Health Consultation

EAST PROVIDENCE TERMINAL
EAST PROVIDENCE, RHODE ISLAND

Prepared by the
Rhode Island Department of Health

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Prepared under a Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

HEALTH CONSULTATION

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Summary and Statement of Issues

Introduction

The Rhode Island Department of Health's (RIDOH) priority is to ensure that the people living and working near the East Providence Terminal have the best information possible to safeguard their health.

In September of 2022, Boston Children's Hospital asked RIDOH to assess whether environmental factors could be related to an unusual pattern of pediatric cancer cases in Riverside, RI. RIDOH investigated sites in the area that have the potential to release chemicals to the environment. The East Providence Terminal (herein referred to as the Terminal or the Site) was identified as a potential source of chemicals in groundwater and ambient air at the area of concern. Past spills at the Terminal contaminated soil and groundwater with petroleum-related volatile organic compounds (VOCs), including benzene. Benzene was identified as the primary contaminant of concern for human health in the area. The Terminal has ongoing monitoring and remediation to address the contamination.

RIDOH has developed this Health Consultation in accordance with guidance provided by ATSDR to examine the potential health implications of groundwater contamination at the East Providence Terminal. RIDOH also identified outdoor air as a potential route of VOC exposure.

Conclusions

RIDOH reached the following conclusions in this Health Consultation:

Conclusion 1	Breathing indoor air at areas surrounding the East Providence Terminal in East Providence, RI is not expected to harm people's health.
Basis for Conclusion 1	The predicted levels of VOCs in the indoor air as a result of vapor intrusion of chemicals from the groundwater were at levels that did not raise a concern for adverse health effects. Indoor air levels were calculated using the maximum detected concentrations of chemicals in relevant wells from the most recent sampling event (end of 2021 and beginning of 2022). Although benzene was not detected in groundwater at a concentration that could be reliably measured, the estimated concentration provided by the laboratory was greater than ATSDR's comparison value for vapor intrusion. As such, the calculated cancer risk from vapor intrusion from benzene in groundwater was slightly greater than 1 in 1 million.
Next steps	The groundwater has been impacted with VOCs at the East Providence Terminal and has the potential for harm, but that risk appears to be

	adequately controlled by the current mitigation steps in place at the facility. RIDOH recommends that ExxonMobil continue the groundwater monitoring programs at all affected areas to assure that VOC levels remain at or below current levels.
Conclusion 2	There is inadequate air quality data to assess the potential for adverse health effects from breathing outdoor air at areas surrounding the property in East Providence, Rhode Island.
Basis for Conclusion 2	Although there may be a complete exposure pathway for emissions from the East Providence Terminal to outdoor air surrounding the facility, there is inadequate data to evaluate this pathway.
Next Steps	The Rhode Island Department of Environmental Management (RIDEM) is working to identify funding to monitor and evaluate air toxics in the neighborhoods surrounding the East Providence Terminal. RIDOH will work with the community and ExxonMobil to respond to public health questions and concerns about potential exposures from chemicals at the Site.

FOR MORE INFORMATION	For further information about this public health assessment, please contact RIDOH at Michael.byrns@health.ri.gov and ask about exposures from the East Providence Terminal.

Background

Boston Children's Hospital contacted the Rhode Island Department of Health's (RIDOH) Division of Environmental Health for assistance in determining whether environmental factors could have contributed to pediatric cancer outcomes in Riverside, Rhode Island, focusing on the area around Forbes Street on the border between Riverside and East Providence (the area of concern).

RIDOH investigated potential sources of chemical exposures in the area of concern. The Forbes Street Compost site, located at 245 Forbes Street (the southern side of Forbes Street) in Riverside, Rhode Island, was identified by residents as a potential concern. The Forbes Street Compost site is located on the former Forbes Street Landfill. All buildings that were related to the landfill operation have been removed. According to the *Remedial Action Closure Report* prepared by Wood Environment and Infrastructure Solutions, Inc. in 2020, the remediation of the site was completed, including capping of the landfill. Groundwater monitoring was to be conducted for the first eight quarters following remediation [Wood Environment and Infrastructure Solutions, Inc., 2020]. Contaminants detected above the Rhode Island Department of Environmental Management (RIDEM) GA standards[1] included per-and polyfluoroalkyl substances (PFAS) and heavy metals. These contaminants would not have a complete route of exposure. Groundwater flows from the site to the south-southwest. Areas downgradient are classified as GB and are served by public water. There are private wells upgradient, including at a residence 200 feet east of the landfill, but those wells are not impacted by contaminants from the facility. Given that a completed route of contaminant exposure was not identified, this site was not investigated further.

ExxonMobil's East Providence Terminal is located immediately to the north of the area of concern at 1001 Wampanoag Trail in East Providence, Rhode Island (herein referred to as the Terminal, the Facility, or the Site). The Terminal is three miles south-southeast of Providence, Rhode Island, and occupies approximately 800 acres. The Site is situated between the Providence River, which forms the western Site border, and the Runnins River. The surrounding area is occupied by residences, schools, outdoor recreational areas, hospitals, light industries, and small businesses. The Site is utilized as a petroleum bulk storage terminal. Product is delivered to the Terminal via tanker ships at the loading dock in the Providence River on the west side of the Vanity Fair Area (see following paragraph for a description of the Site areas). The product is transferred via pipeline to the east side of the Terminal where it is stored in aboveground storage tanks in the Northern Operations Area tank farm.

Since the 1980s, environmental investigation and remediation activities have been

[1] The Rhode Island Department of Environmental Management (DEM) "Groundwater Quality Rules" classify all of the state's groundwater resources and establish groundwater quality standards for each class. The four classes are designated GAA, GA, GB, and GC in accordance with the RI Groundwater Protection Act of 1985 (RI General Laws 46-13.1). Groundwater classified GAA and GA is to be protected to maintain drinking water quality, whereas groundwater classified GB and GC is known or presumed to be unsuitable for drinking water use without treatment. Greater than 90% of the state's groundwater resources are classified as suitable for drinking water use (i.e., class GAA and GA).

conducted by Mobil and ExxonMobil [Roux, 2009]. Currently, the major concern is a plume of volatile organic compounds (VOCs) including benzene, toluene, ethylbenzene and xylenes (BTEX), naphthalene, and methyl tertiary butyl ether (MTBE) in groundwater. Based on the direction of groundwater flow, the highest concentrations of VOCs are expected to be in the South Operations Area and Leased Asphalt Area [Roux, 2008]. Operations at the Site and remediation efforts may result in emissions of VOCs to outdoor air. There are no available data to evaluate the potential for exposure to VOCs in outdoor air. This health consultation quantitatively addresses the VOCs in groundwater the Site.

The Site has been divided into six geographic areas for the purpose of assessing environmental conditions and reporting results for ongoing remedial activities. The six geographic areas include the (1) North Operations Area, (2) South Operations Area, (3) Leased Asphalt Facility, (4) Pipeline Corridor Area, (5) Vanity Fair Area, (6) Runnins River Area. The South Operations and Leased Asphalt Facility Areas are the areas closest to the area of inquiry. Volatile chemicals can be emitted into outdoor air during operations and remediation activities at the Terminal. Emitted chemicals could potentially migrate in outdoor air to the surrounding community. Volatile chemicals related to petroleum have been detected in groundwater at the Site, and the East Providence Terminal is up-gradient for groundwater flow. Although household use is not a complete pathway of exposure for groundwater (discussed in the following sections of this report), there is the potential for groundwater to flow under the surrounding community. Volatile chemicals in groundwater could migrate upwards as vapors into homes and buildings. As such, in response to the inquiry, indoor air exposures from the East Providence Terminal are evaluated in this Health Consultation.

Exposure Pathway Analysis

RIDOH relies on methods for exposure pathway analysis provided by ATSDR [ATSDR, 2022]. ATSDR provides methodology to evaluate exposure pathways, which are ways that people may come into contact with contaminated media and be exposed to the contaminants.

Potential pathways of exposure to the surrounding community from the East Providence Terminal include:

- contact with soil that may migrate off the Site,
- inhalation of air that may be emitted from operations and remedial actions at the East Providence Terminal,
- household and commercial use of groundwater (i.e., drinking, showering, etc.) that flows from the Terminal to the surrounding community, and
- migration of vapors from chemicals in groundwater upwards into homes and buildings

The potential for exposure from each of these pathways is considered in this Health

Consultation. In order for an exposure pathway to be complete, ATSDR specifies that the following five elements must be present [ATSDR, 2022]:

1. **Contaminant source:** Describes where contaminants came from. For example, contaminants may come from a leaking tank or pipe.
2. **Environmental fate and transport:** Describes how contaminants released to the environment move through and across different media, as well as how they degrade or transform in the environment.
3. **Exposure point:** Describes the specific location(s) where people might come into contact with a contaminated medium.
4. **Exposure route:** Describes the path by which contaminants enter the body (skin, breathing, swallowing; also called dermal, inhalation, ingestion).
5. **Potentially exposed population:** Describes the people who potentially have, do, or could come in contact with environmental contaminants.

If any of these elements is not present, the exposure pathway is considered incomplete and not further evaluated in the Health Consultation.

Soil Exposure Evaluation

There is the potential for contact with soil from the East Providence Terminal as soil may migrate off-site into the surrounding community. Soils exceeding site-specific, risk-based criteria were excavated, consolidated, and capped and a phytotechnology cover was constructed over soils exceeding leachability criteria between May and November 2009 [Roux, 2007; 2022]. The phytotechnology cover implemented onsite involves the use of tall, dense trees and extends for a significant distance between the contaminated area and any nearby residences, which effectively prevents dust migration from the site. An Environmental Land Use Restriction (ELUR) was completed for the South Operations Area and recorded with the City of East Providence, Rhode Island on February 3, 2014. The most recent Annual Certification Inspection for the ELUR was conducted on September 16, 2021. The ELUR for the South Operations area required a Soil Management Plan (SMP) be developed for any soil disturbance activities. As surface soil has been remediated and an SMP is in place, contaminated soil is not expected to migrate off the Terminal property and community exposure to chemicals from soil is not a complete exposure pathway.

Outdoor Air Exposure Evaluation

There is potential for exposure to chemicals in outdoor air that can be emitted from the Terminal during operations (e.g., loading, unloading, transport, maintenance). Contaminants emitted to outdoor air could migrate to the surrounding community and lead to exposure by inhalation. Currently, there are no data available for contaminant concentrations in outdoor air at areas surrounding the Terminal. The Rhode Island Department of Environmental Management (RIDEM) Office of Air Resources issued an Operating Permit on September 6, 2016 (expiration date September 6, 2021) that specifies the requirements for emissions from terminal operations and remediation operations, including emission limitations, operating requirements, monitoring requirements, and

reporting requirements [RIDEM – Office of Air Resources, 2016]. Regarding emissions to outdoor air from operations at the facility, the permit specifies amounts of VOCs that can be emitted along with operating, monitoring, record keeping, and reporting requirements. For the facility, "The total quantity of Hazardous Air Pollutant (HAP) emitted from the entire facility shall not exceed 18,000 pounds of any one (1) HAP or 48,000 pounds of any combination of HAPs in any consecutive 12-month period." Regarding remediation activities, the permit states that "All VOC generated from the air stripping and aeration process shall be captured, contained and routed to C003 for treatment prior to discharge to the atmosphere." The most recent emissions summary report from inventory conducted in 2020 (RI DEM – Office of Air Resources. November 14, 2022. Emissions Summary Report, Exxon Mobil, 1001 Wampanoag Trail, East Providence, FACNO: 1003 – Inventory Year 2020) showed the release of benzene, ethylbenzene, toluene, xylenes, phenol, o-cresol, cumene, naphthalene, sulfur dioxide, nitric oxide, carbon monoxide, carbon dioxide, and hexane into outdoor air [RIDEM, 2022]. There are no air monitoring stations in the surrounding community that would reflect specific emissions coming from the Terminal. Based on the requirements set by the permits, it is not likely that emissions from the facility would cause adverse health effects. Also, the point sources operated at the Terminal are 1600 ft from the nearest residence. This distance effectively reduces the risk posed by the point sources.

Potable Use of Groundwater Exposure Evaluation

Potable use of groundwater leading to exposure to VOCs by ingestion (drinking) or dermal (skin) contact is likely not a complete route of exposure. The East Providence Water Utilities Division supplies drinking water in East Providence and Riverside. People using public water for potable water would not be using groundwater in their homes or businesses and would therefore not be exposed to chemicals in groundwater via ingestion, dermal contact, or inhalation of vapors (from, for example, laundry, showering, and dishwashing). There may be private wells that supply potable water in the area of inquiry. Information regarding the addresses of 23 private wells sampling for VOCs in the well water is supplied in a 1999 memorandum (Memorandum from G. Jablonski, Sanitary Engineer, to R. Mendes, Principal Environmental Scientist at the DOH, 12/6/99. Subject: Private well results). Sampling took place at eight wells in November 1999. Letters from RIDOH, on February 23, 2000, to private well owners stated that no VOCs were detected in water samples.

Additional information comes from the *"Baseline Human Health Risk Assessment for the South Operations Area"* (BHRA) [Roux, 2008]. According to the BHRA, groundwater flows off-property from the South Operations Area toward a residential neighborhood. The BHRA cites a 1996 report entitled *"South Operations Final Assessment Report"* (SOFAR) (September 5, 1996) that identified private water supply wells in the residential area south of the Facility and east of the former Forbes Street Landfill. The report findings indicated "hydrogeologic conditions (i.e., bedrock surfaces topography and ground-water flow direction) present in the area prevent the migration of the dissolved phase contamination from the Facility to the well locations." The BHRA further stated that monitoring at the Site showed a reduction in contaminant

concentrations at private properties to the RIDEM GA groundwater objectives. GA water is considered to be suitable for drinking water use without treatment. The results of the monitoring have been documented in monitoring reports submitted to RIDEM.

More recent information regarding private wells is presented by Wood Environment and Infrastructure Solutions, Inc. [2020]. The report states that properties in the vicinity of the former Forbes Street Landfill are mostly served by the public water supply system but there are private wells located on the roads where the water system does not extend. Specifically, there are 19 residences that have private wells that are located within half a mile of the former landfill area with the closest well located on Hospital Road approximately 200 feet east of the former Phase II disposal area. From these wells, the ones most at risk were presumably the subject of the 1999 sampling that did not detect VOC contamination.

The Terminal has conducted extensive groundwater quality surveys in the area including monitoring wells in the downgradient residential areas. These wells were monitored from 1995 to 2005 and did not detect VOCs for most of their deployment, when monitoring wells on site had much higher concentrations than they do today. This indicates that VOC contamination of groundwater in the nearby residential areas is expected to be well below any levels of potential health concern. Based on the available information, potable use of groundwater leading to exposure to VOCs is not likely to be a complete exposure pathway and was not further considered in this Health Consultation.

Vapor Intrusion to Indoor Air from Chemicals in Groundwater Exposure Evaluation

Vapor intrusion of contaminants from the groundwater into the indoor air of structures is identified as a potential exposure pathway. Vapor intrusion refers to the migration of VOCs from the subsurface-contaminated groundwater and soil through the pore spaces of soil into buildings above. Subsurface vapors can enter residences and other buildings through foundation cracks and gaps, mechanical ventilation systems, and leakage areas (e.g., utility entry points, construction joints, and drainage systems). Subsurface vapor levels are affected by many factors, such as water and air movements; temperature variations in groundwater, soil and the atmosphere; molecular diffusion; biodegradation; barometric pressure; precipitation; building structures; and pressure differences between the inside and outside of buildings. Volatile chemicals related to petroleum have been detected in the groundwater at the Site. There is the potential for VOC exposure if the groundwater flows under the area of inquiry and vapors migrate into indoor air at homes and other structures, leading to inhalation of chemicals in indoor air. ATSDR's *"Guidance for Evaluating Vapor Intrusion Pathways"* [ATSDR 2016] recommends applying a screening attenuation factor of 0.001 to concentrations of chemicals in groundwater to predict concentrations of chemical vapors in indoor air. Note that an attenuation factor of 0.001 means that 0.1% of vapors can migrate to indoor air. ATSDR calculates a comparison value (CV, a concentration of a chemical in groundwater that would not result in adverse health effects if the chemical migrated to indoor air) for each chemical of potential concern detected in groundwater. The CV is then used to screen chemicals for potential to cause adverse health

effects. ATSDR's methodology for CV calculation is as follows:

$CVgw = CVair / (H' * \alpha gw)$

Where:
CVgw = screening level in groundwater
CVair = ATSDR's air CV
H' = unitless Henry's Law constant
α gw = ATSDR's recommended screening groundwater attenuation factor (0.001)

CVs for chemicals detected in relevant groundwater wells at the East Providence Terminal site are presented in Table 1. The CVs can be compared to concentrations of chemicals detected in groundwater to help determine if the concentrations of chemicals in groundwater could present health risks to the surrounding community from vapor intrusion to indoor air.

Table 1: ATSDR Comparison Values for Chemicals Detected in Groundwater

Chemical	**ATSDR Comparison Value – Groundwater Vapor Intrusion to Indoor Air (micrograms/liter, µg/L)**
Benzene	0.57
Toluene	14,000
Ethylbenzene	810
Xylene	370
MTBE	450 (USEPA VISL)
Naphthalene	1.6

µg/L – microgram per liter
USEPA VISL – United Stated Environmental Protection Agency Vapor Intrusion Screening Level

Discussion

Available environmental data for this evaluation

Investigations of groundwater have been conducted at the Terminal since the 1980s. RIDOH evaluated the available environmental sampling information for potential exposure to groundwater contaminants at the Facility in the Southern Operations Area. Concentrations of chemicals in the groundwater in the South Operations Area would provide the best representation of concentrations of chemicals that may migrate off of the Site as groundwater flow is to the south south-east. The most recent groundwater monitoring took place from November 1, 2021, to January 31, 2022 [Roux Associates, Inc., 2022]. The report covers all areas of the Terminal. This Health Consultation focuses on the South Operations Area because, as previously discussed, the complete exposure pathway from the Terminal to receptors surrounding the facility is via migration of chemicals in groundwater to off-site areas followed by vapor intrusion to

indoor air.

Groundwater samples were collected by Roux [2022] from perimeter wells along the southern boundary of the Facility quarterly and/or annually. A map showing the sampling locations is provided in the Roux report. Samples from wells were analyzed for petroleum-related chemicals including benzene, toluene, ethylbenzene, xylenes, MTBE, and naphthalene. Historically, exceedances of RIDEM Groundwater Objectives at the Southern boundary of the Facility only occurred at wells MW-432A and MW-432B so these wells were considered by Roux as the points of compliance (i.e., the wells where chemicals in groundwater were required to meet groundwater standards) for the South Operations Area. The January 2022 groundwater monitoring event showed the following:

- MTBE was not detected in MW-432A and MW-432B. Benzene and naphthalene were detected in MW-432A and MW-432B, both at estimated concentrations of less than 1 microgram per liter (ug/L).
- Concentrations of benzene, toluene, ethylbenzene, xylene, MTBE, and naphthalene for all other monitoring wells on the southern boundary of the Facility sampled during the most recent monitoring period (MW-402, MW-403, MW-404, and MW-453) have remained below RIDEM Class GA Groundwater Objectives [RIDEM, 2009] since sampling began in 1994 (MW-402, MW-403, MW-404) and 2000 (MW-453). The maximum detected concentrations of benzene, toluene, ethylbenzene, xylene, MTBE, and naphthalene from MW-403, MW-404, MW-453, MW-432A, and MW-432B from the most recent sampling round (January, 2022) are presented in Table 2. There were no data provided in the Roux report for MW-402.

Table 2: Maximum Detected Concentrations in Southern Border Wells

Chemical	Maximum Concentration in South Operations Area (µg/L)
Benzene	J 0.76
Toluene	nd<1
Ethylbenzene	nd<1
Xylene	nd<1
MTBE	nd<10
Naphthalene	J 0.21

µg/L – micrograms per liter
nd – not detected at or above the reporting limit
J – result is less than reporting limit (1 ug/L) but greater than or equal to the detection limit. The concentration reported is an approximate value.

Environmental data evaluation and public health impacts

The public health evaluation using data from groundwater to assess the potential for exposure and adverse health effects from vapor intrusion to indoor air is presented

below.

ATSDR provides site-specific public health recommendations based on an evaluation of the toxicological literature. Levels of environmental contaminants detected at a site are compared to accepted CVs for the relevant media and then considered in the context of the characteristics of the exposed population and the frequency and duration of exposure. RIDOH used this approach to determine if groundwater contamination at the East Providence Terminal poses a public health hazard. The hierarchy recommended in the *ATSDR Public Health Guidance Manual* was used to select CVs [ATSDR 2005 and ATSDR 2023]. RIDOH used the following CVs for this health consultation: the ATSDR's environmental media evaluation guide (EMEG), reference dose media evaluation guide (RMEG), cancer risk evaluation guide (CREG), and minimal risk levels (MRL) [ATSDR 2023]. RIDOH also compared concentrations of chemicals detected in groundwater to the Rhode Island Groundwater Quality Standards [RIDOH, 2009 and 2010].

Selection of Relevant Groundwater Data

The most recent groundwater monitoring well data was used to calculate concentrations of chemicals that may be present in indoor air due to vapor migration. As previously discussed, data from the southern-most wells in the South Operations Area are representative of chemicals that may migrate off-site to the community. The sampling data from these wells help to indicate areas where indoor air might have been affected and what might happen in the future.

Evaluation of Potential for Adverse Health Effects

RIDOH evaluated the potential for adverse health effects from chemicals in groundwater that may migrate as vapors to indoor air. RIDOH compared the calculated indoor air contaminant concentrations (calculated for each contaminant using an attenuation factor to predict migration of vapors from groundwater to indoor air) to (1) contaminant-specific ATSDR CVs and (2) the Rhode Island Groundwater Quality Standards [RIDOH, 2009 and 2010]. The results are presented in Table 3.

Table 3: Comparison of Contaminant Concentrations in Groundwater to CVs and RIDEM Groundwater Quality Standards

Chemical	Maximum Concentration in South Operations Area (µg/L)	ATSDR CV GW Vapor Intrusion to Indoor Air (µg/L) (CV Type)	RIDEM GA Groundwater Quality Standards* (µg/L)
Benzene	J 0.76	0.57 (CREG)	5
Toluene	nd<1	14,000 (Chronic EMEG/MRL	1000
Ethylbenzene	nd<1	810 (Chronic EMEG/MRL)	700
Xylene	nd<1	370 (RMEG)	10,000
MTBE	nd<10	450 (VISL)	40
Naphthalene	J 0.21	1.6 (CREG)	100

ATSDR – Agency for Toxic Substances and Disease Registry
CV – comparison value
µg/L – microgram per liter
nd – not detected
J – estimated concentration for chemicals detected at levels below the reporting limit
EMEG/MRL – environmental media evaluation guide minimum risk level
RMEG – reference dose media evaluation guide
CREG – cancer risk evaluation guide – target cancer risk is 1 in 1 million (1E-06)
VISL – no value available from ATSDR; calculated using USEPA's Vapor Intrusion Screening Level (VISL) calculator (https://epa-visl.ornl.gov/cgi-bin/visl_search
*Rhode Island Department of Environmental Management – Office of Water Resources Groundwater Objectives – values refer to a groundwater classification of "GA", where groundwater classified as GA are groundwater resources that are known or presumed to be suitable for drinking water use without treatment. Because GA is suitable for drinking water use without treatment, this class is subject to the Federal Drinking Water Standards (maximum contaminant levels or MCLs) [USEPA, 2023] plus two additional standards for substances frequently encountered in Rhode Island groundwater for which MCLs have not been adopted (naphthalene and MTBE) [RIDEM, 2009]. Numerical Groundwater Quality standards obtained from https://risos-apa-production-public.s3.amazonaws.com/DEM/6069.pdf.

Public Health Implications

As previously discussed, groundwater classified as GA are groundwater resources that are known or presumed to be suitable for drinking water use without treatment. As shown in Table 3, the maximum concentrations of chemicals detected (either a reported or estimated value) were less than the RIDEM Groundwater Quality Standards for Class GA.

ATSDR's CVs are used by health assessors during the screening phase of the public health assessment process to identify environmental contaminants that require further evaluation. ATSDR derives CVs using epidemiological and toxicological data and applying safety factors to ensure they adequately protect public health. Therefore, contaminants detected in concentrations less than CVs are unlikely to pose a health threat.

Media-specific CVs (i.e., CVs specific to soil, groundwater, or air) incorporate standard default exposure assumptions (e.g., resident exposure time is 24 hours per day, exposure duration is 33 years, exposure frequency is 365 days per year, and lifetime expectancy is 78 years) and are not site-specific. ATSDR develops CVs based on cancer health effects (called cancer risk evaluation guides, or CREGs) and noncancer health effects (called environmental media evaluation guides, or EMEGs, and reference dose media evaluation guides, or RDMEs). ATSDR recommends the lowest CV (the most health-protective) when several are available for screening potential contaminants of concern. Contaminant concentrations that meet or exceed their respective CVs do not necessarily pose a health threat. Once they are detected at or above CVs, contaminants require additional evaluation to determine their potential health impact. The concentrations of contaminants in the downgradient well closest to nearby residences are shown in Table 3. This well is expected to represent the worst case exposure for neighborhood residents. The maximum concentration of benzene at the well, reported as an estimated value, exceeds the respective CV for cancer risks but not for non-cancer risks. None of the other chemicals were detected at levels above the corresponding CV at that well. Benzene is therefore further evaluated in this Health Consultation.

ATSDR's CREG for benzene is based on EPA-estimated cancer slope factors. A cancer slope factor is calculated by examining toxicology data on how cancer risk changes with exposure to a chemical. Cancer slope factors are developed under the assumption of a linear dose-response relationship (i.e., as the dose of the chemical increases, the cancer risk increases in a linear fashion). The CREG is based on a target cancer risk of 1 in 1 million (also expressed as 1E-06). In other words, the CV concentration is set at a level that would result in a cancer risk of 1 in 1 million. ATSDR has determined that this is the level of cancer risk that warrants further investigation. For benzene, if the CV is 0.57 µg/L, the cancer risk from vapor intrusion to indoor air from benzene in groundwater at 0.57 µg/L is equal to 1 in 1 million. A ratio can be used to calculate the cancer risk from benzene in groundwater at the estimated concentration of 0.76 ug/L as follows:

Vapor Intrusion Cancer risk from 0.76 µg/L in groundwater:
(0.76 x 1E-06) / 0.57 = 1.3E-06

This cancer risk estimate indicates that the predicted cancer risk is slightly increased over EPA's *de minimis* or insignificant target risk for residents. Typically, cancer risk is reported using 1 significant figure, as such, the cancer risk would be reported as 1 in 1 million, which is equal to EPA's insignificant cancer risk.

The actual risk of cancer from exposure to benzene vapors from groundwater from the Terminal may be lower than predicted for several reasons. First, the calculations are performed using the maximum detected concentrations of chemicals at the property border. The concentrations of chemicals in groundwater would likely be lower once the groundwater migrates to off-site areas. This is supported by the monitoring wells in residential areas installed by the Terminal from 1995 to 2005. These wells showed that groundwater off site had minimal concentrations of VOCs at a time when on-site wells

had higher levels of VOCs. Second, the attenuation factor used to calculate the concentration of vapors in indoor air due to migration from groundwater is very conservative. A default attenuation value of 0.001 is used by ATSDR for assessing potential vapor intrusion impacts to indoor air, given measured groundwater concentrations of volatile chemicals of concern. The actual attenuation factor is not known and may be overestimated [Yao et al., 2018]. Third, the default factors used to calculate the CV may overestimate the amount of exposure residents would actually experience. As previously stated, the CV calculations assume a resident is exposed to vapors in their home for 24 hours per day, 365 days per year, for 33 years. Overall, benzene in groundwater from the ExxonMobil Terminal is anticipated to have a minimal impact on the rates of cancer or other diseases in the adjacent neighborhoods to the south.

Conclusions

RIDOH concludes that the East Providence Terminal, located at 1001 Wampanoag Trail in East Providence, Rhode Island, presents a potential source of chemical exposures to residents in the area of inquiry. Complete exposure pathways include (1) inhalation of chemicals in outdoor air that may be emitted from the Terminal and (2) inhalation of chemicals in indoor air from vapors that migrate upwards from groundwater originating from the Terminal.

There is inadequate data to comprehensively evaluate the potential for adverse health effects from chemicals emitted to outdoor air. However, there are existing permits and controls that should prevent release of chemicals at harmful concentrations in the community surrounding the Terminal. Note that permitted chemical air releases are outside the scope of EHRAP's mandate, which focuses on releases to the environment that fall under the *Comprehensive Environmental Response, Compensation, and Liability Act* or the *Resource Conservation and Recovery Act* not permitted activities covered by the *Clean Air Act* or *Clean Water Act*.

Based on a screening evaluation using conservative CVs, benzene may be present in groundwater at a concentration that exceeds the CV for groundwater vapor intrusion to indoor air. However, the calculated cancer risk from the estimated maximum concentration of benzene in groundwater is within the risk management range of 10 in 1 million to 1 in 1 million. Given the conservative assumptions used in the evaluation, the actual risk is likely less than reported here. No noncancer health effects are anticipated through vapor intrusion from the detected levels of benzene in groundwater.

Recommendations

1. ExxonMobil, in consultation with DEM, should continue remediation and monitoring activities at the East Providence Terminal facility.

Public Health Action Plan

The Public Health Action Plan for the site contains a description of actions that have been or will be taken by RIDOH and/or other government agencies at the site. The purpose of the Public Health Action Plan is to ensure that this public health consultation

not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of RIDOH to follow up on this plan to ensure its implementation.

Actions Taken:

ExxonMobil continues the groundwater monitoring programs at all affected areas.

Actions Planned:

RIDOH will continue to work with the community to respond to public health questions and concerns about the site.

Report Preparation

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