EXECUTIVE SUMMARY

The Source Recovery System (SRS) at Hill AFB's Operable Unit 2 (OU 2) has been in operation since 1993. It uses phase separation and steam stripping to pretreat groundwater contaminated with chlorinated solvents, mainly trichloroethylene (TCE). Some operational problems have developed, which tend to be exacerbated by surfactant-enhanced aquifer remediation (SEAR). After the SRS was designed and built, SEAR was evaluated at OU 2 and was found to be effective; it is being implemented as a remedial action. SEAR technology involves both surfactant floods and partitioning interwell tracer tests (PITT), which generate effluents that can tax the SRS' processes. The purpose of this engineering evaluation is to propose retrofits to address these operational issues. Table ES-1 summarizes engineering solutions discussed in this report and their approximated cost.

This report starts with an examination of the future scope of SEAR at OU 2 to help put the proposed retrofits in perspective. In future surfactant floods, a polymer will probably be used. It will slightly increase the viscosity of the water processed by the SRS. This should not significantly affect the SRS's performance. A simple bench scale test is recommended to confirm the polymer's behavior at steam stripper temperatures.

Recovery and Reuse of Chemicals

Approximately $1 million in remedial fluids probably will be used at OU 2 over the next three years; most of that expense is for surfactant. Substantial savings could be achieved by recovering some of the surfactant from the steam stripper underflow, using micellar-enhanced ultrafiltration (MEUF). This concept should be investigated further.

Sediment Control

The injection and extraction operations during SEAR tend to mobilize additional sediments from the subsurface. Coarse material is intercepted by a Y-strainer in the DNAPL (dense, nonaqueous phase liquid) lines. This strainer clogs frequently; cleaning it is laborious and sometimes has to be repeated several times. We recommend replacing this Y-strainer with a basket strainer, which would have a much larger solids retention capacity and be much easier to clean.

Fine sediment in the aqueous phase tends to accumulate on the plates of the steam stripper preheater (a heat exchanger) and in the stripper column itself. As a result, the performance of the steam stripper system degrades until preheater and column must be dismantled and cleaned, another laborious undertaking. The possibility of filtering out the sediment before it enters the steam stripper was evaluated. The total suspended solids (TSS) content of the stripper feed water was measured. The measurement indicates that approximately eight pounds per day of sediment would have to be intercepted. Filtering such a large amount of solids does not appear practical with a conventional water filter. Since only one TSS sample was taken, we recommend confirmatory sampling.

Surfactant/Antifoam Management

During surfactant floods, antifoam is added to control foaming in the stripper. There are problems feeding antifoam and acid into the stripper feed water. We recommend a bottom-mounted pump and mixer for the antifoam injection, and a more powerful, top-mounted acid feed pump.

IPA Processing

Steam stripper vapors are condensed in a plate heat exchanger cooled by a glycol loop, which releases heat to the atmosphere via an outdoor, air-cooled heat exchanger. In warm weather, this system has insufficient heat transfer capacity, especially when the vapors are rich in isopropyl alcohol (IPA), as is the case during a surfactant flood. As a result, the temperature of the glycol in the closed loop rises and the glycol pumps tend to cavitate, which interrupts the glycol flow, causing failure of the condenser. This in turn causes large amounts of

Table ES-1. Engineering Evaluation Summary

Problem	Proposed Solution/Cost Basis	Cost			
Recovery and Reuse of Chemicals		Sub	Materials	Labor (Radian)	Task Total
Can recovered surfactant be reused to mobilize DNAPL?	Test recovered surfactant for its ability to mobilize DNAPL. Cost for sampling analysis and evaluation.	$15,000	N/A	$2,000	$17,000
Sediment Control					
Sediment removal from DNAPL Y-strainer is laborious and frequent	Replace Y-strainer with basket strainer. Implement between PITTs; the cost installed, including engineering and oversight.	$1,300	$2,000	$10,000	$13,300
Particulate matter deposits on heat exchanger and steam stripper; cleaning is laborious	Sediment control might require a major unit process addition (e.g., coagulation/sedimentation). No solution at this point. Take additional samples to confirm extent of the problem. Cost for sampling, analysis, and evaluation.	$3,100	N/A	$2,400	$5,500
Surfactant/Antifoam Management					
Antifoam pump difficult to prime and requires periodic stirring manually; acid-injection requires new pumps	Modify and relocate antifoam injection system; replace sulfuric acid-injection pumps. Implement between PITTs; installed costs approx.	$1,000	$3,500	$1,000	$5,500
IPA Processing					
Glycol loop overheats and fails, pump impellers melt, massive IPA releases create health and explosion hazard	Increase glycol flow rate to 40 gpm with bigger pumps, to increase heat duty of the outside air cooled heat exchanger; replace expansion tank assembly; and switch to 50/50 weight % propylene glycol/water solution. Implement between PITTs; installed cost, including engineering design, as-builts, procurement, and oversight.	$7,000	$4,500	$15,000	$26,500
Varying IPA concentrations in steam stripper feed may contribute to stripper oscillations	Verify the existence of an IPA gradient in the separators by sampling and analyzing for IPA. Implement during surfactant flood. Costs for sampling analysis, and evaluation.	$1,200	N/A	$2,100	$3,300
IPA builds up in SRS processing loop	Consider storing IPA-rich condensate in the DNAPL tank and hauling it. IPA disposal would add approximately $100,000 over the next 3 years. Not recommended at this point.	N/A	N/A	N/A	N/A

N/A = Not Applicable

IPA vapors to enter the vent system and eventually to escape. Some IPA vapors are vented inside the building, where they cause a serious nuisance and a significant explosion hazard. Because of the explosion hazard, we strongly recommend that no surfactant flood effluent be treated at the SRS until the condenser system is rebuilt.

Increase the heat transfer by increasing the glycol flow rate. This can be addressed by installing larger pumps. Additionally, we recommend replacing the expansion tank, and switching to a 50/50 mixture of propylene glycol and water.

A vertical gradient of IPA concentration appears to develop in the separator tanks during processing of surfactant flood effluent. When the stripper feed is switched from an empty tank to a full one, an abrupt change in the IPA flow into the stripper results, which contributes to the process oscillations that complicate its operation. We recommend that the existence of this IPA gradient be verified by sampling, analysis, and evaluation. If the gradient is significant, the stripper feed can be redesigned to allow blending of water from a nearly empty tank and from a nearly full tank, to even out the IPA concentration peaks. This would involve substantial repiping, valves, controls, and possibly an additional set of pumps and a tank. IPA-rich condensate could also be accumulated in the solvent storage tank and disposed of by the waste management contractor. This would remove much of the IPA from the SRS, alleviating the process cycling problem; it would also lighten the load on the downstream wastewater treatment plant. Thus, it appears that it would be more economical to continue to process IPA through the SRS and the industrial wastewater treatment plant, provided the SRS's glycol loop is rebuilt so it can safely handle IPA-rich vapors.

Conclusion

By implementing these recommendations, the following benefits will be realized:

- Allow the SRS to be fully functional during high (90°F) ambient air temperatures;
- Reduce maintenance activities associated with plugging in the DNAPL transfer line;
- Improve the reliability and efficiency of the acid and antifoam addition systems; and
- Collect data to quantify the nature and extent of several persistent operational problems.