

A NOVEL HYDROGEN RELEASE COMPOUND (HRC®) INJECTION METHOD FOR COMPLICATED SITE GEOLOGY



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ABSTRACT

Chlorinated solvents released at the Millville, NJ site migrated through heterogeneous deposits in the coastal plain of New Jersey's Cumberland County resulting in a contaminant plume forty feet below grade and ranging from forty to one hundred and fifty feet in thickness. Development constraints precluded conventional treatment and the presence of biodegradation products indicated accelerated natural attenuation as a viable alternative. Hydrogen Release Compound (HRC®) was selected to stimulate indigenous dechlorinating bacteria but conventional direct-push applications were unable to consistently deliver the product due to the heterogeneity of the soil and the presence of a hard gravel and sand mixture. A method was developed to reach depth using a hollow-stem auger and inject through the auger using an innovative high pressure tremie tube and a reciprocating piston grout pump.

INTRODUCTION & SITE HISTORY

Located in Millville New Jersey, Millville Airport is in the heart of the Delaware Valley between Philadelphia and Atlantic City. The facility is heavily used by aircraft for training purposes including practice instrument approaches, takeoffs and landings. In addition, several regional industrial facilities have taken residence at the facility. On-site employment is more than 1500 and more than 70,000 takeoffs and landings take place at Millville each year.

In 1939, the Millville Board of City Commissioners purchased 1,000 acres of land approximately three miles west of the center city area. Prior to World War II sightings of German submarines prompted the War Department to establish homeland defense outposts along the Atlantic and Gulf coasts every fifty miles from Maine to Texas. Developed as Army Air Fields, these early air bases served at training facilities for what was to become the Air Force and the Air National Guard. Millville AAF was the first; established in 1941 as a training facility The airfield operated as a military base between 1941 and 1945.



Historical images of Millville Airport

GROUNDWATER CONTAMINATION

In September 1998, an investigation at a former petroleum underground storage tank revealed the presence of chlorinated, volatile organic compounds (VOCs) in ground water. It is believed that the source of the chlorinated VOCs was the former on-site sewer treatment system that was adjacent to the former UST.

Identified contaminants consisted of chlorinated solvents such as tetrachloroethylene (PCE) and its biodegradation products trichloroethylene (TCE) and cis-dichloroethylene (DCE). Historic use and site evaluation indicate there are likely to have been multiple small contaminant releases during active use of the military facility. Contaminants migrated to depths of forty to eighty feet below grade and over a distance of nearly 1000 feet. Variations in concentration are consistent with the co-mingling of plumes from multiple sources.

In general, sediments encountered at the site consisted of brown to orange-brown, well-sorted, fine- to medium-grained quartz sand with occasional silt and gravel to a maximum depth of 12 feet below ground surface. The Soil Survey of Cumberland County, New Jersey shows that the site is underlain by soils of the Downer Series (DrA, sandy loam, 0 to 2 percent slopes). The Downer Series consist of moderately well-drained soils that were formed under a hardwood forest in marine or fluvial deposits. Organic matter is low to moderate and natural fertility is moderate.

REMIEDIATION GOALS

The City of Millville, owner of the property, working in conjunction with the New Jersey Department of Environmental Protection (DEP) and the Delaware River and Bay Authority, manager of the site, assessed the risks associated with the contaminant load and developed two goals for a remediation program: contain the plume within the property boundary and protect the municipal water-supply well field on site.

REMEDY SELECTION

Active development of the property precluded installation and long-term operation of any active engineered systems. The presence of biodegradation products indicated the presence of indigenous microorganisms capable of dechlorinating contaminant compounds to minerals, carbon dioxide and water. Preliminary estimates of biodegradation rates indicated the possibility of off-site migration by low levels of contaminant.

Biostimulation options were evaluated and Hydrogen Release Compound (HRC®) was selected for application during phase one of the program. The zone of treatment required the installation of six barriers consisting of a total of 175 points. A total of 21,090 pounds of HRC needed be injected at completion of the first year.

INJECTION METHOD DEVELOPMENT AND PROCESS

Considering the soil type and specific knowledge of the site geology, it was apparent that the conventional Direct Push Technology (DPT) would have problems achieving the 80 feet in depth required. Therefore, a test hole was completed to a depth of 50 feet using a standard solid stem auger system. The DPT system was advanced from 50 to 80 feet where the injection process would start. This method was efficient, however still time consuming, only allowing a maximum of two injection points per day. The primary problem was the breaking down of the DPT rods. To increase efficiency, a process was developed that enabled the injection of four points per day, each point taking approximately 1 hour and 15 minutes.



A conventional 2-inch hollow-stem auger was used for the advancement of the borehole to a consistent depth of 80 feet below grade. HRC would be injected through the auger as the auger was being withdrawn. While HRC had been applied at depths of forty to eighty feet, injection through an auger had not. The injection equipment consists of an 82' long, high-pressure hydraulic line (4000-psi) with a modified expendable point holder. It should be noted that the line contains marked intervals (e.g., 40', 30', 20'). A custom extraction collar was also fabricated so that the drill rig's winch could be used to extract the auger while allowing the tremie tube and pressure tubing to remain in place.



An application protocol was developed for efficient, consistent application of HRC throughout the injection zone. Prior to beginning each day a water bath was set up to warm the HRC to approximately 110 degrees Fahrenheit. The grout pump used for injection was calibrated so that audible piston strokes could be used to gauge the amount of material delivered to the boring. For each injection:

- The high-pressure line is advanced through the center of the auger to the maximum treatment depth.
- The auger was attached to the winch by the extraction collar and approximately 45 feet of auger was retracted.
- As a section was removed the tether was withdrawn. This was repeated until the auger had been withdrawn to forty feet below grade.
- The hydraulic line is then connected to the Geoprobe GS-2000 and the pump was charged with HRC.
- The pump was engaged and the injection manually withdrawn one foot after counting the appropriate number of piston cycles.
- After injection, the injection tube was removed as well as the remaining auger. Each boring was backfilled with removed material and closed with bentonite.

It should be noted that a key component to the injection process is maintaining a material injection temperature of 110 to 115 degrees Fahrenheit. Through our process this is achieved by using a hot water bath for the containers of material.