Proposed Plan
Former Raritan Arsenal Site
Groundwater and Vapor Intrusion Operable Unit
Edison and Woodbridge, New Jersey

The Proposed Plan

This Proposed Plan was prepared by the U.S. Army Corps of Engineers (the Corps), New York District to present the proposed response to groundwater contamination at the former Raritan Arsenal site (the Site) in Edison and Woodbridge Townships, New Jersey. This plan summarizes the Corps' rationale for recommending monitored natural attenuation (MNA) for the potable water pathway, and both MNA and selected building mitigation and monitoring for the vapor intrusion pathway, associated with volatile organic compounds (VOCs) in groundwater.

Introduction

This Proposed Plan provides information to the public on the Corps' recommended response for groundwater contamination at the former Raritan Arsenal site (the Site) in Edison and Woodbridge Townships, New Jersey. The operable unit covered by this Proposed Plan consists of contaminated groundwater within nine identified plumes (Areas of Concern [AOCs] 2, 4A, 6A, 6C, 8A/B, 8C, 8D, 9 and 10) on the Site. This Proposed Plan presents the Corps' rationale for the preferred remedial approach for the Site and is a tool to encourage and facilitate community participation.

Federal and state environmental laws govern characterization and response activities at federal facilities. The investigation and environmental restoration of the former Raritan Arsenal has been conducted under the Defense Environmental Restoration Program – Formerly Used Defense Sites (DERP-FUDS). The overall goal under the DERP-FUDS is to achieve environmental restoration of the former Raritan Arsenal and to address potential human health and environmental risks associated with past Department of Defense (DoD) activities. The federal statute, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), establishes procedures for site investigation, evaluation, and remediation. The Corps has been working within the framework of CERCLA to identify the scope of the problem and appropriate remedial response. The New Jersey Department of Environmental Protection (NJDEP) has been a partner in this process. The Corps has also been conferring with local stakeholders since 1990 about community concerns regarding the Site.

As the lead agency for implementing the environmental response program for the former Raritan Arsenal, the Corps has prepared this Proposed Plan in accordance with CERCLA Section 117(a) and Section 300.430(f)(2) of the National Contingency Plan (NCP) to continue its community awareness efforts and to encourage public participation. After the public has the opportunity to review and comment on this Proposed Plan, the Corps will summarize and respond to the comments received during the public comment period. The Corps will also host a public meeting. Information on the times and places for public comment and the public meeting are shown in the box below.

Public Comments Are Requested

PUBLIC COMMENT PERIOD

April 6, 2017 through May 12, 2017

Written comments on this Proposed Plan can be submitted to the Corps during this comment period. Comments letters must be postmarked no later than May 12, 2017 and can be sent to Mr. Ajmal Niaz, Project Manager, U.S. Army Corps of Engineers, Jacob K. Javits Federal Building 26 Federal Plaza, Room 1811. New York**,** NY 10278. Comments can also be sent by email to: ajmal.niaz@usace.army.mil

PUBLIC MEETING

May 2, 2017

The Corps will host an information session from 7:00 to 8:00 PM at the Edison Senior Citizen Center, 2963 Woodbridge Avenue, Edison, New Jersey to provide information and answer questions in an informal setting. This meeting will include a brief introduction and summary by the Corps and an opportunity to submit public comments in writing.

The Corps will carefully consider all comments received from the public and provide responses which will be compiled into a Responsiveness Summary. The decision on which action is appropriate for the Site will be detailed in a Decision Document, which will include the Responsiveness Summary.

This Proposed Plan highlights key information from previous reports prepared for the Site, including characterization details for the Site from the *Final Supplemental Groundwater Data Report*, numerous *Indoor Air Quality Reports* (#1 through #12), and the rationale for the proposed action as presented in the *2016 Feasibility Study* (FS) report. These and other documents that support this Proposed Plan are available for review through the Corps' website for the former Raritan Arsenal:

http://www.nan.usace.army.mil/Raritan

Site Background

Where is the former Raritan Arsenal Site?

The former Raritan Arsenal lies along the north bank of the Raritan River, mostly in Edison Township with a portion of the site located in Woodbridge Township, approximately 20 miles southwest of lower Manhattan. It is bordered to the north and northwest by Woodbridge Avenue (Route 514), to the southwest by Mill Road and the Industrial Land Reclamation Landfill, and to the east by vacant and industrial properties.

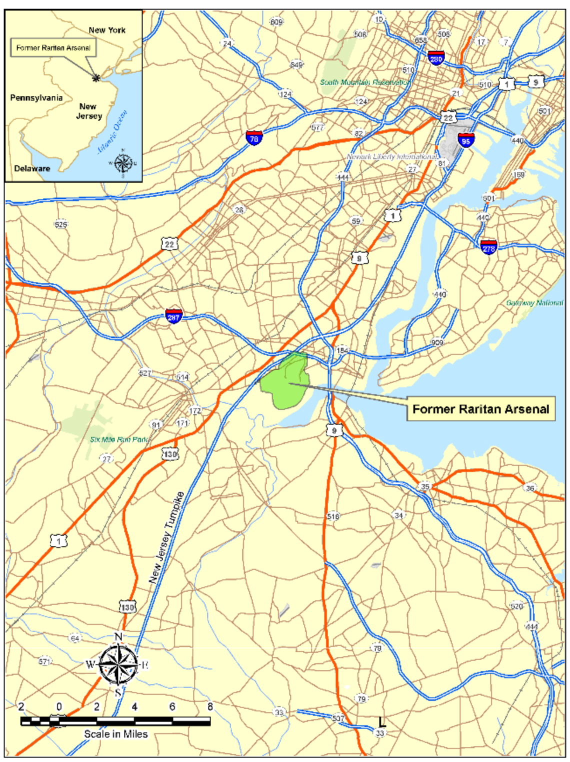

Figure 1 - Map showing the location of the former Raritan Arsenal Site.

What was the former Raritan Arsenal used for?

Prior to the construction of the former Raritan Arsenal in 1917, the area consisted of tidal marsh, clay and sand pit quarries, and farmland with several residences. The U.S. Army used the former Raritan Arsenal from 1917 to 1963. Operations at the Site included the receipt, storage, shipment, and/or decommissioning of ordnance, arms, and machinery. Today much of the northern portion of the Site is developed. Current property owners include Summit Associates, Inc. and Federal Business Centers which have built Raritan Center, a major industrial park complex; the General Services Administration (GSA); U.S. Environmental Protection Agency (USEPA); and Middlesex County, which owns Thomas A. Edison County Park and Middlesex County College (MCC). A small portion of the former Raritan Arsenal along Woodbridge Avenue has been developed for residential use. The southern portion of the Site has remained primarily tidal marsh with limited development since the closing of the former Raritan Arsenal in 1963.

What was the contamination problem and where did it come from?

Based on the history of DoD activities, prior investigations, and the results of the remedial investigation (RI) program, the groundwater chemicals of primary concern at the former Raritan Arsenal are VOCs such as tetrachloroethylene (PCE), trichloroethene (TCE), *cis*-1,2-dichlorethene (*cis*-1,2-DCE), vinyl chloride, as well as explosives (amino-DNT, 1,3-dintrobenzene, 2,6-dinitrotoluene and 2-amino-4,6-dinitrotoluene).

Typical DoD-related sources of these chemicals included machine shops or vehicle maintenance areas at the former Raritan Arsenal that used these chemicals as solvents and degreasers. In the case of explosives, typical sources include the former TNT Washout and Munitions Demilitarization areas, explosives storage buildings, as well as denotation and disposal process areas. When the chemicals were spilled or disposed of, they contaminated the soil; due to their high solubility, they eventually leached into groundwater.

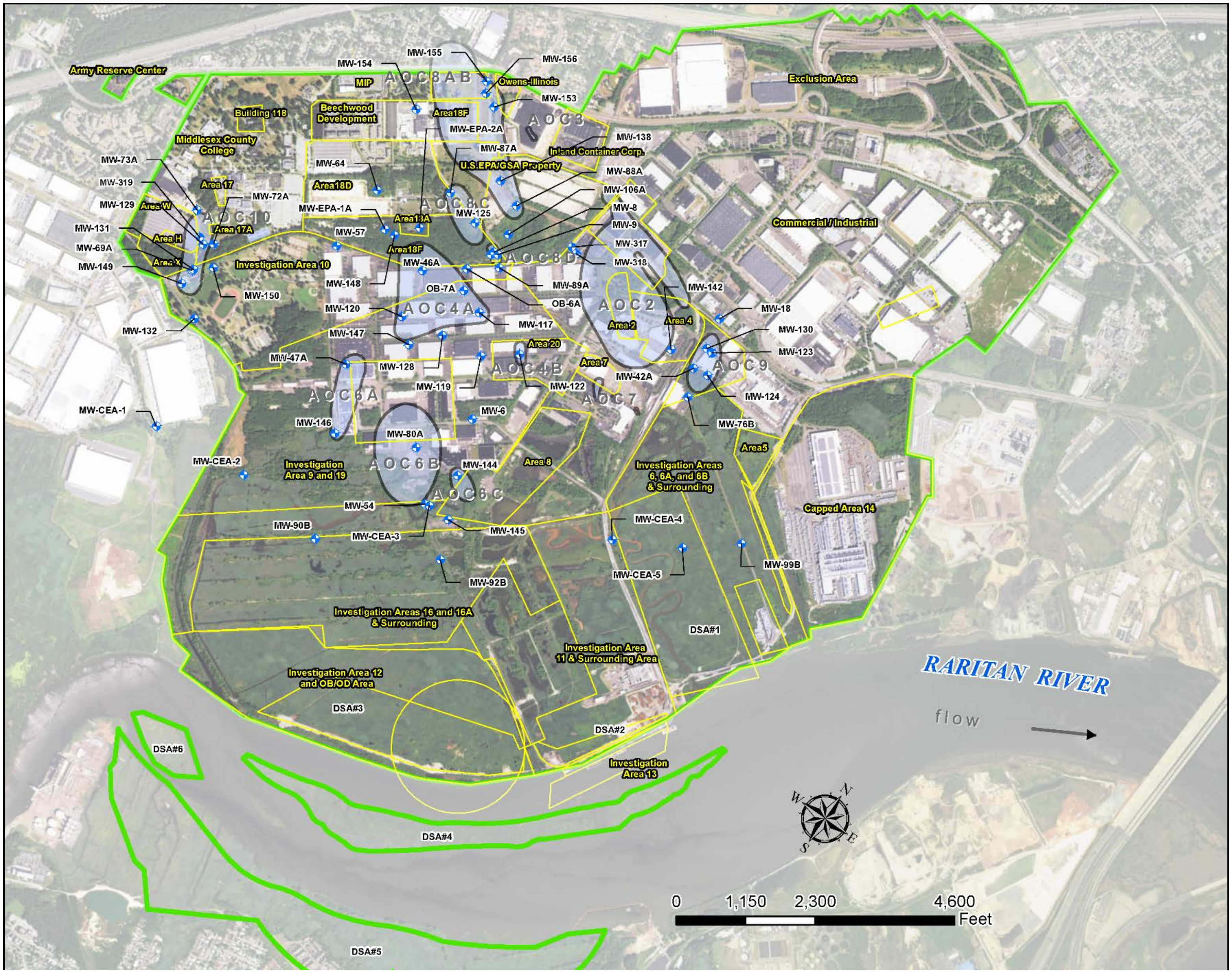

Figure 2 - Map showing the layout of the former Raritan Arsenal Site

Are there health threats from the contaminated groundwater?

Presently no populations are at risk from groundwater contamination at the former Raritan Arsenal. However, the Corps is taking steps to ensure that groundwater does not pose a risk to future inhabitants or users of the site. There are two primary environmental and health concerns pertaining to VOCs in groundwater, both of which have been extensively investigated.

The first is the potential for groundwater to cause health concerns if anyone were to drink the water (the "potable" pathway) in the future. This pathway was evaluated by conducting a risk assessment to evaluate potential future use of the water supply at the former Raritan Arsenal. This human health risk assessment (HHRA) identified several VOCs and explosives in groundwater that would pose unacceptable health risks to individuals that could drink and directly contact the water. However, groundwater use as a future drinking water source has been restricted by a "Classification Exception Area" (CEA) approved by NJDEP and shown on Figure 3 below. The CEA restricts, or requires the restriction of, potable groundwater uses within areas where there are exceedances of New Jersey's Groundwater Quality Standards (GWQS). N.J.A.C. 7:26E-8.3 lists the information that must be submitted for NJDEP to establish a CEA, such as (1) a list of all contaminants and their concentrations, (2) a description of the fate and transport of the contaminant plume, (3) site maps, (4) information regarding current and projected use of the groundwater in the aquifer, such as master plans or zoning plans, and (5) copies of various notification letters to county and municipal officials.

The CEA boundary, which covers all the groundwater AOCs, at the Site is a part of the NJDEP-approved Groundwater Remedial Action Work Plan (GWRAWP) issued in 2008. The Corps sent Notification Letters (dated February 11, 2008) to the local municipalities, the county, the NJDEP, and local property owners informing them of the CEA. The CEA will stay in place until the contaminants of concern (COCs) no longer exceed the New Jersey GWQS. Monitoring and data evaluations will be conducted every 5 years until the expiration of the CEA in 2041 at which time the need for the CEA will be reevaluated.

The second concern is the potential for building inhabitants to be exposed to vapors entering buildings from groundwater AOCs below the buildings. This is known as the Vapor Intrusion (VI) exposure pathway. The Corps has evaluated this potential threat at over 50 buildings and determined that six buildings (Building 160; Campus Plaza 4; EPA Buildings 10, 200, and 205; and 102-168 Fernwood) within the Site require continued monitoring for the vapor intrusion pathway.

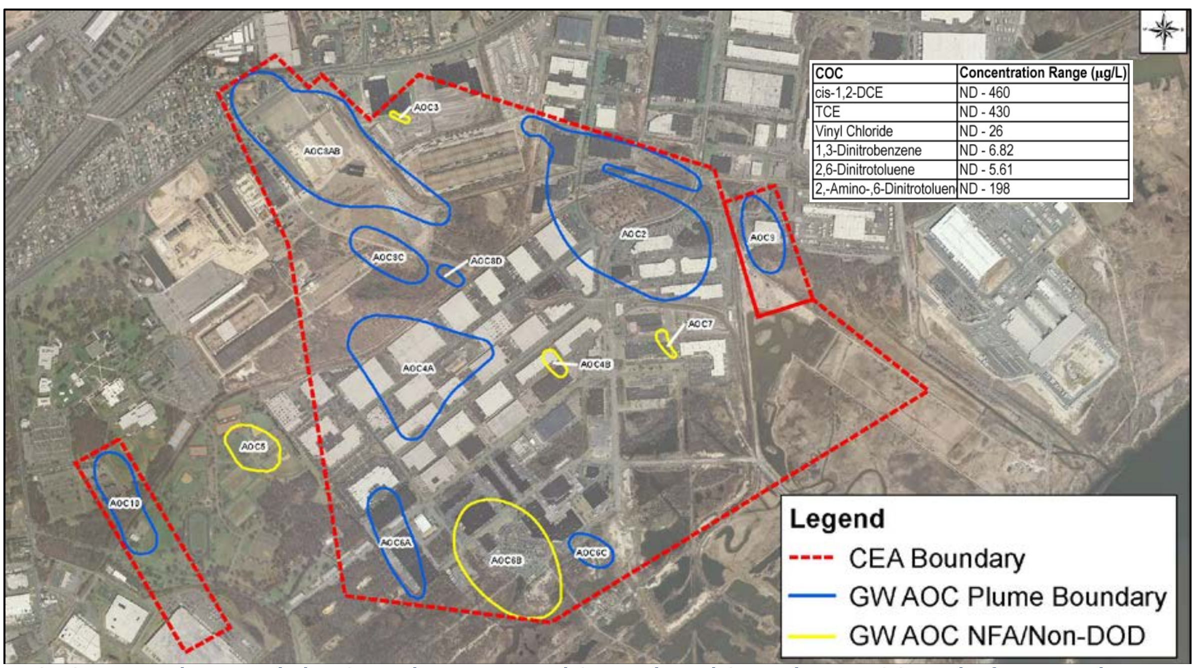

Figure 3 - CEA Boundary Restricting Groundwater Use, and Contaminated Groundwater AOCs at the former Raritan Arsenal.

Site Characterization

What has the Corps done to investigate the site?

Since the late 1980s, the Corps has undertaken extensive investigations that have focused on characterization of contamination at the Site. This process is referred to as the Remedial Investigation (RI) stage of the project. The RI involved investigation of geology and the distribution of contaminants in the area by drilling wells, recording the soil characteristics, and sampling and analyzing the groundwater (see table below). The RI included collecting several rounds of groundwater samples from 1994-2005 from monitoring wells installed at the former Raritan Arsenal. A number of additional groundwater sampling events were conducted between 2006 and 2016.

A phased approach was adopted in investigating groundwater with an RI conducted in 1994 that initially identified and mapped the various plumes or groundwater AOCs at the Site.

RI Characterization Tools

Groundwater:

- Geophysical surveys
- Test pit investigation
- Soil sampling
- Soil gas survey
- Groundwater monitoring well installation and sampling
- PCE and TCE biodegradation analysis

Vapor Intrusion:

- Building Surveys
- Sub-slab Soil Gas and Indoor Air sampling
- Meteorological data
- Ambient air sampling

The results from this RI were summarized in the 1996 *Final Sitewide Hydrogeological Report*. The data collected during the RI were used to develop a three-dimensional conceptual site model that explained the distribution and migration of PCE, TCE, and other VOCs within the groundwater.

To evaluate the potable water pathway, groundwater data from the RIs were compared to NJ GWQS and federal Maximum Contaminant Levels (MCLs). Federal MCLs and NJ GWQS (if they are more stringent than the MCLs) form the applicable or relevant and appropriate requirements (ARARs) for the site AOCs per the GWRAWP issued in 2008 (Table 1). There are currently exceedances of VOC and explosives compound benchmark levels.

Table 2 presents the vapor intrusion COCs generated by comparing groundwater analytical data to the more stringent of the NJDEP Vapor Intrusion Guidance and USEPA 2C groundwater screening levels that were current at the time. Remedial Action Monitoring Goals (Table 3) were established for these COCs in indoor air based on the specific building use. Sub-slab soil gas monitoring goals are established by dividing the indoor air value by an attenuation value of 0.02.

Table 1 – Chemicals of Concern-Potable Pathway - Groundwater Chemical-Specific ARARS and Proposed Cleanup Levels

Compound	USEPA MCL (µg/l)	NJDEP GWQS (µg/l)
cis-1,2-DCE	70	70
TCE	5	1
Vinyl Chloride	2	1
1,3-Dinitrobenzene	1.5	NLE
2,6-Dinitrotoluene	0.4	NLE
2-Amino-4,6-Dinitrotoluene	30	10
Amino-DNTs	30	NLE

Notes:
- µg/l - micrograms per liter
- NLE - No Level Established
- Shaded text box indicates the proposed criteria value

Table 2 – Contaminants of Concern in Groundwater Exceeding Vapor Intrusion Screening Levels in Groundwater

Compound	NJDEP Groundwater Screening Levels (µg/l)	USEPA Screening Levels for Groundwater (µg/l)
PCE	**31**	**5**
TCE	**2**	**5**
Vinyl Chloride	**1**	**2**

Notes:
- µg/l - micrograms per liter
- NJDEP Groundwater Screening Levels are provided in Table 1 of the "Vapor Intrusion Guidance" document (March 2013)
- USEPA Screening Levels for Groundwater from Table 2C of the "Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils" (November 2002)

Table 3 – Summary of Remedial Action Monitoring Goals for Indoor Air and Soil Gas

COC	Receptor-Specific Goal for Minimal Risk (µg/m^3) Worker	
	Indoor Air	Soil Gas
PCE	47	2400
TCE	3	150
Vinyl Chloride	2.8	140

Notes:
- µg/m^3 - micrograms per cubic meter
- Value shown is the lower of the risk based concentration for noncancer or cancer effects.
- The Worker receptor values apply to all buildings currently being monitored within the former Raritan Arsenal.
- Soil gas level is derived by dividing the indoor air value by an attenuation factor of 0.02.

Groundwater monitoring data were subsequently collected over several years following the initial RI documenting that the concentrations of VOCs were generally decreasing in individual wells sampled throughout the Site. These results were summarized in the 2003 *Final Groundwater Natural Attenuation Report*. PCE and TCE, two of the primary groundwater COCs, decompose in the environment under certain conditions and form breakdown products. Breakdown products such as *cis*-1,2-DCE and vinyl chloride have also been detected in groundwater at the Site indicating that decomposition is well underway. In general, concentrations of VOCs in groundwater have been decreasing over time as a result of natural dispersion and dilution of groundwater contaminants as groundwater slowly migrates through the subsurface.

A supplemental groundwater investigation conducted in 2005 delineated 9 AOCs at the former Raritan Arsenal as shown on Figure 3. Eight of these are VOC plumes, and one (AOC 9) contains explosives compounds.

The supplemental groundwater investigation was conducted to better understand the extent of VOC-impacted groundwater in relation to existing buildings on the Site that were constructed years after the U.S. Army left.

Following delineation of contaminated groundwater AOCs, 50 buildings were evaluated for vapor intrusion. First, the groundwater concentrations of VOCs in nearby groundwater wells were compared to screening levels to determine if the groundwater was a potential source of vapors to each building. If the groundwater VOC concentrations exceeded the screening levels, the buildings were sampled to determine if there was a complete vapor intrusion pathway. Both air under the buildings (referred to as sub-slab soil gas) and indoor air were analyzed for VOCs. Air samples were collected in Summa canisters such as the one in the photo below.

Figure 4 - Vapor Intrusion studies were conducted at several buildings in which sub-slab soil gas and indoor air were sampled for the presence of VOCs to determine if vapor from groundwater was entering buildings.

The Corps sampled many buildings over several events; in some cases buildings were sampled over 25 times over the past 12 years to monitor concentrations of VOCs in soil gas and indoor air. Analytical results from those investigations were compared to screening levels for soil gas and indoor air to determine if there were potential risks to human health. Meteorological data and background ambient air data were also used for interpreting results.

The Corps also performed a HHRA for vapor intrusion to evaluate inhalation cancer risks and non-cancer hazards associated with potential exposure to TCE and breakdown products at the Site. This HHRA is included as an appendix to the *Groundwater and Vapor Intrusion Feasibility Study* dated November 2016.

What did the Groundwater/Vapor Intrusion Investigations and HHRA conclude?

The groundwater investigations concluded that VOCs were present in groundwater at concentrations greater than potable standards at eight DoD-related AOCs on the Site, shown in Figure 3. One explosives groundwater plume (AOC 9) was also identified, as shown on the figure. Groundwater monitoring events indicate that degradation of TCE is apparent in 10 of the 11 groundwater plumes. The exception is AOC 8A/B where analytical results for TCE appear to be stable with slight variations. While ingestion of contaminated groundwater is not a current risk since people do not drink the water, restrictions on future land use are required to eliminate potential exposure.

The indoor air evaluations indicated that potential vapor intrusion risks from groundwater were present for some building inhabitants. The HHRA for the vapor intrusion pathway established monitoring goals for buildings that currently have a vapor mitigation system in place.

The HHRA for the potable pathway concluded that several DoD-related VOCs and explosives detected in groundwater pose unacceptable risk to human health for a hypothetical future use scenario. However, the CEA is currently in place to address this risk.

What has the Corps done to date to address the problem?

The Corps, in accordance with CERCLA guidance, initially focused on source removal. This included direct excavation of VOC-contaminated soils that could further impact groundwater through leaching of contaminants. The Corps removed approximately 2,450 cubic yards of soil in 1998 and 3,500 cubic yards of soil in 2002 from the Investigation Area 18C Ramp Area, the primary VOC source for Groundwater AOC 2. Groundwater AOC 2 currently has 2 buildings (160 Fieldcrest and Campus Plaza IV) being monitored for vapor intrusion. The Corps also removed approximately 2,950 tons of VOC-contaminated soils from Investigation Area 18E on the USEPA property in the vicinity of Groundwater AOC 8; approximately 760 tons of VOC-contaminated soil from Investigation Area W within AOC 10; approximately 15,300 gallons of surface water, 170 tons of tar-based materials, and 3,012 cubic yards of soil from Investigation Area 18A (Former Unlined Pond); and approximately 6,160 cubic yards of soil from multiple Drum Disposal Areas (DDAs) within AOC 2.

From 2008 to 2010, the Corps conducted a pilot study for in situ chemical oxidation (ISCO) with permanganate at 165 Fieldcrest Avenue (i.e., Building 165) and bioaugmentation at Investigation Area 18C Ramp Area within Groundwater AOC 2. Both studies were successful in helping to significantly reduce the VOC concentrations present near the source of the AOC 2 plume.

The Corps is monitoring the vapor mitigation systems at five buildings (EPA Buildings 10, 200, 205; Building 160; and 102-168 Fernwood) to ensure they are operating as designed. The mitigation systems have been installed at these buildings by the Corps, USEPA, NJDEP, or landowners to ensure there were no unacceptable risks to building occupants. All of the above buildings are being sampled and inspected at a minimum of every five years to ensure that conditions do not change and are protective of human health.

The Corps completed 2 mitigation system shutdown testing events at Building 165 in 2016. The testing p

Figure 5 - Installation of a well at the former Raritan Arsenal for groundwater characterization.

The mitigation systems at EPA Buildings 200 and 205 were optimized by the Corps to reduce energy consumption while maintaining system protectiveness and protection of human health. The Corps plans to continue optimizing the mitigation systems at the other buildings when conditions warrant.

There is one building (Campus Plaza 4) that does not have a vapor mitigation system and the Corps continues to monitor and investigate possible sources of vapor contamination.

Technology Evaluation

What is a Feasibility Study (FS)?

The Corps conducted an FS to provide additional documentation for the selection of a preferred remedial alternative for both the potable groundwater and vapor intrusion pathways.

The FS consists of:

- Evaluating physical, geological, geochemical, and hydrogeological conditions pertinent to remedy selection;
- Identifying Remedial Action Objectives (RAOs) for both the potable and vapor intrusion pathways in groundwater; and
- Identifying and comparing potential options to achieve RAOs for both the potable and vapor intrusion pathways.

Potential remedial options for addressing risks from the potable pathway and the vapor intrusion pathway were screened for their technical feasibility. The analysis was subsequently used to develop comprehensive remedial alternatives.

What are the Remedial Action Objectives (RAOs) for the Site?

The RAOs for the former Raritan Arsenal groundwater and vapor intrusion to indoor air pathways are based on human health and environmental risks that drive the formulation and implementation of response actions. Alternatives have been developed based on the criteria outlined under CERCLA.

The incorporation of applicable or relevant and appropriate requirements (ARARs) is considered in the development of RAOs and in the evaluation of remedial alternatives. ARARs are used to develop the remedial action cleanup levels that are used to determine the appropriate extent of site cleanup. The groundwater COCs for the site AOCs are cis-1,2-DCE, TCE and vinyl chloride, with the exception of AOC 9 COCs which are amino-DNT, 1,3-dintrobenzene, 2,6-dinitrotoluene and 2-amino-4,6-dinitrotoluene.

The proposed RAOs for the former Raritan Arsenal groundwater have an overall objective of ensuring that DoD-related contaminants meet state and/or federal potable water standards, as well as ensuring that groundwater and soil gas concentrations no longer pose a potential health threat to inhabitants of future or existing buildings.

Specific RAOs established to address the potable groundwater pathway include:

- Prevent ingestion or exposure to groundwater with concentrations of COCs above federal MCLs or promulgated NJ GWQS (whichever are more stringent).
- Ensure that the CEA remains in place until such time as the concentrations of COCs in the groundwater are below federal MCLs or promulgated NJ GWQS (whichever are more stringent).

The proposed RAOs for the groundwater vapor intrusion pathway are as follows:

- Prevent exposure to concentrations of COCs that are above site-specific, risk-based criteria for indoor air.
- Ensure that mitigation systems operate until such time that soil gas concentrations of VOCs no longer pose health risks to building inhabitants.
- Vapor Mitigation System Termination Process: When indoor air and soil gas levels are below the established action levels for DoD-related COCs, system shutdown will be proposed. The mitigation system will be shut down for a period of 30-45 days prior to sampling. Two sampling events of indoor air and soil gas monitoring will be collected, with one during the heating season and the other during the cooling season. The mitigation system will be operated in normal mode between sampling events. The data collected from the two sampling events will be compared to established action levels. If monitoring results support No Further Action (NFA), the vapor mitigation system will be terminated. This mitigation termination process is consistent with NJDEP guidance.

What alternatives were considered in the FS?

The ***Remedial Alternatives*** highlight box summarizes the alternatives that were identified and evaluated in the FS for the Site. With respect to vapor intrusion, because remedies were already implemented at the Site to address real or perceived health risks, remedial alternatives that were considered focused on measures related to augmenting the efficiency and/or effectiveness of existing remedies. For both the potable water and vapor intrusion pathways, federal regulations require consideration of the No Further Action (NFA) alternative as well.

Summary of Alternative Evaluation

A summary of the nine evaluation criteria required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to evaluate the selected remedial alternatives is presented in the FS. The nine criteria are divided into the following three groups:

- Threshold Criteria:
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Primary Balancing Criteria:
  - Short-term effectiveness
  - Long-term effectiveness and permanence
  - Reduction in toxicity, mobility, or volume
  - Implementability
  - Cost
- Modifying Criteria:
  - State acceptance
  - Community acceptance

The following is a brief summary of the comparative evaluation process. It should be noted that state and community acceptance of all alternatives would be addressed in the Decision Document once all comments have been received.

Threshold Criteria (Must Be Met)

<u>Overall Protection of Human Health and the Environment</u>

This criterion addresses whether each alternative provides adequate protection of human health and the environment by eliminating, reducing, or controlling exposure to human or environmental receptors.

Alternative No. 1 is not protective of human health or the environment since this alternative does not restrict the use of groundwater and impacts to indoor air would continue unabated and unmonitored.

Remedial Alternatives

- Alternative 1 – No Further Action
  Take No Further Action at the former Raritan Arsenal to address groundwater contamination. This alternative is required under CERLCA regulations as a baseline from which to compare the other alternatives.
- Alternative 2 – Monitored Natural Attenuation with Land Use Controls (LUCs)
  Complete groundwater sampling of groundwater wells at the Site every 5 years, to confirm that contaminant concentrations in the groundwater are stable or declining, or remaining below MCLs for DoD-related COCs. A CEA will stay in place until concentrations of VOCs and explosives are less than the lower of NJ GWQS or MCLs. Conduct 5-year reviews until the CEA expiration in 2041, at which time the program will be reevaluated to determine the necessity of renewing the CEA.
- Alternative 3 – Extraction and Treatment with LUCs
  Withdraw contaminated groundwater via extraction wells, treating it in an on-site treatment unit, and disposing the clean, treated water in a surface water body or a publically owned treatment works (POTW). A fluidized bed reactor (FBR) would be used to treat both VOC- and TNT-related compounds for about 20 years, with monitoring thereafter to ensure DoD-related contaminant concentrations in groundwater are reduced to levels below the NJ GWQS and MCLs. Five year reviews will be conducted until unlimited use and unrestricted exposure (UU/UE) is achieved.

  Alternative 4 – In-Situ Bioremediation with LUCs
  Incorporate in situ treatment with LUCs as described for Alternative No. 2. The in situ treatment would consist of adding bacteria that break down VOCs and explosives compounds in the groundwater over time.
- Alternative 5 – ISCO with LUCs
  Inject chemicals called oxidants into the wells in order to break down VOCs and explosives contaminants in groundwater over time.

Alternative Nos. 2, 3, 4, and 5 are each protective of human health and the environment. Groundwater would not be used and future use would be controlled by instituting well restrictions in a CEA. Indoor air quality (IAQ) impacts are mitigated using subslab venting systems. Therefore, the potential for future exposure to COCs above ARARs would be controlled with active remediation and/or institutional controls during implementation of the remedy and would eventually be eliminated once RAOs are achieved and proven through monitoring.

Alternative Nos. 3, 4, and 5 actively treat the contaminants in groundwater, thus reducing the concentrations more quickly and preventing offsite migration.

Compliance with ARARs

ARARs are used to develop remedial action cleanup levels, determine the appropriate extent of site cleanup, and govern implementation and operation of the selected remedial action. Vapor intrusion pathway assessments have identified buildings with the potential to pose risk to human health. However, potential risks have been mitigated via installation of sub-slab venting mitigation systems. Available analytical data indicates that there is no risk to human health while the mitigation systems are operating.

Alternative No. 1 would not comply with ARARs, since no clean-up activities would be performed. Although under this alternative COCs may degrade naturally, there is no active management or documentation that the RAOs will be achieved over time.

Alternative Nos. 2 through 5 would meet groundwater cleanup goals over various time frames for AOCs 2, 4A, 4B, 6A, 6B, 6C, 8A/8B, 8C, 8D, 9, and 10. Alternative Nos. 3, 4, and 5 would meet groundwater cleanup goals sooner, since these alternatives include active treatment of groundwater contaminants.

All of these alternatives provide a CEA with Well Restriction Area (WRA) and mitigation of IAQ until the groundwater cleanup goals are achieved. Vapor intrusion and/or groundwater monitoring coupled with the statutory five-year reviews would provide documentation that the criteria have been met.

Primary Balancing Criteria (Identifies Major Trade-offs Among Alternatives)

Short-Term Effectiveness

The short-term effectiveness criterion addresses potential impacts to site workers, the community, and the environment during cleanup. This assessment includes the amount of time it takes to complete the remedial action. It also addresses off-site impacts in relation to the effects on the adjacent community during off-site disposal, including transportation of the waste and impacts in the area of the disposal facility.

Alternative No. 1 would not involve construction or monitoring activities; therefore, there would be no risk to workers or the community. However, a reduction of contamination and achievement of site protection would not occur under this alternative.

Alternative No. 2 requires monitoring and construction/abandonment of monitoring wells, presenting a low to moderate risk to site workers and the local community, but no risk to the environment.

Alternative No. 3 presents a moderate risk to remedial workers during drilling and installation of extraction and monitoring wells, and construction of the treatment plant. There would a low risk posed to remedial workers during well abandonment, and a low risk posed to workers and the community during monitoring activities. Site-wide pumping could result in the water levels of local wetlands being drawn down, but this could be counter-acted. Piping across multiple properties, and an NJPDES permit would be needed for discharge of effluent to surface water.

Alternatives Nos. 4 and 5 pose a moderate risk to remedial workers during drilling and installation of extraction and monitoring wells, and handling and injection of chemicals during performance of tasks. There would be a low risk posed to remedial workers during well abandonment and a low risk posed to workers and the community during monitoring activities.

While Alternative No. 4 utilizes a mixing and delivery system for biotreatment liquids that pose a moderate risk, Alternative No. 5 utilizes ISCO oxidizing solutions that pose a potential short-term risk to remediation personnel. The implementation of proper engineering controls and safety equipment would be required, and a site-specific Health and Safety Plan would be needed to address these activities. Storage of more than 400 pounds of potassium permanganate will require that a

Department of Homeland Security "Top Screen" form be completed and submitted. Short-term water quality changes in color, TDS, metals, and chloride concentrations are to be expected. Risks to the local community would be present during shipment of chemicals to the treatment area.

Under Alternative Nos. 2, 3, 4, and 5, USACE would notify local contractors, utilities and governments of the dermal/inhalation risks from site-related groundwater contaminants. These entities, in turn, would be asked to notify their workers.

Long-Term Effectiveness and Permanence

Long term effectiveness and permanence considers the expected residual risk and the ability of a remedy to protect human health and the environment over time, once cleanup levels have been met.

Under Alternative No. 1, source areas would not be addressed; therefore, there would be no management of risk. Although under this alternative COCs may degrade naturally, there is no active management or documentation that the RAOs will be achieved over time.

Under Alternative Nos. 2, 3, 4, and 5, groundwater use at all AOCs would be controlled using LUCs, such as well restrictions in the already established CEA. Any indoor air exposures would be mitigated using subslab venting mitigation systems. Both groundwater and vapor intrusion monitoring would be conducted to provide a measurable level of attainment of long-term effectiveness and permanence.

Alternative No. 2 is an effective permanent long-term option because it relies on processes already at work in the aquifer to reduce COCs below NJDEP Class IIA Aquifer criteria. Additionally, COC levels should not rebound, as might be seen under the extraction and treatment alternative (Alternative No. 3). Further, effectiveness does not rely upon the ability of the alternative to deliver active ingredients throughout the treatment zone, as is the case with the biotreatment alternative (Alternative No. 4), and the ISCO alternative (Alternative No. 5).

For all of the AOCs, Alternative No. 3 (Extraction and Treatment) will reduce groundwater COCs to below groundwater cleanup goals. However, VOC and TNT source areas within the low permeability aquifer zones, or TNT source areas within the vadose zone may continue to release contaminants once the pumping system is shut down, causing concentrations to rebound. Alternative 3 may be difficult to implement at AOC 8A/8B, since it appears that a large portion of the contamination is under Building 238.

Alternative Nos. 4 and 5 may reduce groundwater COCs to below groundwater cleanup goals at all AOCs. However, the in situ treatment systems are challenged by the need to achieve ubiquitous contact in the groundwater between the treatment components (biological or ISCO) and the contaminants. This issue can be particularly problematic in hydrogeologic settings such as those at the former Raritan Arsenal, where fine grain materials are intermixed with conductive sands, creating a heterogeneity that limits access to some portions of the treatment zone. Thus, VOC or TNT source areas within low permeability aquifer zones may continue to release contaminants after treatment is completed, causing concentrations to rebound. In addition, Alternative No. 5 requires low soil oxidant demand (SOD) to be most effective, which is not necessarily found at all areas of the former Raritan Arsenal (AOC 2 - Area 18C and Building 256 Ramp Area have high SOD values) and may further limit the effectiveness of Alternative No. 5. Pilot tests have been completed within AOC 2 to determine the full-scale design needs and to confirm the appropriateness of Alternative Nos. 4 and 5.

Estimated time to complete remedial design and construction, and to reach remediation goals are as follows:

- Alternative No. 1 – 0 years;
- Alternative No. 2 – Approximately 41 years;
- Alternative No. 3 – Approximately 30 years;
- Alternative No. 4 – Approximately 4-8 years, with groundwater monitoring through year 10; and
- Alternative No. 5 – Approximately 2-4 years, with groundwater monitoring through year 10.

Reduction in Toxicity, Mobility, or Volume

This criterion evaluates the anticipated performance of treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of hazardous substances that are the principal threat at a site.

Alternative No. 1 does not reduce the toxicity, mobility, or volume of contamination.

Alternative No. 2 relies on natural attenuation and biological conditions to reduce the toxicity and volume of contaminants present. The reliability of natural degradation to occur depends on the contaminant and the geochemical conditions of the aquifer. The primary contaminant at AOC 9 is TNT. Although TNT will naturally degrade, it does not do so as readily as the solvent-related VOCs observed at the other AOCs. Natural degradation has been demonstrated to be ongoing at an acceptable rate in all AOCs.

Alternative Nos. 3, 4, and 5 are comparable at reducing toxicity and volume via contaminant treatment. However, Alternative No. 4 is the most common in situ treatment used to treat VOCs and explosives in groundwater. Alternative Nos. 4 and 5 via in situ treatment will both reduce the toxicity and mobility of the COCs at a faster rate than Alternative No. 3, where groundwater is extracted and treated ex situ.

Implementability

This criterion addresses the technical and administrative feasibility of a remedial alternative from design through construction and operation, including the availability of materials and services and the need for permits and other forms of documentation required for operation.

All of the alternatives for groundwater remediation are implementable at each of the AOCs because the necessary resources are readily available. Alternatives were distinguished from one another based upon the level of engineering design and construction required to implement them at the former Raritan Arsenal.

Alternative No. 1 would require no implementation.

Alternative No. 2 requires indoor air sampling, sub-slab soil gas sampling, monitoring well installation or abandonment, and groundwater sampling which are straightforward to implement and use proven technologies.

Alternative No. 3 would be straightforward to implement, but can become complex in areas of high infrastructure density. The number of extraction wells that would be required to create an adequate capture zone would be relatively high due to the large percentage of the fine grain materials in the subsurface. Aquifer testing and groundwater modeling would have to be performed to design the extraction system. Construction activities would include the installation of extraction wells (and possibly injection wells), FBR treatment equipment, and an electric power source with controls. FBR biomedia mix would have to be optimized based on bench scale testing. The waste stream generated from operation of biologic FBRs has to be conveyed to a POTW or pumped from a holding tank and trucked to an appropriate disposal facility. A permit would be required for discharge to the local waterway. All other activities would be related to periodic groundwater and vapor intrusion monitoring (indoor air and sub-slab soil gas), reporting, system maintenance, and system optimization (i.e., adjusting extraction rates or composition of FBR media based on performance). Bench scale testing, design, and system installation for a pump and treat system could take six months to one year to implement.

Alternative No. 4 would be complex to implement. The numbers of injection wells that would be required for containment would be relatively high, compared to some other hydrogeologic settings, as a large percentage of the subsurface is comprised of fine grain materials. Aquifer testing and groundwater modeling would have to be performed to design the injection system. Construction activities would include the installation of injection wells, a mixing and delivery system for biotreatment components (substrate, and in some cases select active bacteria), and an electric power source with controls. Bench scale and pilot testing have both been completed. All other activities would be related to periodic groundwater and vapor intrusion monitoring (indoor air and subslab soil gas), reporting, system maintenance and system optimization (i.e., adjusting treatment specifications based on performance).

Alternative No. 5 would be complex to implement. ISCO has been demonstrated in many field-scale applications to be capable of achieving complete destruction of chlorinated ethenes. The low permeability and heterogeneous nature of the soils across the site would require tight injection well spacing. Aquifer testing and groundwater modeling would have to be performed to design the injection system. Several discrete injections across each vertical treatment zone (at least one injection per 2-foot interval) may be necessary to provide the best chance at achieving uniform distribution. The oxidizing solution is easily injected into the subsurface via injection wells or points as a liquid. The chemicals and equipment required for this remedial alternative are readily available, and the injection technologies have been repeatedly field tested. Bench scale and pilot testing have both been completed in AOC 2. All other activities would be related to periodic groundwater and vapor intrusion monitoring (indoor air and subslab soil gas), reporting, system maintenance and system optimization (i.e., adjusting treatment specifications based on performance).

Cost

This section compares the differences in cost, including capital, and operation and maintenance costs for implementing each of the alternatives at the AOCs. The following costs are based on the detailed descriptions of the alternatives.

There are no costs for Alternative No. 1.

Capital costs for Alternative No. 2 are $0, while the present worth costs for lifetime operation and maintenance costs, assuming 30 years, are $2,637,000. Total present worth costs are $2,637,000.

Capital costs for Alternative No. 3 are $25,461,400, while the present worth costs for lifetime operation and maintenance costs, assuming 30 years, are $15,454,300. Total present worth costs are $40,915,700.

Capital costs for Alternative No. 4 are $46,711,600, while the present worth costs for lifetime operation and maintenance costs, assuming 10 years, are $1,716,000. Total present worth costs are $48,427,600.

Capital costs for Alternative No. 5 are $73,936,600 while the present worth costs for lifetime operation and maintenance costs, assuming 10 years, are $1,716,000. Total present worth costs are $75,652,600.

Preferred Alternative

What is the preferred alternative for the Site?

The preferred alternative is Alternative No. 2 – Monitored Natural Attenuation with Land Use Controls.

Alternative No. 1 would not be effective in protecting human health and the environment because without monitoring there can be no confirmation that contaminant concentrations will sufficiently attenuate over time. Alternative Nos. 3, 4, and 5 were not selected because results from the RI indicated that concentrations of TCE in groundwater at the former Raritan Arsenal have already decreased significantly over the past 10 to 15 years. The potential benefits of these additional treatment alternatives do not justify the significantly higher costs for their implementation. It is the lead agency's current judgment that the Preferred Alternative identified in the Proposed Plan or one of the other active measures considered in the Proposed Plan, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Next Steps

What happens next?

The Corps will hold a public meeting on May 2, 2017, at the Edison Senior Citizen Center (2963 Woodbridge Avenue, Edison, New Jersey). Once the community has reviewed this Proposed Plan, the Corps and the NJDEP will consider all of the comments that are received from the public. The Corps will provide written responses to all substantive comments and combine them into a Responsiveness Summary, which will be included in the Decision Document for the Site. The preferred alternative may be revisited if new information becomes available or in response to public comments. The Decision Document will describe the selected remedy and summarize community participation in the selection process. The Corps and NJDEP anticipate that the Decision Document will be finalized and signed before the end of 2017, at which time it will be made available to the public at on the Corps' webpage for the former Raritan Arsenal:

http://www.nan.usace.army.mil/Raritan

Based on the available information, USACE believes the Preferred Alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. USACE expects the Preferred Alternative to satisfy the following statutory requirements of CERCLA § 121(b): 1) to be protective of human health and the environment; 2) comply with ARARs; 3) to be cost effective; 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 5) satisfy the preference for treatment as a principal element (or justify not meeting the preference). Similarly, it is the lead agency's current determination that the Preferred Alternative identified in this Proposed Plan or one of the other active measures considered in the Proposed Plan is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Glossary of Terms

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): A federal law passed in 1980 and amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA), commonly known as Superfund. The Corps' characterization and remediation at DERP FUDS sites is conducted under the framework of CERCLA/SARA, while funded by the Defense Environmental Restoration Program (DERP).

Corps of Engineers (the Corps): The U.S. Army Corps of Engineers provides comprehensive environmental restoration services for the Army, Department of Defense (DOD), Environmental Protection Agency (EPA), Department of Energy (DOE), and other federal agencies. The DOD has designated the Corps to oversee the environmental program at the Site, under the Formerly Used Defense Site (FUDS) program.

Decision Document: A legal, technical and public document that explains the rationale and remedy decision for a given site. It also summarizes the public's involvement in the decision process.

Feasibility Study (FS): An engineering study of the potential remedies for a site.

Groundwater (GW): Groundwater is the water found beneath the earth's surface that fills pores between such materials as soil and bedrock.

Human Health Risk Assessment (HHRA): A site-specific assessment used to estimate the nature and probability of potential adverse health effects for humans who may be exposed to site contaminants.

Indoor Air: Air within buildings and structures.

Information Repository: A public file containing site/project information and documents of onsite investigation and remediation activities in either hard copy or electronic form.

Leaching: To remove soluble or other constituents from by the action of a percolating liquid

Maximum Contaminant Level (MCL): Enforceable drinking water standard developed by EPA based on laboratory research and toxicity data for impacts of specific chemicals. The MCL for PCE, TCE and *cis*-1,2-DCE is 5 µg/L.

Natural Attenuation: The natural dispersion, dilution and overall dissipation of groundwater contaminants over time as the groundwater slowly migrates through the subsurface.

Potable Pathway: Potential risk to humans associated with water used, or intended to be used, for culinary purposes or drinking.

Remedial Action Objectives (RAOs): Media-specific or area-specific goals developed for a remedial action to protect human health and the environment.

Remedial Investigation (RI): The collection of data and information necessary to characterize the nature and extent of contamination at a site. The RI also includes information as to whether or not the contamination poses significant risk to human health and/or the environment.

Sub-slab Soil Gas: Gaseous elements and compounds in the small spaces between particles of the earth and soil.

Vapor Intrusion: The migration of volatile chemicals from the subsurface into overlying buildings through subsurface soils or preferential pathways (such as underground utilities)

Volatile Organic Compounds (VOCs): Organic chemicals that have a high vapor pressure at ordinary room temperature which causes large numbers of molecules to evaporate from the liquid form of the compound and enter the surrounding air.

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