

# THE RIO TINTO MINE A VOLUNTEER CLEAN-UP SUCCESS STORY<sup>1</sup>

by

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**Abstract.** Underground copper mining at the Rio Tinto mine in northern Nevada commenced in 1932 and continued intermittently for approximately forty years. Since 1975 the site has been essentially inactive. Mine operations included placement of tailings generated from ore processing in the Mill Creek drainage. In 1993, due to concerns about environmental damage to surrounding surface waters, four of the previous owners and operators of the site jointly formed the Rio Tinto Working Group (RTWG) to remediate the site in cooperation with the State of Nevada, Department of Conservation and Natural Resource and the Division of Environmental Protection (NDEP). The Rio Tinto Working Group consists of the Atlantic Richfield Company, Cleveland Cliffs Iron Company, E.I. DuPont de Nemours and Company, and Cominco American Inc.

The regulatory and technical approach taken by the RTWG to achieve their objective of proactively implementing remedial measures at the site, rather than following the CERCLA process, are discussed. The steps included preparing an 18-element remedial program to be completed at the site and negotiating an Administrative Order on Consent (AOC) with the State of Nevada, which included a deferral from EPA for listing of the site on the NPL list. By entering into a cooperative relationship with the NDEP and avoiding the CERCLA process, the Rio Tinto Working Group was able to fast track site investigation and remedial designs, leading to a timely start up of remedial construction activities.

## Introduction

Mining processes implemented in the western United States during the 19<sup>th</sup> and 20<sup>th</sup> centuries generated economic excitement throughout the West. As new mineral processes were developed in the 1900s, old mines were reworked and reprocessed to continue to provide such riches. Unfortunately, technologies for providing protection to the environment, as well as environmental regulations, lagged the processing technology. As a result, mining operations were generally conducted without fully considering impacts to the environment. After final extraction of the mineral, the sites would

often be abandoned or temporarily closed according to practices of the times in which the owners envisioned future discoveries that would revitalize the mine and provide new wealth. Consequently, historic mining states within the western United States have been left with a sizable number of abandoned mines. According to a 1985 report to Congress, over 50 billion tons of mining waste is estimated to exist in the United States.

Many of the environmental impacts caused by abandoned mines have resulted from historically poor handling and storage practices of mine waste and mill tailings material. Characteristic problems associated with abandoned mines often include one or more of the following: health and safety hazards associated with open shafts or adits, acid rock drainage (ARD) from adits or deposited tailings/waste material, and instability of waste or tailings material. Frequently, ARD will cause excessive metals loading to receiving surface water courses.

With the onset in 1980 of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), commonly known as Superfund, some of the most

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highly polluted abandoned mines in the West started to be addressed. A number of Mining CERCLA cleanup actions have been focused on the western states where mining has been a major industry. These include the states of Nevada, Colorado, New Mexico and Montana.

The primary guidance document for CERCLA response comes from the National Contingency Plan (NCP). The NCP sets forth specific responsibilities for organizations involved in the site response. It establishes methods and criteria for determining appropriate responses to abandoned environmental hazards. It also specifies a stringent process to be followed from the initial listing of a site on the National Priorities List (NPL) to the final Record of Decision (ROD) and implementation of the ROD. It does not, however, specify the type of remedy to be employed in each remedial action. This vagueness has allowed major disagreements among several parties on the type and extent of remedial actions selected (Arbuckle et al., 1993).

The process set out by the NCP begins with an initial evaluation, or Preliminary Assessment (PA) of the site. The site is then scored in accordance with the NPL's Hazardous Ranking System. Once a site is scored high enough to be placed on the NPL, it is committed to the CERCLA remedial process. The site will go through a lengthy remedial investigation and feasibility study in which All Relevant and Appropriate Requirements (ARARs) are achieved. This means that remediation of CERCLA sites must meet the highest cleanup levels established by any federal and state standards. Nine criteria will be applied while determining the best remedial alternative (Arbuckle et al., 1993).

As demonstrated by many projects, the CERCLA process can be a very long and expensive procedure. Because of the high cost involved in the CERCLA process and the subsequent cost to implement the remedial action, incentive sometimes exists for Potentially Responsible Parties (PRPs) to fight the CERCLA process through litigation especially if a PRP feels it has limited responsibility for the problem.

Recently, some of the state regulatory agencies have begun to pursue cleanups of abandoned mines outside of the CERCLA process. By avoiding the rigid nature of the CERCLA process and negotiating site-specific cleanup approaches with PRPs and other stakeholders, the state agencies have

created a cooperative atmosphere in which PRPs will take a proactive approach to site cleanup. Due to the nature of environmental impacts associated with abandoned mines and the existing remedial technologies that have been previously proven, the regulatory agencies and PRPs are more likely to be cooperative and proactive in coming to an agreement which allows remedial activities to be implemented in a more timely and cost-effective manner. This approach has been implemented at Idarado Mine near Telluride, CO the Upper Blackfoot Mining Complex in Lewis and Clark County, Montana (Anderson and Hansen, 1999).

#### The Rio Tinto Mine, Nevada

The Rio Tinto mine site in northern Nevada is another further example of this voluntary approach to implementing remedial measures at an abandoned mine site. The Rio Tinto Working Group (RTWG), comprised of Atlantic Richfield Company/ARCO Environmental Remediation L.L.C., Cleveland-Cliffs Iron Company, E.I. Du Pont de Nemours and Company, and Cominco American Incorporated, entered into an Administrative Order on Consent (AOC) with the State of Nevada to carry out remedial actions at the abandoned site. Implementation of the remedial elements detailed in the Remedial Work Plan began in 1996 and was completed in 1997.

#### Site Background/Environmental Setting

The historic Rio Tinto mine is located near Mountain City, Nevada which is about 90 miles north of Elko. A rich copper sulfide ore deposit was discovered at the site in 1931 and underground mining continued between 1932 and 1947. The mine supported the adjoining townsite of Rio Tinto and neighboring developments at Patsville and Mountain City.

After the high-grade ores were exhausted, the mine closed in 1947 and the Rio Tinto townsite was abandoned. During the ensuing years there were a number of operations at the site that included reworking of the old tailings, leaching stockpiles of ore, leaching the underground workings and exploration for additional mineral deposits. The property has been dormant since the mid 1970's when private parties acquired it.

The mine site is located in an area characterized by rugged mountainous terrain with rocky slopes. Elevation ranges from approximately

5,800 to 6,200 feet above sea level. The main shaft, historical plant site and town site are situated on a hillside above the Mill Creek drainage. A heap leach pad is located above the plant site and town site. Several small tailings piles lie on the hillside below the town site. In the early stages of the mine, Mill Creek was diverted along the south side of the valley to allow for mill tailings disposal along the valley floor. Tailings were transported by gravity flow to the Mill Creek valley and deposited in a series of impoundments (historically called Pond 3 and Pond 4). A fresh water pond (Pond 1), used as makeup water, and a sludge pond (Pond 2) lie upstream of the tailings ponds. Downstream of the Pond 4 tailings embankment, Mill Creek meanders through flood-irrigated pastureland for approximately 1 mile and eventually flows into the Owyhee River. Figure 1, *Site Plan with Remedial Components*, which illustrates the site remedial elements, depicts general features of the project area.

Beginning in the 1980's, various state and federal agencies, local residents at Mountain City, and the nearby Shoshone-Paiute Tribes of the Duck Valley Reservation (the Tribe) raised concerns about potential environmental problems at the site. In 1986, some work was done at the site to reinforce the Mill Creek Diversion Channel. As concerns were again raised in recent years by agencies and individuals, the NDEP issued orders in 1993 to various entities alleged to be the current owners, previous owners, and operators of the Rio Tinto mine site to assist in remediating the potential environmental problems at the site. Environmental concerns at the Rio Tinto mine included tailings stability, water quality in receiving streams and site health and safety. Although there were a number of companies and individuals involved at the site over the years, only the four which formed the RTWG agreed to work together to conduct a cleanup of the abandoned site. None of these four are the current owner and none had been active at the site for the past 20 years.

#### Regulatory Framework and Approach

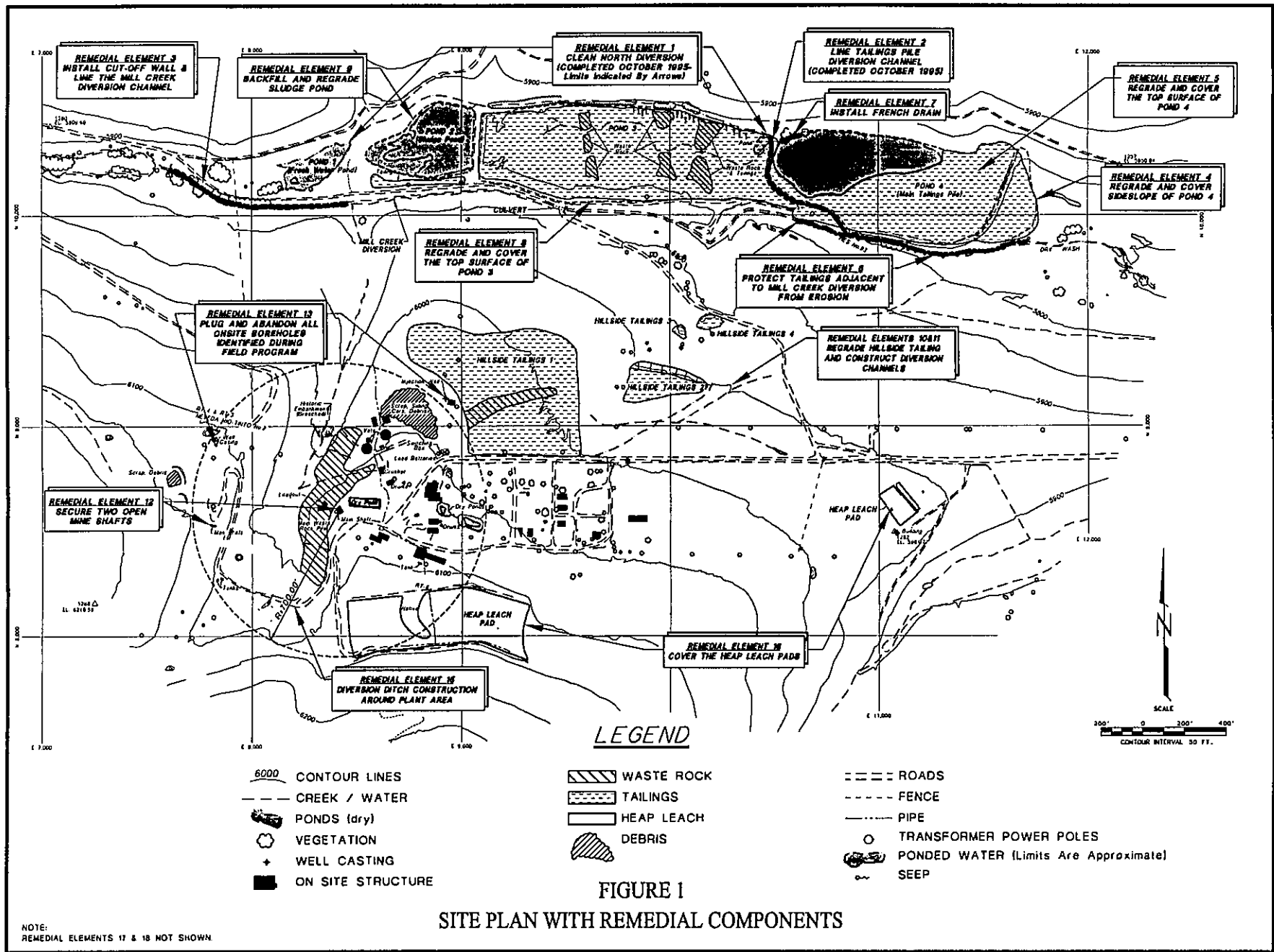
The process that started the ultimate remediation of the Rio Tinto mine was very similar to most contaminated sites. Representatives of the local community contacted the EPA and the State of Nevada Division of Environmental Protection regarding a colored discharge from Mill Creek flowing into the Owyhee River. The EPA and NDEP performed a site inspection and determined the

source for the colored discharge was from the Rio Tinto mine. As a result, the EPA indicated they were considering scoring the site for inclusion on the NPL list. However, the NDEP felt they could deal with the situation without involving the EPA. Therefore, the NDEP issued an order under the federal Clean Water Act (CWA) to the previous owners and operators of the site to address various environment issues.

The notice issued by NDEP in 1993 went to several individuals and companies, as well as the USDA Forest Service, which owns portions of the impacted lands. The RTWG companies began to negotiate a cost sharing basis amongst themselves for implementing remedial activities. The companies hired a technical consultant to help them understand the scope of the impacts and advise on potential solutions.

The goal of the RTWG was to proactively and voluntarily address the State's and other stakeholders concerns and hopefully avoid a NPL listing. Montgomery Watson (MW) was retained to assist the RTWG with developing remedial measures. MW immediately conducted a site inspection and field investigations and began developing remediation measures. Some obvious concerns were addressed shortly thereafter and then the RTWG began a process of meetings with the stakeholders to develop some long-term solutions that were intended to address all concerns at the site. After agreeing on the remedial components, the State wanted to have some regulatory mechanisms to cover the proposed remedial measures while the companies wanted to have some assurance the EPA would defer scoring the site until these measures were implemented. As a result, an AOC was drafted and signed by the State of Nevada and the RTWG.

The AOC is the agreement between the NDEP and the RTWG to perform the remedial activities at the Rio Tinto mine site. The AOC was executed by the NDEP and each of the companies after extensive meetings with all of the project shareholders to make sure that the plan addressed their concerns. The AOC was signed and became effective on September 13, 1996. The AOC provided for two years of site remediation work followed by three years of water quality monitoring. As part of the AOC, the EPA deferred consideration of listing the site on the NPL until after evaluation of the remedial program (including the three years of



monitoring). Exhibits to the AOC describe the work to be performed and the water monitoring plan. The specific exhibits are:

- Exhibit A – Remedial Work Plan
- Exhibit B – Water Monitoring Plan
- Exhibit C - Rio Tinto Mine Site Drawings

Rio Tinto Work Plan

A separate document called the Remedial Work Plan (Work Plan) was written to further define the remedial work outlined in Exhibits A through C of the AOC. The Work plan describes the eighteen remedial elements for the Rio Tinto mine site and the activities to be performed for their implementation in more detail than provided in the AOC. A description of the work associated with each element was presented and the discussion was broken into the following components:

- Work Specifications
- Performance Demonstration
- Completion Determination

The *Work Specifications* were prepared to provide a description of the work to be completed for each remedial element and the specifications that were to be followed during construction. The *Performance Demonstration* describes the performance criteria that must be met to complete each remedial element, and provides details on how the NDEP and the RTWG will be able to determine if the specifications for a particular remedial element have been met. The *Completion Determination* outlines the criteria that will be used to confirm and document the completion of a remedial elements in accordance with the specifications.

Figure 1 illustrates the remedial components. The eighteen remedial elements outlined in the Work Plan are listed in Table 1, Remedial Elements.

Table 1 Remedial Elements	
Number	Description
4	Regrade and cover side-slopes of Pond 4
5	Regrade and cover top surface of Pond 4
6	Protect tailings adjacent to Mill Creek Diversion Channel from erosion
7	Install Pond 4 French drain
8	Regrade and cover tope surface of Pond 3
9	Backfill and regrade sludge pond (Pond 2)
10	Regrade and cover the hillside tailings piles
11	Construct diversion ditches around hillside tailings pile
12	Secure two open mine shafts
13	Plug and abandon all onsite boreholes identified during field program
14	Limited plant site clean up
15	Construct diversion ditches for mine waste rock pile
16	Cover heap leach pads
17	Monitor surface water as outlined in the Water Monitoring Plan
18	Install one down-gradient well

Instead of discussing each one of these work elements, the remedial elements listed above can be divided into major categories with specific objectives. Essentially, the work plan consists of the following types of tasks: tailings regrading and covering, diversion channel construction and channel linings, subsurface drains, addressing health and safety issues and monitoring. These general tasks are discussed below.

To promote surface water drainage, minimize infiltration into the tailings, stabilize embankments, prevent dispersion of wind blown tailings, and improve the aesthetic appearance of the site, all tailings ponds and waste piles at the site, as well as the main heap leach pad, were regraded and covered with a native borrow source. The small heap leach pad was removed and incorporated into the tailings regrading plans. The top surfaces of ponds were regraded to a slope no less than 1.5 percent. In

Table 1 Remedial Elements	
Number	Description
1	Clean out the North Diversion Channel
2	Line the Tailings Pond Diversion Channel
3	Install cut-off wall and line Mill Creek Diversion Channel

instances where slope angles of the covered surfaces indicated high potential for erosion, rock-filled horizontal furrows were placed in the surface to reduce sediment production. The covered surfaces were seeded with a native seed mix to promote vegetation. Additionally, the south and east side slopes of Pond 4 were regraded to improve slope stability and reduce the potential for erosion. These slopes received a 12-inch layer of rocky fill material to reduce erosion potential. Riprap was placed along the south side of Pond 4 (covering the native starter berm) to a level to protect the slope from flow in Mill Creek associated with the 100-year/24-hour precipitation event. Over 80,000 cubic yards of mine tailings and spent ore were regraded. Over 120,000 cubic yards of native fill and cover material were placed over the regraded tailings and heap leach pad. Over 40 acres of covered tailings, spent ore and borrow sources were reseeded.

In an effort to limit surface and groundwater contact with mine waste, over 7,500 feet of surface water diversion channels were improved or constructed around all tailings ponds and piles, the main heap leach pad and the main waste rock pile. The diversions were sized to pass the 100 year/24-hour or 25 year/24-hour storm event depending on the location of the diversion. Additionally, a cut-off wall and channel lining system were constructed in Mill Creek upstream from the pond facilities.

Prior to liner and cut-off wall construction, the channel was cleared of vegetation, graded and improved to contain the 100-year/24-hour precipitation event. A 1,000-foot section of the Mill Creek Diversion channel upstream of Pond 2 was lined with a geosynthetic clay liner (GCL). The GCL extended to the limits of the 25-year/24-hour design flow depths and was covered by a protective soil layer. Riprap was then placed over the liner system to the limits of the 100-year/24-hour design depth.

The excavation for the cutoff wall extended down to bedrock, an average of 15 feet. The lateral length of the cut-off wall was approximately 210 feet. Vertical GCL panels were deployed on the downstream vertical face of the excavation and draped on the bottom. A compacted 8-percent soil-bentonite mixture was used to backfill against the GCL curtain on the upstream side.

In an effort to minimize near surface groundwater contact with tailings material, over 3000 feet of subsurface drains were installed where seeps were observed along the north sides of Pond 3 and

Pond 4 as well as between Ponds 3 and 4. Typical drain construction consisted of a perforated collector pipe bedded in gravel and wrapped in geotextile. Depending on the season, the drains capture approximately 30 gallons per minute (gpm) of near surface groundwater flow before it contacts tailings material.

The Work Plan addressed several health and safety concerns at the site. Two open mine shafts existed at the site: the main shaft and a 42-inch man (ventilation) shaft. Both shafts were closed with steel and/or concrete plugs. The main shaft closure took advantage of previous caving of material that allowed a reinforced concrete plug to be installed and backfilled with general fill material. Backfill material for both plugs was mounded to promote surface water drainage away from the shaft. Miscellaneous trash and debris found on site was collected and disposed of in a permitted on-site landfill. As part of the plant site cleanup, a survey of potential hazardous materials was conducted. An inventory of drums found on site was completed and the contents of the drums were analyzed to determine if the material was hazardous. A small amount of hazardous material was removed from the site for proper disposal at off-site hazardous waste facilities. A borehole-plugging program closed all open wells and drill holes, many related to an in-situ leaching research program. Seventy-two boreholes and one deep injection well were abandoned according to methods approved by the Nevada Division of Water Resources (NDWK).

Finally, to characterize the existing surface water quality and evaluate the effectiveness of the remedial measures, a surface water monitoring plan for the site was completed and implemented. Also, one downstream groundwater well was installed to characterize groundwater conditions. Figure 2, *Surface Water Monitoring Stations*, shows the locations of surface water monitoring stations and the groundwater characterization well location. The sites were selected to give a general overview of the water quality upstream and downstream of the Rio Tinto Mine site on Mill Creek, Dry Creek and the Owyhee River.

### Results

Construction of the remedial elements took place over the 1996 and 1997 construction seasons as scheduled in the AOC. The Completion Report, documenting that performance and completion criteria were met, was submitted to NDEP in January

# LEGEND

- FULL SURFACE WATER MONITORING STATION
- ROAD
- - - DIRT ROAD

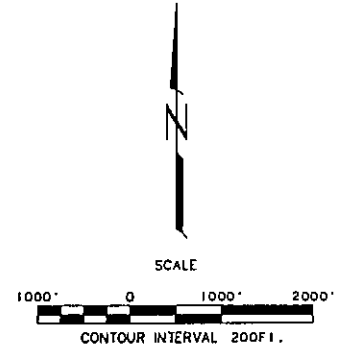
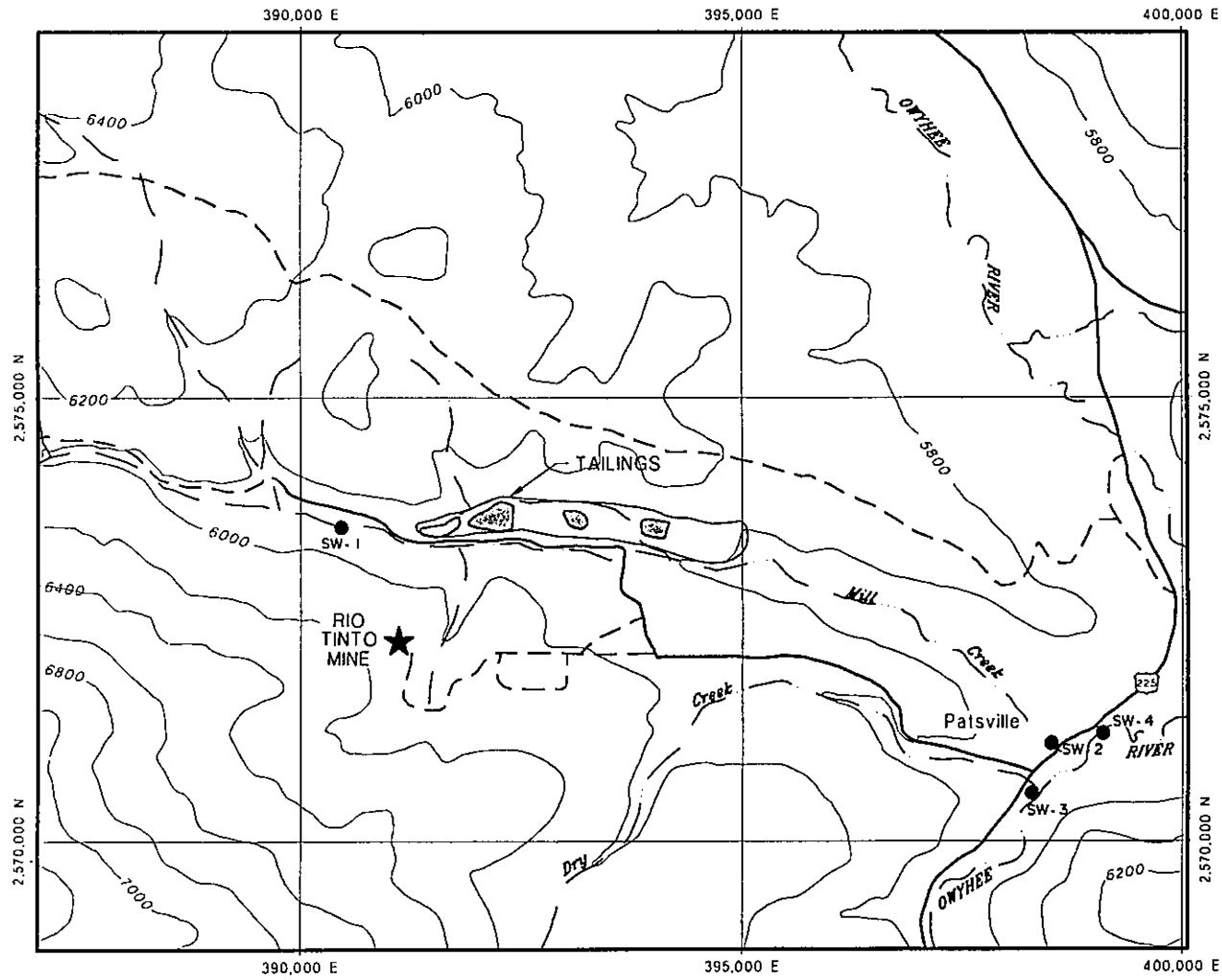


FIGURE 2  
SURFACE WATER MONITORING STATIONS

1998 (the deep injection well abandonment was completed in March, 1998). The report was accepted by NDEP and the site is currently in the second year of the three-year post construction monitoring program. Completion is scheduled for October, 2000.

During the 1997 construction season, the RTWG identified items outside the scope of the Work Plan which could be completed to further enhance the overall cleanup effort. Due to the cooperative relationship with NDEP and proactive approach taken by the RTWG, the group chose to implement over 25 additional construction items that were not part of the Remedial Work Plan or AOC. The purpose of this additional, voluntary construction was to improve the probability of meeting the following project objectives: to improve downstream surface water quality and ensure the integrity of the system. The extra construction items included installation of over 2700 feet of 6-inch HDPE piping to transport fresh water from Pond 1 to Mill Creek without potentially contacting tailings. Flow rates of 70 gallons per minute have been measured at the outlet of this pipeline. Other additional construction items include 7-foot culvert installation, USFS road regrading and improvements, additional French drain construction, as well as many other items.

The cooperative and proactive approach taken by the RTWG allowed the group to focus efforts on actual remedial construction instead of costly litigation or regulatory documentation requirements and studies (CERCLA remediation). In fact, over 70% of the overall project costs went to remedial construction. Figure 3, *Breakdown of External Costs (RTWG)*, shows a diagram illustrating the breakdown of external costs incurred by the RTWG.

Finally, quarterly downstream water quality results after completion of the remedial construction show significant decreases in metals loading to Mill Creek and the Owyhee River. Figure 4, *Rio Tinto Water Monitoring Dissolved Copper Concentrations* and Figure 5, *Rio Tinto Water Monitoring Dissolved Copper Concentrations*, illustrate dissolved copper levels (indicator parameter) over time at downstream monitoring locations on Mill Creek and the Owyhee River. As shown in the figures, dissolved copper levels have decreased by 2 to 3 orders of magnitude since original monitoring began in 1995. Groundwater sampling results suggest that

groundwater quality has not been significantly impacted by the mine site.

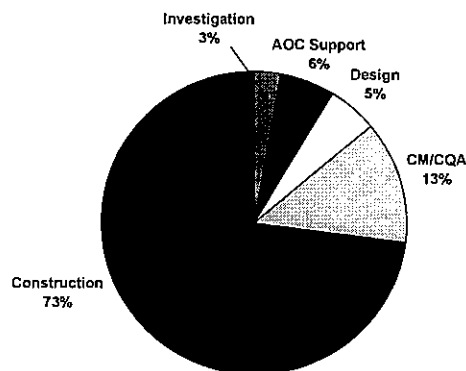


Figure 3  
Breakdown of External Costs  
(RTWG)

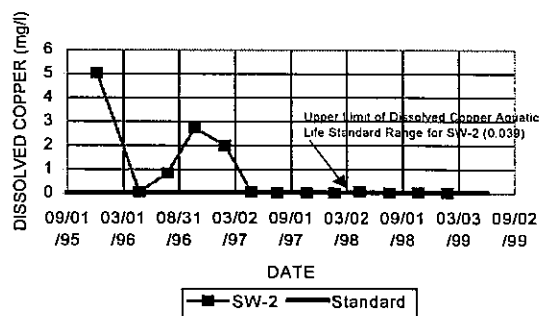


Figure 4  
Rio Tinto Water Monitoring  
Dissolved Copper Concentrations

In summary, the RTWG has successfully achieved its goal of working cooperatively and proactively with NDEP and other stakeholders to complete remedial cleanup of the Rio Tinto Mine Site. The remediation occurred timely - beginning shortly after the environmental issues were identified. The construction of the final remedial measures generally followed the schedule set out in the Remedial Work Plan. In the atmosphere created amongst stakeholders, the RTWG voluntarily chose to implement additional construction items that contributed to the overall project success. This resulted in promptly focusing the available project



funds towards actual construction of the remedial elements rather than litigation and extensive investigative studies. Finally, the source control measures implemented as part of the mine site remediation have resulted in a substantial improvement in the surface water quality in both of the receiving streams downstream from the mine site. It is expected that improvements will continue as the full effect of the remediation work is realized and the conditions stabilize.

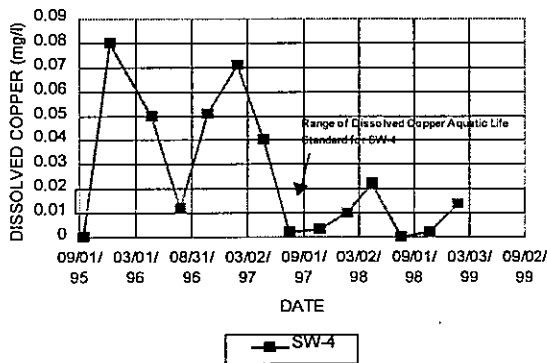


Figure 5  
Rio Tinto Water Monitoring  
Dissolved Copper  
Concentrations

### Literature Cited

- Anderson, R.C. and Hansen, B.G. 1999. *Mine waste and water management at the Upper Blackfoot Mining Complex*. Proceedings of Sixth International Conference on Tailings and Mine Waste '99. Fort Collins, Colorado.
- Arbuckle, J.G. et al., 1993. *Environmental Law Handbook (Twelfth Edition)*. Government Institutes, Inc, Rockville, MD.
- Rio Tinto Working Group and TerraMatrix/Montgomery Watson. 1998. *Rio Tinto Mine Remediation Project, Mountain City, Nevada; Completion and Semi-Annual Report*. Prepared for the Nevada Division of Environmental Protection.
- TerraMatrix. 1996. *Exhibit B to the Administrative Order on Consent, Water Monitoring Plan Rio Tinto Project Mountain City, Nevada*. Prepared for Rio Tinto Working Group.
- TerraMatrix. 1996. *Remedial Work Plan. Rio Tinto Mine Remediation Project, Mountain City, Nevada*. Prepared for the Rio Tinto Working Group.