

## **Ten-Year Case Study of Successful Adaptive Management of a Groundwater to Surface Water Discharge Site Regulated under CERCLA**

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**Background/Objectives.** Use of adaptive management at CERCLA sites can be challenging given the specific process required by the regulation and the policy drivers that govern achievement of record of decision and remedial action completion. In particular, the process needs of CERCLA can be difficult to reconcile with the flexibility required for adaptive management over time. This case study involves a site where metals and chlorinated solvents in groundwater were discharging to a shallow pond from buried waste deemed too hazardous to remove due to munitions concerns. Over the past 10 years, the project successfully moved from feasibility study (FS), through record of decision (ROD), to remedial construction, and finally monitoring and maintenance. During this time, key CERCLA milestones were achieved, including record of decision, interim remedial action completion, and remedial action completion. A key component of the remedy for this site was successful use of adaptive management through incorporation of active and passive remedy components and a well-defined set of remedial objectives allowing transition from one to the other while remaining protective.

**Approach/Activities.** At the draft FS, a range of alternatives had been identified for the site that each bore advantages and disadvantages. Removal of buried waste would be costly and involve high safety hazards. Capping waste in place with a RCRA Type C cap would meet regulatory requirements but fail to fully address groundwater seeps and hazards from buried waste. The FS was revised to include a new alternative that combined a soil cover with an in situ bioremediation barrier, constructed wetland buffer, and bio-beneficial sediment cover. This system created an in situ treatment train in which buried munitions were allowed to degrade, decreasing their hazard; injections into groundwater bioremediated chlorinated solvents and sequestered metals; and the wetland buffer and sediment cover both reduced exposure to sediments and seeps and provided polishing for groundwater. The point of performance monitoring for the effectiveness of the system was established as the groundwater immediately downgradient of the waste but upgradient of the entry-point into water. Remedial goals for groundwater were set as aquatic life criteria for surface water, with the important provision that goals could be modified based on the results of monitoring to include the influence of the wetland buffer and sediment cover on remedy effectiveness. This approach allowed the use of site-specific data to adapt remedial goals over time and move toward more sustainable remedial components. After 8 years of monitoring, goals have effectively been modified and the site is transitioning to more sustainable management.

**Results/Lessons Learned.** Use of adaptive management within the CERCLA process required careful crafting of goals through a collaborative process between the site owner, technical staff, regulators, and stakeholders. It specifically required establishment of dual remedial functions supported by goals that could be adapted using site-specific monitoring data over time. This was reflected in full use of the CERCLA process' provisions for interim remedial action completion and final remedial action completion, and ultimately resulted in a more sustainable, cost efficient remedy.