NONPOINT SOURCE CONTROL IN COLORADO: INACTIVE/ABANDONED MINES NONPOINT SOURCE PROGRAM[1]

by

Camille M. Meyer[2]

Abstract. Heavy metals and acid generation from inactive draining mine tunnels and erosion and leaching of inactive mine waste piles have adversely impacted nearly 1,300 stream miles in Colorado. Colorado's Inactive/Abandoned Mines Nonpoint Source Program, authorized by Section 319 of the federal Clean Water Act, identifies sites for voluntary and cost-sharing demonstration projects or further studies to advance the state of knowledge of Best Management Practices for control of mining nonpoint sources, and assess the extent of pollution of the listed sources. Project development and implementation requirements, Best Management Practices and case studies of completed and scheduled demonstration projects are presented.

Additional Key Words: acid mine drainage, best management practices, Clean Water Act, heavy metal pollution, mine waste, matching funds, water quality.

Program Organization

The Federal Clean Water Act of 1987 established a new direction for the water quality efforts of Colorado, with special emphasis placed on control of nonpoint source pollution. Nonpoint sources are defined as those which are diffuse in nature, and are not regulated through the permit program of the Clean Water Act. Nonpoint sources of pollution are commonly associated with urban runoff, agriculture, forestry and logging, construction, hydrologic modification (reservoirs), and abandoned and/or inactive mines. Primary pollutants associated with these activities are sediment, salinity, heavy metals, nutrients (phosphorus and nitrogen) and bacteria.

[1]Paper presented at the 1991 National Meeting of the American Society for Surface Mining and Reclamation, Durango, Colorado, May 14-16, 1991.

[2]Reclamation Specialist/Project Manager, Colorado Mined Land Reclamation Division, Inactive Mine Reclamation Program, Denver, Colorado 80203

Proceedings America Society of Mining and Reclamation, 1991 pp 705-714
DOI: 10.21000/JASMR91020705
https://doi.org/10.21000/JASMR91010705

The Colorado Department of Health, Water Quality Control Division, (the "Division") has the primary responsibility for the Nonpoint Source Program in Colorado. The Colorado Nonpoint Source Task Force, formed at the request of the Water Quality Control Division in May of 1987, provides direct guidance to the Division for conducting the nonpoint source program.

The Task Force has four subcommittees which represent the major categories of nonpoint source pollution in Colorado:

1. Urban and Construction Runoff Subcommittee;
2. Agricultural/Silviculture Subcommittee;
3. Hydrologic Modification Subcommittee; and,
4. Mining Subcommittee

The subcommittees provide specific recommendations for projects, programs, management practices and assessment issues from their area of expertise. These recommendations are then considered by the Task Force for final recommendation to the Division. The subcommittees also provide a device for broad public input into the states's nonpoint source program.

The "Colorado Nonpoint Source Management Program", prepared by the Division with the assistance of the Colorado Nonpoint Source Task Force to meet the requirements of Section 319 of the Federal Clean Water Act, provides an implementation strategy for the treatment of the water quality problems previously identified in the "Colorado Nonpoint Assessment Report".

The objective of the Colorado Management Program for Nonpoint Source mining impacts is to achieve improvement in water quality and its associated beneficial uses: recreation; water supply; and aquatic life. The Nonpoint Source Management Program stresses the voluntary approach to nonpoint source control and the importance of public education regarding the extent of nonpoint source pollution. Best management practices available to treat identified pollution sources and possible sources of financial assistance to install the needed best management practices are identified. The Task Force believes that with proper education and planning, the public will proceed to implement the management program on a voluntary basis.

Management practices for control of mining non-point sources of pollution are still experimental in nature, and therefore require implementation of a variety of treatment techniques to demonstrate performance, maintenance and economic feasibilities. To date, the Colorado Mined Land Reclamation Division, Inactive Mine Reclamation Program (MLRD, IMRP), has been the lead agency involved in the development and implementation of nonpoint source mining projects. As such, the MLRD, IMRP continually interacts with the Nonpoint Source Mining Subcommittee; the Colorado Department of Health, Water Quality Control Division, Nonpoint Source Program (WQCD); the Environmental Protection Agency (EPA); U.S. Forest Service (USFS); U.S. Bureau of Mines (USBOM); U.S. Bureau of Reclamation (USBOR); Colorado Division of Wildlife (CDOW); local governments; various mining

companies; and, volunteer groups for technical and financial support.

The October, 1990, Nonpoint Source Management Program presented a list of demonstration projects for implementation or further study in the Federal fiscal years 1990 through 1994. The intent of the projects is to further advance the state of knowledge of: the Best Management Practices for control of mining nonpoint sources; the extent of pollution from many of these listed sources; and, to develop plans to correct those problems. Table 1 lists proposed projects.

Nonpoint Source Mining Impacts

The Colorado Nonpoint Source Assessment Report notes that heavy metals and acid generation from inactive/abandoned draining mine tunnels (adits) and erosion and leaching of inactive mine waste piles have negatively impacted nearly 1,300 stream miles in Colorado. Heavy metals such as lead, zinc, copper, cadmium, mercury and silver can be chronically or acutely toxic to aquatic life, and degrade the stream such that the water does not meet the standards specified for other uses, such as domestic water supply and recreation. Acid formation is also a water quality problem associated with mining activities. Pyrite, a mineral commonly associated with valuable mineral deposits, oxidizes when exposed to water and air and leads to a process which yields acid concentrations. These acid concentrations can impact surface waters by depressing instream pH levels and solubilizing otherwise stable metals, which can create chronic or toxic conditions for aquatic life.

The Best Management Practices (BMP's) for abandoned/inactive mining were reported by the Mined Land Reclamation Division (MLRD) in November, 1988. These management practices represent the best knowledge of agencies and individuals at the present time. Following project implementation, the practices will be reviewed for their ability to reduce nonpoint source pollution to receiving streams. Emerging technology and refinement of existing methods will be incorporated into the BMP guidelines by the Nonpoint Source Mining Subcommittee.

The MLRD advised that few of the BMP's could be used in isolation to completely address a nonpoint source pollution problem, and that management practices must be used in combination as part of an overall strategy to achieve improvements in water quality throughout a watershed. Further, the BMP's were described to be necessarily general and were intended to provide a wide range of common sense approaches to remedy frequently encountered mining nonpoint source problems.

TABLE 1

Priority Watersheds and Projects for
Mining Nonpoint Source
Management Program FY 90 - 94

Project/Watershed	County	Responsible Agency	PIP Completion	Implementation	Source of Funds
Gamble Creek (PLATTE RIVER BASIN)	Gilpin	MLRD	FY 89	FY 90	IMRP, 319, 201(g)
S. Mosquito Creek (PLATTE RIVER BASIN) Local funds	Park	MLRD, WQCD	FY 90	FY 90-91	IMRP, 319, 201(g)
Mosquito Creek (PLATTE RIVER BASIN) local funds	Park	MLRD, WQCD	FY 91	FY 92	IMRP, 319, 201(g)
N. Fork So. Platte River (PLATTE RIVER BASIN) local funds	Park	MLRD, WQCD	FY 92	FY 92-94	IMRP, 319, 201(g)
James/Little James Cr (PLATTE RIVER BASIN) local funds	Boulder	MLRD, WQCD	FY 91	FY 92-93	IMRP, 319, 201(g)
Chalk Creek (ARKANSAS RIVER BASIN)	Chaffee	MLRD, DOW, USFS	FY 90	FY 90-91	IMRP, 319, DOW, 201(g)
Slate River/Peanut Mill (COLORADO RIVER BASIN)	Gunnison	MLRD, WQCD	FY 93	FY 94	IMRP, 319, 201(g)
Howards Fork of the San Miguel River (COLORADO RIVER BASIN)	San Miguel	MLRD, WQCD	FY 93	FY 94	IMRP, 319, 201(g)
Peru Creek (COLORADO RIVER BASIN)	Summit	MLRD, WQCD, USFS	FY 88	FY 90	IMRP, USFS 319, 201(g)

TABLE 1 (Cont.)

Priority Watersheds and Projects for
Mining Nonpoint Source
Management Program FY 90 - 94

Project/Watershed	County	Responsible Agency	PIP Completion	Implementation	Source of Funds
Upper Dolores River (COLORADO RIVER BASIN)	Dolores	MLRD, WQCD, BOR	FY 92	FY 93	IMRP, 319, 201(g)
Upper Animas & Tributaries (COLORADO RIVER BASIN)	San Juan	MLRD, WQCD, BOR	FY 92	FY 93-94	IMRP, 319, 201(g)
French Gulch (COLORADO RIVER BASIN)	Summit	MLRD, WQCD	FY 90	FY 91	IMRP, 319, 201(g)
E. Fork La Plata River (COLORADO RIVER BASIN)	La Plata	MLRD, WQCD	FY 92	FY 92	IMRP, 319, 201(g)
Upper Snake River (COLORADO RIVER BASIN) local funds	Summit	MLRD, WQCD	FY 93	FY 94	IMRP, 319, 201(g)
W. Fork Willow Creek (RIO GRANDE RIVER BASIN)	Mineral	MLRD	FY 91	FY 92	IMRP, 319, 201(g)
E. Fork Willow Creek (RIO GRANDE RIVER BASIN)	Mineral	MLRD	FY 90	FY 91	IMRP, 319, 201(g)
Kerber Creek (RIO GRANDE RIVER BASIN) local funds	Saguache	USFS	FY 93	FY 94	IMRP, 319, 201(g)

As outlined in the October, 1990 Nonpoint Source Management Program, the BMP's are grouped in three categories. The first category addresses preventative measures and hydrologic controls which are aimed at preventing the contamination of water in mining areas. Preventative measures to control drainage and seepage from mine waste include: diversions to redirect run-on water away from mine water recharge areas or waste piles; infiltration barriers to prevent water from entering mine workings or waste piles; runoff controls such as terracing and contouring of mine waste; and removal operations for tailings and waste piles near water courses and atop alluvial floodplains.

Bulkhead seals and other types of mine seals are additional measures which may reduce or eliminate mine drainage impacts and provide surge control and flow equalization in conjunction with treatment.

The second category of management practices may be described as passive mine drainage and mine waste treatment techniques. The term passive mine drainage treatment (PMDT) refers to mine drainage impact abatement activities which accomplish the goals of metal removal, removal of dissolved solids and neutralization of mineral acidity using low cost material and construction techniques which do not require frequent maintenance operations. PMDT systems must be designed on a site-by-site basis and adapted to local environmental conditions. Site-specific treatments are required to compensate for unique problems related to access, elevation, surface hydrology, specific pollutants, type of mining and legal restrictions such as water rights and land use controls. A major goal of PMDT approaches is to minimize the need for ongoing operation and maintenance activities.

The third category of management practices is active treatment systems for mine waste and mine drainage. Active treatment systems include physical chemical treatment plants, activated biological treatment systems, electrostatic and electrochemical systems, osmotic membrane systems and combinations of such systems. While there are hybrid systems which are inexpensive to build and uncomplicated to operate, active treatment systems normally involve closed conduits and pumps, automated metering systems for chemical additives and strict operational and maintenance requirements. Accordingly, active systems require near constant operation and maintenance activities. It is unlikely that such systems will be employed under the nonpoint source program except in special circumstances.

Project Implementation

In order for a project to be considered for ranking and funding, a project implementation plan (PIP) must be prepared and submitted to the NPS Task Force and Water Quality Control Division for review. The PIP must document baseline conditions, proposed improvements, anticipated water quality and beneficial use improvements, project costs, and long term monitoring, maintenance and financial arrangements.

Section 319 of the Clean Water Act specifies that 60% of project funding sources be provided by Federal money, and 40% be provided by local matching funds.

Extensive surface water sampling and analyses are conducted prior to and following project implementation to assess undisturbed background conditions, baseline characteristics of the contaminated area, and post-reclamation effectiveness of the remedy employed to treat the problem. Continual government, industry and environmental group interaction is an integral component of project development, implementation and follow-up.

Case Studies

The Gamble Gulch and Pennsylvania Mine Inactive Mining Nonpoint Source projects were completed in 1990. The St. Elmo/Chalk Creek, South Mosquito Creek and East Willow Creek projects are scheduled for implementation this field season, i.e., 1991. The Animas River Water Quality Assessment project will commence this summer, and is scheduled for completion for the Field season of 1992. The French Gulch reclamation project is scheduled for implementation during the 1992 field season.

Gamble Gulch. The Gamble Gulch NPS Project, located approximately 2 miles southwest of Rollinsville in Gamble Gulch, a tributary of South Boulder Creek, consisted of constructing wetlands to treat acid mine drainage from the Perigo or Tip Top mine, moving approximately 3,000 cu. yds. each of mine waste and mine tailings from the streambed of Gamble Gulch, and revegetating mill tailings and mine waste disposal areas. The project employed the BMP's of run-on control, mine waste removal, construction of wetlands and protection of unstable areas. First year analyses of mine effluent following flow through the constructed wetlands indicated a 71% reduction in aluminum; 89% reduction in iron; 28% reduction in manganese; 87% reduction in copper; 55% reduction in zinc; and, a 67% reduction in nickel concentrations. pH remained constant at 4. Gamble Gulch is a component of the South Platte River Basin.

Pennsylvania Mine. The Pennsylvania mine NPS project, located approximately 13 miles north of Keystone Ski Resort in Summit county, consisted of transmitting acid mine drainage through a limestone delivery apparatus and a settling basin before return to Peru Creek. The limestone "ribbon blender" is powered by the mine drainage. The mine flow powers a turbine, attached to a gear reducer, which, by way of a large rubber belt, rotates the internal lime circulation and delivery auger. Run-on Control, runoff control, protection of unstable areas and utilization of a ph Modulation/ Neutralization method of passive mine drainage treatment BMP's were used. Initial operation of the apparatus increased the pH of the mine effluent from 4.8 to 6.8. Full scale operation of the apparatus is awaiting a design change of the belt drive system.

St. Elmo/Chalk Creek. The St. Elmo/Chalk Creek NPS project, located approximately 20 miles southwest of Buena Vista, in Chaffee County, will utilize the BMPs of: run-on controls; a modified bulkhead seal for mine drainage surge protection; run-off and erosion controls; mine waste removal; protection of unstable areas; and, a constructed wetland for treatment of neutral mine drainage. Chalk Creek is a tributary of the Arkansas River.

South Mosquito Creek. The South Mosquito Creek NPS Project, located approximately 20 miles northwest of Alma in Park county, is a tailings relocation and mine drainage treatment project, expected to utilize the same hydrological control BMP's previously listed. The acid mine drainage source has been identified as minor seeps within the draining tunnel. The individual seeps will be separted from the uncontaminated flow within the tunnel and treated by means of ph modification/neutralization. South Mosquito Creek is a component of the South Platte River Basin.

East Willow Creek. The East Willow Creek NPS project, located within the Rio Grande River Basin, is a drainage relocation and mine waste stabilization project.

French Gulch. The French Gulch NPS project is currently being studied through groundwater and surface water analyses to determine the extent and source of pollution in preparation of BMP determination and project development. French Gulch flows into the Blue River, a component of the Colorado River Basin.

Conclusion

Management practices for control of mining non-point sources of pollution are still experimental in nature, and therefore require implementation of a variety of treatment techniques to demonstrate performance, maintenance and economic feasibilities. Post-reclamation monitoring will be conducted to determine the effectiveness of the best management practices chosen. Evaluating performance of the BMPs will allow refinements, amendments, elimination or addition of BMP's to increase the effectiveness in treating nonpoint sources of pollution resulting from inactive mines.

Literature Cited

Colorado Mined Land Reclamation, November, 1988. Division Management Practices for Nonpoint Source Pollution Related to Mine Waste and Mine Drainage.

Colorado Water Quality Control Division in Association with the Colorado Nonpoint Source Task Force, October, 1990. Nonpoint Source Management Program. Colorado Department of Health, Water Quality Control Division, 4210, E. 11th Ave, Denver, Colorado 80220.

Herron, James A., June, 1990 Gamble Gulch Invitation and Bid Document RN-Mines-219. Colorado Mined Land Reclamation Division, Inactive Mine Reclamation Program, 1313 Sherman Street, Room 215, Denver, Colorado 80203.

Meyer, Camille M., April, 1990. St. Elmo/Chalk Creek Nonpoint Source Project Implementation Plan. Colorado Mined Land Reclamation Division, Inactive Mine Reclamation Program, 1313 Sherman Street, Room 215, Denver, Colorado 80203.