A PROACTIVE REMOVAL PROGRAM AT THE BONANZA MINING DISTRICT BONANZA, COLORADO

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INTRODUCTION

By working together, government and private industry have found a creative and expedited solution to the environmental effects of historic mining and milling in the Bonanza Mining District. The Bonanza District is located in the northeastern San Juan Mountains of Southern Colorado near the head of the San Luis Valley (Figure 1). The approximately 2000-acre mining district is drained by the Kerber Creek watershed, which drains into San Luis Creek. This paper describes the role of ASARCO Incorporated (Asarco) in a proactive removal program at the Bonanza Mining District.

Historical Perspective

Ore deposits were first discovered and mined in the Bonanza District in the late 1800's. Prior to 1902, production from the Rawley Mine, which was one of the largest mines in the District, was small because the ore was of comparatively low grade for shipping and treatment at that time. In 1902, a 100 ton/day mill was constructed on the south side of Rawley Gulch near the Rawley Mine, and mine production occurred between 1902 and 1905. However, operation of the mill was unsuccessful because water flows in Rawley Gulch were inadequate to run the mill at capacity for more than a short time each year. Between 1905 and 1910, work focused on development of the mine. In 1910, the mine had been developed to a depth of 600 feet, or to the "6th" level (approximately 200 feet below the base of the adjacent Rawley Gulch).

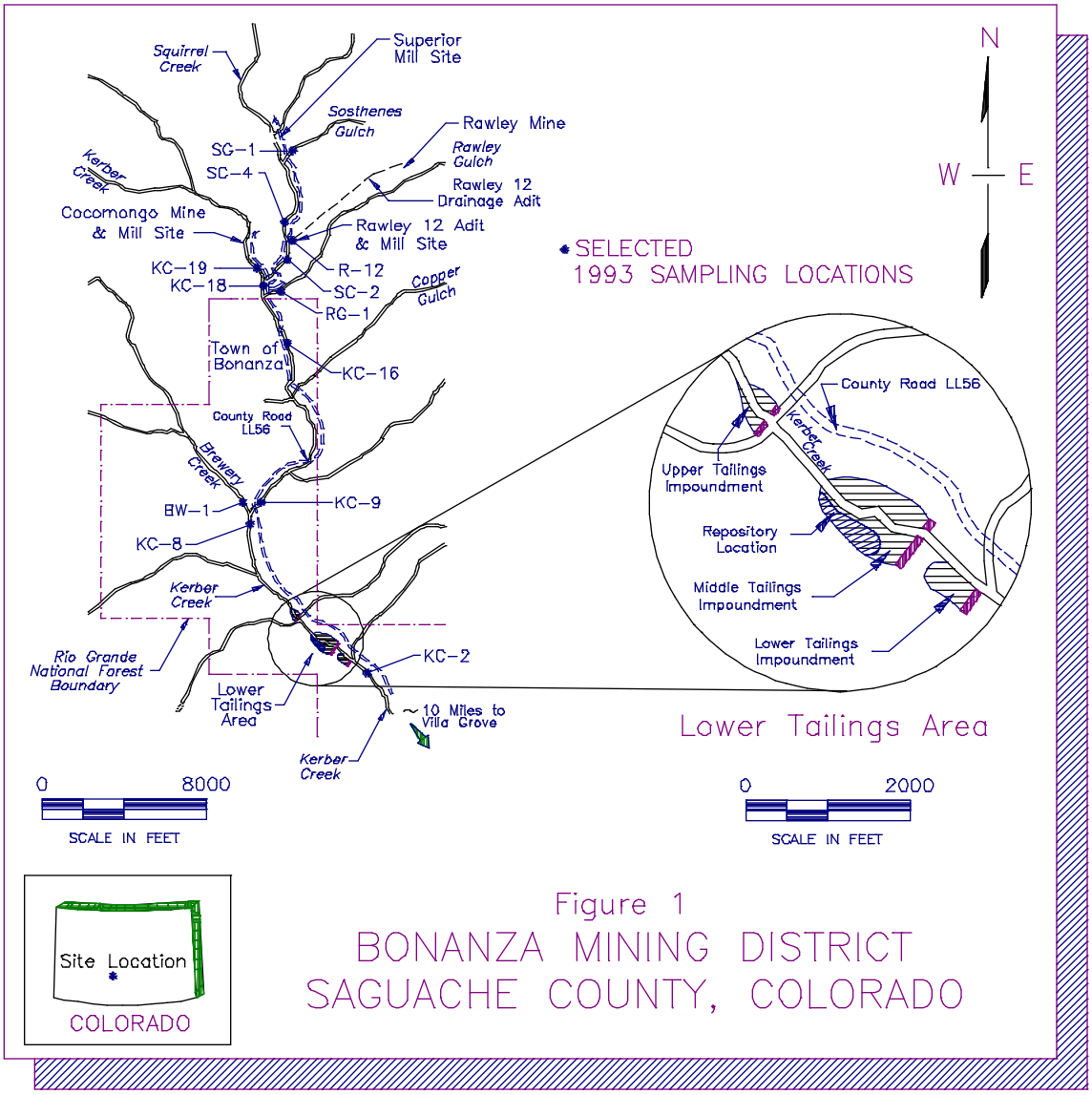
During 1911 and 1912, a 6200-foot-long drainage and haulage tunnel, referred to as the Rawley 12 adit, was constructed between Squirrel Creek and the Rawley Vein, 600 feet below the 6th level (at the 1200-foot or "12th" level). After encountering the Rawley Vein, the mine workings above the 6th level were completely drained in less than 40 days, facilitating further mine development.

In 1916, preparation of the mine and planning for a 300 ton/day mill near the Rawley 12 portal in Squirrel Gulch began. The mill in Squirrel Gulch ("Rawley Mill") was not completed until 1923. An aerial tramway extending from the new mill site about 7.25 miles north to Shirley, Colorado was constructed to deliver concentrates to the Denver & Rio Grande Railroad. Along with construction of the Rawley Mill, a 40-foot-high timber crib dam was constructed across Squirrel Creek below the mill.

The development and mining activities in the early 1920's were conducted by the Colorado Corporation. Asarco and other creditors became involved in the Bonanza District in 1925, when the Colorado Corporation went bankrupt. Creditors of that corporation, formed a new company to operate the Rawley Mine and Mill in an attempt to recover their debts. In 1930, the Bonanza District properties were acquired in a tax sale.

After bankruptcy of the previous operators and subsequent re-organization in 1925, the Rawley Mill was remodeled and increased in capacity to 350 tons/day. The largest production from the Rawley Mine occurred between 1925 and 1930. During this period, three tailing dams were constructed across Kerber Creek downstream of the Town of Bonanza (Lower Tailings Area).

Approximately 90 percent of the production from the Rawley Mine reportedly occurred prior to 1931. The remaining production occurred intermittently through the early 1970's.



Regulatory Perspective

Prior to 1993, the U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) began evaluating the Bonanza Mining District for possible listing on the National Priorities List (NPL) as a Superfund site. In 1992, the USDA Forest Service (USFS) prepared a Preliminary Site Assessment, and later that year sent out Section 104(e) information requests under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to companies and individuals who had historic involvement in the District. The identified environmental issues were impacts to surface water and potential impacts to groundwater, air, and soil from historic mining and milling activities.

Upon receipt of its 104(e) notice, Asarco initiated discussions with the regulatory agencies and other private parties historically involved in the Bonanza District and assisted in organizing the private parties into what is known as the Bonanza Mining District Group (Bonanza Group). The Bonanza Group then held discussions with the CDPHE, USFS and EPA regarding deferral of the NPL process in favor of a proactive approach to addressing the environmental concerns in the Bonanza District in a manner consistent with the National Contingency Plan (NCP).

As a result, the following agreements were reached. One, EPA agreed to defer the hazard ranking process and possible listing of the site on the NPL and to defer project oversight to the CDPHE provided efforts to address the environmental issues in the Bonanza District proceeded. Two, in cooperation with the CDPHE Water Quality Control Division, long-term water quality goals were established for the Kerber Creek watershed, which included meeting drinking water and agricultural standards in the most heavily impacted portion of the Kerber Creek watershed (above the Brewery Creek confluence), and achieving site-specific aquatic life standards in Kerber Creek below that portion. Three, the Bonanza Group agreed to address the metals loading sources linked to their involvement in the District.

The work on private lands would be performed in accordance with applicable State and Federal permits and an

agreement with the CDPHE. For work on public lands managed by the USFS, two options were available. The first option was to perform the work under the National Environmental Policy Act (NEPA), which would include preparation of environmental impact statements (EISs). The second option was to perform the work as CERCLA Time-Critical or Non-Time-Critical Removal Actions. The latter option was implemented by the Bonanza Group and the USFS due to the ability to expedite the removal activities.

WATER CHEMISTRY AND METALS LOADING SOURCES

The drainages most-heavily impacted by historic mining and milling activities include Kerber Creek below the Cocomongo Mine and Mill site, Squirrel Creek, Sosthenes Gulch, Rawley Gulch, and Copper Gulch (Figure 1). The sources of metals loading being addressed by the Bonanza Group include the Superior Mill site, Cocomongo Mine and Mill site, the Rawley Mine (discharge from the 400-level adit into Rawley Gulch), the Rawley 12 Adit and Mill site, the Lower Tailings Area, and portions of creeks impacted by fluvial tailings from those areas. Numerous other mine and mill sites exist along Kerber Creek and its tributaries and also impact water quality. Asarco is cooperating with the CDPHE, USFS and Saguache County in their efforts to address these orphaned sites.

The primary constituents of concern in surface waters at the Bonanza Mining District include zinc, copper, cadmium, iron, lead, manganese and arsenic. Table 1 provides a summary of pH, specific conductance, zinc concentration and zinc loading data for selected sample sites during 1993 high-flow and low-flow conditions (pre-removal). The sampling station locations are shown on Figure 1.

The discharge rate and chemistry of water from the Rawley 12 adit are relatively constant year-round. Based on observations from the 1960's and a recently installed piezometer near the mine workings, the water level within the mine is between the 400- and 500-foot mine levels. The mine apparently is saturated to this level as a result of collapses within the main shaft and/or the Rawley 12 adit near the main mine workings. The Rawley 12 adit was last rehabilitated to the Paragon Fault zone, about 4000 feet in from the portal, in the late-1960's. The mine was not drained as a result of these rehabilitation activities. In the early 1970's, the pH of the adit discharge was reported to be approximately 3.5. Several years thereafter, the portal apparently collapsed, limiting oxygen inflow to the mine and causing the pH of the discharge to rise to approximately 5.5 to 6.

A portion of the Rawley 400-foot level adit lies beneath the base of Rawley Gulch adjacent to the mine. Discharge from this adit appears to originate from some combination of infiltration of Rawley Gulch streamflow into the mine, local infiltration of precipitation into upper mine workings, and potential inflow from other shallow mines near the Rawley Mine. Adit discharge also occurs from several other mines along Rawley Gulch that are not associated with the Rawley Mine.

Downstream of Squirrel Creek and Rawley Gulch, fluvial tailing deposits and mine waste rock from mine and mill sites along Kerber Creek also affect water quality.

WATER QUALITY GOALS

Brewery Creek provides a major source of dilution to Kerber Creek, which allows for more-stringent long-term stream classification goals for Kerber Creek downstream of the Brewery Creek confluence. The long-term goals for the mining-impacted portions of the Kerber Creek watershed above the Brewery Creek confluence are to achieve drinking water and agricultural use standards. Below the Brewery Creek confluence, the long-term goal for Kerber Creek is to establish water quality suitable for brook trout. In order to facilitate the removal activities, the Colorado Water Quality Control Commission issued a temporary modification allowing ambient water quality until the removal activities progressed. The removal actions performed by the Bonanza Group are being conducted in a manner that is consistent with anti-degradation standards and achievement of the long-term water quality goals.

REMEDY DEVELOPMENT

Administrative Process

The remedy being implemented at the Bonanza District was selected through a series of cooperative arrangements between CDPHE, USFS, the Bonanza Group, Saguache County, and the Town of Bonanza. At the onset of the project, Asarco and the Bonanza Group retained the environmental science and engineering consulting firm of McCulley, Frick & Gilman, Inc. (MFG), which has provided technical and administrative management of the Bonanza Group activities, performed agency liaison and negotiations, performed sampling activities, developed work plans and reports, secured permits, developed conceptual and final design and contract documents, and performed construction management and other activities associated with development and implementation of the remedy. Asarco's construction contractor has been SLV Earth Movers Inc. of Monte Vista, Colorado.

Although the removal actions are being conducted in accordance with CERCLA and the NCP, the traditional method for selecting a remedy through the rigorous CERCLA Remedial Investigation/Feasibility Study (RI/FS) has not been applied. Asarco agreed to prepare a focused remedy-screening and Engineering Evaluation/Cost Analysis (EE/CA) document, which was submitted to the CDPHE and USFS for approval and subjected to the NCP process, including public review and comment. One of the major criteria for remedy selection was achievement of long-term water quality goals, established by the Water Quality Control Commission on the basis of use attainability assessments and habitat evaluations performed by MFG and the Water Quality

Control Division.

To implement the remedy, roles of involved parties were identified in a document called the Statement of Roles and Responsibilities (SRR), which was signed by the CDPHE and the Bonanza Group. This document identified the oversight

Table 1. Summary of Selected 1993 Chemistry Data

Sample Location	High-Flow Event (June)					Low-Flow Event (September)				
	Discharge (cfs)	pH (units)	Specific Conductance (µS/cm)	Dissolved Zinc (mg/L)	Dissolved Zinc Loadings (lbs/day)	Discharge (cfs)	pH (units)	Specific Conductance (µS/cm)	Dissolved Zinc (mg/L)	Dissolved Zinc Loadings (lbs/day)
SG-1	0.281	4.60	863	42.9	65.0	0.0025	3.98	728	9.41	0.127
SC-4	6.59	7.00	178	1.60	56.9	0.15	7.47	382	0.289	0.234
R-12	0.47	5.82	1210	57.2	145	0.63	5.80	1252	45.1	153
SC-2	7.93	6.60	239	4.64	198	0.40	5.21	1048	35.1	75.7
KC-19	18.3	7.54	60	0.043	4.24	0.37	5.88	575	0.032	0.064
KC-18	27.6	7.01	109	1.34	199	0.40	6.09	527	17.3	37.3
RG-1	3.20	4.62	292	8.18	141	0.18	3.55	430	14.2	13.8
KC-16	31.1	6.90	111	1.88	315	1.06	5.40	491	16.7	95.5
KC-9	38.7	7.08	113	1.61	336	1.94	6.14	367	9.39	98.3
BW-1	39.2	7.29	55	<0.007	0.74	1.57	6.74	124	0.028	0.237
KC-8	75.2	7.30	84	0.700	284	4.02	6.39	249	4.68	101
KC-2	79.9	7.98	101	0.755	325	3.70	6.31	266	4.60	92

role of the CDPHE as well as the Bonanza Group's commitments including deliverables, monitoring requirements, and a general schedule for remedy implementation.

A second agreement, a Memorandum of Understanding (MOU), was entered into between the USFS and the CDPHE, which defined agency management and oversight roles for activities conducted on public versus private lands. The USFS assumed management of activities conducted on public lands pursuant to its CERCLA authority. The CDPHE assumed the lead for work conducted on private lands and assumed general site oversight responsibilities. Work on private lands has been conducted pursuant to applicable State and Federal permits.

As part of Saguache County permitting requirements and NCP public input requirements for a CERCLA Non-Time Critical Removal Action, Asarco participated in a public meeting near Bonanza prior to any construction activities. In addition, Asarco met with representatives of the Town of Bonanza, which had approximately ten year-round residents, and reached an agreement with the town regarding noise control, speed limits and traffic control. Prior to construction, Asarco also worked with Saguache County to provide improvements to roads that may potentially be impacted by construction activities. In addition to involving the local public in the process, Asarco's construction contractor hired local workers and used locally available equipment, when feasible. As a result of Asarco's outreach efforts with the Town of Bonanza, construction activities have moved forward with overall support from the community. Local land owners have cooperated by providing access to perform sampling activities, conduct the removal activities and develop a site repository for tailings consolidation and closure. In addition, local land owners have cooperated with Asarco on water rights issues and the development of a local limestone quarry, which is supplying limestone to the project.

Technical Process

Technical implementation of the proactive removal plan began with semi-annual surface water monitoring throughout the Bonanza District during high-flow and low-flow conditions. In addition to the surface water quality monitoring, monitoring has been performed to assess the

aquatic biology within and downstream of the District. The water quality and biological monitoring events have served to establish baseline conditions and assisted in the development of long-term water quality goals. In conjunction with the monitoring and as part of the process of negotiating stream standard and classification goals, use attainability assessments and pre-removal aquatic habitat evaluations were also performed. Currently, semi-annual water quality monitoring is used to develop additional baseline data in some areas as well as track improvements in water quality as a result of the removal activities.

Program implementation evolved rapidly after formation of the Bonanza Group in May 1993, beginning with development of Conceptual Management Plans and schedules for each area of Group involvement. These conceptual plans formed a technical basis for the initial Group/Agency agreements. Asarco's plans were further developed in a document which addressed EPA guidance for development of an EE/CA and a Feasibility Study. Other plans and design documents have been prepared as required to satisfy State and Federal permit requirements for work on private lands and the requirements for Time-Critical and Non-Time-Critical Removal Actions on the public lands.

Permits and authorizations for the work on private lands have included a Certificate of Designation and associated land use changes from Saguache County for the tailings repository, a construction stormwater permit from the CDPHE, a Clean Water Act Section 404 Nationwide Permit from the U.S. Army Corps of Engineers, an Air Pollution Emissions Notice (APEN), and water use agreements with water rights holders. Numerous plans and reports have been prepared in support of permits, CERCLA Removal Actions and the Statement of Roles and Responsibilities. These have included annual work plans and EE/CA's, sampling and analysis plans and reports, an engineering design and operations report for the solid waste permit for the tailings repository, a Bonanza Group site ownership and production report, a geologic mapping report for the Rawley Mine and Rawley 12 adit, construction stormwater management plans, site health and safety plans, traffic control plans, construction plans and specifications, construction management plans, a site operation and maintenance plan, a monitoring and control plan for Rawley 12 adit construction activities, and annual construction completion reports.

In order to address EPA concerns regarding potential human health risks due to fluvial deposits of tailings in the Town of Bonanza, the Bonanza Group, in coordination with the CDPHE, collected and analyzed soil samples from residential yards for lead and arsenic. The results of the investigation indicated that there were no significant health risks from residential yards as a result of fluvial tailings deposits.

REMEDY IMPLEMENTATION

Removal Action Overview

Asarco has implemented and/or developed plans to address environmental impacts from several sources within the Bonanza District, including the discharge from the Rawley 12 adit, discharge from the upper workings of the Rawley Mine into Rawley Gulch, the tailings impoundment below the former mill located adjacent to the Rawley 12 portal, and tailings in the three impoundments along Kerber Creek below the Town of Bonanza (Figure 1). The overall removal action will consolidate tailings and other mine wastes into the permitted solid waste landfill (repository) at the Lower Tailings Area. For the Rawley Mine, if feasible, one or more plugs will be installed to reduce mine discharges and acid-generation within the mine workings. Remaining flows would be addressed as necessary through the use of passive treatment systems.

Removal work at the Superior Mill and Cocomongo Mine and Mill sites is anticipated to be completed by other members of the Bonanza Group. This work is expected to include consolidation, regrading and capping of tailings and mine waste rock, stormwater diversions, revegetation, and riparian zone enhancements.

Construction Phases

The first phase of construction activities (Phase 1) was performed in 1994 at the Rawley 12 Area and included excavating tailings from the Rawley 12 Area, and moving these tailings to an interim repository at the Lower Tailings Area. The relocation of the Rawley 12 tailings involved dismantling the timber crib dam and excavation and hauling of approximately 31,000 cubic yards of tailings through the Town of Bonanza to the repository.

Work performed during 1995 (Phase 2) at the Lower Tailings Area included removal and consolidation of approximately 85,000 cubic yards of tailings from the three tailing impoundments into the repository, regrading of these removal areas, and soil amendment and reseeding at the upper impoundment. Other Phase 2 work included regrading a portion of the Rawley 12 tailings removal area; diversion of flows in Rawley Gulch around the upper workings of the Rawley Mine; miscellaneous stormwater and sediment controls; development of a limestone quarry in the Bonanza area; and production and stockpiling of limestone to be used for repository capping, soil amendment, and erosion protection.

Construction work related to the Rawley Mine in 1996 (Phase 3) includes drilling and installation of a piezometer to monitor water levels in the mine, construction of a lined surge and oxidation and sedimentation pond at the Rawley 12 adit portal, opening and reconstruction of the Rawley 12 adit portal, and rehabilitation and geologic reconnaissance of the adit. The purpose of the adit rehabilitation and geologic reconnaissance is to investigate the feasibility of installing an adit plug approximately 3000 feet inward from the portal.

The portal pond will provide passive treatment of the

adit drainage via oxidation and precipitation of iron and other metals. Contingencies will also be in place for active water treatment (pH adjustment) in the pond. In addition to treating the adit drainage, the pond will detain potential surge flows from the adit that may occur during the adit reconnaissance and construction activities.

Other work proposed for 1996 at the Rawley 12 Area includes reclamation of the Squirrel Creek channel and adjacent tailings removal areas. Squirrel Creek will be modified and stabilized to provide flood protection for the oxidation/sedimentation pond, the adjacent roadway embankment, and the reclaimed area. Revegetation and riparian-zone enhancements will also be included along the modified portion of Squirrel Creek.

Construction work proposed for 1996 at the Lower Tailings Area includes rehandling and compacting wet tailings stored at the repository in 1995, regrading of the repository and staging of materials in preparation for closure, maintenance of sediment control structures, and construction of a sludge dewatering bed for handling sludges removed from the Rawley 12 adit and/or portal pond.

Construction work anticipated by Asarco for 1997 (Phase 4) includes partial closure of the repository, reclamation of additional tailings removal/impacted areas and associated creek rehabilitation, and possible further adit rehabilitation and plug construction in the Rawley 12 adit, if plugging is determined to be feasible. The scope of additional removal activities associated with the Rawley Mine are dependent upon the feasibility and/or success of a Rawley 12 adit plug.

Longer term, Asarco intends to provide post-closure care and maintenance of the tailings repository and other constructed works, as necessary or required by permits.

DISCUSSION

The process in place at the Bonanza Mining District is an excellent example of how industry and regulatory agencies can work together in an amicable fashion to resolve environmental issues on public and private lands. The success of the proactive removal program is founded on open communication and cooperation between the Bonanza Group, MFG, the construction contractor, CDPHE, USFS, EPA, Saguache County, and the Town of Bonanza. In contrast to the numerous years of study typically performed prior to initiating large-scale removal actions at similar sites, the cooperative relationships on the Bonanza project resulted in on-the-ground construction only 16 months after the initial meeting between the Bonanza Group and the regulatory agencies. Issues that remain to be addressed include certain orphan sites and other non-mining impacts in the area, such as agriculture, that may affect the ability to achieve long-term water quality goals.