Reclamation Project Allows New Phase for Moon Creek

by Susan M. Alvarez, Jeff K. Johnson and Rob Spafford

NEARLY five to six years ago, when one walked through the lower tailings areas of the Moon Creek site, it may have indeed seemed like a lunar landscape: there were very few trees or plants growing along the narrow valley floor, only the tan and dusty tailings remaining from the abandoned upstream mine and mill. Lead, zinc, cadmium, arsenic and other heavy metals within these tailings were preventing plant growth, and contaminating Moon Creek as it flowed through the site. Susan Alvarez made this first visit in the spring of 1996. Her firm, Ridolfi, had just been hired by Region 1 of the U.S. Forest Service (USFS) to conduct an Engineering Evaluation/Cost Analyses (EE/CA), and to develop construction plans for a non-time-critical removal action to reclaim the site, as a project to be implemented under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA).

The Moon Creek Reclamation Project is located on the East Fork of Moon Creek within the Idaho Panhandle National Forest, about five miles northeast of Kellogg, Idaho, in Shoshone County. The project site encompasses approximately 20 acres, and a 3,300 feet long segment of Moon Creek, a third-order perennial stream. The Moon Creek site is in a popular recreation area located approximately three miles upstream of the creeks’ confluence with the South Fork of the Coeur d’Alene River. A small community with about 50 homes is located in the downstream portion of the Moon Creek watershed, near the river confluence. Westslope cutthroat trout (Oncorhynchus clarki lewisi) are another resident of Moon Creek. At the time of the development of the Moon Creek response action, Westslope cutthroat trout were listed as a sensitive species by the USFS Region 1. A walk-through survey of Moon Creek conducted by USFS biologists found that habitat in the upper sections of the stream was limited due to low water, lack of pools, and heavy metal concentrations.

Under the provisions of CERCLA, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and Executive Order 12580, the USFS is the lead federal agency for addressing sites with uncontrolled hazardous substances located on National Forest land. Based upon earlier and limited characterization of the site performed by the U.S. Bureau of Mines (USBM), and data from previous USFS studies, removal action to address sources of hazardous substance releases within the site. The non-time-critical removal action for the Moon Creek Reclamation Project was conducted in accordance with "Guidance on Conducting Non-Time-Critical Removal Actions Under CERCLA" (USEPA, 1993).

"The overall goal of the removal action for the Moon Creek site was to reduce the release and threat of release of hazardous substances from this site, thereby reducing risks to human health and the environment" explained Jeff Johnson, the current USFS On-Scene Coordinator for the project. “Our objectives for this project were to reduce the release of heavy metals to Moon...
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Creek, rehabilitate the site to limit human health and ecological exposures, and to improve cutthroat trout habitat".

The Moon Creek project site is an abandoned hard rock mine and custom mill complex that was originally operated as part of the Coeur d'Alene Mining District, also known as the "Silver Valley of Idaho".

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The complex includes the Charles Dickens Mine, which was operated from 1902 until 1930, and the Silver Crescent Mine and Mill that operated from 1922 to 1954. The mine facility included at least four adits, two shafts, and several miles of underground workings. These mines together produced about 4,600 tons of ore. The Silver Crescent mill was operated as a custom mill that processed lead and zinc ores from the Moon Creek mines, and from many other areas of the Silver Valley.

The primary site features include the main waste rock dump and jig tailings (20,300 CY), two smaller waste dumps (7,700 CY), terraced flotation tailings impoundment located within the active floodplain of the creek (42,000 CY), several open and caved adits and shafts, contaminated soils (17,400 CY) and several structures including a mill building and blacksmith shop.

The initial site characterization was conducted by a multi-discipline, multi-agency team that included engineers, scientists, and forest managers from the USES, the Bureau of Mines, the Bureau of Land Management and Ridelof. "I think it was really important to be able to walk the site and discuss the project with the scientists, early in the design process, as we did", Susan explained. "The different disciplines each had a unique outlook on what they thought needed to happen. Collectively, I think getting this input at the very beginning resulted in a better project, as we were able to think more holistically about what needed to happen with the engineering, in order to kick-start the ecology of the stream through this site."

Reclamation doesn't happen overnight

Through the EE/CA and subsequent reclamation design process, the scope of work for the project evolved to a flexible design that could effectively address the overall goals and objectives. The implementation of this removal action occurred over a period of nearly seven years, with four years in characterization, planning and preparation of administrative and construction documents, and three construction seasons. The original Bureau of Mines' Characterization Study was completed in 1995. The EE/CA was completed in 1996. The construction documents, Design Analysis Report, Construction Quality Assurance Plan and Engineer's Cost Estimate were completed in 1997.

On September 30, 1998, Environmental Reclamation Inc, (ERI), of Kellogg, Idaho, was selected by the USFS as the Project Contractor. The USES based their selection on a two-part "Best Value" selection process that assessed prior experience, references, credentials, and technical approach, prior to review of the sealed cost proposals. "As it turned out, the firm that had been ranked first in the technical and qualifications evaluation, also submitted the most competitive cost proposal" Rob Spafford, the USES Coordinator at the time explained. "The selection of ERI through this process yielded a contractor with a good understanding of project complexity. ERI became a conscientious, proactive member of the construction and reclamation team. We also included the design engineer into this process and this was also beneficial. Susan helped to assess the Contractor's approach with respect to the original design intent. Overall, this process helped form the working relationships necessary for the next phase of the project."

A Changing Moon - the Reclamation Construction

The reclamation of Moon Creek had six primary construction elements:

- Removal of an estimated 88,000 cubic yards jig and flotation tailings, contaminated soils, and waste rock;
- Construction of an onsite combined waste containment to safely contain these materials;
- Closure of the mine workings (shafts and adits);
- Stream rehabilitation of about 3,300 feet of stream and adjacent riparian zone;
- Construction of a wetlands buffer; and
- Installation of measures to stabilize the site following reclamation.
The containment features a special foundation that allows its construction on top of the soft, saturated in-situ tailings. Foundation elements included an impervious below-grade scour protection berm, gravel and limestone wick drains within the tailings to allow de-watering, and a Geoweb® mattress filled with waste rock to provide a surcharge over the tailings, as well as, to provide lateral load reinforcement. Waste rock material was mixed with the fine-grained tailings as they were placed in the containment, to improve work-ability and help accelerate de-watering. The containment was covered with an engineered cap that included a geosynthetic clay liner, overlain by a gravel drainage layer, and two feet of soil. An erosion protection mat was also installed to help stabilize the containment, and to provide root matrix reinforcement for the native grasses forbs used in the seed mixture.

The final repository size was 800 feet in length, by 220 feet in width, and 40 feet in height, to hold a total volume of 130,000 cubic yards. The additional volume resulted from including waste material from two other sites with similar material, and additional materials that were encountered onsite during the excavation. The Contractor's careful attention to de-watering, mixing and placing material in the containment allowed the project to take full advantage of the flexible elements of the design.

Other actions included re-building a natural bank-full width channel and flood plain, and an off-channel wetlands to accommodate groundwater from the hillside south of the containment. The site was planted with a native seed/forb mixture that was developed in collaboration with the Forest Service botanist. The requirements of CERCLA allow planting for site stabilization; so over 800 plants were strategically planted on the 20 acre site using "block planting" methods, where several trees and shrubs were grouped together. This provides shade between the plants and mimics the plant associations identified during the initial site characterization efforts. (The USES has since installed additional plants onsite during the field seasons following construction).

Implementation of the initial site work for the response action began in October 1998. Construction extended over three field seasons, and required provisions for over-wintering. The construction and reclamation work were substantially complete in November 2000.

The final cost for this project was $1.9 million, which was within the range of costs estimated in the EE/CA. While there was nearly a 50 percent increase in the quantity of waste materials handled, offsetting savings were developed in many areas, such as mixing growth media, and reducing backfill in the new floodplain. This helped keep the total project cost within nine (9) percent of the original bid amount.

Lessons learned under the change-of-the-moon

As in life, there are lessons learned under each phase of the moon. For the Moon Creek, we've identified several such lessons:

Effective water control key to construction. Tailings can form an effective aquitard. In this case, removing the layers of tailings freed the ground water to flow along historic springs and along the valley. This reflected a change to the ground water paths originally identified in the characterization effort. It also required innovative construction sequencing and additional water handling measures such as interim french drains.

A measure in time is worth nine. At the appropriate time, a good initial
Topographic survey could provide cost savings by preventing some field changes. Two flood events occurred onsite between time of the initial (limited) site survey, and the notice-to-proceed for construction. This resulted in changes to the base grades for the containment and to the overall shape of the containment.

One never has enough data. With historical sites, there is often a relatively high degree of uncertainty associated with the nature and extent of the on-site contaminants. The Moon Creek site had had an extensive characterization effort within a limited area; however, during construction, tailings were located in areas with vegetation (that had not been sampled), and to a greater extent than was determined through the previous sampling efforts. Changes to the grading that evolved from these removals had a significant effect on stream grades in the upper portion of the project.

Flexibility is good. Given the uncertainties in topography and in the definition of the extent of the removals, it was beneficial to have a design with sufficient flexibility to allow adjustment as necessary to reflect unanticipated field conditions. The flexible elements for the Moon Creek project were the cap and a conservative foundation design that provided the ability to add additional height to the Combined Waste Containment.

Flotation tailings move in strange and mysterious ways. There were several observations related to the workability of the saturated tailings:
- When the tailings were moved, they gave up water; the Contractor handled the tailings about three times on the way to final placement in the containment to accelerate the dewatering process.
- As the tailings became dryer, the angle of repose approached nearly vertical.
- A three-day "set-up time" for the tailings in the Combined Waste Containment was sufficient to form a layer that was stable enough to add the next layer.

The Best Value Method yielded a good result. The "Best Value" method of Contractor selection did, in fact, provide the Forest Service with a good partner for the construction of the Moon Creek Reclamation Project.

A good team and good teamwork are the keys to successful project implementation. A good collaborative working relationship was established between the USFS, Ridolfi and FRI personnel involved in this project. Each member of the team has independently confirmed that this was an essential element to the successful completion of a complex project like Moon Creek. Open communication,
data sharing, consultation and mutual respect helped the team work towards creating effective ways to address the necessary field changes.

**Measuring Success**

Forest Service personnel have been monitoring ground water, surface water, vegetation, fisheries, and stream morphology of the site from 1999 to 2003, and plan another sampling event in the summer of 2004. However, the data shows a remarkable response to the reclamation the Moon Creek site. In the surface water, both dissolved and particulate metals have been reduced to below aquatic water quality criteria, from above the millsite, all the way to the confluence with the South Fork Coeur d’Alene River. Ground water monitoring also shows metals at a "non-detect level" following the cleanup. Vegetation and stream monitoring both show stabilization of the site, and that natural succession processes are occurring. "Probably one of the most gratifying things that has happened since the construction occurred when we were collecting a surface water sample just below the site - a very large and territorial trout swam out at us from one of the stream banks." Johnson laughed. "It really scared us at the time, but it's good to see them back in that part of the creek again."

**A New Moon on the Horizon?**

With the reclamation complete, one might be tempted to smile and move on to the next challenge. However, that is not the case for Moon Creek.

"We feel that we have accomplished all of our objectives for the reclamation of Moon Creek," Johnson explained, "However, we are now looking at performing true restoration of the site. We're looking at re-building the riparian zone, enhancing aquatic habitat for cutthroat trout, and creating better upland habitat for winter elk". Restoration experts at the Forest Service are planning the restoration in 2004, along with making arrangements with their nursery to grow native plants for the project. Construction of the next phase for Moon Creek is planned to be completed during the 2005 field season. **L&W**

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