locations

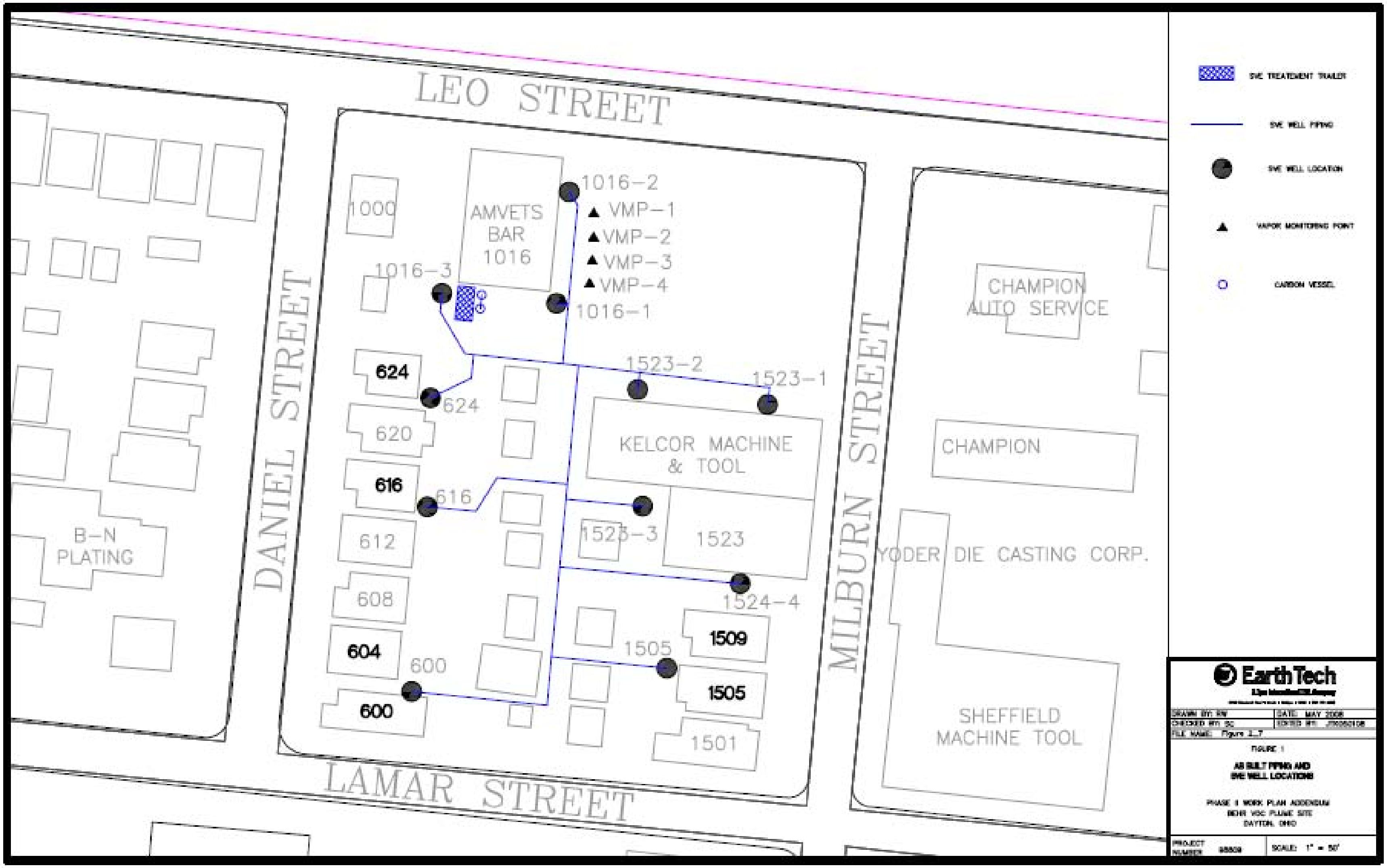


Figure 6 As Built Soil Vapor Extraction

APPENDIX A

"ACTION LEVELS" (Parts per billion per volume) FOR CHLORINATED SOLVENTS BEHR-DAYTON SITE, DAYTON, MONTGOMERY COUNTY

Residential	Short-term Action Level[1]	Short-term Action Level	Long-term Screening Level[2]	Long-term Screening Level
Chemical	**Indoor Residential**	**Sub-slab Residential**	**Indoor Residential**	**Sub-slab Residential**
Trichloroethylene	100	1,000	0.4	4.0
Perchloroethylene	200	2,000	12	120
cis 1,2 DCE	200	2,000	8.8	88
trans 1,2 DCE	200	2,000	18	180
1,1,1 TCA	700	7,000	400	4,000
Vinyl chloride	30	300	11	110

[1] = ATSDR Intermediate Environmental Media Evaluation Guide (EMEG) for air
[2] = US EPA Draft Vapor Intrusion Guidance document (2002) [Target Indoor air concentration at the 10^{-4} Risk Level]

Note: TCE, PCE, and Vinyl chloride are considered to be human carcinogens and values are based on a 10^{-4} cancer risk number. 1,2 DCE and 1,1,1 TCA are non-carcinogens and risk value based on a chronic hazard index of 1.0

"Short-term Action Level" denotes a level that would trigger immediate action to be taken to reduce exposure levels, either through installation of a sub-slab depressurization system, improved ventilation, or some other action that could be implemented to reduce exposure until the source could be remediated. The "Intermediate" ATSDR EMEG is used instead of the "Acute" EMEG as these exposures would more likely represent something greater than 14 days but less than a lifetime. As such, an exceedence does not necessarily indicate that the home would be unsafe for occupancy, necessitating evacuation of residents. These numbers represent fairly conservative screening criteria.

Evacuation might be a potential course of action if levels of COCs exceeded an Acute EMEG value [2,000 ppb for TCE] or more appropriately a Temporary Emergency Exposure Limit (TEEL) [= 100 ppm for TCE].

Commercial	Short-term Action Level [1]	Short-term Action Level	Long-term Screening Level [2]	Long-term Screening Level
Chemical	**Indoor Commercial**	**Sub-slab Commercial**	**Indoor Commercial**	**Sub-slab Commercial**
Trichloroethylene	420	4,200	1.7	17
Perchloroethylene	840	8,400	50	500
cis 1,2 DCE	840	8,400	37	370
trans 1,2 DCE	840	8,400	76	760
1,1,1 TCA				
Vinyl chloride	126	1,260	46	460

[1] = ATSDR Intermediate Environmental Media Evaluation Guidance (EMEG); adjusted for 8-hr day
[2] = Target Indoor air concentrations US EPA Vapor Intrusion Guidance document (2001); adjusted for 8-hour day

APPENDIX B

The fact sheets for *Exposure to Toxic Chemicals*, the *Vapor Intrusion Pathway*, and *Trichloroethylene* can be found at the Ohio Department of Health web link;

www.odh.ohio.gov/odhPrograms/eh/hlth_as/chemfs1.aspx

CERTIFICATION

This Behr VOC Plume Site Chrysler Corporation, Phase I Area Health Assessment was prepared by the Ohio 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.
Editorial review was completed by the cooperative agreement partner.

Technical Project Officer, Cooperative Agreement Program Evaluation Branch (CAPEB), Division of Health Assessment and Consultation (DHAC), ATSDR

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

Gregg V. Ulirsch

Team Leader, CAPEB, DHAC, ATSDR