

ground water and removal of exposure via inhalation of wind-blown dust). Criteria to evaluate the effectiveness of the selected remedy were developed subsequent to the ROD.

#### *Response Actions*

The selected remedy was implemented through use of a phased approach. The remedy included biodegradation of hydrocarbons through landfarming to treat the soil and sediments. A pilot study was conducted during the summer of 1991 to determine the parameters required to produce maximum degradation of contaminants. Because the primary contaminant of concern was petroleum hydrocarbons, biodegradation through landfarming was known to be effective. The focus of the pilot study was to determine the optimum mixture of water, air, nutrients, and microorganisms. The results of the pilot study indicated that there was no significant increase in biodegradation through the addition of commercially developed microorganisms and that the microorganisms present at the site were sufficient to produce effective removal of contaminants.

The biodegradation of soils and sediments began in June 1992 and continued until October 1999. The volume of lake bottom sediments treated was 57,245 cubic yards and the volume of soils treated was 125,235 cubic yards. All of the sediments were treated and placed in the On-site Storage Facility (OSF). Of the soil treated, 86,515 cubic yards met the cleanup criteria and remained in place while 38,720 cubic yards met the stabilization criteria (which is above the cleanup criteria) and was placed in the OSF for final storage. The design included the use of a dike and moat system to prevent surface water run-on into the lake basin area to allow for evaporation of the lake water and prevent surface water run-on to the treatment areas. The remedy design also incorporated the use of a spray evaporation system. The purpose of the system was to collect lake water and run-off from the treatment irrigation system and to route that water through fine mist spray nozzles to enhance evaporation.

The ROD stated that the lake water would be sprayed over the 26-acre beach area for evaporation. During the final remedial design, it was determined that evaporation would be more effective through a evaporation system that allow for continued management of storm water and irrigation water run-off throughout the bioremediation phase. Three treatment areas, divided into eleven treatment sections, were

designated in order to optimize and track treatment of contaminated materials. Each beach treatment area was approximately 2.25 acres in size. To provide adequate moisture for treatment within each of the treatment sections, three separate irrigation systems were designed and installed. In addition, the irrigation system for bioremediation, also provided adequate moisture for purposes of dust control.

*On-site Storage Facility*—The OSF was designed to hold all treated sediments and any treated soils that stabilized prior to meeting the cleanup criteria. The Land Treatment Area described in the ROD was refined and referred to as the OSF. The primary differences between the OSF and the Land Treatment Area described in the ROD are:

- The impermeable layer of the cap was changed to high-density polyethylene (HDPE) rather than polyvinyl chloride (PVC) due to its better durability and applicability to the site conditions.
- The depth of the excavated floor of the OSF and the height of the containment dikes were expanded beyond those of the Land Treatment Area but did not significantly change the purpose or effectiveness of the OSF. The modification incorporated a refined estimate of the volume of sediments present in the lake bottom.

Additionally, the development of a cleanup standard for the site allowed in-situ treatment of some soils. Treated soils that met the cleanup standard remained in place within the former lake basin and beach areas.

The volume of the OSF was calculated to hold all of the treated sediments and any treated soils that did not meet the cleanup criteria. An area approximately 5 acres in size was excavated to 5 feet below grade at a slope of approximately 2 percent. Following treatment and placement of all materials to be held in the OSF, the design required the OSF to be capped. The cap was designed to consist of an HDPE liner to provide an impermeable layer, with an overlying geotextile to provide for drainage of infiltrated liquids away from the liner, followed by a 12-inch soil protective layer, covered by 6 inches of topsoil. The design required vegetation of the topsoil layer with native grasses. Construction of the OSF, with the exception of the cap, was completed in May 1993.

Sediments were treated within the OSF beginning in September 1993, following placement of a layer of treated soils to provide a "bioseed" of microbial organisms to enhance treatment. Treated sediments remained in place within the

OSF, with subsequent layers of sediments applied for additional treatment. Throughout the treatment phase, treated soils that met the stabilization criteria were placed in the OSF. Treatment of all sediments and soils was completed in October 1999. As stated previously, a total of 57,245 cubic yards of treated sediment and 38,720 cubic yards of treated soil that met the stabilization criteria is stored in the OSF.

Closure of the OSF, as well as the rest of the site, began in June 2000. Any soils that met the stabilization criteria that had not already been placed in the OSF were moved to the OSF at this time. As per the design for site restoration, construction debris removed from the treatment areas was buried within the OSF. A layer of clean soil was placed on top of the treated material and buried debris to provide a stable base for the cap. The OSF was capped as described above and construction of the cap was completed in October 2000.

#### *Cleanup Standards*

- Definition of the cleanup level of 1,000 mg/kg total recoverable petroleum hydrocarbons (TRPH);
- Definition of a stabilization criteria (less than 10 percent degradation in any two of three consecutive confirmation sampling events);
- Contaminated soils were defined as materials that are firm and coarse-grained, containing TRPH above 1,000 mg/kg;
- Sediments were defined as materials that are soft and fine-grained, located within the 4212 elevation contour present at the start of treatment;
- Layout of treatment areas within the original beach area and, later, within the original lake basin;
- Definition of the active biodegradation season as March 1 through October 31 of each treatment year;
- Method of biodegradation (aeration of soil through weekly use of disc or till-oll, maintaining moisture content between 15 and 25 percent, maintaining pH near neutral, and maintaining proper nutrient levels);
- Construction of the OSF to store all treated sediments and soils that were treated, but contained TRPH above 1,000 mg/kg (the OSF was a refinement of the Land Treatment Area discussed in the ROD);
- Addition of the option to treat sediments on top of previously treated soils, or in the OSF, rather than only in the "treatment area" referenced in the ROD, with a requirement that confirmation sampling of the underlying previously treated soils be conducted