Winter 2000 ❄

RPM News

▲ Remedial Project Manager News ▲

"Communicating Navy Installation Restoration Program News and Information Among All Participants"

In This Issue:

Risky Business

Risk-based clean up standards used for RCRA closure of a hazardous waste storage facility at NWS Charleston, SC

EXECUTIVE SUMMARY

Using alternative risk-based clean up standards in lieu of clean up levels based solely on background or non-detect levels can save millions of dollars in clean up and permitting costs while being protective of human health and the environment.

DETAILS

The RCRA interim status hazardous waste storage facility at the Naval Weapons Station Charleston, SC was closed on 23 June 2000. On this date, confirmation was received from the state regulatory agency that verification of risk based clean closure was achieved. The site is approximately 100' x 100' with 1/3 of the facility's flooring constructed of concrete. The site's concrete flooring was first decontaminated, followed by an extensive site characterization.

During the early 90's, the closure plan followed the only clean up alternative available at the time, which was clean up to background/non-detection levels. If these clean-up levels could not be met, the site could not be "decontaminated" per 40 CFR 264/5 and the site would then undergo post-closure. Under this scenario, the post-closure regulations require the unit to be closed as a hazardous waste landfill. This would include site construction of an impermeable cap, corrective action, and 30 years of groundwater monitoring.

To be protective of human health and the environment, and "close" the site according the state and federal requirements, a proposal was made for closure to alternative risk based levels using the Tier I partnering process with the regulators. This effort evolved from first attempting to use industrial standards or levels that would invoke institutional controls and additional permitting requirements as well as certain property restrictions for future use. After intense negotiations with all parties involved, it was determined that the Tier I team goals were to clean up the site using the best available criteria and prevent future land use restrictions if possible. It was agreed that residential-based concentrations (RBC) would be used as a screening tool and that a site specific risk assessment in accordance with Risk Assessment Guidance - Superfund (RAGS) under a residential scenario would be performed for those constituents of concern that exceeded the RBC values. In addition, an ecological risk assessment in accordance with RAGS would be performed.

CONCLUSIONS

Site specific human health and ecological risk assessments results concluded that no adverse impact occurred from onsite contaminant concentrations and that no additional remedial efforts were required to close the site. Once risk based closure was achieved, no future land use restrictions were required for the site.

The projected cost avoidance for the site closure are as follows:
Construction of impervious cap and initial post closure permitting cost: $500,000
30 years of groundwater monitoring and subsequent permitting cost :
$250,000 x 30 years = $7,000,000
Total projected cost avoidance = $7,500,000

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Remedial Project Manager News

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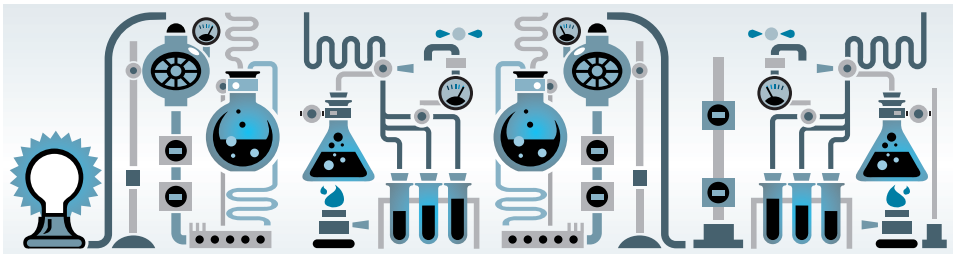
New Cleanup Technology:

In-Situ Chemical Oxidation for Remediation of Chlorinated Compounds



In-situ chemical oxidation (ISCO) is an emerging technology that can remediate soil and groundwater contaminated with chlorinated compounds such as tetracholoroethylene (PCE) and trichloroethylene (TCE). A large number of Navy / Marine Corps and Department of Defense sites are contaminated with these compounds. At many of these sites, contaminants from source areas are expected to continue impacting the groundwater for decades. Remediation at these sites is challenging and often requires extended time and high cost. Here is a brief overview of ISCO and its potential for reducing remediation costs.

The ISCO process is conducted by introducing strong oxidizing chemicals into the contaminated subsurface. These chemicals react with contaminants and form non-toxic products such as carbon dioxide, water, and chlorides. Hydrogen peroxide and potassium permanganate are the two common chemical oxidants used or evaluated for use in the remediation of chlorinated contaminants. Ozone is also a strong oxidant, but its application for in situ oxidation has been very limited due to its high generation cost and difficulty with uniform distribution in the subsurface.

Hydrogen peroxide has been used at more sites than other oxidants. For site remediation, an iron catalyst is added to peroxide to form the compound known as "Fenton's reagent". This combination generates hydroxyl radicals that are strong oxidants. Typically, a 50% solution of hydrogen peroxide is used for this application. The reaction requires pH less than 6, and an acid addition may be

needed to ensure optimum site conditions. The strong 50% peroxide solution is corrosive and requires great care in handling. (In comparison, 3% peroxide solution is used for household purposes.)

Two successful applications of Fenton's reagent have been at the Naval Air Station Pensacola, Florida, and Naval Submarine Base, Kings Bay, Georgia. At both locations, the process reduced contaminant concentrations in source areas to levels that allowed shut down of pump & treat systems. Final polishing to achieve required cleanup levels at these sites will be provided by monitored natural attenuation (MNA). By applying ISCO, the sites are expected to achieve cleanup goals at lower costs and in shorter time. These two applications were discussed in detail in the Summer '99 issue of RPM News.

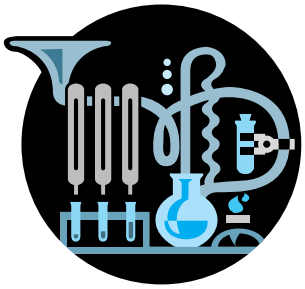
Recently, a few sites have used potassium permanganate as an oxidant. It is available as crystals or granules, and a 1 to 5% solution is prepared on site for subsurface injection. Unlike peroxide, catalyst addition or pH adjustment is not needed. Permanganate oxidizes the chlorinated contaminants readily, but it has a few limitations that may restrict its use. The oxidation reaction generates manganese dioxide precipitate that can potentially reduce aquifer permeability to the extent that retards further permanganate injection and distribution. At two sites, permanganate solution actually came up to the ground surface along the injector walls, instead of the desired radial dispersion from the injector. Permanganate also has a tendency to mobilize metals (chromium, selenium, etc.) from soil.

The chemical oxidants are non-selective and, in addition to the contaminants, these will oxidize the organic matter and some minerals present in soil matrix. In fact, for most sites, the chemical demand for organic matter will far exceed the stoichiometric demand for contaminants. A pilot study with site soils and groundwater is highly recommended to determine the required chemical demand.

Now a word of caution about ISCO - Technology vendors often publicize using ISCO for petroleum contamination, but its use for petroleum sites can be problematic. Hydrogen peroxide reacts very rapidly and can generate tremendous amount of heat that can boil groundwater and volatilize contaminants that can pose a safety hazard. At one site, the heat and off-gases caused pavement upheaval, and a small fire. The main causes of the accident were high concentrations of gasoline contamination and inadequate safety procedures.

In closing, ISCO has a potential for reducing remediation cost and time frame for sites contaminated with chlorinated contaminants. An effective strategy may include source zone reduction by ISCO followed by MNA, bioremediation, or other technologies that are more applicable for residual contamination. In general, Fenton's reagent has been used more effectively than potassium permanganate for remediation of chlorinated compounds. However, field studies using potassium permanganate are now underway at several sites and findings from these case studies may identify necessary measures to improve its performance. Typically, ISCO is not cost effective for treating low contaminant concentrations. Additionally, site specific factors such as low permeability, high organic contents, and mobilization of metals may limit its use for some sites. These factors should be evaluated during pilot scale work prior to full-scale applications.

For further information on ISCO, visit the NFESC web site at: http://erb.nfesc.navy.mil/ The webpage includes a NAVFAC Tech Data sheet for the NAS Pensacola project, a technical paper prepared by (South Div), et al., and links to other information sources.



Innovation Offsets Additional Data Collection at Louisville

by Tetra Tech NUS, Inc.

At the Naval Ordnance Station Louisville (NOSL), Kentucky, conventional methods of determining groundwater flow velocity and direction in the bedrock aquifer were unreliable, since water levels in some monitoring wells installed in the limestone did not recover in over two years. Several downhole geophysical methods in conjunction with a colloidal borescope were used in an attempt to reliably identify fracture zones and measure groundwater flow directions and rates. This innovative, tiered approach established groundwater flow direction and rates and ultimately assisted in characterizing the extent of groundwater contamination, thus eliminating the need for additional data collection.

Identification of the Problem

During installation of bedrock wells at NOSL, rock cores revealed that a vuggy zone (a zone of unfilled large pores) having a higher porosity was present in the upper portion of the limestone. It was also identified that this zone contained free-phase petroleum. These observations raised concerns that the vuggy zone might be a major contaminant transport zone, even though this zone was overlain by ten feet of confining shale and an average of ten feet of silty clay overburden.

Innovative Site Characterization

Prior to completion of additional monitoring wells, borehole geophysical logging was performed on several open coreholes. The goal of the geophysical logging was to determine the location of major fracture zones and zones of porosity for selecting packer test and colloidal borescope measurement intervals, to ultimately support well screen placement for additional bedrock monitoring wells. Electric, mechanical, nuclear, and acoustic geophysical techniques were performed.

In general, taking into account borehole fluid effects, all of the electric logs showed the limestone formation to be consistently resistive with few deflections, indicating that porous zones were not prevalent in the boreholes. The electric logs also indicated that while porous, the vuggy zone lacked interconnective porosity, suggesting that little flow would be present in this zone. The borehole televiewer, which is able to image certain geologic features such as fractures, bedding planes, and vugs by emitting an acoustic signal to produce a 360 degree, oriented picture of the well bore, perhaps provided the most useful data with respect to determining that significant fracture zones are not present in the strata underlying NOSL (Figure 1).

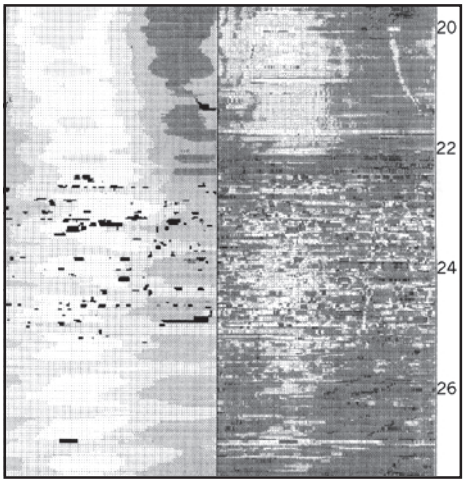


Figure 1. Acoustic televiewer log showing vuggy zone from 22.5 ft to 25 ft

The colloidal borescope (http://homer.hsr.ornl.gov/ets/borescop.html) study focused on zones of suspected higher permeability or porosity identified during the downhole geophysical investigation. The borescope provides in-situ observation of natural particles (i.e., colloids) in monitoring wells. By observing the movement of these natural particles in the well screen, it is possible to measure the groundwater flow direction and velocities at specified aquifer depths (Figure 2).

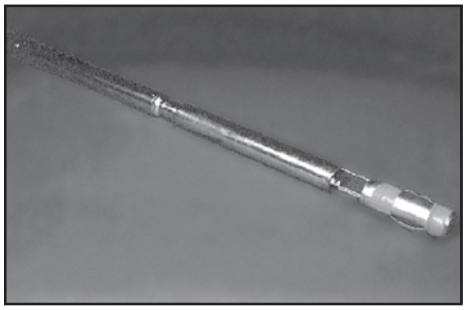


Figure 2. The colloidal boroscope. (Taken from http://homer.hsr.ornl.gov/ets/borescop.html)

The borescope study confirmed that groundwater flow in the limestone at NOSL occurs in few discrete fractures, and that many intervals, including the vuggy zone, exhibit no flow. The study also demonstrated that the flow direction in the limestone closely followed the inferred regional structure, and not the topography of the limestone, which represents an unconformity.

Project Successes

This approach ultimately decreased the number of subsequent water level monitoring events and precluded the need for further aquifer testing data by rapidly establishing groundwater flow direction and velocities. The establishment of "no flow" zones simplified site characterization and led to a quicker, more accurate development of a conceptual site model for bedrock groundwater. This information rapidly established the locations of wells that were indicative of upgradient groundwater quality. This information could not have been obtained using conventional means due to the slow recharge observed in bedrock monitoring wells over a two-year period.

The absence of flow in the vuggy zone of the limestone, coupled with the presence of the shale confining unit, and analytical results showing that the petroleum in the bedrock is naturally-occurring crude oil, supported the theory that groundwater in the bedrock was unaffected by site activities and required no further action.

The results of the borescope study also showed that the presence of methyl tert-butyl ether (MTBE) in bedrock groundwater at a site-perimeter well was representative of groundwater entering the site from an adjacent property. The source of MTBE in bedrock groundwater may have remained indeterminate without the borescope results.

Lessons Learned

- Innovative and less-used technologies can be applied during the site characterization process to yield cost-effective results.
- Application of these technologies may result in additional costs at the beginning of a project; however, development of accurate site information in a timely manner will offset future data collection and evaluation costs.
- The use of a tiered approach to site characterization allows for better placement of monitoring wells, and provides less ambiguity during interpretation of collected data.

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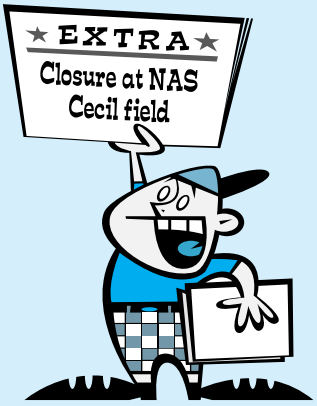
Transferring a Closing TSD from RCRA to CERCLA at NAS Cecil Field

by SOUTHDIV

During closure of the Part B permitted TSD (Treatment, Storage and Disposal) at Naval Air Station Cecil Field (Jacksonville, Florida) soil contaminated with organics was discovered at the site. An industrial history of this site had already been performed under the Base Realignment and Closure (BRAC) program, which had identified this site as a past Navy PWC (Public Works Center) maintenance center prior to the establishment of the TSD at this site. The remediation standards under RCRA closure would be extremely difficult to meet as they are typically at or near background. This means that you must reach non-detect for organics. To address this site under CERCLA it would be imperative that the regulators could be convinced that: (1) the soil contamination was due to activities that had occurred prior to establishing the site as a TSD and (2) the Navy would adequately address the contaminated soil under CERCLA through the BRAC process.

In order to show the regulators that the soil contamination occurred when the area was a PWC maintenance facility, the various contaminants were identified. Other PWC maintenance areas on the base were also scrutinized with respect to soil contaminants. The TSD site and the other PWC sites were shown to have contaminants in common. Also, samples taken directly adjacent to the pad of the TSD (which was



constructed in the early 80's) had no indication of contamination. It was proposed to the regulators that soil contamination was not found around the pad because of soil disturbance, which occurred during the construction of the TSD pad. We also pointed out that there had been no reported spills at the site when it was operated as a TSD.

The Navy personnel on the Cecil Field BRAC team were instrumental in convincing the regulators (both CERCLA and RCRA) that the site would be better handled under the current BRAC program (i.e. CERCLA) which already had a plan of action to investigate the site and the site could be addressed expeditiously. The CERCLA and RCRA regulators finally agreed to defer the soil (and any possible groundwater) investigation of the site to CERCLA. This allowed the Navy to proceed with the disestablishment of the Part B permit without conducting RCRA post-closure requirements.

Innovative Technologies: A Case Study at NTC Orlando

Executive Summary

Innovative technologies applied to environmental problems often promise to do "it" faster, better, and cheaper than conventional remediation technologies. At the Naval Training Center (NTC) in Orlando Florida, two innovative technologies were implemented at the former dry cleaning facility for groundwater remediation, in-situ chemical oxidation using potassium permanganate ($KMnO_4$) injection and groundwater re-circulation wells. A potassium permanganate pilot study has successfully reduced average source area concentrations of chlorinated solvents in groundwater by 99 % in about 120 days at a cost of approximately $200,000. Downgradient of the source area at the same site, two re-circulation wells were installed to intercept and treat groundwater containing elevated levels of contaminants prior to migration to a nearby surface water body. Poor reinjection rates believed to have been caused in part by bio-fouling resulted in intermittent system operation. These operational problems resulted in failure of circulation cell development, critical to the success of the re-circulation well technology. However, these wells are being converted to standard extraction wells for containment and will be integrated into the full-scale in-situ chemical oxidation system to further remediate the site.

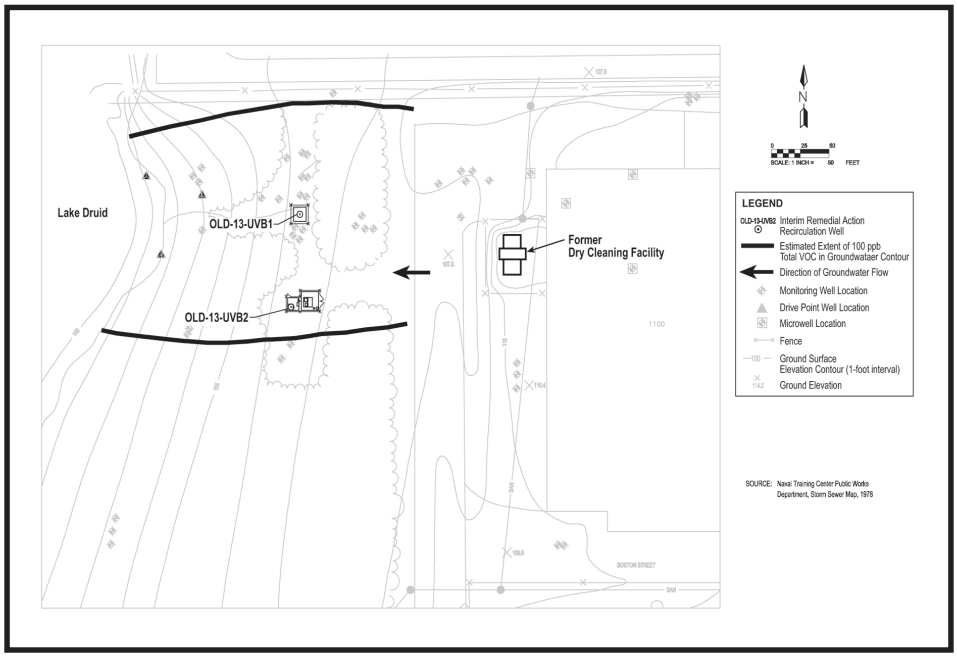


Figure 1: Site Plan

Details (Re-circulation Wells)

In response to the migration of chlorinated solvents toward a surface water body (Lake Druid), two UVB™ groundwater re-circulation wells were installed as part of an Interim Remedial Action at NTC Orlando in 1998. The wells were designed to contain migrating groundwater with concentrations greater than 100 parts per billion (ppb) of total volatile organic compounds (VOCs) while the investigation at the site continued. Each well was anticipated to have maximum radius of influence of 80 feet and the wells were installed with 100 percent overlap (i.e. 80 feet on center). **Figure 1** is a site plan and illustrates the current 100 ppb contour of total VOCs in the groundwater plume, groundwater flow direction, and re-circulation well location. Since

chlorinated solvents were present at shallow and deep aquifer zones, the groundwater re-circulation wells were designed to achieve capture in both the vertical and horizontal planes to encompass the entire profile of the contaminant Pume.

The two UVB™ wells were designed to operate in a reverse flow pattern by removing water from the upper screen and reinjecting it into the lower screen. Chlorinated compounds entering the well with the influent groundwater were volatilized/stripped and the clean groundwater was discharged into the lower well screen. The results of the simultaneous extraction and reinjection in the same well causes drawdown and mounding of the groundwater which aids in the development of the circulation treatment cell. Groundwater that migrates into the circulation cell is captured by the system, treated, and reinjected as clean groundwater. The system was designed to operate at 8 gallons per minute (gpm) in order to develop the circulation cell necessary to contain groundwater at the site with greater than 100 PPB total VOCs.

Initial operation of the wells was successful, although operation and maintenance costs were higher than expected. Downgradient VOC concentrations in groundwater decreased, and gradually met State of Florida criteria at the lake. However, continuous and consistent operation of the re-circulation wells became more difficult with time, and the intermittent operation eventually caused downgradient VOC concentrations to increase once again. In order for the circulation cell to develop, the re-circulation well must be operated on a continuous basis.

Because of the increasing solvent concentrations downgradient of the re-circulation wells, the intermittent operation, and high operation and maintenance costs, the Navy Remediation Program Manager (RPM) was prompted to re-evaluate the effectiveness of this technology at the site. During the evaluation process, limited recharge capacity of the lower screened interval was identified as the primary problem with the system. Bio-fouling and/or changes in the aquifer characteristics were determined to be the cause of the limited recharge capacity of the lower screen interval.

In an effort to enhance the lower screen interval recharge capacity, the well screens were acid treated and redeveloped. This was followed by down hole video observation to investigate the integrity of the well casing. Evidence of some bio-fouling was noted on screened intervals on both re-circulation wells. Pump testing of the recharge screens after re-development indicated that they were capable of accepting approximately 2 gpm, significantly less than the 8 gpm flow rate initially achieved at system startup and required for the re-circulation well to capture the groundwater containing greater than 100 ppb total VOC. Based on monitoring data, the decreased actual flow rate was not capable of developing the circulation cell necessary for successful implementation of the technology.

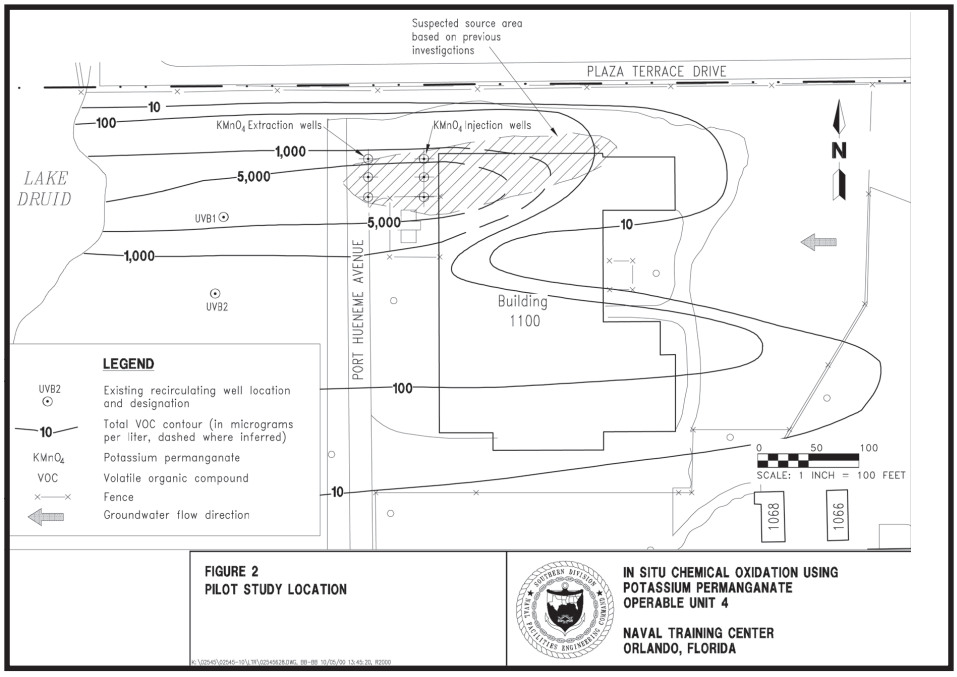


Figure 2: Pilot Study Location

The existing system is in the process of being converted into a standard groundwater recovery and treatment system for temporary containment. Use of multiple screen UVB™ wells allows groundwater to be extracted above and below an identified restrictive (semi-confining) aquifer zone that exists at approximately 18 to 25 feet below land surface. The system will be operated to contain groundwater containing greater than 100 ppb total VOC, consistent with previous design objectives. The groundwater will be pumped to an ex-situ low-profile tray air stripper, treated, and discharged to the City of Orlando sanitary sewer; the modified system will operate in this mode until the full-scale chemical oxidation remedy can be implemented at the site. Future work is anticipated to evaluate modifications to amend the treated water with potassium permanganate and reinject it to enhance capture and treatment of the contaminated groundwater plume.

Details (In-Situ Chemical Oxidation Using Potassium Permanganate)

The chlorinated solvent plume discussed above was found to originate at the former base dry cleaning facility, located approximately 350 feet upgradient of Lake Druid. Total VOC concentrations in groundwater (primarily tetracholoroethylene (PCE)) were detected as high as 30,000 ug/L. The VOC source area was estimated to be approximately 250 feet long, 60 feet wide, and 25 to 35 feet thick. The majority of the source was located beneath the abandoned laundry building itself.

The pilot study location was chosen in the only portion of the source area accessible outside the building (**Figure 2**). Three extraction and injection well pairs were drilled approximately 65 feet apart, with numerous monitoring wells installed between to monitor the pilot study performance. Groundwater was extracted from the extraction wells, dosed with $KMnO_4$, and injected into the aquifer through the injection wells. This process created an in-situ treatment cell, maintaining hydraulic control of the injected $KMnO_4$ and preventing contaminated groundwater from the remaining upgradient source from entering the treatment zone. KMnO4 was injected from mid-February 2000 until late June.

VOCs in extracted groundwater needed to be treated to meet drinking water standards before Florida would allow injection of the $KMnO_4$ solution. The $KMnO_4$ feed system was designed with this in mind, and reduced the concentrations of VOCs in the extracted groundwater from over 4,000 ug/L to less than 3 ug/L prior to injection.

The $KMnO_4$ solution was a deep, opaque purple color. The progress of the $KMnO_4$ solution across the treatment cell was easily seen by observing changes in groundwater color and conductivity. Destruction of VOCs occurred rapidly and almost immediately upon arrival of the $KMnO_4$ at each monitoring point. Occasionally, groundwater concentrations leveled off for a period before continuing

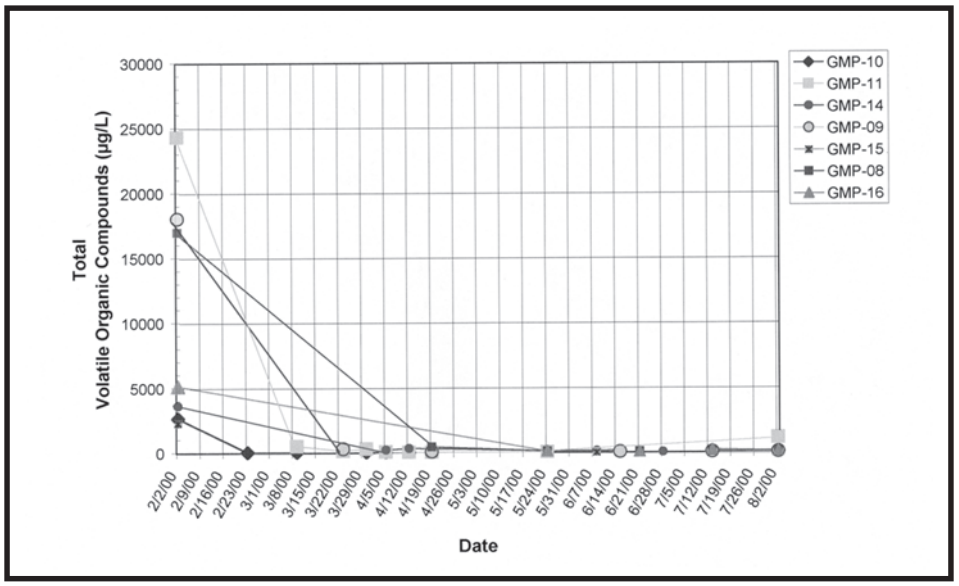


Figure 3: Volatile organic compound concentrations vs. time

to decrease. The plateau was believed due to the presence of tight, low permeability zones within the aquifer that the $KMnO_4$ was slow to penetrate, and/or the presence of residual pure PCE in these areas. Once the $KMnO_4$ completely permeated the aquifer, the PCE was consumed and groundwater concentrations continued to decrease, often to below detection. The decrease in VOCs measured in several of the monitoring wells located within the treatment cell is shown on **Figure 3**. Increasing VOC concentrations after completion of the pilot test shown in the last few data points likely represents treated groundwater being displaced by contaminated groundwater from the upgradient source that is moving into the treatment cell after system shutdown.

Based on these results, plans are progressing to design a $KMnO_4$ treatment system that will be used to treat the remaining source area without razing the former laundry building. As discussed above, the full-scale $KMnO_4$ system will be integrated with the groundwater recovery and treatment containment system that has replaced the re-circulation wells. The objective of this design will be to not only attack the source area, but also to reduce groundwater concentrations between the source area and the former UVB™ wells, and minimize the duration of pump and treat operations. This approach is expected to significantly reduce VOC groundwater concentrations so natural attenuation alone will be capable of effectively remediating residual concentrations to achieve Florida standards at the lake and eventually achieve overall site closure.

Conclusions

The chemical oxidation pilot is an example of the successful implementation of an innovative technology. Groundwater contamination was rapidly destroyed as average concentrations of PCE were reduced by 99% in 120 days. Operation and design of this technology was dependent on an understanding of the same aquifer hydraulics used to select and design the failed re-circulation well system. The importance of a complete hydrogeological characterization cannot be over-emphasized. Although the pilot study encountered some equipment and operational problems (primarily related to control of precipitated solids and distribution of the $KMnO_4$ across the full source area thickness), these were overcome at least partly because of the excellent understanding of the aquifer hydraulics at this site. The pilot study results will help overcome these issues during full-scale implementation, and these results will enable an accurate prediction of the time required for full-scale source area treatment.

It is critically important to evaluate the success and the failure of innovative systems in order to gain a better understanding of the design factors that must be considered in determining their applicability. This case study highlights the importance of understanding the hydraulic and geochemical characteristics of the aquifer prior to the implementation of a re-circulation well system. The lessons learned with the operation of the re-circulation wells and their subsequent retrofit, along with implementation of the $KMnO_4$ chemical oxidation pilot test has lead to an innovative approach that compared to more traditional remedies will significantly reduce life-cycle costs and accelerate site closure.

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Clean up Review Tiger Teams

A Clean Up Review Tiger Team (CURTT) recently reviewed selected sites with Methyl-tertiary Butyl Ether (MTBE) at Navy bases on the West Coast. The MTBE CURTT documented related work performed to date, offered advice on the selection of remediation technologies, and provided guidance on site characterization, risk assessments, and regulatory negotiations. The MTBE CURTT was comprised of technical experts from the Department of Defense, the United States Geological Survey (USGS), and private industry.

A general recommendation from the MTBE CURTT is to apply a "Layered Technology Approach" to MTBE sites. This strategy is based on the Navy's Technology Pyramid, a concept of selecting the lowest level of intervention that will result in an acceptable level of risk. For MTBE, this approach is comprised of four layers: active source reduction, plume control, a contingency plan, and monitoring. Specific recommendations from the MTBE CURTT for each of the four layers include:

- Apply an active, low-logistics remediation technology, such as oxygen release compounds, air sparging, or chemical oxidation for active source reduction. These technologies can reduce high levels of MTBE in a relatively short time period.
- Control the plume with an in-situ technology, such as phytoremediation, at its leading edge or within the plume at property boundaries where it is desirable to reduce movement of mass.
- Prepare a contingency plan for plume control. This involves preparing a design for quick implementation in the event that more aggressive measures, such as a pump and treat containment system or an aeration trench, are necessary to control the plume.
- Monitor for natural attenuation parameters early in the project and as the project progresses to ensure data is available when applicability of monitored natural attenuation is being evaluated.

General approaches, such as the previous examples, and site specific recommendations give a Remedial Project Manager (RPM) new options to consider, that are scientifically defensible and backed by a panel of experts in the field. RPMs often invite these experts to assist in discussions with the regulators and the public, particularly when presenting a new approach.

CURTTs can be assembled to provide technical assistance on any remediation topic. Just this year, CURTTs assisted RPMs in tackling issues related to sites with ammonium perchlorate, sites with unexploded ordnance, and sites with MTBE. The review process involves the RPM presenting site information and project challenges to a group of handpicked experts. Discussions evolve into recommendations. A final report captures relevant background information, the current approach, and either verification that the current approach is most appropriate or recommendations for a new strategy.

CURTT reviews are centrally-funded and available to any RPM. Follow-on assistance to any recommendation, including implementation of innovative technologies or strategies, can be provided upon request. If you are interested in a CURTT review of your site(s), please contact (805) 982-4998 or your NFESC Technical Services Representative.

Deep Air Sparging of Chlorinated Solvents at Naval Air Station Cecil Field, Jacksonville, Florida

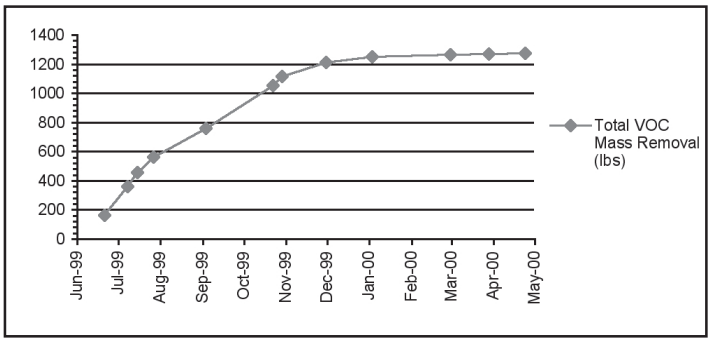
The Base Realignment and Closure Cleanup Team (BCT) for the Naval Air Station (NAS) Cecil Field has selected air sparging/soil vapor extraction (AS/SVE) as the preferred remedy to treat chlorinated solvents present in groundwater to a depth of 94 feet below the water table. Contamination was found to be present in the shallow aquifer to a depth of 100 feet below ground surface (bgs) at the Aircraft Intermediate Maintenance Department (AIMD) Seepage Pit (Site 16). The BCT established a remediation goal to actively treat trichloroethene (TCE) contamination in the source area to below 1000 mg/l and then to shut down the system and allow natural attenuation to occur.

Since application of AS/SVE to such great depths below the water table is not common practice, the BCT elected to perform a pilot scale study to determine applicability of AS/SVE to the site and to establish design criteria for full-scale implementation. The pilot study evaluated vacuum extraction in two wells and air injection in two wells. The injection wells were nested together and were screened at 58 to 60 feet bgs and at 95 to 100 feet bgs. Injection depths were selected to ensure air would be delivered below the area of the highest VOC concentration at the site. The results of the pilot study indicated the system was capable of removing contaminants from the groundwater and that the effective radius of influence was 15 feet for the vacuum wells and 30 feet for the air injection well pair.

Pilot - scale Treatability Study System

Based on the results of the treatability study, the design of the full-scale system included three pairs of nested injection wells, 19 soil vapor extraction wells, and offgas treatment using granular activated carbon (GAC). The system was placed in operation in June of 1999 and was expected to operate for three years based on modeling results for reduction of TCE. Since the site is adjacent to a building, piezometers were installed within the zone of influence and monitored for pressure/vacuum to verify complete capture of volatilized contaminants. If a pressure reading was detected in a piezometer, the system was adjusted until a vacuum or zero pressure was achieved. In addition, regular off gas monitoring was performed to ensure that the GAC was effectively removing VOCs. This information was also used to determine the mass of VOCs removed from the site over time.

During the first week of operation, the SVE system was extracting 22 lbs/day of VOCs. After eleven months of operation, the extraction rate of VOCs dropped to below 0.2 lbs/day. The total mass removed over the eleven months of operation is estimated to be 1,272 pounds of total VOCs (which is over 100 percent of the originally estimated VOC mass). This removal correlates to a TCE concentration in a monitoring well



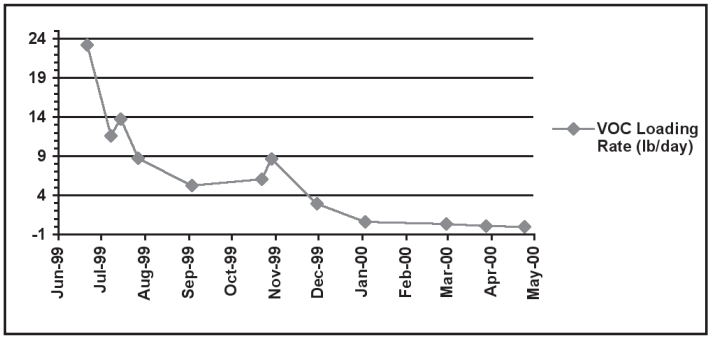
VOC extraction rate (lbs/day) in the SVE Offgas

being reduced from 978,000 mg/l to non-detect prior in May 2000. As of May 2000, all monitoring wells within the source area had TCE concentrations below the remediation goal of 1,000 mg/l. The highest concentration of TCE remaining in a monitoring well was 318 mg/l.

Monitoring results for groundwater sampled at the periphery of the source area during system operation indicated that contamination was not being forced to other areas from the air injection. This suggests that the system was in fact removing contamination through volatilization.

Quarterly groundwater monitoring results indicated that the TCE concentrations were reduced to below the remediation goal for two consecutive events. Following the May 2000 groundwater sampling event the system was shut down. The source area wells were sampled in July 2000 and the results indicated that limited rebound has occurred. The BCT has determine that the system will remain shut down until results from the October 2000 sampling event can be evaluated. At that time the system will be re-activated, if necessary. Based on future sampling events, the system may be restarted in a pulse-type operation mode.

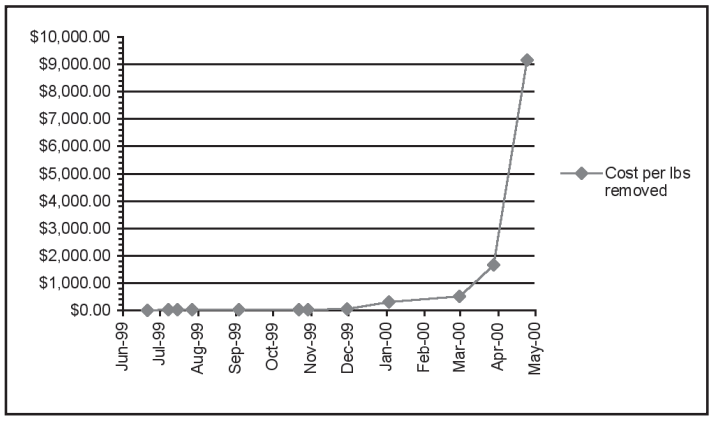
By focusing active remediation on the area of highest contaminant concentrations, maximum efficiencies were realized by installing a smaller system that was capable of removing a large amount of mass. This approach minimized the cost/pound of contaminants removed.



Total VOC mass removal (lbs)

Through modeling, an active system remediation goal, other than MCLs, that would be protective of downgradient receptors was determined. This resulted in a shorter duration for active remediation and greatly reduced remedial action operation and long-term management (RAO/LTM) costs over more traditional active remedy alternatives such as pump and treat. By performing a pilot scale treatability study, the most effective full-scale system was installed.

Use of air sparging to treat contaminants at these depths was an innovative application of the technology that yielded a significant time and cost savings over other options. The system has achieved its goal in less than half of the expected operation time. In addition, reductions in the TCE concentrations below 1000 mg/l will significantly reduce the time frame for natural attenuation.



AS/SVE system operation cost per pound of contaminant removed

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EPA Proposes Revisions to CAMU Rule

RCRA Corrective Action Management Unit (CAMU) regulations provide for a type of site-specific RCRA unit intended for treatment, storage, and disposal of hazardous remediation waste. CAMU units are not subject to Environmental Protection Agency's (EPA) minimum technology requirements for hazardous waste land disposal units. Instead, EPA or authorized state regulatory officials may specify site-specific design, operating, closure, and post-closure requirements. The CAMU approach is intended to save money, expedite remediation, and specifically allow consolidation of wastes from separate areas within a facility to minimize the land area used for disposal.

A related EPA policy for RCRA cleanups called the "Area of Contamination Policy" allows certain discrete areas of generally dispersed contamination to be considered RCRA units (usually landfills). Consolidation or in-situ treatment within the Area of Contamination (AOC) does not create a new point of hazardous waste generation under RCRA. A March 13, 1996 EPA Memo "Use of the Area of Contamination Concept During RCRA Cleanups" is available on EPA's RCRA On-line website: http://www.epa.gov/rcraonline/.

CAMU regulations (40 CFR 264.552) address permitted and interim status RCRA treatment, storage, and disposal (TSD) facilities that are under RCRA "corrective action" orders for remediation of releases of hazardous wastes or releases of hazardous waste constituents from "solid waste management units." Additionally, EPA guidance indicates that a CAMU can be implemented at a CERCLA site, by invoking the CAMU regulations as applicable, relevant and appropriate regulations (ARARs) for the site. (See "Management of Remediation Waste Under RCRA" EPA530-F-98-026 also available at http://www.epa.gov/rcraonline/). Details of such agreement would of course be documented in the Record of Decision for the site.

EPA's CAMU regulations have been under court challenge since 1993, which has tended to discourage the use of the CAMU approach. As part of a negotiated settlement EPA proposed changes to the CAMU rule on August 22, 2000 (65 FR 51079) http://www.epa.gov/fedrgstr/EPA-WASTE/2000/August/Day-22/f20534.pdf. The proposed amendments would more specifically define the wastes eligible for management in CAMUs, establish minimum treatment requirements for such wastes, and set minimum technical standards for CAMUs. The proposed amendments would "grandfather" CAMUs approved before the final CAMU rule change. The current regulations for the grandfathered CAMUs would also be retained under a new section number (section 264.552 redesignated as 264.551). Finally, the proposed regulations would include a new section specifically addressing CAMUs used only for treatment or storage (i.e., those in which wastes will not remain after closure).

For CAMUs used for ultimate waste disposal, new minimum design requirements would generally call for use of a liner and leachate collection system or alternative design at least as effective at preventing groundwater contamination. New waste treatment standards applied to "principal hazardous constituents" (site specific and designated by the regulator) are similar to the Land Disposal Restrictions (LDR) treatment standards for contaminated soils, calling for a 90% reduction in hazardous constituent concentration or a reduction to ten times the universal treatment standard (proposed section 264.552 (e)(4)(iii)). Treatment standards may be adjusted (either up or down) to reflect site-specific cleanup standards or for other reasons. Proposed section 264.552 (e)(4) would impose requirements for groundwater monitoring. An exception is provided in section (g) for placement of wastes with constituent levels at or below remedial levels of goals applicable to the site. CAMUs containing only such wastes would not require liners, caps, or groundwater monitoring.

The proposed rule provides better definition of requirements than previously and may make it easier to implement CAMU agreements, particularly for on-site storage or treatment CAMUs where wastes are not disposed permanently. Additionally the requirements are mild where wastes disposed in a CAMU already meet the remediation goals for the site. Unfortunately, since the new rules are more prescriptive, they represent a step back from the flexibility provided by the former CAMU rules.

Enhanced Decision Making, Using an Environmental Geographic Information System

Through utilization of state of the art software, the Navy has enhanced the ability for a project team to make site decisions. In 1993, the Base Realignment and Closure (BRAC) commission recommended Naval Air Station (NAS) Dallas for closure. Work commenced at the site in early 1998 to complete the RCRA Facility Investigation (RFI) and to perform post-RFI services. In addition, environmental baseline survey and finding of suitability documents were required to support transfer of over 700 acres of property.

The management of environmental data is required to support both the RCRA and CERCLA regulatory requirements at the site and to effectively communicate site conditions at BCT and public meetings.

Managing the substantial amount of data generated at NAS Dallas could have been overwhelming without the use of a Geographic Information System (GIS) and the Internet. Use of these tools has significantly enhanced the decision making and productivity of the NAS Dallas BRAC Clean-up Team (BCT).

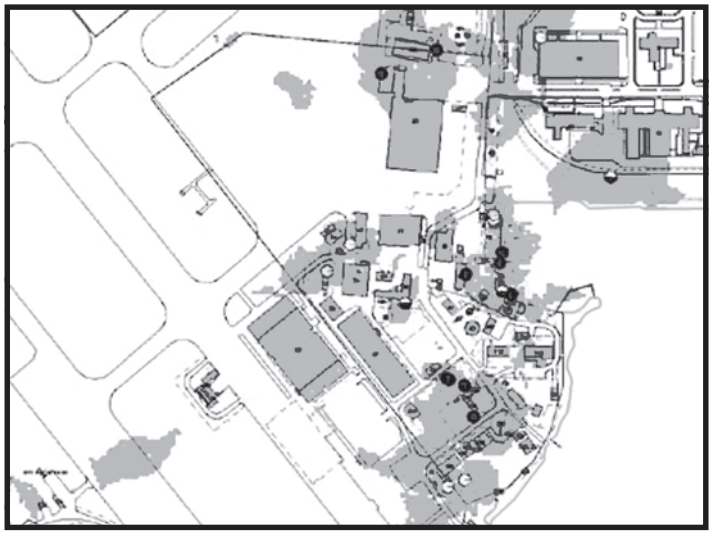

Figure 1: EGIS used to map extent of soil exceedances.

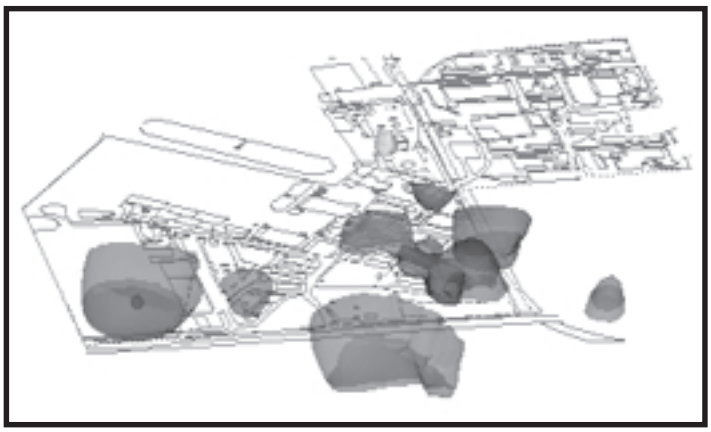

Figure 2: EVS output showing soil concentrations.

Challenges

During the RCRA Facilities Investigation/Corrective Measures Study (RFI/CMS) and BRAC activities at NAS Dallas, nearly 5 gigabytes of electronic information has been collected. This information includes base mapping, digital photographs, and chemical, geological, and hydrogeological data from over 1,200 sampling locations. The information is stored within an Environmental Geographic Information System (EGIS) that is primarily based on an ArcView GIS, but has grown to encompass many alternative software applications.

Components of the NAS Dallas Environmental Information System:

- ArcView GIS system that integrates relational databases, mapping, imagery, and movie files.
- High-resolution aerial photography, both historical and current.
- ArcView mapping hot-links to descriptions of buildings and Soild Waste Management Units (SWMUs), geologic cross-sections, and hundreds of field photographs taken with a digital camera.
- Customized ArcView menus and buttons that allow the user to zoom to a specific site, select a specific view, launch new project files, and instantaneously extract chemical data for selected sample locations.

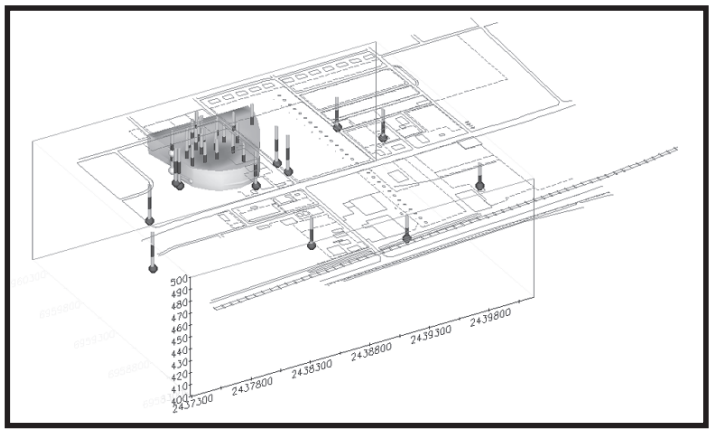

Figure 3: EVS output showing groundwater concentrations.

- NAS Dallas Internet site that links to analytical querying interfaces and ArcView GIS mapping served by ESRI's Internet Map Server.
- Three-dimensional modeling of contamination and geology using Ctech's Environmental Visualization System (EVS).
- Animation of three-dimensional geostatistical models in AVI format using Adobe Premiere.
- Two-dimensional kriging of contamination data using Geosoft and EVS.
- Generation of electronic documents in portable document file (PDF) format via Adobe Acrobat Exchange.

Cost Avoidance Measures

- Hard copy reports, especially voluminous appendices, have been converted into electronic PDF format and distributed to NAS Dallas team members on CD-ROM thereby eliminating copying costs.
- The EGIS enhanced decision making allowed for the completion of six RFI reports within ten months, thereby allowing property to be made available for transfer.

Project Successes

The following helped enhance decision-making and saved overall time/cost:

- The ArcView GIS, which stores output from a Visual FoxPro data management system, allows the user to query and spatially display environmental data for the entire facility.
- The GIS is operated by the BCT as an interactive presentation tool (facilitates visualization) during BCT and public meetings.
- Customization of the ArcView GIS, via the Avenue programming language, facilitates the retrieval and presentation of information.
- An NAS Dallas Internet site provides up-to-date postings of relevant information and documents.
- Links from the Internet site include an analytical querying interface and an on-line ArcView GIS served through ESRI's Internet Map Server.
- Output from the ArcView GIS is used to model site contamination and geology in two and three dimensions.
- Three-dimensional models have been animated in Avi format and presented at public meetings. In addition, the ArcView GIS is used to output figures for RFI/CMS reports.

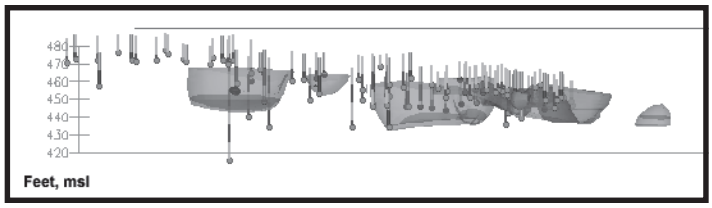

Figure 3: EVS output showing groundwater concentrations.

Lesson Learned

One of the primary reasons for the success of the NAS Dallas EGIS was the planning that took place prior to its implementation. A Site Data Management Plan (SDMP) was developed to outline the data flow process, sample tracking procedure, Electronic Data Deliverable (EDD) requirements for analytical and survey data, the EGIS data structure, as well as the software to be used for the various outputs of the EGIS. The SDMP allowed the field team, technical staff, project managers and subcontractors to understand their data requirements such that EGIS development, integration, and output could be expedited to meet the demanding schedule of the RFI reports.

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