Using Innovative Technologies to Reduce Reserves for Corporate Environmental Liability

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Key Words: corporate, environmental liability, reduce, innovative, remediation, technologies

Abstract: Cleanup costs for properties having environmental liabilities must be treated as any other financial liability – by establishing reserves to cover expected costs. Many times companies overlook how recent understanding of natural attenuation processes and innovative remediation technologies can provide for closure-focused solutions that significantly reduce reserves for environmental liabilities.

Introduction:
In the mid-1990s the Securities and Exchange Commission (SEC) set about to develop a consistent declaration of environmental liabilities for the various publicly traded companies' financial disclosures (10k and 10q forms). For non-publicly traded companies, the Federal Accounting Standards Board (FASB) developed similar requirements, to put everyone on a level playing field. This requires that companies deal with the financial accounting of environmental liabilities in the same manner as other liabilities, through establishing reserves to cover the expected costs.

Prior to this, there were inconsistencies in accounting for environmental liabilities. For instance, costs may have been attached to a plant's operating budget, resulting in a situation where the remediation goal was to minimize the cash flow rather than develop a closure-focused solution. While the accounting procedures have changed, many companies have not re-evaluated their remediation systems in light of these changes to minimize liabilities.

Concurrently, a better understanding of fate and transport processes (natural attenuation) was also being developed in the mid- to late- 1990s, largely through efforts of such organizations as the Air Force Center for Environmental Excellence and Lawrence Livermore National Laboratory. Further, innovative remediation technologies have been developed and proven effective. These techniques, when coupled with natural attenuation process, provide for closure-focused solutions that significantly reduce reserves for environmental liabilities.

A number of sites with existing remediation systems have been evaluated and remediation systems have been and are being re-engineered to minimize liability. Evaluating costs on a life-cycle basis has shown significant savings. In 91% of the cases evaluated, savings of greater than 50% of established reserves could be achieved.

Hypothetical Costs for Cleanup Options
From Rice and McNab (1998), there are three basic stages in remediation projects:

- Uncertainty Reduction, where the release of contaminants are defined and remedial solutions are developed and tested.
- Engineered Processes, where solutions are implemented and containment, or contaminant mass is reduced.
- Natural Processes, where after the source mass has been sufficiently reduced, natural processes can be effective in preventing exposure or provide for meeting regulatory compliance.

Rice and McNab (1998) present hypothetical costs versus cleanup examples using pump and treat alone and incorporating natural attenuation (Figure 1). From their example, there is a distinct reduction in costs, represented mainly by a reduction in annual costs when natural processes are incorporated into the remediation strategy, and a reduction in the timeframe for engineered processes.

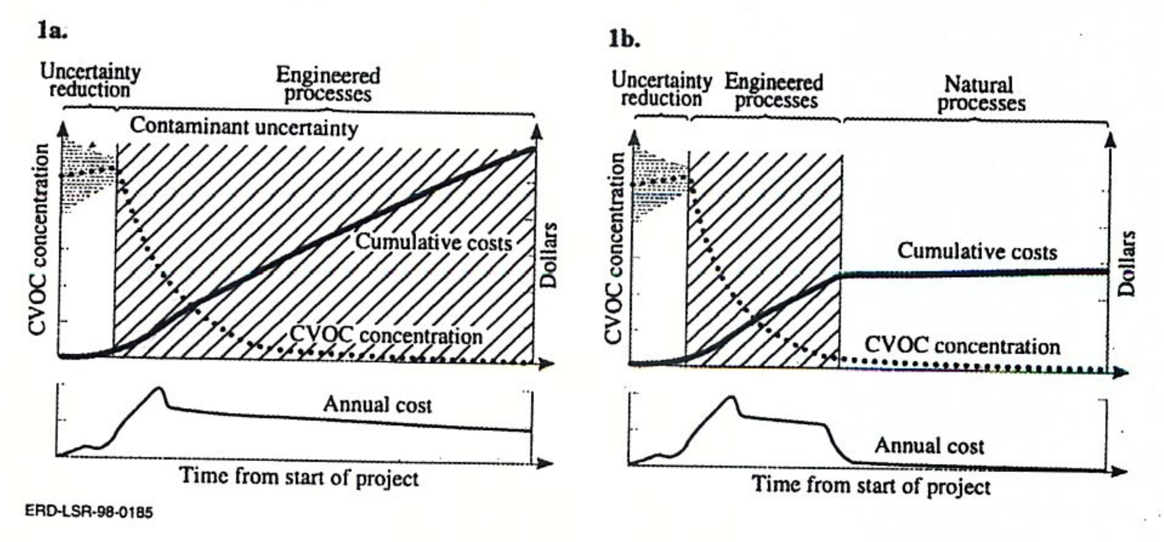


Figure 1. **Hypothetical cost versus cleanup strategy**

1a) Base case: total pumping time is 50 years; pumping stopped at 5 µg/l.
1b). Alternative case: total pumping time 17 years; pumping stopped at 200 µg/l; natural processes used to complete cleanup (from Rice and McNab (1998)).

Natural processes
The processes that affect the fate and transport of contaminants in groundwater have been widely studied over the past decade, resulting in a greater understanding of the chemical/biological processes that take place in the subsurface. This understanding has shown that natural processes represent far greater reduction of contaminant mass in the subsurface than had been previously thought.

The paradigm for addressing organic compounds in groundwater began to shift in the mid to late 1990s. Prior to this, it was believed that when a compound was released to groundwater, the plume continued to grow and move downgradient, with the main source also having the ability to migrate as well. As such, typical strategies for groundwater cleanup involved placing wells at the toe of the groundwater plume and pumping to prevent further migration. However, a number of studies where conducted that found that groundwater plumes appeared to attain limiting conditions. The six main processes that limit movement of pollutants in groundwater: are dilution, retardation, precipitation, biochemical reactions and abiotic reactions (Nyer and Gearhart (1997). Nyer and Gearhart (1997) make the case that treating plumes by providing a hydraulic barrier against migration provides a very poor strategy from the perspective of removal of organic mass, for at the toe of the plume, the mass is diffuse and typically being naturally degraded.

Rice and McNab, (1998) provided studies of natural biodegradation of organic compounds in groundwater, analyzing plumes of gasoline and chlorinated volatile organic compounds (CVOC). A large number of petroleum hydrocarbon plumes in California and Texas were analyzed, using benzene as the characteristic compound. The changes in benzene concentration with time are summarized in Table 1. Rice and McNab (1998) also analyzed 247 CVOC plumes and found correlations with maximum historical concentrations and mean groundwater velocity, suggesting the plume length being governed by quantity of mass released and the flux to groundwater.

Table 1. Summary of California and Texas Plumes Evaluating Benzene Plume Dimensions

	Percent of Total Number of Sites	
	California	**Texas**
Decreasing Benzene Concentrations	59%	58%
Increasing Benzene Concentrations	8%	14%
Stable Benzene Concentrations	33%	27%

Total Number of Sites Evaluated	271	217

Presented below is a depiction of a plume illustrating the reduction in plume dimensions realized over three years as a result of natural attenuation processes.

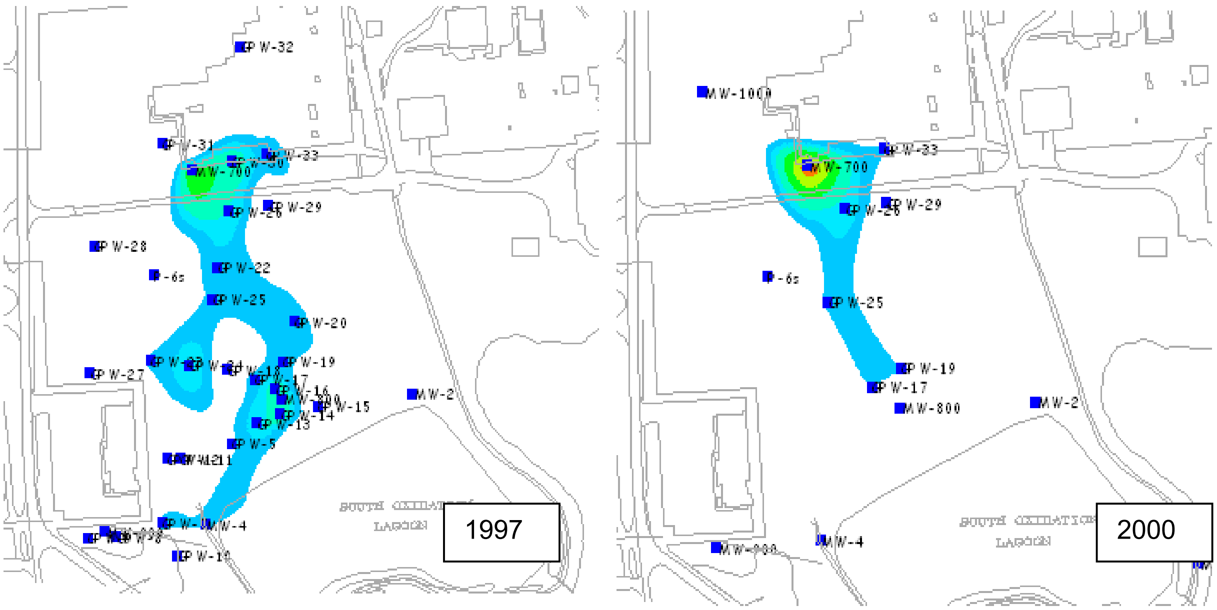


Figure 2. Plume depiction for trichloroethene in groundwater as defined by the 200 µg/l contour at an industrial site. Hydraulic containment was provided at the toe of the plume in the southwest corner to prevent offsite migration.

In this instance, it was determined that the hydraulic containment system located at the toe of the plume could be shut down and reduction of liability could be better achieved through addressing the source. Innovative Technologies.

The study by Rice and McNab (1998) recommended addressing source areas, while utilizing natural attenuation processes for the dissolved portions of the plume. Source area treatment technologies involve containment or contaminant mass removal/reduction. A number of techniques have proven effective for source treatment of volatile organic compounds, namely abiotic thermal treatment methods. Abiotic methods for CVOC include the use of zero valent iron (ZVI) reactive barriers. ZVI is a mild reductant when introduced into water, which promotes the reductive dehalogenation of CVOC, and can be used to promote the precipitation of some inorganic compounds.

There are several thermal methods that have proven effective for source area treatment. These include thermal conduction (Terratherm®), electrical resistive heating (3 and 6 phase heating) and in situ steam stripping. These three processes have proven successful in source area reduction for source area reduction for CVOC, with six phase heating and in situ steam stripping resulting in no further action determinations (Smith, et. al., 2000).

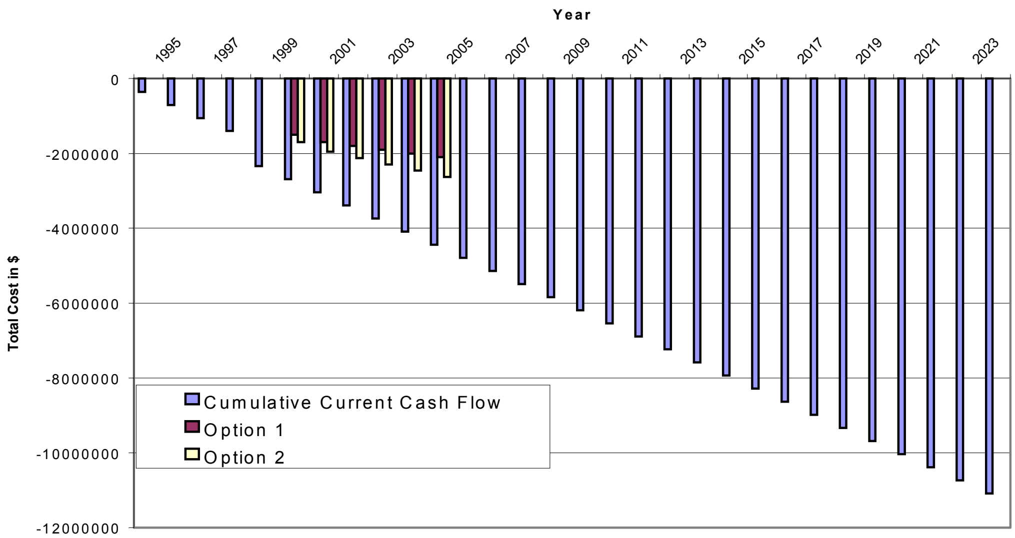
Case Study

At this location, the groundwater had become contaminated with trichloroethene (TCE) from plant operations. A pump and treat system was installed in 1984 to provide for containment. More recently the wells have experienced bio-fouling, increasing maintenance costs estimated to be in the order of $450,000 per year.

A natural attenuation evaluation was performed that showed that concentrations were decreasing, but concentrations at the fence line would achieve drinking water maximum contaminant levels in 18 years.

Presented below is a graph illustrating the annual costs for the existing system and the re-engineered approach of using a ZVI reactive barrier. On a present value life cycle cost basis at a discount rate of 8%, for 18 years, $4.8 million would need to be reserved to cover the annual costs. The present value of the re-engineered solutions was estimated at between $1.5M and $1.93M (Option 1 and 2), which frees up the remainder of the reserve for other business purposes.

Figure 3: Comparison of Cash Flows, Existing versus Re-Engineered Approach



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