Health Consultation

PARCEL C (AKA: FORMER GORHAM SITE)

PROVIDENCE, RHODE ISLAND

EPA FACILITY ID: RID001195015

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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

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Summary and Statement of Issues

The Agency for Toxic Substances and Disease Registry (ATSDR) was requested[1] to review and evaluate available environmental data and exposure scenarios to determine whether the levels of contaminants detected at the former Gorham Manufacturing Facility site (Gorham site), located at 333 Adelaide Avenue, Providence, Rhode Island, pose a public health threat under current and future land uses.

For development purposes, the Gorham site has been divided into four distinct parcels (A, B, C, and D). In December 2006, ATSDR released a health consultation for Parcel B that evaluated whether the remediation plans for the Adelaide Avenue High School were protective of public health [ATSDR 2006]. The Parcel B health consult concluded that the proposed mitigation technique should prevent harmful exposures to school occupants from the vapor intrusion exposure pathway and the proposed periodic sampling should determine if the sub-slab ventilation system is operating according to design. Parcels A and D of the Gorham site will be addressed by ATSDR in subsequent health consultations. The purpose and focus of this health consultation for Parcel C of the Gorham site is to evaluate the available environmental data (groundwater, soil and soil vapor) and current site conditions to determine if this parcel poses a public health threat.

Parcel C is currently an undeveloped 5-acre portion of land located in the western area of the site (Figure 1). The City of Providence owns Parcel C. The YMCA of Greater Providence (YMCA) holds a long-term lease for Parcel C, but no remediation or construction has occurred on this parcel and there are currently no plans to develop it.

Investigations have revealed that the groundwater, soil, and soil vapor beneath Parcel C contain elevated levels of contaminants, including volatile organic compounds (VOCs), metals, and polycyclic aromatic hydrocarbons (PAHs). In addition, methane was detected by field-screening methods. However, most of the data collected for this parcel is at least seven years old, leaving some uncertainties about the current nature and extent of contamination.

ATSDR identified three possible ways people might encounter detected levels of contaminants at Parcel C: incidental ingestion of and dermal contact with contaminated soil (trespassers); inhalation of vapors that could potentially migrate from groundwater or soil vapor into buildings that may be constructed during development of the property (future occupants of the buildings); and exposure to physical hazards currently and during the development of the parcel (trespassers and on-site future construction workers).

Given the incomplete plans as to the future use of Parcel C and the lack of current data, ATSDR concludes that the parcel poses an *indeterminate public health hazard*. Detected levels of contamination in groundwater and soil vapor, and the continued potential for methane gas production, in particular, require closer examination as future plans for parcel remediation and development unfold.

[1] ATSDR responds to formal petitions requesting the agency to review chemical exposure data. The purpose of the data reviews is to provide public health advice that prevents people from harmful exposures to chemicals.

ATSDR therefore recommends that site investigators address uncertainties regarding the nature and extent of Parcel C contamination and identify contaminant sources. An assessment of exposure potential and any possible associated hazards should be conducted when contamination of the parcel is characterized and future development plans are determined. This may include estimating indoor air exposures using models similar to those used in ATSDR's public health evaluation of Parcel B [ATSDR 2006].

Background

The Gorham site is a 37-acre parcel of land in Providence, Rhode Island, where Gorham manufactured silverware, both sterling and plated, and bronze castings from 1890 to 1986 (Figure 1). Substances used or released on the site as a result of process operations include: VOCs, PAHs, cyanides, and heavy metals. Trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,1,1-trichloroethane (TCA) were used as degreasers at the site [MACTEC 2006].

Parcel C is a 5-acre portion of land located in the western area of the site, adjacent to the Adelaide Avenue High School (Parcel B) (Figure 1). The property is largely flat, at an elevation of approximately 65 feet above mean sea level [ABB 1995]. Buildings on Parcel C associated with the operations at Gorham Silver were not used for production or manufacturing, but only for storage [ABB 1995]. However, Parcel C was used as a landfill for the Gorham facility [ABB 1995]. In 2001, the buildings and structures on Parcel C were demolished [EA 2005]. Currently, the parcel contains a 1,000 cubic yard stockpile of uncertain composition, and is surrounded by a locked, chain-link fence [GZA 2002, 2005a]. The parcel is undeveloped, and plans for future development or construction are uncertain.

Potential Contamination Sources

Though no known industrial processes occurred on Parcel C, a significant amount of heterogeneous fill underlies most of the parcel. It appears that this fill was deposited gradually throughout the course of production and manufacturing, and contains casting sands, construction, demolition, and miscellaneous debris such as fire bricks, wood beams, metal debris, pipes, cloth, glass, canisters, and crushed drums. Reports indicate that the thickness of fill ranges from 2 to 27 feet, and that the fill is in a loose to medium state, and there is no documentation that fill materials on the parcel have ever been compacted [ABB 1995; GZA 2005a]. Pre-existing underground storage tanks have been removed, and no additional tanks have been reported in or around Parcel C [GZA 2005a]. The primary source of soil contamination is attributed to the underlying fill [Harding ESE 2001] and the soil vapor contamination is being attributed to the volatilization of VOCs from the underlying groundwater [GZA 2006].

There are conflicting interpretations of the source of Parcel C groundwater contamination from two environmental contractors as indicated in the above paragraph. By most accounts, the source appears to be the fill material beneath the parcel, as detailed below:

- Earlier reports suggest that the primary source of groundwater contamination beneath Parcel C is from the underlying fill material [ABB 1995; HLA 1999]. These reports indicate that a VOC plume extended from Parcel A and across the northeast portion of Parcel B, but did not come into contact with Parcel C.

- Figure 4-2 in the 1995 remedial investigation report presents a schematic of TCE in the shallow groundwater based on data available in the mid-1990's. In addition to the plume originating from Parcel A sources, an area of TCE contamination in Parcel C is also shown. The plumes are not shown to be connected in any way, and the source is described as the fill material [ABB 1995].

However, other reports indicate that VOCs in soil gas in Parcel C are associated with the "groundwater contamination plume," in addition to the landfill areas located beneath this area [GZA 2002, 2006]. GZA (2006) states that previous studies have documented that "VOCs, primarily TCE and freon, are present in soil gas at low levels (ppmv) beneath the central and northern areas of Parcel C. These appear to be associated with the volatilization of these constituents from the groundwater plume that has been identified beneath the site, but originating from an adjoining parcel."

The most recent (limited) groundwater investigations indicate that the VOC plume originating from Parcel A appears to be contained within Parcel A [Shaw 2007]. However, there have been no remedial actions taken to contain or remove the VOC plume within Parcel A.

At this time, ATSDR considers both the fill material and groundwater contamination as contributors to the soil gas contamination detected on Parcel C.

Hydrology and Groundwater Use

A glacial outwash plain underlies the entire site, and consists of sorted sands and local deposits of gravel, underlain by approximately 55 feet of brown, fine to medium sand. In the northern and western portions of Parcel C, industrial fill lies on top of this outwash plain. On average, depth to groundwater beneath Parcel C is about 28 feet [GZA 2005a].

Groundwater beneath Parcel C has been reported to flow northwest in an unconfined aquifer, toward Mashapaug Pond [GZA 2006]. ABB's 1995 remedial investigation (RI) also described shallow and deep groundwater as generally flowing north and northwest, toward Mashapaug Pond and Mashapaug Cove. Groundwater flow documented for other site parcels is generally north or northwest, toward the pond/cove [Shaw 2006; ENSR 2007].

The Rhode Island Department of Environmental Management (RIDEM) has classified the groundwater as Class GB: not suitable for public or private drinking water use. No public or private wells exist within a 4-mile radius of the site, and the nearest public water supply is the Scituate Reservoir, located approximately 9 miles to the west [ABB 1995; MACTEC 2006].

Proposed Remedial Actions and Objectives

To date, no remediation has been conducted on Parcel C. There were once plans to construct a large building on Parcel C, and remedial objectives to address exposure concerns associated with the development were detailed in a RIDEM approved Remedial Action Work Plan (RAWP)

[GZA 2005a]. The proposed actions included environmental land use restrictions (ELUR detailed in RAWP), capping the soil (with asphalt, concrete, building structures, or clean soil) and maintaining the remedy if the cap is disturbed, land use restrictions, constructing a detention pond to manage post-construction surface water runoff, and installing a sub-slab negative pressure ventilation system beneath the proposed building (s). Future construction plans may consider similar actions.

Comparison values (CVs)—or screening values—are health-based values developed by ATSDR from available scientific literature concerning exposure and health effects. Comparison values are derived for specific environmental media (water, soil, air) and reflect an estimated contaminant concentration that is not expected to cause harmful health effects, assuming a standard daily contact rate. Because they reflect concentrations that are much lower than those that have been observed to cause adverse health effects, CVs are protective of public health in essentially all exposure situations. As a result, **concentrations detected at or below ATSDR's CVs are not considered to be a public health hazard.** Those contaminants detected at concentrations above ATSDR's CVs require further evaluation.

Discussion

To study the possible health impacts of exposure to contaminants on Parcel C, ATSDR reviewed groundwater, soil, and soil vapor sampling data provided in various reports prepared by the City of Providence, Textron (former property owners), and other parties. All analytical data were provided by RIDEM. Most environmental sampling data considered in this consultation were required to meet specific quality assurance and quality control measures for chain-of-custody procedures, laboratory procedures, and data reporting (see Appendix A for details).

ATSDR evaluated the limited data available to determine if the contaminant levels detected pose a public health hazard. As an initial screen, ATSDR compared concentrations of detected contaminants to health-based screening values. This evaluation enabled ATSDR to consider all detected contaminants, but focus on those contaminants of greatest potential public health concern. ATSDR also examined the possible ways people might come in contact with reported contamination and whether those exposures might be harmful.

Exposure Pathways

For a person to be exposed to a contaminant, the exposure pathway must contain the following five elements [ATSDR 2005]:

- A source of contamination.
- A release mechanism into water, soil, air, food chain (biota) or transfer between media (i.e., the fate and transport of environmental contamination).
- An exposure point or area (e.g., drinking well water, residential yard).
- An exposure route (e.g., ingestion, dermal contact, inhalation).
- A receptor population (i.e., residents, children, workers).

A *potential* exposure pathway exists when information about one or more of the five elements of an exposure pathway is missing or uncertain. Potential exposure pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring, or could occur in the future.[ATSDR 2005]

A future potential exposure pathway includes situations in which contamination does not currently exist at an exposure point but is speculated to occur in the future. For example, if buildings are constructed on Parcel C, then a future potential exposure pathway may exist from vapor intrusion into the indoor air of those buildings from the contaminants in the groundwater and subsurface soil.

For Parcel C, ATSDR identified the following current and future potential exposure pathways based on a review of available parcel data:

Current potential exposure pathways:

- Exposure to surface soils
- Exposure to physical hazards

Future potential exposure pathways:

- Exposure to surface soils
- Exposure to physical hazards including explosions
- Vapor intrusion from underlying groundwater and soil into indoor air if buildings are constructed

Following is a detailed discussion on these exposure pathways and associated contaminants, including perspective on potential health hazards where possible.

Exposure to Surface Soils

A total of 15 surface soil samples were collected from Parcel C during the years 1989, 1994, 1998, 2001, and 2005 [GZA 2003] (see Table 1, 2). Most samples collected prior to 2005 were analyzed for PAHs and metals, and a small subset of samples was analyzed for VOCs and TPHs. In 2005, a single soil sample was collected from the northern edge of Parcel C. This sample was analyzed for metals, polychlorinated biphenyls (PCBs), pesticides, semi-volatile organic compounds (SVOCs), and dioxins and furans.

As shown in Table 2, Parcel C surface soils contained arsenic, cadmium, chromium, copper, lead, and silver at concentrations exceeding CVs. Surface soils also contained several PAHs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene at concentrations exceeding CVs in about half the samples collected. TPH was detected in surface soil samples at an average concentration of 1,300 parts per million (ppm). In 2005, the single sample analyzed for dioxins and furans slightly exceeded the CV.

In addition to the surface soil sampling, site investigators collected a *single composite sample* from the top 12 inches of the stockpile (sample GZ-1). Detected concentrations of PAHs in the stockpile soil were above CVs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene [GZA 2005b]. Additionally, TPH was detected at an elevated concentration of 2,300 ppm—slightly higher than the average TPH concentration detected throughout the rest of Parcel C. The sample was also analyzed for asbestos, which was not detected.

Exposure Assessment and Health Effects Evaluation: Surface Soils

Parcel C is currently partially enclosed by a locked, chain-link fence in good condition.
It was very clear to ATSDR during our site visit in December of 2006 that people could trespass onto the site and onto Parcel D (Park/Pond Parcel) due to several breaks in the fence. The soil is overgrown with vegetation throughout Parcel C. There are also no trespassing signs posted along the fence. Based on current parcel use and conditions, it is unlikely that the general public would come into contact with surface soil contamination on Parcel C for a sufficient amount of time to result in any adverse health effects. ATSDR personnel also met and spoke to a homeless woman camping on the Park Parcel D and fishing in the pond. Trespassers currently represent the population most likely to come into contact with the contaminated surface soil on Parcel C. Parcel C has not been fully characterized for the nature and extent of contamination.

PAHs and metals (e.g. lead) in the soil appear to be the primary contaminants of interest and may drive the need for measures to prevent soil exposures. However, site characterization is incomplete. For example, a single 2001 soil sample revealed an elevated lead concentration (1,780 ppm), which could increase the risk of unhealthy lead exposures to a child exposed on a daily basis to soils with this concentration. Though the remaining 13 samples analyzed for lead did not show elevated concentrations, questions still remain on the property that can only be answered by characterizing the nature and extent of the contamination on Parcel C (approximately 5 acres in size).

Depending on future land use at Parcel C, additional surface soil sampling may be necessary to fully evaluate the public health hazards associated with contaminated soil, especially for young children. Currently, trespassers represent the most likely population to come into contact with site related contamination (surface soil) and physical hazards. Although contaminant levels are above CVs, trespassers are not likely to come into contact with contaminants at sufficient amounts, concentrations, or durations to result in any adverse health effects. The need for further characterization would be particularly important if remedial actions such as those proposed in the 2005 RAWP are not implemented (e.g., capping all soil with asphalt pavement, building structures, or 2 feet of clean soil). However, a soil cap may not adequately protect the underlying soil from being disturbed and brought to the surface. If the current Parcel C ELUR will be implemented by any future owners of Parcel C then the soil contamination exposure route may not be a public health concern.

Vapor Intrusion from Underlying Groundwater and Soil to Indoor Air

Vapor intrusion refers to the process by which vapors move from a subsurface source (i.e., groundwater or soil) into the indoor air of overlying buildings. This evaluation is presented to determine the extent to which harmful exposures might occur if buildings are constructed on Parcel C. As ATSDR communicated in the Parcel B health consultation, conditions beneath the Gorham Silver site are such that the vapor intrusion scenario is plausible [ATSDR 2006]. This section describes Parcel C groundwater and subsurface soil conditions in the context of evaluating the future potential for vapor intrusion.

Groundwater Conditions and Sampling

Twelve groundwater samples were collected from five monitoring wells (some wells were sampled more than once) in 1989, 1994, and 1998, and evaluated primarily for VOCs. SVOCs, TPH, and metals. Monitoring well locations are mapped in Figure 3, and sampling depths are listed in Table 4.

The following contaminants were detected in Parcel C groundwater at concentrations exceeding selected screening values: 1,2-dichloroethene (total), bis(2-ethylhexyl)phthalate, TCE, arsenic, copper, iron, lead, and manganese. Only TCE consistently exceeded the Connecticut's Groundwater Volatilization Criteria (CT GWVC) screening value, which was used specifically to provide additional perspective and a more realistic screen for the exposure pathway of interest (vapor intrusion). ATSDR has not developed screening values that account for vapor migration from groundwater and soil gas into indoor air. Therefore, ATSDR examined screening criteria developed by various states (e.g., California, Connecticut, and Michigan) that set target or "safe" indoor air concentrations and establish groundwater and soil gas concentrations associated with those target indoor air concentrations. Connecticut's Remediation Standard Regulations "Volatilization Criteria" (proposed revisions) [CT DEP 2003] were selected to serve as an appropriate health-protective screening guide. The Connecticut target indoor air concentrations (TACs) consider both cancer and non-cancer health effects for the VOCs of interest and are based on the best available science. Further, the Connecticut criteria were proposed in RIDEM-approved remedial action work plans for the Gorham Silver site.

A single detection of vinyl chloride (1998) also exceeded the CT GWVC. Nearly all of the samples with the highest levels of contamination in Parcel C were analyzed in 1989 and 1994, and most of these samples were from wells located in the northern portion of the parcel. Based on available data, concentrations of most VOCs in groundwater at and near Parcel C have decreased over time (but the limited number of samples poses uncertainty of the contamination for the entire site (5 acres)). Results of historic groundwater sampling are listed in Table 5. Table 6 summarizes groundwater sampling results from 1998 only, which are the most recent sampling dates. Even though groundwater beneath the parcel is not being used for drinking water or any other purposes, a comparison of detected contaminant concentrations to health-based CVs for drinking water is presented to provide overall perspective on the nature and extent of contamination.

Groundwater Data Gaps

According to site investigators, no post-1998 groundwater sampling data are available for Parcel C. Therefore, current conditions are not known. Further, none of the available documentation depicts the full lateral and vertical extent of Parcel C groundwater contamination. For example, sampling is limited largely to the northern portion of the parcel.

Another information gap relates to the source of the detected contamination. Knowledge of the source would support assumptions about whether the concentrations of contamination would be expected to decrease, remain the same, or increase in the future. As noted earlier, a localized source (i.e., fill material) was identified as the primary source of groundwater contamination in earlier site investigation reports, but some more recent site-related documents and communications seem to indicate that the primary source of Parcel C groundwater contamination originates in another site parcel (i.e., Parcel A) [GZA 2005a; J. Hartley, GZA, personal communication, April 2007]. Site investigators from Textron disagree that groundwater from Parcel A extends beneath Parcel C [G. Simpson, Textron, Inc., personal communication, April 2007; HLA 1999]. The groundwater contamination could be coming from a combination of both sources discussed above. However, this cannot be determined without a full underground (groundwater and subsurface soils) characterization to determine the nature and extent of the contamination.

Subsurface Soil Conditions and Sampling

Fifteen subsurface soil samples were collected from Parcel C during the years 1989, 1994, and 2001. Subsurface soils are defined as those more than 12 inches below the ground surface. Some of these are composite samples, which combined material from multiple sampling locations and depths. Altogether, these 15 samples come from 8 different sampling locations (some locations were sampled more than once, at different depth intervals) (Figure 4). Samples were analyzed for VOCs, PAHs, TPH, and metals.

Results of the subsurface soil sampling in Parcel C indicate that, like the surface soil, elevated levels of the PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene) were detected at concentrations approximately 100 times above CVs (see Table 7). Copper, arsenic, and lead were all detected above the CVs. TPH was detected in subsurface soils at an average concentration of nearly 5,000 ppm. VOCs were detected at concentrations thousands of times lower than screening values. None of the most recent (2001) subsurface soil samples were tested for VOCs.

Subsurface Data Gaps

No documentation was identified describing the current nature of the fill material (e.g., presence of buried materials), which could be a continued source of subsurface soil and groundwater contamination. Additional sampling is needed to determine the nature and extent of subsurface soil contamination.

Soil Vapor Conditions and Sampling

Soil vapor samples were collected in 2001 from 10 distinct probe locations in Parcel C. Samples were taken from 2.5 feet below ground surface, from locations throughout Parcel C (see Figure 5). In 2001, investigators also conducted field screening of 28 soil gas probes located throughout Parcel C for total VOCs, methane, oxygen, and carbon dioxide.

The following VOCs were detected at concentrations above ATSDR's CVs: PCE (three samples greater than CV), TCE (seven samples greater than CV), trichlorofluoromethane (six samples greater than CV), benzene (one sample greater than CV), dichloroethene (one sample greater than CV) and vinyl chloride (one sample greater than CV) [Table 8]. Because these concentrations do not represent exposure point concentrations, detected soil vapor concentrations were also compared to Soil Vapor Volatilization Criteria (SVVC) developed by the state of Connecticut.[2] For comparison, the Connecticut Target Indoor Air Concentration (TAC) values also have been included in the summary table (Table 8) [ATSDR 2008]. If this parcel is developed (buildings constructed on parcel), the vapor intrusion pathway would represent the most important route of exposure to investigate.

Of the 28 field screening samples, only one showed detectable VOCs. However, the detection limit for VOCs was 100 parts per billion by volume (ppbv), which is higher than many CVs. The screening data indicate that biodegradation of organic material may be occurring in the soils beneath Parcel C. As noted above, methane was detected in 3 of 28 screening locations in Parcel C, at concentrations as high as 5.4%.

Soil Vapor Data Gaps
The sampling confirms the presence of VOCs. However, temporal trends characterizing the profile of the VOC contamination (e.g., possible attenuation over time), or plotting soil vapor data against changing groundwater conditions is not possible. Further, no vertical profile of conditions is available because all samples were collected from the same depth (2.5 feet). Additionally, laboratory detection limits were generally above the most conservative CVs. For example, the detection limit for vinyl chloride was 391 ppbv, nearly 10,000 times the CREG of 0.04 ppbv.

Exposure Assessment and Health Hazard Evaluation: Groundwater, soil vapor, and subsurface soil

The presence of VOCs (e.g., TCE and PCE) in Parcel C groundwater and soil vapor at concentrations above health-based CVs means the potential exists for the VOCs to migrate as vapors into building air at levels of possible health concern.[ATSDR 2008]

While available data on groundwater and soil vapor contamination provide a glimpse into how indoor air quality might be affected if buildings are built on Parcel C, additional data are needed

[2] The Connecticut Soil Vapor Volatilization Criteria (SVVC) represents the concentration in soil vapor that would be associated with the health-based target indoor air concentrations assuming attenuation as the vapor passes through soil, across the building foundation, and into indoor space. Connecticut developed a residential and industrial/commercial SVVC. For screening purposes, the lower residential SVVC values were used.

to fully characterize the potential for vapor intrusion into future buildings, and for ATSDR to complete a full analysis of potential health impacts. Specifically, data gaps or limitations include:

- The extent of lateral and vertical contamination is not known.
- The source of VOCs in groundwater is not certain.
- Future land use is currently unknown.

A complete analysis of potential health impacts would also require an understanding of any planned parcel development and remediation or engineering controls. For example, if a building is proposed, where would it be located in relation to known or suspected VOC contamination beneath Parcel C, and what type of cleanup activities or other actions, e.g. engineering controls, are planned to prevent people from being exposed to contamination?

For these reasons, ATSDR has not conducted vapor intrusion modeling for Parcel C, as was done for Parcel B.

Exposure to Physical Hazards – Including Explosion

Though relatively benign from a toxicity perspective, methane gas could present an explosion hazard to construction workers and future occupants at Parcel C under certain conditions. The concentration at which a gas has the potential to explode is defined by its lower explosive limit (LEL) and upper explosive limit (UEL), which are measures of the percent of a gas in the air by volume. The LEL for methane is 5% and the UEL is 15% by volume [ATSDR 2001]. An explosion hazard exists if a gas is present in the air between the LEL and UEL and an ignition source is present.

As noted above, methane was detected at three out of 28 screening locations in Parcel C, at concentrations as high as 5.4%, and reduced oxygen has been correlated with increased carbon dioxide concentrations [GZA 2002]. The maximum screening concentration reported (5.4% by volume) lies between the LEL and UEL for methane. Because these findings represent screening results from samples collected during a single monitoring event more than seven years ago, we do not know with any certainty how widespread or persistent methane conditions may be throughout Parcel C. Additional sampling would be needed to determine the potential hazard posed, particularly in the context of future plans for the parcel. In the adjacent parcel (Parcel B) where the high school is located, a sub-slab ventilation system and methane monitors are in place to prevent harmful exposures to school occupants from the vapor intrusion exposure pathway and from an explosive hazard (Figure 1) [ATSDR 2006].

In addition, no documentation exists to determine whether or to what extent the foundation soils (and fill materials) have or will be compacted. This information is needed to evaluate whether a hazard will exist for workers during construction, and whether the integrity of building foundations will be in question.

Child Health Considerations

ATSDR considers children in the evaluation of all exposures, and the Agency uses health guidelines that are protective of children. ATSDR also considers unique exposure situations on a site-specific basis. In general, ATSDR assumes that children are more susceptible to chemical exposures. Children weigh less than adults, which may result in higher doses of chemical exposures relative to body weight; children have higher rates of respiration; metabolism and detoxification mechanisms may differ, and if toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. While these characteristics apply largely to younger children, scientists continue to explore vulnerabilities at all growth stages, including puberty and early adolescence. Consideration is also given to the effects of possible exposures on the fetus, or unborn child. ATSDR has considered these factors in the development of conclusions and recommendations for this parcel.

Based on currently available data, the potential concern for children's health relates to the possible extent of lead and TPHs (Table 2) in surface soils and physical hazards (most of the site was a landfill)posed by the current parcel

For example, a single 2001 soil sample revealed an elevated lead concentration (1,780 ppm), which could increase the risk of unhealthy lead exposures to a child exposed on a daily basis to soils with this concentration. Though the remaining 13 samples analyzed for lead did not show elevated concentrations, questions still remain.on the property that can only be answered by characterizing the nature and extent of the contamination on Parcel C (approximately 5 acres in size).

Currently the parcel has a fence, locked gate, and warning signs indicating do not trespass. But ATSDR noticed on a site visit several breaks in the fence that could allow access to Parcel C. However, it is unlikely that young children would be exposed to the maximum concentrations of PAHs and lead detected in the surface soils for a long enough period on a regular basis for the levels of contaminants to pose a health concern. However, potential exposures of children should be considerd in future development plans (e.g., schools, daycare facilities, playgrounds, etc.) for the parcel.

Conclusions

In summary, ATSDR concludes that Parcel C of the Gorham site poses an *indeterminate public health hazard* based on inadequate site characterization (environmental data gaps) and uncertainties about future plans for Parcel C remediation and development. Detected levels of contamination in some available surface soil, groundwater, and soil vapor samples exceed health-based screening values. However, possible health impacts, if any, cannot be fully evaluated without more information about current site conditions, including the potential for methane gas production. ATSDR's conclusions regarding each exposure scenario evaluated are listed below.

Current and Future Site Conditions: Exposure Scenarios for Surface Soils and Physical Hazards:

Exposure to contaminated surface soil and physical hazards is an indeterminate public health hazard. To fully evaluate possible health hazards, ATSDR needs to better understand whether detected levels of contamination truly represent parcel-wide conditions and the extent to which future land users may be exposed. Depending on future land use at Parcel C, additional soil sampling may or may not be necessary to fully evaluate possible public health hazards associated with contaminated soil. Soil hazards may be minimized, if not eliminated, if parcel developers plan to cap all soil with asphalt pavement, building structures, or clean soil, as was proposed in earlier parcel remediation plans. At this time, soil conditions based on available data are not expected to pose a hazard to current trespassers. Physical hazards exist on site due to the past use of most of the parcel as a landfill.

Future Site Conditions: Exposure Scenarios for Physical Hazards and Vapor Intrusion:

- *Exposure to physical hazards is an indeterminate public health hazard*. In the case of future remedial and construction activities and future building plans, physical hazards may be present on Parcel C (including explosion hazards) below the surface. Not only are there explosive hazards during remedial and construction activities but after buildings are built methane gas can enter and concentrate causing an explosive condition. In addition, because the underlying soil beneath Parcel C is heterogeneous fill with no documentation of compaction, the area will require some sort of improvement in order to allow for the safe construction of the building foundations [GZA 2005a].

- *Vapor intrusion from underlying groundwater and soil vapor into indoor air is an indeterminate public health hazard.* The presence of VOCs in Parcel C groundwater and soil vapor at concentrations above health-based CVs means the potential exists for the VOCs to migrate as vapors into building air at concentrations of possible health concern [ATSDR 2008]. However, in the absence of more recent data and knowledge of future building plans, ATSDR cannot fully evaluate any potential human health hazards. Available data (2001 soil gas and subsurface soil samples collected; 1998 groundwater samples collected) are not representative of current levels of contamination or collected from a representative number of locations across the parcel to evaluate current and future exposure potential. Additional data would be needed to fully evaluate more recent conditions and whether harmful levels of VOCs could migrate into any future buildings developed on site.

Recommendations

ATSDR recommendations, as presented below, relate primarily to the need to better characterize the condition of Parcel C surface soil and subsurface conditions, as well as measures to be taken to protect public health in the context of any Parcel C development plans. These recommendations apply to current and future land owners of Parcel C- Gorham site with oversight from RIDEM and the Rhode Island Department of Health (RIDOH) as appropriate.

- Address uncertainties regarding the nature and extent of Parcel C contamination and clarify contaminant source(s), including:
    - Characterizing current surface soil conditions in order to understand what remediation activities will most effectively eliminate access to contaminated soil.
    - If soil from the stockpile will be used as fill on Parcel C, conducting further testing to determine if limited composite sampling conducted to date adequately characterizes the soil contamination.
    - Determining the current conditions of Parcel C groundwater and describing any continuing sources of groundwater contamination.
    - Ensuring that groundwater contaminant sources, concentrations, and migration patterns at and near Parcel A continue to be monitored and evaluated so that its contribution to Parcel C groundwater contamination, if any, can be determined. Measures should be taken to carefully evaluate and document any potential changes in groundwater flow dynamics, especially those that might result from underground utility work (e.g., relining sewer pipes), as such actions could influence Parcel C groundwater.
    - Collecting additional soil vapor data, including VOCs and methane, from various depths below ground surface.

  Any future analysis of samples should use methods that can achieve detection limits that are below ATSDR's health-based CVs.

- When future Parcel C development plans are determined, evaluate the completeness and applicability of planned remedial actions. Preventive public health measures to be addressed include:
    - Ensuring that action plans cover potential future construction and land use scenarios for the entirety of Parcel C.
    - Conducting a geophysical survey to ensure that no drums, cylinders, or tanks are buried on the parcel.
    - Preventing physical and explosive hazards during construction activities.
    - Documenting plans for compacting buried materials.
    - Establishing long-term operations and maintenance and monitoring plans for a VOC mitigation system after the site is developed (construction of buildings on Parcel C) to prevent exposures.

Public Health Actions for Future Owners and the City of Providence for Parcel C

- The responsible parties (City of Providence or future land owners) should continue to maintain the fence, locked gate and no trespass signs to restrict access to Parcel C.
- The responsible parties (City of Providence or future land owners), with oversight from RIDEM, should address uncertainties regarding the nature and extent of Parcel C contamination and clarify investigators' understanding of contaminant source(s) for soil, groundwater, and soil vapor.
- If Parcel C development plans are made, then the current land owners or future land owners, with oversight from RIDEM and RIDOH, should ensure that remedial actions adequately address current contamination and eliminate the chance of human exposure to harmful materials.

Upon request, ATSDR would be available to review and evaluate sampling plans (e.g., for soil gas, groundwater, surface and sub-surface soil samples (discrete versus composite sampling, etc.)) future data and/or remediation plans for Parcel C of the Gorham site. This may include estimating indoor air exposures using models similar to those used in ATSDR's public health evaluation of Parcel B [ATSDR 2006].

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Tables

Table 1. Soil Samples, Former Gorham Site, Parcel C

Name	*Sub-parcel, Location*[1]	*Depth*[1]	*Date Sampled*
S Comp A	North, E edge (TP-16)	subsurface	03/23/1989
S Comp B	North, W corner (TP-11)	subsurface	03/23/1989
S Comp C	Multiple (TP-7 & TP-12)	subsurface	03/23/1989
S Comp D	Multiple (TP-12 & others)	subsurface	03/23/1989
S Comp E	Multiple (TP-7 & TP-11)	subsurface	03/23/1989
S Comp F	Multiple (S comp D & E)	subsurface	03/23/1989
SB-1 (13)	South, N edge	subsurface	10/25/1994
SB-2 (5)	South, N edge	subsurface	10/25/1994
SB-3 (0)	North, NW corner	surface	10/25/1994
SB-4 (0)	North, central	surface	10/25/1994
SB-5 (0)	North, central	surface	10/26/1994
SS-105	North, NW corner	surface	05/27/1998
SS-106	North, W edge	surface	05/27/1998
SS-107	Central, central	surface	05/27/1998
SS-108	South, central	surface	05/27/1998
SS-109	South, W edge	surface	05/27/1998
SS-409S	South, NE corner	surface	03/01/2001
SS-410D	Central, W edge	subsurface	03/12/2001
SS-410S	Central, W edge	surface	03/12/2001
SS-411D	Central, NW corner	subsurface	03/01/2001
SS-411S	Central, NW corner	surface	03/01/2001
SS-412D	Central, central	subsurface	03/01/2001
SS-412S	Central, central	surface	03/01/2001
SS-413S	South, central	surface	03/01/2001
SS-1005	North, E edge	surface	12/28/2005
TP-7 (S3)	Central, NW edge	surface	03/23/1989
TP-11 (S1)	North, NW corner	subsurface	03/23/1989
TP-11 (S4)	North, NW corner	subsurface	03/23/1989
TP-12 (S1)	North, central	subsurface	03/23/1989
TP-12 (S2)	North, central	subsurface	03/23/1989

[1] - Surface depth is any soil sampled from 0 to 12 inches bgs. Subsurface depth is any soil sampled from greater than 12 inches bgs. See 2 for 15 soil sample locations.

Table 2. Surface Soil Sampling, Former Gorham Site, Parcel C—1989, 1994, 1998, 2001, 2005 . See Figure 2 for Suface Soil Sample Locations.

Analyte	*# of detects*	*Minimum (ppm)*	*Maximum (ppm)*	*Maximum Sample Name*	*Date of Maximum*	*CV (ppm)*	*Source of CV*	*# > CV*
Volatile Organic Compounds								
Acetone	4/6	0.075 J	0.391	SS-107	05/27/1998	50,000	RMEG (Child)	0/6
cis-1,2 Dichloroethene	2/3	0.005 J	0.04	SB-3 (0)	10/25/1994	20,000	Intermediate EMEG (Child)	0/3
Methyl-ethyl ketone	1/6	0.065 J	0.065 J	SB-5 (0)	10/26/1994	30,000	RMEG (Child)	0/6
Methylene chloride	2/6	0.018 J	0.034 J	SB-4 (0)	10/25/1994	90	CREG	0/6
Naphthalene	1/6	0.012	0.012	SS-107	05/27/1998	1,000	RMEG (Child)	0/6
Tetrachloroethylene	1/3	0.285	0.285	SB-3 (0)	10/25/1994	500	RMEG (Child)	0/3
Toluene	1/6	0.005 J	0.005 J	SB-5 (0)	10/26/1994	1,000	Intermediate EMEG (Child)	0/6
Trichloroethylene	1/6	0.175	0.175	SB-3 (0)	10/25/1994	1.6	RBC	0/6
Semi-volatile Organic Compounds								
Acenaphthene	1/14	0.033	0.033	SS-1005	12/28/2005	3,000	RMEG (Child)	0/14
Acenaphthylene	2/9	0.05	4.03	SS-409S	03/01/2001	3,000	RMEG (Child; Acenaphthene)	0/9
Anthracene	4/14	0.14	17.3	SS-409S	03/01/2001	20,000	RMEG (Child)	0/14
Benzo(a)anthracene	7/14	0.48	25.3	SS-409S	03/01/2001	0.22	RBC	7/14
Benzo(a)pyrene	7/14	0.45	25.3	SS-409S	03/01/2001	0.1	CREG	7/14
Benzo(b)fluoranthene	7/14	0.781	21.3	SS-409S	03/01/2001	0.22	RBC	5/14
Benzo(g,h,i)perylene	5/14	0.24	11.5	SS-409S	03/01/2001	20,000	RMEG (Child; Anthracene)	0/14
Benzo(k)fluoranthene	6/14	0.23	26.5	SS-409S	03/01/2001	2.2	RBC	3/14
Chyrsene	7/14	0.56	19.8	SS-409S	03/01/2001	22	RBC	0/14
Dibenzo(a,h)anthracene	4/14	0.054	4.77	SS-409S	03/01/2001	0.022	RBC	4/14
Di-n-butylphthalate	1/4	36	36	SS-1005	12/28/2005	5,000	RMEG (Child)	0/4
Fluoranthene	7/14	0.986	67.7	SS-409S	03/01/2001	2,000	RMEG (Child)	0/14
Fluorene	2/14	0.049	3.88	SS-409S	03/01/2001	2,000	RMEG (Child)	0/14
Indeno(1,2,3-cd) pyrene	5/14	0.19	11.7	SS-409S	03/01/2001	0.22	RBC	4/14
Naphthalene	1/11	0.049	0.049	SS-1005	12/28/2005	1,000	RMEG (Child)	0/11
Phenanthrene	7/14	0.375	64.6	SS-409S	03/01/2001	2,000	RMEG (Child; Pyrene)	0/14

Analyte	# of detects	Minimum (ppm)	Maximum (ppm)	Maximum Sample Name	Date of Maximum	CV (ppm)	Source of CV	# > CV
Pyrene	7/14	0.878	48.6	SS-409S	03/01/2001	2,000	RMEG (Child)	0/14
Polychlorinated Biphenyls, Pesticides, Dioxins/Furans								
Aroclor 1260	1/4	0.023	0.023	SS-1005	12/28/2005	0.32	RBC	0/4
4,4-DDE	1/1	0.0027	0.0027	SS-1005	12/28/2005	1.9	RBC	0/1
4,4-DDT	1/1	0.0042	0.0042	SS-1005	12/28/2005	30	Intermediate EMEG (Child)	0/1
Alpha-Chlordane	1/1	0.0044	0.0044	SS-1005	12/28/2005	30	Chronic EMEG (Child; Chlordane)	0/1
gamma-Chlordane	1/1	0.004	0.004	SS-1005	12/28/2005	30	Chronic EMEG (Child; Chlordane)	0/1
Dioxins/Furans[1]	1/1	0.000178	0.000178	SS-1005	12/28/2005	0.00005	Chronic EMEG (Child; 2,3,7,8 TCDD)	1/1
Total Petroleum Hydrocarbons	6/8	36	5,100	SB-5 (0)	10/26/1994	NA		
Inorganics								
Antimony	1/12	4.9	4.9	SS-1005	12/28/2005	20	RMEG (Child)	0/12
Arsenic	13/14	1.88	11	SS-1005	12/28/2005	0.5	CREG	13/14
						20	Chronic EMEG (Child)	0/14
Barium	3/4	20.5	3,000	SS-1005	12/28/2005	10,000	RMEG (Child)	0/4
Beryllium	5/12	0.076	0.3	SS-108	05/27/1998	100	Chronic EMEG (Child)	0/12
Cadmium	6/12	1	14	SB-3 (0)	10/25/1994	10	Chronic EMEG (Child)	1/12
Chromium	9/12	6	610	SS-1005	12/28/2005	200	RMEG (Child; Hexavalent.Cr)	2/12
Copper	14/14	3	10,100	SB-3 (0)	10/25/1994	500	Intermediate EMEG (Child)	7/14
Cyanide (total)	2/5	0.5	4	SB-3 (0)	10/25/1994	1,000	RMEG (Child)	0/5
Lead	12/14	23	1,780	SS-411S	03/01/2001	400	EPA Action Level	1/14
Mercury	4/12	0.1	0.293	SS-409S	03/01/2001	20	RMEG (Child; Mercuric Chloride)	0/12
Nickel	11/12	3	204	SB-3 (0)	10/25/1994	1,000	RMEG (Child)	0/12
Silver	10/12	3	472	SB-4 (0)	10/25/1994	300	RMEG (Child)	1/12
Zinc	12/12	11	5,750	SB-3 (0)	10/25/1994	20,000	Chronic EMEG (Child)	0/12

[1] - Total relative concentrations were calculated using the toxic equivalency factor (TEF) approach for dioxins. This approach to evaluating health hazards has been developed and used to some extent to guide public health decisions. In short, the TEF approach compares the relative potency of individual congeners with that of 2,3,7,8- tetrachlorodibenzo-p-dioxin (TCDD), the best-studied member of this chemical class. The concentration of each dioxin-like congener is multiplied by its TEF to arrive at a toxic equivalent (TEQ), and the TEQs are added to give the total toxic equivalency. The total toxic equivalency is then compared to reference exposure levels for 2,3,7,8-TCDD. The total TEQ concentrations reported here were estimated using the TOTAL dioxin/furan analysis results. The maximum total TEQ

concentration was also estimated using congener-specific totals, with a resulting value of 0.000014 ppm (below the CV), and was detected in the same sample (SS-SI002).

CREG - cancer risk evaluation guide
EMEG - environmental media evaluation guide
J - estimated value between the detection limit and the quantitative value
ppm - part per million

CV - comparison value
EPA RBC- risk-based concentration
NA - not available
RMEG - reference media evaluation guide

Sources:

[ABB] ABB Environmental Services. 1995. Remedial investigation report.

[CDM] Camp Dresser and McKee. 1993. Site inspection report.

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Table 3. Background Surface Soil Sampling, Former Gorham Site, Parcel C—1994

Analyte	*BK-1 (ppm)*	*BK-2 (ppm)*	*BK-3 (ppm)*	*BK-4 (ppm)*	*BK-5 (ppm)*	*CV (ppm)*	*Source of CV*
Total Cyanide	2.4	<0.5	<0.5	<0.5	0.5	1,564	RBC
TPH	54	87	<23	<21	3,600	NA	
Inorganics							
Antimony	<10	<10	<10	<10	<10	20	RMEG (Child)
Arsenic	124	3	3	11	60	0.5	CREG
						20	Chronic EMEG (Child)
Beryllium	<1	<1	<1	<1	<1	100	Chronic EMEG (Child)
Cadmium	1	<1	<1	<1	<1	10	Chronic EMEG (Child)
Chromium	76	5	6	10	70	200	RMEG (Child; Hexavalent Cr)
Copper	1,110	162	93	66	49	500	Intermediate EMEG (Child)
Lead	1,380	109	66	279	591	400	EPA Action Level
Mercury	1.7	<0.5	<0.5	<0.5	0.5	20	RMEG (Child; Mercuric chloride)
Nickel	12	5	5	17	11	1,000	RMEG (Child)
Selenium	<1	<1	<1	<1	<1	391	RBC
Silver	<1	4	2	52	5	300	RMEG (Child)
Thallium	<1	<1	<1	<1	<1	5.5	RBC
Zinc	95 J	65 J	36 J	74 J	77 J	20,000	Chronic EMEG (Child)

< - Indicates that sample is a non-detect, because it was below detection limits. Number succeeding ‘<’ is the sample detection limit.
CREG - cancer risk evaluation guide
CV – comparison value
EMEG - environmental media evaluation guide
EPA RBC - risk-based concentration
J - estimated value between the detection limit and the quantitative value
ppm - part per million
RMEG - reference media evaluation guide

Source:

[ABB] ABB Environmental Services. 1995. Remedial investigation report.

Table 4. Groundwater Samples, Former Gorham Site, Parcel C

Well ID	*Number of samples*	*Screen Interval (bgs)[1]*	*Sample Year(s)*
MW-111D	2	69-78’	1994, 1998
MW-B	2	18-33’	1989, 1994
MW-C	3	19-34’	1989, 1994, 1998
MW-D	3	17-32’	1989, 1994, 1998
MW-E	2	14-34’	1989, 1998

[1] - Screen interval refers to the interval between the top and bottom well screens.

Table 5. Groundwater Sampling, Former Gorham Site, Parcel C—1989, 1994, 1998. See Figure 3 for Monitoring Well Sample Locations.

Analyte	*# of detects*	*Minimum (ppb)*	*Maximum (ppb)*	*Maximum Sample Name*	*Date of Maximum*	*CV (ppb)*	*Source of CV**	*# > CV*
Volatile Organic Compounds								
1,1-Dichloroethene	1/11	2	2	MW-C	12/08/1998	90	Chronic EMEG (Child)	0/11
						190	CT GWVC	0/11
1,2-Dichloroethene (total)	2/4	57	210	MW-C	1989	200	RMEG (trans 1,2-Dichloroethene)	1/4
						1,000	CT GWVC (trans 1,2-Dichloroethene)	0/4
Chloroform	1/11	2	2	MW-D	12/09/1998	100	Chronic EMEG (Child)	0/11
						26	CT GWVC	0/11
cis 1,2-Dichloroethene	5/7	4	88	MW-D	09/21/1994	3,000	Intermediate EMEG (Child)	0/7
						830	CT GWVC	0/7
Tetrachloroethylene	8/11	8	250	MW-C	1989	100	RMEG (Child)	1/11
						340	CT GWVC	0/11
Trichloroethylene	9/11	2	1,500	MW-C	1989	0.026	RBC Tap Water	9/11
						27	CT GWVC	7/11
Vinyl chloride	1/11	3	3	MW-D	12/09/1998	0.03	CREG	1/11
						30	Chronic EMEG (Child)	0/11
						1.6	CT GWVC	1/11
Semi-volatile Organic Compounds								
bis(2-ethylhexyl)phthalate	1/4	11	11	MW-C	1989	4.8	RBC Tap Water	1/4
Total Petroleum Hydrocarbons	1/4	19,000	19,000	MW-C	1989	NA		
Inorganics								
Aluminum	3/3	200	300	MW-D	09/21/1994	20,000	Intermediate EMEG (Child)	0/3
Arsenic	1/5	20	20	MW-111D	12/29/1994	0.02	CREG	1/5
						3	Chronic EMEG (Child)	1/5
Cadmium	1/5	10	10	MW-E	1989	2	Chronic EMEG (Child)	1/5
Calcium	3/3	49,300	120,000	MW-111D	12/29/1994	NA		

Analyte	***# of detects***	***Minimum (ppb)***	***Maximum (ppb)***	***Maximum Sample Name***	***Date of Maximum***	***CV (ppb)***	***Source of CV****	***# > CV***
Copper	2/5	70	140	MW-E	1989	100	Intermediate EMEG (Child)	1/5
Iron	2/3	100	51,800	MW-111D	12/29/1994	10,950	RBC Tap Water	1/3
Lead	2/8	9	16	MW-D	09/21/1994	15	EPA Action Level	1/8
Magnesium	3/3	15,700	47,700	MW-C	09/21/1994	NA		
Manganese	3/3	470	21,900	MW-111D	12/29/1994	500	RMEG (Child)	2/3
Nickel	2/5	30	50	MW-E	1989	200	RMEG (Child)	0/5
Potassium	3/3	1,800	7,400	MW-111D	12/29/1994	NA		
Sodium	3/3	25,100	113,000	MW-111D	12/29/1994	NA		
Zinc	4/5	50	470	MW-E	1989	3,000	Chronic EMEG (Child)	0/5

*ATSDR drinking water CVs were used as conservative screening values, though it is acknowledged that the groundwater at Parcel B is not used as a drinking water source. In the absence of ATSDR derived CVs, U.S. EPA risk-based concentrations (RBCs) for tap water were used. The inclusion of the Connecticut GWVC provides additional perspective and a more realistic screen for the exposure pathway of interest.

CREG - cancer risk evaluation guide
CV - comparison value
EPA RBC - risk-based concentration
ppb - part per billion
CT GWVC - Connecticut's groundwater volatilization criteria
EMEG - environmental media evaluation guide
NA - not available
RMEG - reference media evaluation guide

Sources:

[ABB] ABB Environmental Services. 1995. Remedial investigation report.

[CDM] Camp Dresser and McKee. 1993. Site inspection report.

[HLA] Harding Lawson Associates. 1999. Site investigation summary report and risk assessment, Volumes 1 & 2.

Table 6. Groundwater Sampling, Former Gorham Site, Parcel C—1998. See Figure 3 for sample locations.

Analyte	***# of detects***	***Minimum (ppb)***	***Maximum (ppb)***	***Maximum Sample Name***	***Date of Maximum***	***CV (ppb)***	***Source of CV****	***# > CV***
Volatile Organic Compounds								
1,1-Dichloroethene	1/3	2	2	MW-C	12/08/1998	90	Chronic EMEG (Child)	0/3
						190	CT GWVC	0/3
Chloroform	1/3	2	2	MW-D	12/09/1998	100	Chronic EMEG (Child)	0/3
						26	CT GWVC	0/3
cis 1,2-Dichloroethene	3/3	4	70	MW-D	12/09/1998	3,000	Intermediate EMEG (Child)	0/3
						830	CT GWVC	0/3
Tetrachloroethylene	2/3	8	52	MW-C	12/08/1998	100	RMEG (Child)	0/3
						340	CT GWVC	0/3
Trichloroethylene	3/3	2	495	MW-C	12/08/1998	0.026	RBC Tap Water	3/3
						27	CT GWVC	2/3
Vinyl chloride	1/3	3	3	MW-D	12/09/1998	0.03	CREG	1/3
						30	Chronic EMEG (Child)	0/3
						1.6	CT GWVC	1/3

*ATSDR drinking water CVs were used as conservative screening values, though it is acknowledged that the groundwater at Parcel B is not used as a drinking water source. In the absence of ATSDR derived CVs, U.S. EPA risk-based concentrations (RBCs) for tap water were used. The inclusion of the Connecticut GWVC provides additional perspective and a more realistic screen for the exposure pathway of interest.

CT GWVC - Connecticut's groundwater volatilization criteria
EMEG - environmental media evaluation guide
ppb - part per billion
CV - comparison value
EPA RBC - risk-based concentration
RMEG - reference media evaluation guide

Source:

[HLA] Harding Lawson Associates. 1999. Site investigation summary report and risk assessment, Volumes 1 & 2.

Table 7. Subsurface Soil Sampling, Former Gorham Site, Parcel C—1989, 1994, 2001 (See Figure 4 for sample locations?)

Analyte	# of detects	Minimum (ppm)	Maximum (ppm)	Maximum Sample Name	Date of Maximum	CV (ppm)	Source of CV	# > CV
Volatile Organic Compounds								
Methylene Chloride	2/2	0.011	0.018 J	SB-2 (5)	10/25/1994	90	CREG	0/2
Tetrachloroethylene	1/4	0.071 J	0.071 J	SB-2 (5)	10/25/1994	500	RMEG (Child)	0/4
Trichlorothylene	1/4	0.134 J	0.134 J	SB-2 (5)	10/25/1994	1.6	RBC	0/4
Xylenes (total)	1/3	1	1	TP-11 (S4)	03/23/1989	10,000	RMEG (Child)	0/3
Polycyclic Aromatic Hydrocarbons								
Anthracene	2/5	0.952	4.29	SS-411D	03/01/2001	20,000	RMEG (Child)	0/5
Benzo(a)anthracene	3/5	0.414	8.43	SS-411D	03/01/2001	0.22	RBC	3/5
Benzo(a)pyrene	3/5	0.445	13.8	SS-410D	03/12/2001	0.1	CREG	3/5
Benzo(b)fluoranthene	4/5	0.406	11.9	SS-410D	03/12/2001	0.22	RBC	4/5
Benzo(g,h,i)perylene	2/5	0.406	4.57	SS-410D	03/12/2001	20,000	RMEG (Child; Anthracene)	0/5
Benzo(k)fluoranthene	3/5	0.352	12.3	SS-410D	03/12/2001	2.2	RBC	1/5
Chyrsene	3/5	0.448	8.25	SS-411D	03/01/2001	22	RBC	0/5
Dibenzo(a,h) anthracene	1/5	1.94	1.94	SS-410D	03/12/2001	0.022	RBC	1/5
Fluoranthene	4/5	0.749	18.1	SS-411D	03/01/2001	2,000	RMEG (Child)	0/5
Indeno(1,2,3-cd) pyrene	1/5	4.4	4.4	SS-410D	03/12/2001	0.87	RBC	1/5
Phenanthrene	3/5	0.777	17.8	SS-411D	03/01/2001	2,000	RMEG (Child; Pyrene)	0/5
Pyrene	4/5	0.788	16.9	SS-411D	03/01/2001	2,000	RMEG (Child)	0/5
Total Petroleum Hydrocarbons	6/7	37	23,800	TP-12 (S1)	03/23/1989	NA		
Inorganics								
Arsenic	3/9	1.49	8.76	SS-410D	03/12/2001	0.5	CREG	3/9
						20	Chronic EMEG (Child)	0/9
Barium	3/5	26	73	S comp B	03/23/1989	10,000	RMEG (Child)	0/5
Beryllium	1/7	0.089	0.089	SS-412D	03/01/2001	100	Chronic EMEG (Child)	0/7
Cadmium	4/7	2	4	S comp A	03/23/1989	10	Chronic EMEG (Child)	0/7
Chromium	4/7	8	3,750	S comp B	03/23/1989	200	RMEG (Child; Hexavalent Cr)	1/7
Copper	9/9	22	11,300	S comp D	03/23/1989	500	Intermediate EMEG (Child)	6/9
Cyanide (total)	2/8	1.35	5.38	TP-12 (S2)	03/23/1989	1,000	RMEG (Child)	0/8
Lead	8/9	9.1	22,600	SS-411D	03/01/2001	400	EPA Action Level	2/9
Nickel	7/7	3.39	2,820	S comp D	03/23/1989	1,000	RMEG (Child)	1/7
Silver	5/7	6	6,970	S comp D	03/23/1989	300	RMEG (Child)	1/7
Thallium	1/7	10	10	S comp A	03/23/1989	5.5	RBC	1/7
Zinc	7/7	38.6	9,230	S comp D	03/23/1989	20,000	Chronic EMEG (Child)	0/7

CREG - cancer risk evaluation guide

CV - comparison value

EMEG - environmental media evaluation guide
J - estimated value between the detection limit and the quantitative value
ppm - part per million
EPA RBC - risk-based concentration
NA - not available
RMEG - reference media evaluation guide

Sources:

[ABB] ABB Environmental Services. 1995. Remedial investigation report.

[CDM] Camp Dresser and McKee. 1993. Site inspection report.

Harding ESE. 2001. Remedial Action Work Plan.

Table 8. Soil Vapor Sampling, Former Site, Parcel C—2001 See Figure 5 for Soil Vapor sample locations.

Analyte	*# of detects*	*Detection Limits (ppbv)*	*Minimum (ppbv)*	*Maximum (ppbv)*	*Maximum Sample Name*	*Date of Maximum*	*CV (ppbv)*	*Source of CV*	*# > CV*
Volatile Organic Compounds									
Benzene	1/10	313	157 J	157 J	S-12	10/31/2001	0.03	CREG	1/10
							3	Chronic EMEG	1/10
							780	CT SVVC	0/10
							1.03	CT TAC	1/10
Cis-1,2 Dichloroethene	1/10	252	504	504	S-22	10/31/2001	3,400	CT SVVC	0/10
							4.5	CT TAC	1/10
Chlorobenzene	1/10	217	43 J	43 J	S-12	10/31/2001	6,100	CT SVVC	0/10
							8	CT TAC	0/10
Tetrachloroethylene	3/10	147	44.2 J	1,032	S-14	10/31/2001	40	Chronic EMEG	3/10
							560	CT SVVC	1/10
							0.7	CT TAC	3/10
Trichloroethylene	7/10	186	74.4	1,489	S-33	10/31/2001	100	Intermediate EMEG	5/10
							140	CT SVVC	4/10
							0.2	CT TAC	7/10
Trichlorofluoromethane	6/10	178	356	5,696	S-42	10/31/2001	130	RBC	6/10
							50,000	CT SVVC	0/10
							49	CT TAC	6/10
Vinyl Chloride	1/10	391	1,174	1,174	S-12	10/31/2001	0.04	CREG	1/10
							41	CT SVVC	1/10
							0.06	CT TAC	1/10

CREG - cancer risk evaluation guide
CV - comparison value
EPA RBC - risk-based concentration
ppbv - part per billion volume
CT SVVC – Connecticut soil vapor volatilization criteria
EMEG - environmental media evaluation guide
J - estimated value between the detection limit and the quantitative value
CT TAC - Connecticut target indoor air concentration

Source: [GZA] GZA GeoEnvironmental, Inc. 2002. Site investigation report—additional assessment tasks, Providence YMCA—Parcel C.

Figures

Figure 1. Gorham Silver Site, Providence, Rhode Island

Figure 2. Surface Soil Sample Locations, Former Gorham Site, Parcel C

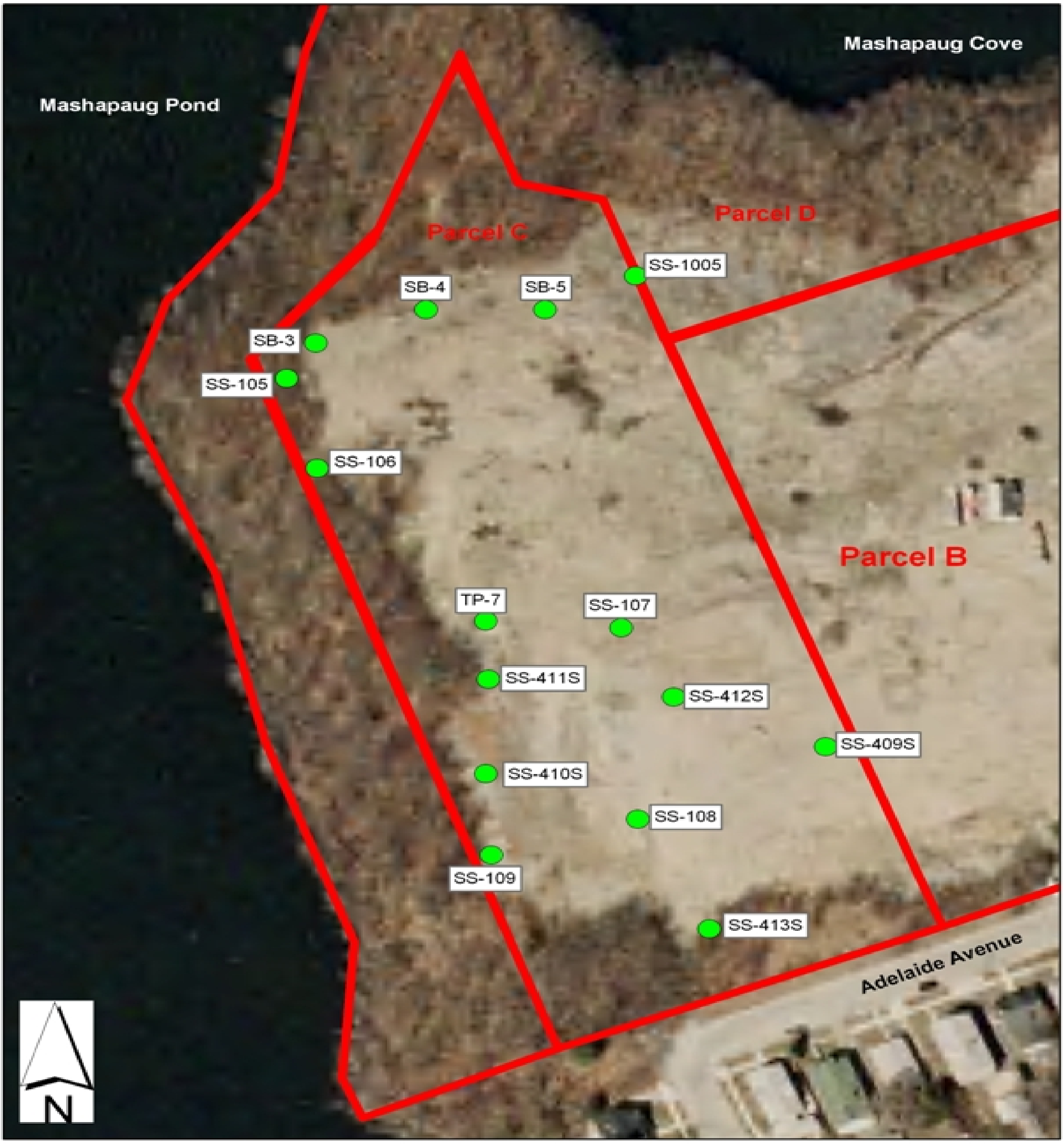


Figure 3. Groundwater Sample Locations, Former Gorham Site, Parcel C

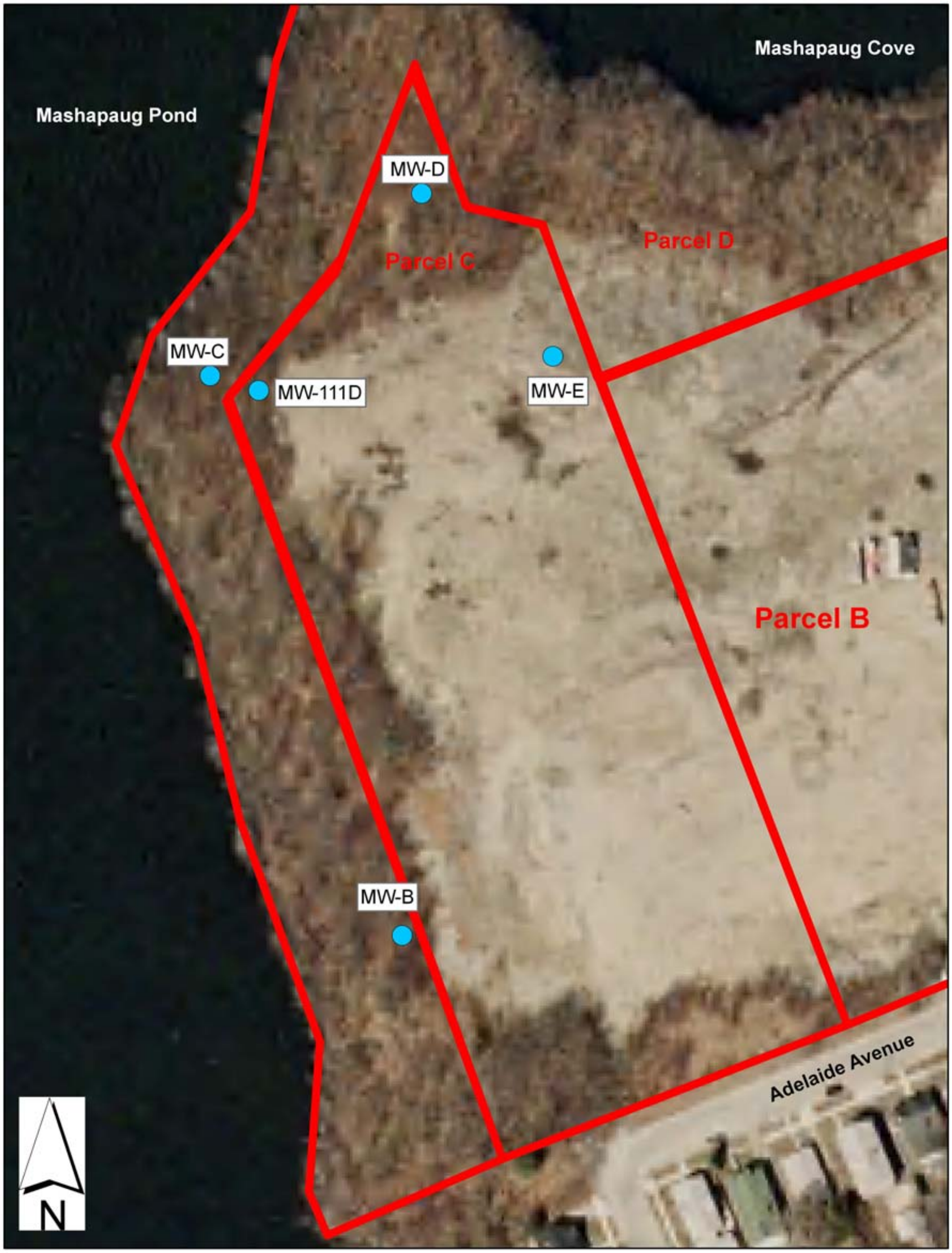


Figure 4. Subsurface Soil Sample Locations, Former Gorham Site, Parcel C

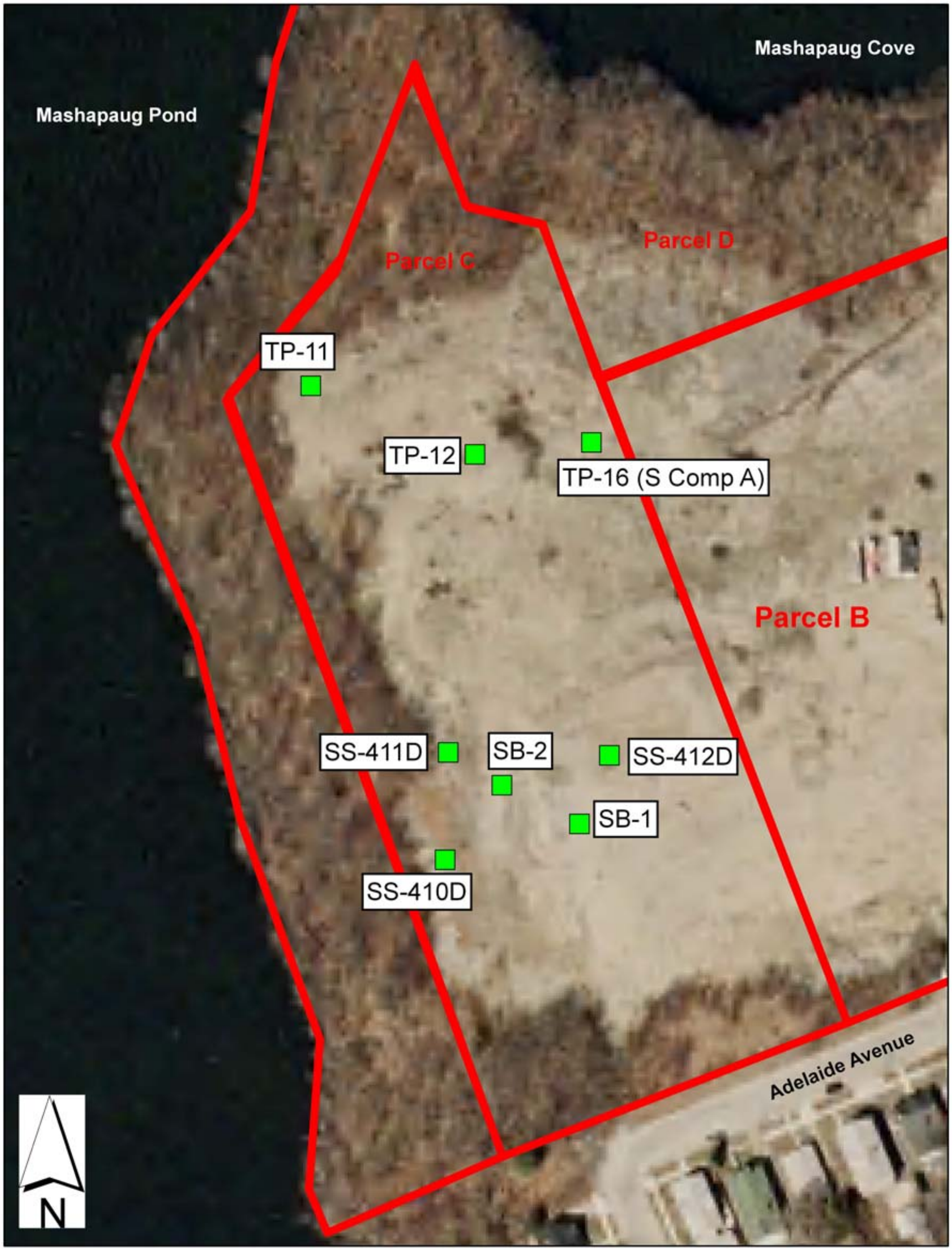
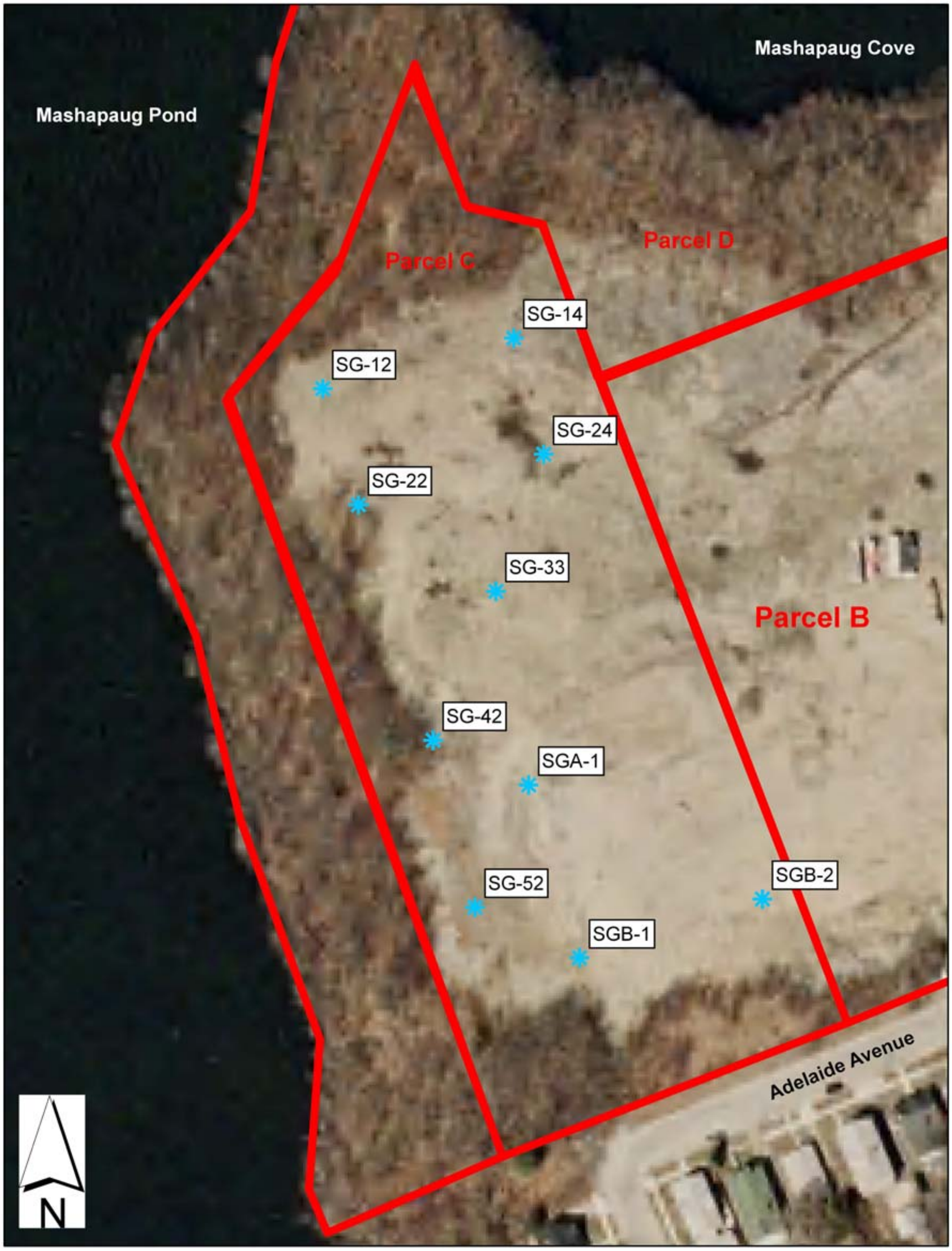


Figure 5. Soil Vapor Sample Locations, Former Gorham Site, Parcel C



Appendix A

EPA Methods and Analytes, by Source

Source	*Analytes*	*EPA Method(s)*
[ABB] ABB Environmental Services. 1995. Supplemental remedial investigation report.	Metals	6000/7000
	PCBs	8080
	SVOCs	8270
	Total cyanide/amenable cyanide	335.2/335.1
	TPH	418.1
	VOCs	8240
[CDM] Camp Dresser & McKee. 1993. Site inspection report, Appendix E: 1989 Hunter, Inc. Soil and groundwater contamination site assessment.	Metals	Unavailable
	VOCs	Unavailable
[HLA] Harding Lawson Associates. 1999. Site investigation summary report and risk assessment, Volumes 1 & 2.	Metals	6000/7000
	SVOCs	Not clearly specified
	Total lead	6010
	TPH	Not clearly specified
	VOCs	8260
Harding ESE. 2001. Remedial Action Work Plan.	Metals	6010/7471/7841
	PAHs	8270C
Fuss & O'Neill. 2006. Supplemental site investigation former Gorham manufacturing property and Mashapaug Cove.	Metals	6010B/7471/9012
	PCBs	8082
	Pesticides	8081A
	SVOCs	8270C
	TPH	8100M
	VOCs	8260B
[GZA] GeoEnvironmental, Inc. 2002. Site investigation report-additional assessment tasks, Providence YMCA-Parcel C	VOCs	8260