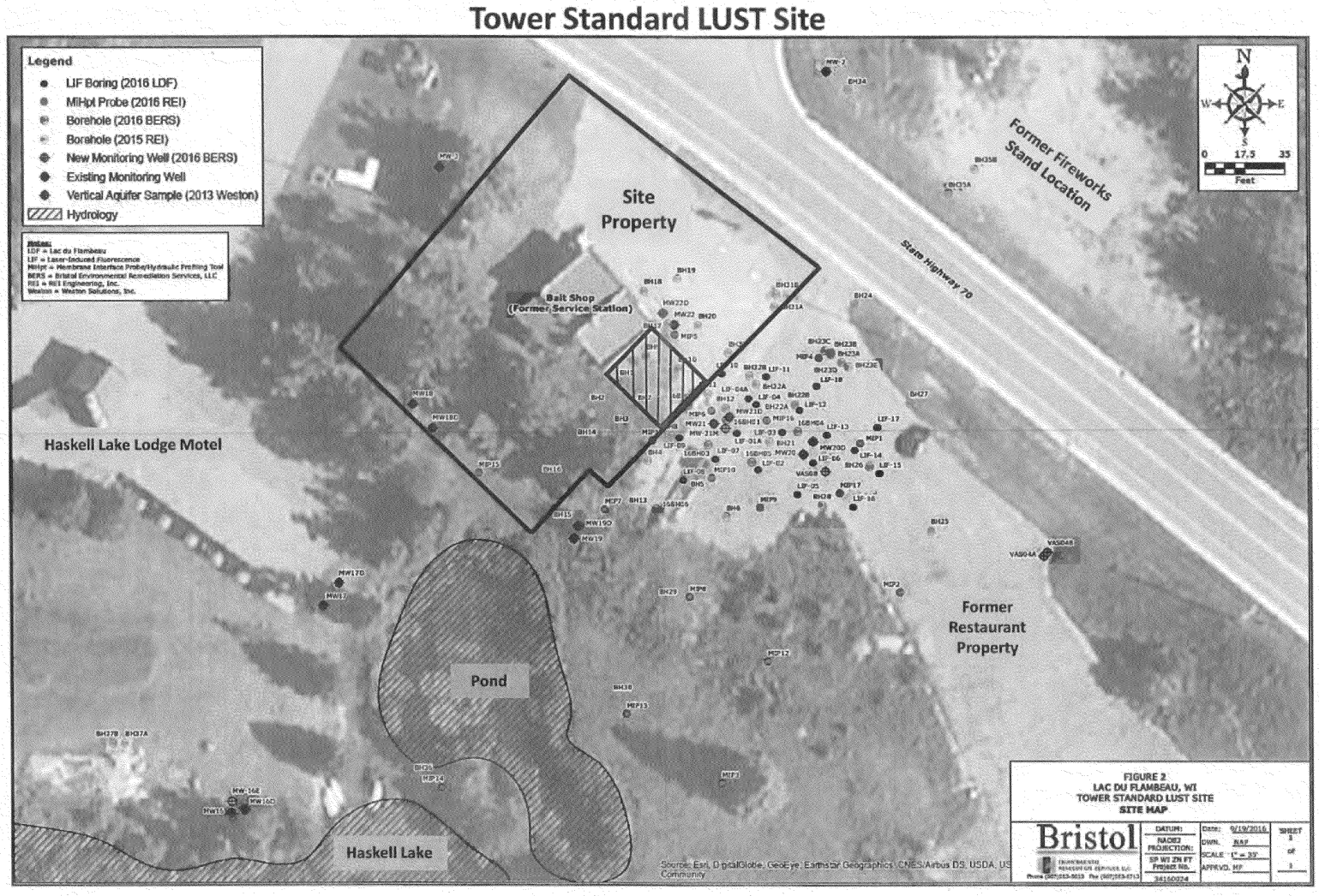
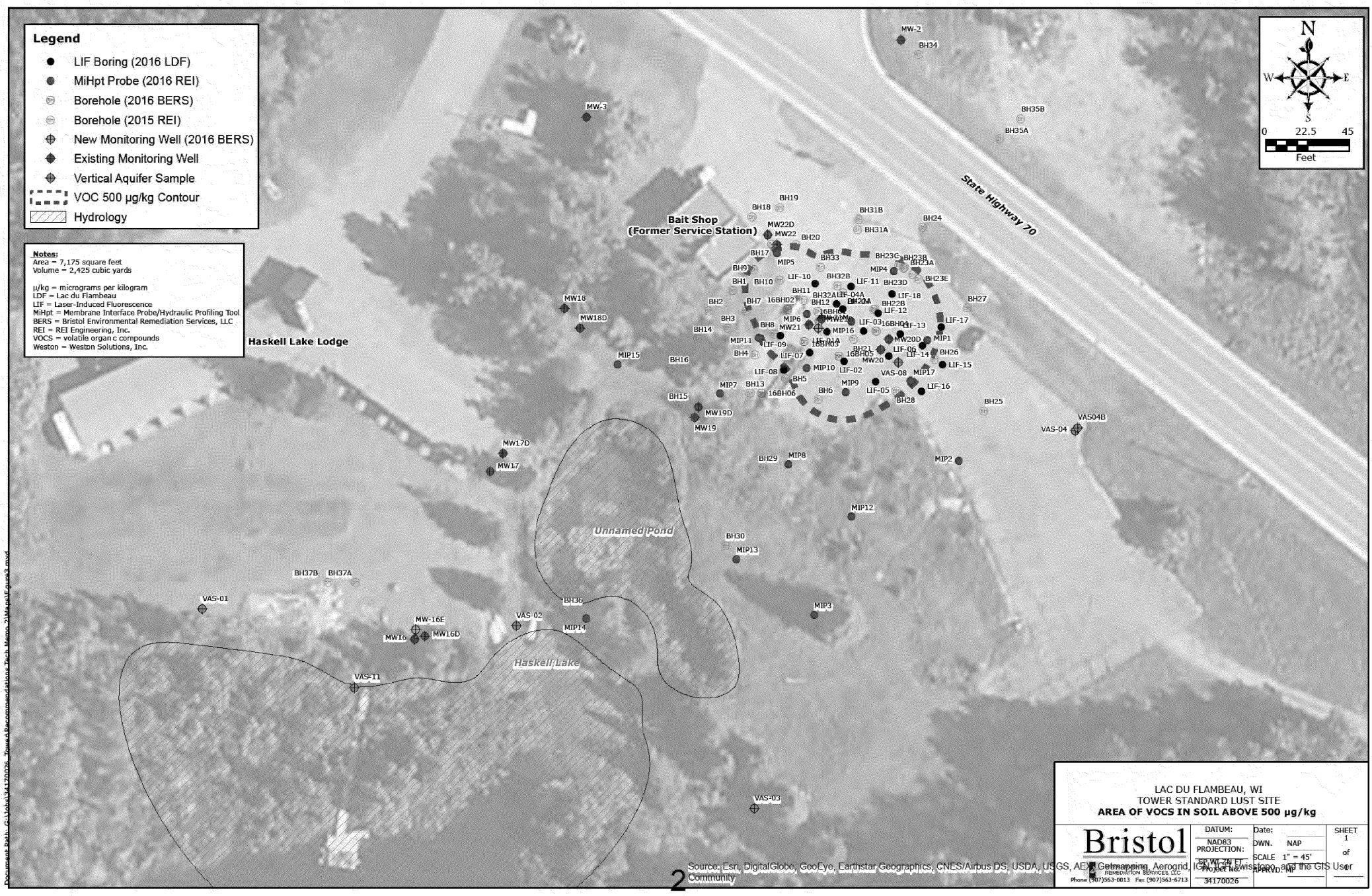
Tower Standard LUST Site





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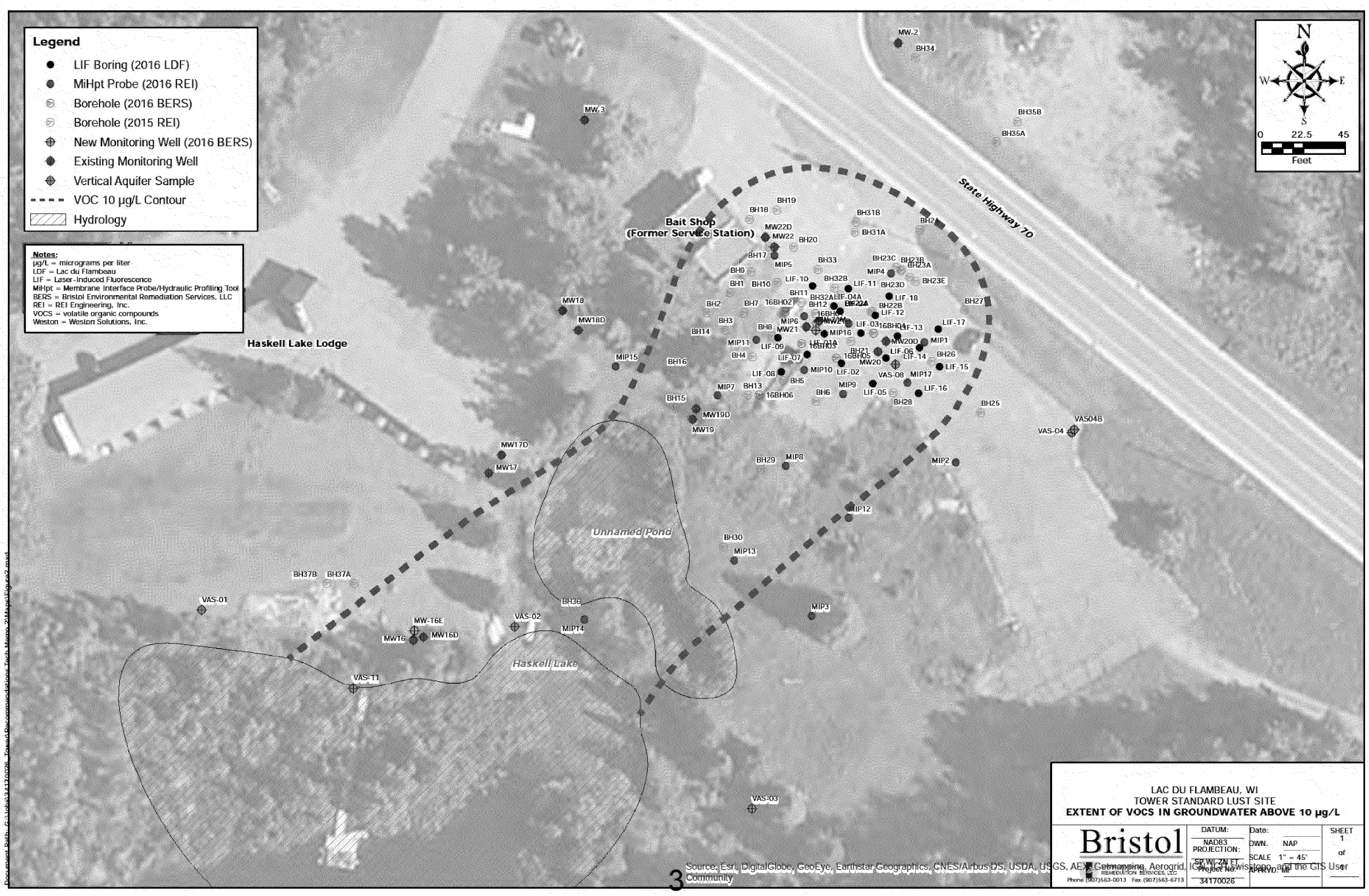

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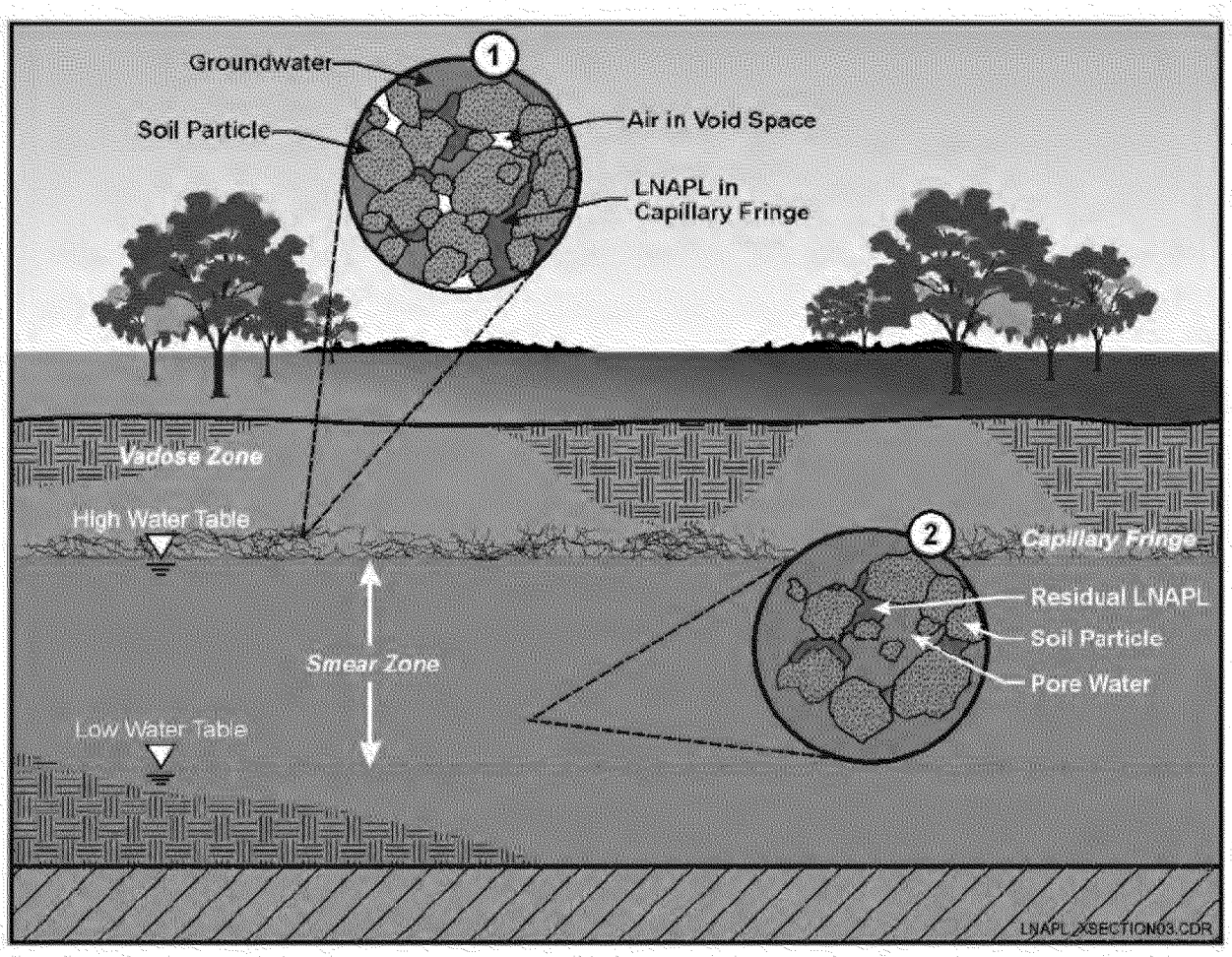

Groundwater
1
Soil Particle
Air in Void Space
LNAPL in
Capillary Fringe
Vadose Zone
High Water Table
2
Capillary Fringe
Residual LNAPL
Soil Particle
Pore Water
Smear Zone
Low Water Table
LNAPL_XSECTION03.CDR

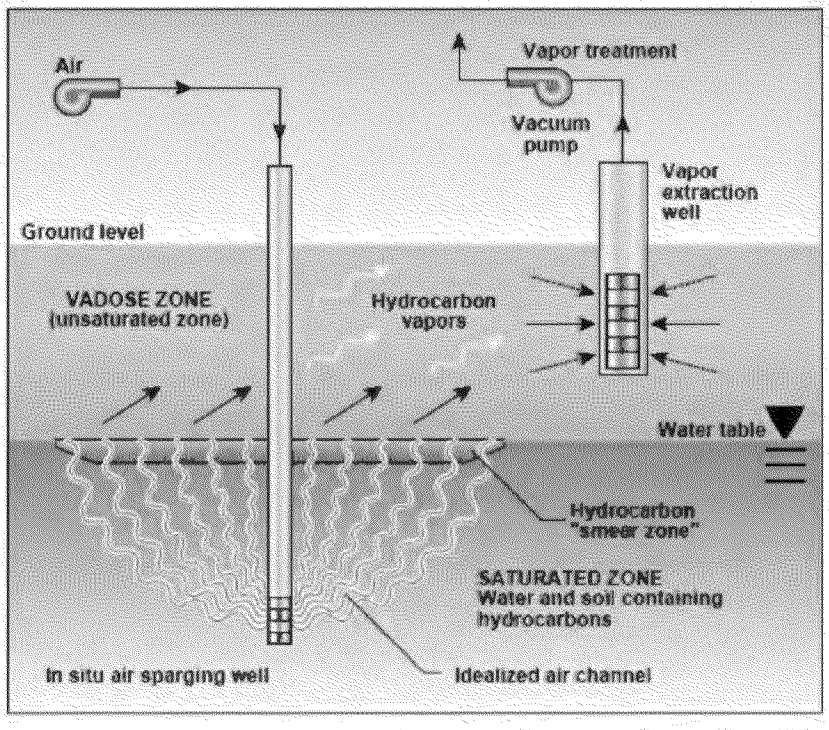
AS/SVE Technology Description

Use Air Sparging and Vapor Extraction to Remediate Subsurface Organics

By M.C. Marley, E.X. Droste, H.H.Hopkins and C.J. Bruel

From *Environmental Management: Wastewater and Groundwater Treatment*

Excerpted from:
In situ air sparging (IAS) is used to remove volatile organic compounds (VOCs) from ground water aquifers. Conceptually, the standard IAS process is simple — clean air is injected into an aquifer beneath the water table. This induces the mass transfer of VOCs dissolved in ground water, forcing them into the vapor phase. It also adds oxygen to the groundwater, promoting aerobic bioremediation (Figure 1). By forcing contaminated vapors to migrate from the saturated portions of the aquifer to the vadose (unsaturated) zone above the water table, IAS promotes aquifer remediation by a host of physical, chemical and biological processes.



To control the potential migration of organic vapors as they move from the aquifer to the vadose zone — or to capture unwanted pollutants for destruction or recycling at the surface — soil vapor extraction (SVE) is often applied in conjunction with IAS [1,2]. In such a setup, vacuum pumps at the surface induce the movement of sparged contaminants to a series of vapor-extraction wells. Vapors collected at the surface are then subjected to any combination of standard ex situ treatment schemes, including carbon adsorption, catalytic oxidation, biofiltration or condensation.

FIGURE 1 (above). By injecting air beneath a groundwater aquifer, air sparging operations can induce aquifer mixing, and promote the volatilization or biodegradataion of dissolved organic contaminants. Vapor-extraction wells then create a vacuum in the subsurface, to direct the flow of liberated vapors to recovery or monitoring wells

A Citizen's Guide to Soil Vapor Extraction and Air Sparging

EPA

What Are Soil Vapor Extraction And Air Sparging?

Both soil vapor extraction, or "SVE," and air sparging extract (remove) contaminant vapors from below ground for treatment above ground. Vapors are the gases that form when chemicals evaporate. SVE extracts vapors from the soil *above* the water table by applying a vacuum to pull the vapors out. Air sparging, on the other hand, pumps air underground to help extract vapors from groundwater and wet soil found *beneath* the water table. The addition of air makes the chemicals evaporate faster, which makes them easier to extract with another technology, such as SVE.

Both methods are used for chemicals that evaporate easily—like those found in solvents and gasoline. These chemicals are known as "volatile organic compounds," or "VOCs."

How Do They Work?

Extraction:

SVE involves drilling one or more *extraction* wells into the contaminated soil to a depth above the water table, which must be deeper than 3 feet below the ground surface. Attached to the wells is equipment (such as a blower or vacuum pump) that creates a vacuum. The vacuum pulls air and vapors through the soil and up the well to the ground surface for treatment.

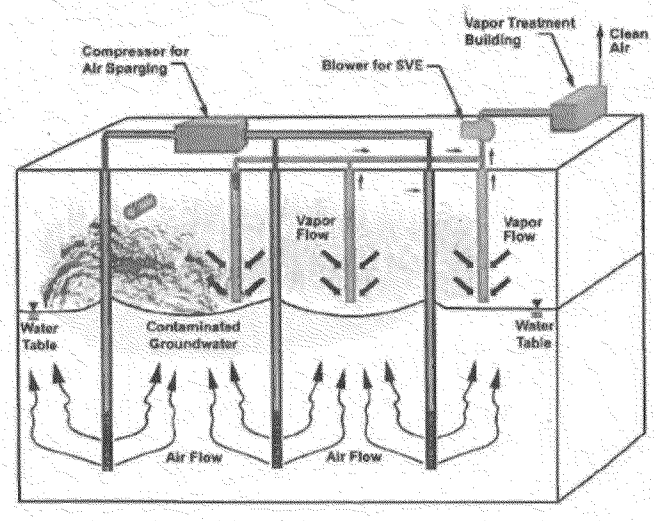


Illustration of a combined air sparging and SVE system.

Sometimes the ground must be paved or covered with a tarp to make sure that the vacuum does not pull air from above into the system. Pulling in clean air would reduce the efficiency of the cleanup. The cover also prevents any vapors from escaping from the ground to the air above.

Air sparging involves drilling one or more *injection* wells into the groundwater-soaked soil below the water table. An air compressor at the surface pumps air underground through the wells. As air bubbles through the groundwater, it carries contaminant vapors upward into the soil above the water table. The mixture of air and vapors is then pulled out of the ground for treatment using SVE.

Treatment:

Extracted air and contaminant vapors, sometimes referred to as "off-gases," are treated to remove any harmful levels of contaminants. The off-gases are first piped from the extraction wells to an air-water separator to remove moisture, which interferes with treatment. The vapors are then separated from the air, usually by pumping them through containers of activated carbon. The chemicals are captured by the carbon while clean air exits to the atmosphere. (See *A Citizen's Guide to Activated Carbon Treatment* [EPA 542-12-001.]).

Filter materials other than activated carbon may be used. In a process called "biofiltration," tiny microbes (bacteria) are added to break down the vapors into gases, such as carbon dioxide and water vapor. Another option is to destroy vapors by heating them to high temperatures.

How Long Will They Take?

Cleaning up a site using SVE or air sparging may take several years. The actual cleanup time depends on several factors. For example, cleanup may take longer where:

- Contaminant concentrations are high.
- The contaminated area is large or deep.
- The soil is dense or moist, which slows the movement of vapors.

These factors vary from site to site.

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Are SVE And Air Sparging Safe?

When properly designed and operated, SVE and air sparging pose little risk to site workers or the community. Treatment of the vapors involves no harmful chemicals that must be transported to the site. Chemical vapors are contained from extraction to treatment so they cannot be accidentally inhaled by anyone nearby. Only clean air that meets air quality standards is released. The air released to the atmosphere following treatment may be sampled to make sure all harmful vapors have been removed or destroyed.

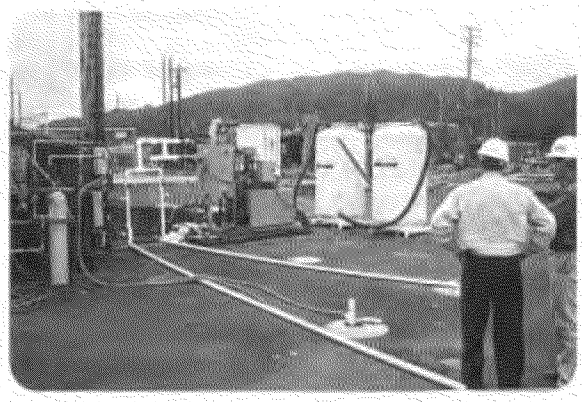
How Might It Affect Me?

Area neighborhoods may experience some increased truck traffic as the equipment for SVE or air sparging is delivered and later removed. Installation of the systems involves the use of drilling rigs and sometimes other heavy machinery to install wells, blowers, and treatment equipment. Sheds or larger buildings may be built to house the treatment systems, keeping any noise to a minimum. Workers will visit these systems regularly to ensure they are working.

Why Use Soil Vapor Extraction And Air Sparging?

SVE and air sparging are efficient ways to remove VOCs above and below the water table. Both methods can help clean up contamination under buildings, and cause little disruption to nearby activities when in full operation. SVE and air sparging are often used together. SVE and air sparging are being used or have been selected for use at approximately 285 and 80 Superfund sites, respectively.

Pipes transport vapors from the underground SVE extraction well to treatment.



Above-ground treatment system includes two tanks of activated carbon.

Example

Both SVE and air sparging are being used to clean up several acres of contaminated soil and groundwater at the Vienna PCE Superfund site in West Virginia. Two dry cleaning facilities contaminated the area with PCE (also known as perchloroethene or "perc"), a solvent used to clean clothing, forcing the shutdown of the town's drinking water wells.

In 2005, construction of the cleanup systems was completed and included 74 air sparging wells, 34 extraction wells, and four treatment buildings. The off-gases are piped to an air-water separator, followed by containers of activated carbon for treatment. By 2010, 1,618 pounds of PCE had been removed and PCE concentrations had decreased by as much as 99% in some wells. EPA will continue to operate the systems and monitor PCE levels until cleanup objectives have been reached throughout the site.

For More Information

For more information about this and other technologies in the Citizen's Guide Series, visit:

www.cluin.org/remediation
www.cluin.org/products/citguide
www.cluin.org/sve
www.cluin.org/airsparging

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United States Environmental Protection Agency

Office of Solid Waste and Emergency Response (5102G)

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