Amphenol

Amphenol Corporation

Aerospace Operations
40-60 Delaware Avenue
Sidney, NY 13838-1395
Telephone (607) 563-5940
Fax (607) 563-5849

April 14, 1998

Certified Mail

Mr. Walter Wintsch, Engineering Geologist II
New York State Department of
Environmental Conservation
Region 4 - Headquarters
1150 North Westcott Road
Schenectady, New York 12306

Re: Site #4130003 Amphenol Corporation - B.C.O.
Hill Site Area - Assesment of Remedial Technologies

Mr. Wintsch:

Attached herewith please find the first administrative review of new remedial technologies for the above noted site as required by the Record of Decision. Although the new technologies reviewed would likely be effective at reducing concentrations at the site, each would be severely restricted by the site hydrogeological conditions. As a result, each may have limited effect in enhancing the current remedial program.

If you have any questions on the above or if there is anything of which I may be of assistance, please contact me at (607)563-5859.

Very truly yours

Joseph M. Bianchi
Supervisor, Safety and Environmental Affairs

cc: Sam Waldo

Environmental
Resources
Management

855 Springdale Drive
Exton, Pennsylvania 19341
(610) 524-3500
(610) 524-7335 (fax)
http://www.erm.com

ERM

13 April 1998
Reference: 30165.00.01

Mr. Joseph Bianchi
Amphenol Corporation
40-60 Delaware Avenue
Sidney, NY 13838

Dear Mr. Bianchi:

The purpose of this letter is to present to the Amphenol Corporation (Amphenol) an updated assessment of available remedial technologies for application at the Hill Site, located in Sidney, New York. This work has been requested by Amphenol pursuant to the New York State Department of Environmental Conservation's (NYSDEC) requirement that this evaluation be performed every five years after the issuance of the Record of Decision (ROD). The Hill Site ROD was issued by NYDEC in 1993. This assessment marks the first administrative review of new remedial technologies for the site.

The purpose of the assessment is to identify remedial technologies which have either been developed or come into more common usage in the first five year period since the ROD was issued. During the 1980s and early 1990s, remedial activities were completed which included excavation of contaminated soil from and capping of the former disposal pit, elimination of the Hill Site seep, and the excavation of PCB-contaminated soils from the Route 8 drainageway. These activities were recommended in the formal feasibility study completed by ERM in April 1987.

Aside from the elimination of the Hill Site seep, ground water contamination could not be addressed given the constraints of the site conditions (low permeability and thickness of overburden materials) on the remedial technologies available at the time. Ground water remedial technologies evaluated in the 21 April 1987 Feasibility Study included installation of large and small diameter recovery wells, and plume management technologies including interceptor trenches and slurry walls.

The focus of this updated remedial technology assessment will be on ground water. It is not anticipated that soil remediation will need to be addressed since a large majority of the impacted soil in the unsaturated zone at the source area (i.e. the disposal pit) was removed in 1982 and 1983. Soil from within and around the disposal pit (originally 25 by 50 feet) was excavated to dimensions of 45 by 90 feet by 16 feet deep. PCB concentrations decreased noticeably with depth as virtually all of the oil-containing soil was excavated at land surface and in the upper few feet of the dense glacial till. The permeability of the glacial till were seen to be the controlling factor for the vertical distribution of the oil and PCBs. The excavation extended to within one foot of the water table. Soil samples from borings completed through the floor of the excavation within the saturated zone exhibited PCB concentrations in excess of 10 mg/kg. However, no oil stained zones or free oil was seen, and therefore the PCBs detected likely represent remnants of PCB migration which has been immobilized by adsorption to the soil.

The remainder of this document is divided into two sections, which include:

(1) A site background including brief descriptions of site geology, hydrogeology, and remedial technologies previously evaluated for the Site; and

(2) Identification, description, and evaluation of remedial alternatives which have come into more common usage over the past five years; and

This document provides a qualitative, concept level assessment of the remedial alternatives selected for screening as a focused assessment for this updated review rather than a formal feasibility study.

BACKGROUND

The geologic and hydrogeologic conditions were defined in the August, 1985 Remedial Investigation and the 21 April 1987 Feasibility Study for the Hill Site. These documents remain the most appropriate source of this information.

Geology

The site geology consists of unconsolidated glacial till overlying Devonian aged shale and siltstone bedrock. The glacial till was deposited directly from glacial ice without significant sorting by water. This process created a poorly sorted, very dense till with low primary permeability. The thickness of the glacial till above the bedrock ranges from 38 to 110 feet, with the greatest thickness seen nearer the former disposal pit. A representative cross section of the site (Figure 3-1 from the 1985 Remedial Investigation Report) is included as an attachment to this letter.

The glacial till consists of several distinct sub-units which vary in color, composition, density and water content. The principal glacial unit is a basal unit of red dense till, consisting of compacted silt with varying amounts of embedded coarse sand and gravel. In most areas, this unit directly overlies the bedrock. The upper five to 15 feet of this unit is a zone of similar red silt, sand, and gravel content although the sediments within are less dense due to weathering.

Hydrogeology

The principal ground water flow system is the glacial overburden. This system is very complex due to the presence of a downward vertical gradient and channeling of the flow through the dense, low permeability red till. The two basic flow components within the till occur as:

- A shallow ground water component which flows preferentially through the weathered zone in the upper five to 15 feet of the red till; and

- A deeper ground water flow component which occurs in the thin, saturated sandy zones in the dense red till.

Although the two flow components are hydraulically connected, the occurrence of the more permeable weathered zone in the upper portion of the red till creates a stronger component of lateral flow than that seen in the underlying denser red till. Investigation of the underlying denser unit showed that the till was only dry to moist, except for occasional 0.5 to 1-foot thick saturated gravelly zones. Therefore, it appears the majority of ground water flow in the dense till occurs primarily in these thin channels.

Hydraulic conductivity and ground water flow velocities were calculated in the Remedial Investigation Report based on data collected prior to and during the RI. Average hydraulic conductivities and ground water velocities for the dense red till were 2.71×10^{-5} cm/sec. and 13 ft/year, resepctively. This comparatively low conductivity value is not unexpected given the makeup of the aquifer material (primarily dense silt with thin sand stringers). These values for the shallow, weathered portion of the till were higher, at 2.9×10^{-4} cm/sec. and 98 ft/year, respectively.

Although the red till is very dense, there does appear to be vertical recharge that is readily, if slowly, transmitted. This is indicated by the strong downward vertical hydraulic gradient throughout the glacial till system, the fact that the two glacial till flow components are unconfined, and the distribution of VOCs vertically through the system. This vertical recharge appears to occur mainly through the more permeable thin sandy zones within the dense till.

Lateral ground water flow directions in both the glacial till and bedrock flow zones are towards the north-northwest and mimic the general topographic gradient. A potentiometric surface map for the bedrock flow zone is included as Attachment 1. This map was constructed using the fourth quarter 1997 data from both the Hill Site and the Amphenol Route 8 site, which is located approximately 1,000 feet to the north of the Hill Site. As shown on the figure, the bedrock ground water flows north-northwest until approximately midway between the two sites, where the flow turns more directly northward toward the primary ground water extraction point for the Route 8 Site (i.e., the Unalam well). Given this flow pattern, it appears that at least a significant portion of the bedrock ground water from the Hill Site would ultimately flow to the area within the capture zone of the Unalam well.

Previously Evaluated Remedial Technologies

Elimination of the Hill Site Seep was completed subsequent to the Feasibility Study to eliminate a direct contact threat to the overburden ground water. Other technologies which were evaluated for the overburden ground water included a large diameter or several small diameter recovery wells, shallow and deep slurry walls, and shallow and deep interceptor trenches. For the bedrock aquifer, off-site recovery wells were considered.

Recovery wells within the overburden material were discounted due to the anticipated low efficiency of these systems and the calculated excessive time period (between 32 and 320 years) that would be required to achieve the necessary flushing of the aquifer to reach the 10 μg/L cleanup goal for TCE. Likewise, a deep slurry wall was not pursued due to the anticipated difficulty in constructing a wall to the required depth (up to 90 feet) and the difficulties collecting ground water accumulated behind the slurry wall under low permeability conditions. This potential inefficient recovery was viewed as having the potential to result in seepage around the wall and generation of new migration directions for VOCs in ground water. The shallow slurry wall option was not selected since a shallow interceptor trench would afford the same ground water flow control, but would also directly collect ground water, thereby eliminating the need for recovery via wells upgradient of the slurry wall.

The shallow and deep interceptor trenches were also not pursued. For the deep trench, the difficulties associated with keeping such a deep excavation open (40 to 90 feet) rendered it of questionable technical feasibility at the site. The shallow trench (approximately 20 feet deep) was not selected since, although it would address the shallow flow component in the weathered till, VOCs in the deeper portion of the till would be unaffected. Elimination of the Hill Site Seep, which was completed, served a similar purpose as the shallow trench by eliminating this direct contact threat.

IDENTIFICATION OF REMEDIAL ALTERNATIVES

The following section provides a summary of remedial technologies which are new or which have come into more common usage since the issuance of the ROD. The purpose of this summary is to provide a brief description of each technology and qualitatively assess the potnetial applicability to the site. For the purpose of this discussion, three technologies have been selected for discussion: (1) in-well treatment and re-injection; (2) chemical oxidation; and (3) bioremediation.

In-Well Treatment and Re-Injection

In-well treatment and reinjection (also known as the UVB, or Unterduck - Verdampfer - Brunnen, process) is implemented via a network of double screened large-diameter wells through which water is collected, treated, and then reinjected into the aquifer within the same well at the water table surface.

The mechanics of the system are as follows. Vertical ground water circulation in the saturated zone is established by creating a pressure differential by a pump or vacuum blower across the two screens in the well. In the normal operational mode, ground water enters the well through the lower screen and exits through the upper. The circulation mode can also be reversed if desired. While traveling through the well, the ground water passes through one or more in-well treatment systems such as an air stripper/aerator. VOCs stripped from the water are transported through the well shaft and to the gas treatment unit or atmosphere by means of the vacuum blower. The treated water is injected through the upper screen into the vadose zone above the water table surface. Ground water leaving the treatment well is supplemented with dissolved oxygen as a result of the stripping action, which may enhance natural biodegradation of the organic compounds in the saturated zones. A majority of the ground water recharged through the upper screen is again captured by the lower intake screen, thus creating a circulation pattern around the well. In general, approximately 85% of the water collected through the bottom screen has been recirculated, and 15% represents fresh aquifer water.

The radius of influence of each individual well is small since most of water collected has been/will be recirculated. As a rule of thumb, the zone of impact, or "treatment cell", for each individual well is typically two to five times the distance between the upper and lower well screens, which are generally constructed 10 feet apart. Therefore, the lateral radius of influence for a typically designed well is usually 20 to 50 feet.

With regards to application of this technology at the Hill Site, there are drawbacks to the implementation of this system based on site hydrogeologic conditions. To begin with, the low hydraulic conductivity (10^{-5} cm/sec) would not allow for the development of efficient treatment cells. The low well yield and expected low re-injection rate of treated water back into the aquifer would require treatment to be performed inefficiently and at a comparatively slow rate.

Additionally, high ground water gradients also limit the effectiveness of the system. As reported in the Remedial Investigation Report, ground water gradients within the overburden were steep, at approximately 0.08 feet/foot (or 8%). Gradients of this magnitude may also limit the effectiveness of treatment cells in that a larger portion of the re-injected water may preferentially migrate down-gradient rather than be recirculated into the system for further treatment. This would also restrict the size of the capture zone for each UVB well.

Given these limitations, the in-well stripping and re-injection methodology does not appear to be an effective ground water containment technology for the Site.

Chemical Oxidation

In-situ chemical oxidation involves the addition of oxidizing agents injected or emplaced in a source area for the purpose of initiating a chemical reaction, or series of reactions, which break down a contaminant into its component parts. The use of an oxidizing agent is most effective when introduced as an aqueous solution; therefore the effectiveness is controlled by the rate of diffusion.

The mechanism by which chemical oxidation works is through a series of oxidation/reduction reactions. Destruction of contaminant results from the cleavage of carbon-carbon bonds. Subsequent oxidative reductions break down the fragmented compounds completely to carbon dioxide and water. Typical oxidizing agents include potassium permanganate, Fenton's Reagent, hydrogen peroxide, and ozone.

The general reaction between a chlorinated hydrocarbon compound (RC) and an oxidizing agent is defined by:

$RC + OH^- \rightarrow H_2O$ + oxides + salts

An example of this process is illustrated below by the reaction between trichloroethene (TCE) and potassium permanganate:

$C_2Cl_3H + 2MnO_4^- \rightarrow 2CO_2 + 2\,MnO_2\,(s) + 3Cl^- + H^+$

In this reaction, the potassium permanganate (as MnO_4^- radical) is reduced to manganese dioxide (MnO_2), resulting in the TCE being oxidized to carbon dioxide (CO_2), chloride ions (Cl^-) and hydrogen ions (H^+). It is expected that the chlorinated organics present in the site ground water would be amenable to break-down through this chemical oxidation process.

The oxidizing agent indiscriminately scavenges and oxidizes organic material within the soil zone, including naturally occurring organics. Therefore, the application of this technique is generally focused on source area mass destruction. This ideally results in a reduction in contaminant concentrations in the downgradient plume. Because of the propensity to oxidize all organic material, the amount of oxidant to be added to the source area must be understood to ensure enough oxidant is made available for reaction with the contaminants. Therefore, it is important that the source area be adequately defined. The design and implementation of the delivery system of the oxidant to the source area is dependent on the definition of the physical properties of the source area. This also includes the amount of oxidant to be used to react within a source zone.

This technique has not been actively applied at a full scale level; therefore, the behavior of oxidizing agents under natural conditions is not fully understood. A site-specific pilot test would be required to define the anticipated behavior of the oxidant in the aquifer.

As with any method involving injection of fluids, the application is heavily dependent upon the physical properties of the formation. Properties such as hydraulic conductivity (ability to transmit fluid) of the formation, lithology, and ground water flow velocity all impact the effectiveness of the technique.

The low hydraulic conductivity and the resulting low ground water velocity in the dense till are expected to greatly reduce the efficiency and cost effectiveness of this option by restricting the rate of leaching of the oxidant into the aquifer matrix. This slow leaching would result in each insertion point for the oxidant being effective over a comparatively small radius. As an additional consideration, a significant portion of the ground water flow occurs in the thin gravelly or sandy lenses within the dense till. Although the rate of diffusion would likely be higher in these zones, the variability in size and orientation of these features typical in glacially derived sediments would make it very problematic to ensure that wells installed for the purpose of introduction of the oxidant also intersect these discrete features. This could be addressed by utilizing the currently existing wells for introduction of the oxidant. However, this would likely not be desirable since these wells would effectively be lost from the site monitoring network, as their chemical quality would be immediately altered and would no longer be representative of the aquifer as a whole.

In summary, chemical oxidation is an effective technology which would likely provide treatment of the contaminants present in ground water at the Hill Site. However, the application is heavily dependent upon the physical properties of the formation. The low hydraulic conductivity of the formation and the flow of ground water within small, discrete permeable lenses suggest that the treatment might be effective in localized areas but would not represent an effective site-wide alternative for the Hill Site.

Bioremediation

Enhanced bioremediation involves the addition of, or stimulation of, naturally occurring microorganisms that consume the contaminants as a food source. Bioremediation of contaminants derived from petroleum hydrocarbons is well known and well documented. Bioremediation of chlorinated solvents, however, is more difficult and research efforts are proceeding from the laboratory into the field.

Until recently, it was believed that chlorinated solvents were nonbiodegradable, however, transformation products of these compounds have been detected in ground water. The transformations are brought about in two ways: (1) use of contaminant as a primary substrate (foodsource), or (2) cometabolism through interactions of the chlorinated solvents with enzymes produced by microorganisms for other purposes. Transformations of chlorinated solvents in the natural environment can occur in two ways: chemically (abiotic) or biologically (biotic).

Enhanced bioremediation may be accomplished in several ways:

(1) injection of cosubstrate such as methane or glucose;

(2) injection of oxygen or other alternate acceptors;

(3) injection of suitable microbial populations.

As is the case with chemical oxidation, bioremediation of chlorinated solvents is heavily dependent upon the physical properties of the formation. These conditions must be adequate to promote growth of either anaerobic or aerobic microorganisms and allow for the contact between chlorinated solvent and these microbes. Properties such as hydraulic conductivity (ability to transmit fluid) of the formation, lithology, and ground water flow velocity all impact the effectiveness of the technique. In low conductivity units such as the glacial till at the Hill Site, diffusion of introduced cosubstrates or microbial populations are expected to be insufficient to significantly enhance the biodegradation process beyond a comparatively small radius surrounding the injection point.

In summary, the physical treatment process offered by enhanced bioremediation may be appropriate for reduction of the VOCs at the Hill Site. However, while this technology could be introduced to the site, its efficiency and therefore cost effectiveness may be reduced by the low hydraulic conductivities which may retard or restrict the growth of microbial populations at the site, thereby limiting its usefulness as a source area mass reduction and plume control/reduction technique.

CONCLUSIONS

Each of the remedial technologies discussed herein (in well treatment and re-injection, chemical oxidation, and bioremediation) would likely be effective at reducing concentrations of the suite of VOC compounds seen in ground water at the Hill Site. However, each of these techniques are also expected to be severely restricted in their actual implementation by site hydrogeological conditions. The effectiveness of in well re-injection (UVB) would likely be limited by the low hydraulic conductivity and high ground water gradients, which would restrict development of an efficient circulation cell for ground water treatment. Likewise, the effectiveness of both chemical oxidation and bioremediation as would be limited by the low hydraulic conductivity of the dense till. This property would likely result in only a small radius of effect around each injection point for both technologies, thereby limiting their usefulness in source area mass reduction and plume control/reduction. The likely variable orientation and size of the higher permeability sand channels within the dense till would also make effective delivery of oxidants or microbial populations/nutrients problematic.

As stated in hydrogeologic description, it appears that regional ground water flow from the Hill Site is towards the zone of influence of the Unalam well recovery system at the Route 8 Site, located approximately 1,000 feet north of the Hill Site. The necessity for implementation of an active remedial system at the Hill Site should be viewed in this context.

ERM appreciates the opportunity to assist Amphenol in evaluating the Hill Site, and we trust that this document provides all necessary information regarding potential remedial alternatives. If you have any questions or comments regarding this assessment, please call.

Sincerely,

Peter D. Beyer, P.G.
Project Manager

David P. Steele
Project Director

Attachments: Figure 3-1, Combined ground water contour map for the Hill Site and Route 8 Site.

Figure 3-1
Hydrogeologic Cross Section A-A'