Section 1.0
Introduction

This section provides background information about the Superfund Innovative Technology Evaluation (SITE) Program, discusses the purpose of this Innovative Technology Evaluation Report (ITER), and describes Earth Tech's Enhanced In-Situ Bioremediation process. Key contacts are listed at the end of this section for inquiries regarding additional information about the SITE Program, this technology, and the site where the technology was demonstrated.

1.1 Background

A pilot-scale technology demonstration of the Enhanced In-Situ Bioremediation process was conducted from March 1998 to August 1999 at the ITT Industries Night Vision (ITTNV) Division plant in Roanoke, Virginia. The ITTNV facility is an active manufacturing plant that produces night vision devices and related night vision products for both government and commercial customers. Groundwater contamination has been detected at several areas at the facility. The area focused on during the demonstration is immediately downgradient of a solvent release source area. At this locality, several volatile organic compounds (VOCs) have been measured at concentrations above regulatory levels in both an upper and lower fractured zone in the underlying shallow bedrock. Four specific VOC compounds were designated as "critical parameters" for evaluating the technology: chloroethane (CA), 1,1-dichloroethane (1,1-DCA), cis-1,2-dichloroethene (cis 1,2-DCE), and vinyl chloride (VC).

The pilot treatment system that Earth Tech installed within the area of contamination consisted of eleven monitoring points (i.e., an injection well, four monitoring wells located within the anticipated radius of influence [designated as "critical wells"], two monitoring wells located outside of the anticipated radius of influence, and four soil vapor monitoring points). Over the duration of the demonstration combinations of air, nutrients, and methane were injected into the lower fractured zone approximately 43 feet below land surface. One of the monitoring wells was activated as a second injection well during the demonstration.

The primary objective of the demonstration was to evaluate Earth Tech's claim that there would be a minimum 75% reduction in groundwater concentrations in the treatment zone for each of the four critical VOCs, following six months of treatment. A statistical analysis recommended collecting 28 samples to confidently detect a 75% reduction at a 90% lower confidence level (LCL) for those VOCs within the critical wells, over the course of the demonstration. Collecting samples daily represented a conservative basis for ensuring sample independence based upon the groundwater gradient. This approach also took into account both temporal and spatial variability for the four critical analytes. Therefore, four wells sampled seven consecutive days yielded the 28 samples needed for evaluating Earth Tech's claim. For each critical analyte, the concentration for the baseline and final events were calculated by averaging the 28 values.

Although emphasis was placed on evaluating treatment effectiveness at the injection depth, groundwater in both the upper and lower fractured zones of the bedrock were sampled and analyzed by the SITE Program. This was conducted by sampling wells specially designed by Earth Tech to separately monitor the upper and lower fractured zones, and by sampling of existing wells screened in the upper fractured zone.

1.2 Brief Description of the SITE Program

The SITE Program is a formal program established by the EPA's Office of Solid Waste and Emergency Response (OSWER) and Office of Research and Development (ORD) in response to the Superfund Amendments and Reauthorization Act of 1986 (SARA). The SITE Program promotes the development, demonstration, and use of new or innovative technologies to clean up Superfund sites across the country.

The SITE Program's primary purpose is to maximize the use of alternatives in cleaning hazardous waste sites by encouraging the development and demonstration of new, innovative treatment and monitoring technologies. It consists of three major elements:

- the Demonstration Program,
- the Consortium for Site Characterization Technologies (CSCT), and
- the Technology Transfer Program.

The objective of the Demonstration Program is to develop reliable performance and cost data on innovative technologies so that potential users can assess the technology's site-specific applicability. Technologies evaluated are either available commercially or close to being available for full-scale remediation of Superfund sites. SITE demonstrations usually are conducted at hazardous waste sites under conditions that closely simulate full-scale remediation conditions, thus assuring the usefulness and reliability of the information collected. Data collected are used to assess: (1) the performance of the technology; (2) the potential need for pre- and post-treatment of wastes; (3) potential operating problems; and (4) the approximate costs. The demonstration also provides opportunities to evaluate the long term risks and limitations of a technology.

Existing and new technologies and test procedures that improve field monitoring and site characterizations are explored in the CSCT Program. New monitoring technologies, or analytical methods that provide faster, more cost-effective contamination and site assessment data are supported by this program. The CSCT Program also formulates the protocols and standard operating procedures for demonstration methods and equipment.

The Technology Transfer Program disseminates technical information on innovative technologies in the Demonstration and CSCT Programs through various activities. These activities increase awareness and promote the use of innovative technologies for assessment and remediation at Superfund sites. The goal of technology transfer activities is to develop interactive communication among individuals requiring up-to-date technical information.

1.3 The SITE Demonstration Program and Reports

For the first ten years in the history of the SITE program, technologies had been selected for evaluation through annual requests for proposals. EPA reviewed proposals to determine the technologies with promise for use at hazardous waste sites. Several technologies also entered the program from current Superfund projects, in which innovative techniques of broad interest were identified under the program.

In 1997 the program shifted from a technology driven focus to a more integrated approach driven by the needs of the hazardous waste remediation community. The SITE program now annually solicits applications for participation in the Demonstration program from parties responsible for clean up operations at hazardous waste sites. A team of stakeholders led by SITE program personnel will select sites and work with site representatives in bringing technologies for demonstration to their respective sites.

Once the EPA ha accepted an application, cooperative arrangements are established among EPA, the developer, and the stakeholders to set forth responsibilities for conducting the demonstration and evaluating the technology. Developers are responsible for operating their innovative systems at a selected site, and are expected to pay the costs to transport equipment to the site, operate the equipment on site during the demonstration, and remove the equipment from the site. EPA is responsible for project planning, sampling and analysis, quality assurance and quality control, preparing reports, and disseminating information. Typically, results of Demonstration Projects are published in three documents: the SITE Demonstration Bulletin, the Technology Capsule, and the ITER. The Bulletin describes the technology and provides preliminary results of the field demonstration. The Technology Capsule provides more detailed information about the technology and emphasizes key results of the SITE field demonstration. An additional report, the Technology Evaluation Report (TER), is available by request only. The TER contains a comprehensive presentation of the data collected during the demonstration and provides a detailed quality assurance review of the data. For the Earth Tech

Enhanced In-Situ Bioremediation process demonstration, there is a SITE Technology Bulletin, Capsule, and ITER; all of which are intended for use by remedial managers for making a detailed evaluation of the technology for a specific site and waste. A TER is also submitted for this demonstration to serve as verification documentation.

1.4 Purpose of the Innovative Technology Evaluation Report (ITER)

This ITER provides information on Earth Tech's pilot scale implementation of the Enhanced In-Situ Bioremediation process for treatment of VOC-contaminated groundwater in fractured bedrock. This report includes a comprehensive description of this demonstration and its results. The ITER is intended for use by EPA remedial project managers (RPMs), EPA on-scene coordinators (OSCs), contractors, and other decision-makers carrying out specific remedial actions. The ITER is designed to aid decision-makers in evaluating specific technologies for further consideration as applicable options in a particular cleanup operation.

To encourage the general use of demonstrated technologies, the EPA provides information regarding the applicability of each technology to specific sites and wastes. The ITER includes information on cost and desirable site-specific characteristics; and discusses technology advantages, disadvantages, and limitations.

Each SITE demonstration evaluates the performance of a technology in treating a specific waste matrix. The characteristics of other wastes and other sites may differ from the those of the treated waste. Thus, a successful field demonstration of a technology at one site does not necessarily ensure its applicability at other sites. Data from the field demonstration may require extrapolation for estimating the operating ranges in which the technology will perform satisfactorily. Only limited conclusions can be drawn from a single field demonstration.

1.5 Technology Description

The Enhanced In-Situ Bioremediation Process is a biostimulation technology developed by the U.S. Department of Energy (DOE) at the Westinghouse Savannah River Plant site in Aiken, S.C. DOE refers to their phosphate injection technology as PHOSter™ and has licensed the process to Earth Tech, Inc. (Earth Tech). Earth Tech is utilizing the process to deliver a gaseous phase mixture of air, nutrients, and methane to contaminated groundwater in fractured bedrock. These enhancements are delivered to groundwater via one or more injection wells to stimulate and accelerate the growth of existing microbial populations, especially methanotrophs. This type of aerobic bacteria has the ability to metabolize methane and produce enzymes capable of degrading chlorinated solvents and their degradation products to non-hazardous constituents.

The primary components of Earth Tech's treatment system consist of an injection well (or wells), air injection equipment, groundwater monitoring wells, and soil vapor monitoring points. **Figure 1-1** shows a 3-D representation of the treatment area (below the fractured bedrock surface), the injection well, and monitoring points.

The injection well is designed to deliver air, gaseous-phase nutrients, and methane to groundwater in the underlying bedrock For the system evaluated at the ITT Roanoke facility, the air was supplied by a compressor that was capable of delivering 15-30 pounds per square inch (psi) and approximately 10-100 standard cubic feet per hour (scfh) to the injection well 30-50 feet below land surface (bls). At smaller/shallower sites, a smaller compressor may suffice. The monitoring wells and soil vapor monitoring points were installed upgradient, down-gradient and cross-gradient relative to the injection well location to delineate the zone of influence and to monitor groundwater within and outside the zone of influence. The soil vapor monitoring points can be designed to release or capture vapors that may build up in the overburden. The monitoring wells were constructed in a manner to allow them to be converted to either injection wells or soil vapor extraction points.

The typical injection system consists of air, nutrient, and methane injection equipment (all housed in a temporary building or shed). A compressor serves as the air source, and includes a condensate tank ("trap") with a drain, an air line, coalescing filters and pressure regulators and valves.Methane and nitrous oxide provide the source of carbon and nitrogen, respectively. Both are provided in standard gas cylinders and are piped into the main air line using regulators and flow meters. Triethyl phosphate (TEP), the phosphorus source, is stored as a liquid in a

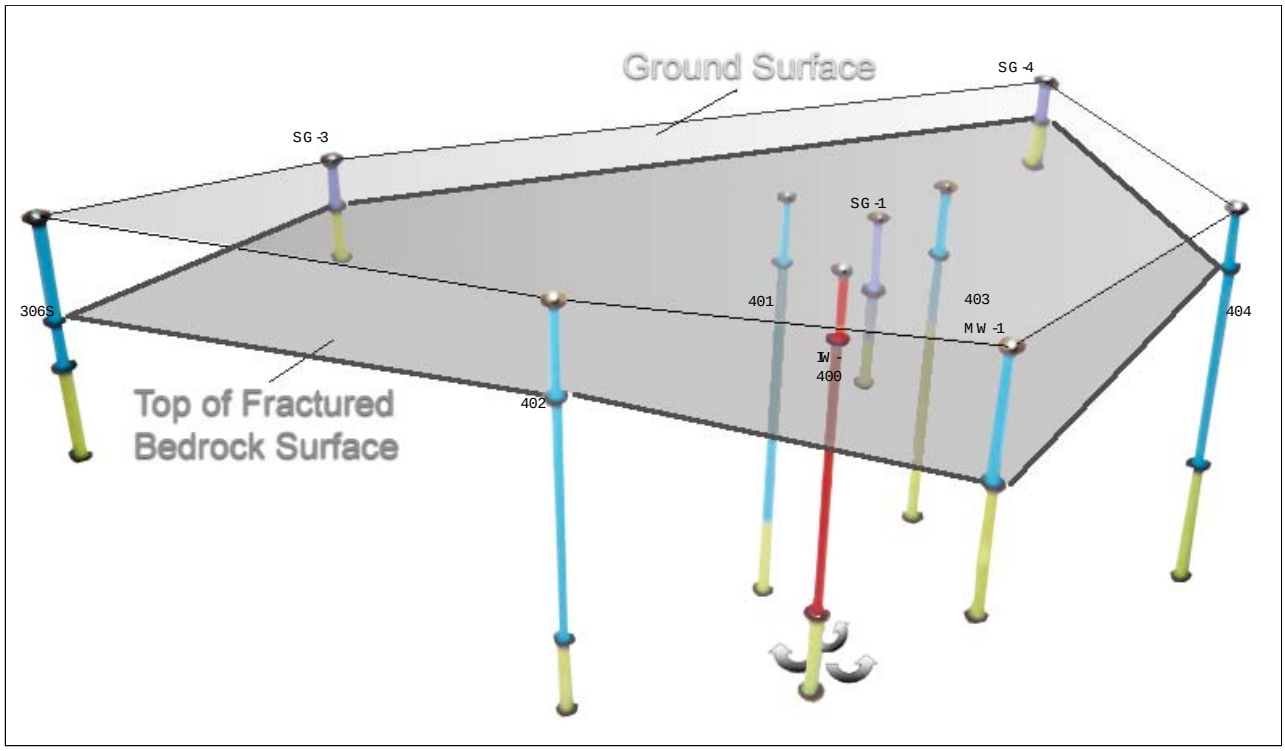

Figure 1-1. Treatment Area Showing Fractured Bedrock Surface, Injection Well and Monitoring Points.

(TEP), the phosphorus source, is stored as a liquid in a pressure rated steel tank. Air from the main line is diverted through the tank to volatilize the TEP for subsurface delivery. The air, nitrous oxide, and TEP are injected continuously while the methane is injected on a pulsed schedule. The methane is closely monitored just prior to injecting into subsurface wells to ensure that the injection concentration does not exceed 4% by volume, thus avoiding the methane lower explosive limit (LEL) of 5%.

1.6 Key Contacts

Additional information regarding Earth Tech's Enhanced In-Situ Bioremediation process, the ITTNV site, and the SITE Program can be obtained from the following sources:

Technology Licensee Contacts:
Greg Carter - Project Manager
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(540) 563-0371

David Woodward - Senior Remediation Specialist
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PHOSter™ Process Contact:
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Demonstration Site Contact:
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The SITE Program

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Information on the SITE Program is available through the following on-line information clearinghouses:

- The SITE Home page (www.epa.gov/ORD/SITE) provides general program information, current project status, technology documents, and access to other remediation home pages.

- The OSWER CLU-In electronic bulletin board (http://www.clu-in.org) contains status information of SITE technology demonstrations. The system operator can be reached at (301) 585-8368.

Technical reports may be obtained by writing to USEPA/NSCEP, P.O. Box 42419, Cincinnati, OH 45242-2419, or by calling (800) 490-9198 or (513) 489-8190.