

THE USE OF LIVESTOCK AS A TOOL FOR RECLAMATION OF COPPER TAILINGS IN SOUTHERN ARIZONA¹

by

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Abstract. The use of livestock as a tool for reclamation of copper tailings is not necessarily new. It stems from the concept of using livestock as a management tool for enhancing ecosystems. ASARCO Incorporated's use of "ASARCOWs" began in 1994. Today, more than 300 acres of copper tailings slopes have been stabilized and reclamation begun by livestock impacts in southern Arizona. The livestock are concentrated on relatively small areas for a very short duration and fed hay. An abundance of organic matter is incorporated into the tailings by the hoof action of the animals. As the organic matter builds up in the sterile tailings, a soil-like medium is produced which enhances the reclamation of the tailings site. As plant communities develop, a self-sustaining ecosystem becomes established.

Additional Key Words: copper tailings, steep slopes.

Introduction

The standard methods for reclamation of copper tailings relies almost exclusively on the use of mechanical and other high-tech methods. These would include the use of heavy equipment for surface manipulation of slopes and top-soiling; as well as irrigation, fertilizers, and other soil amendments to try to induce plant growth on the tailings reclamation site. A far simpler, and perhaps more ecologically sound, approach is to use livestock. Livestock can incorporate organic matter into the tailings to build a soil-like medium that will support plant growth. Livestock also helps to stabilize the steep slopes with their hoof action traveling up and down the slopes. The concept of using livestock for reclamation is nothing new. The original idea came from a wildlife biologist working in South Africa. He observed the impacts of large herds of ungulates on the vegetative communities. He noticed that, as these large herds migrated across the arid plains, they would severely disturb the soil surface, breaking up the heavy soil crust, opening it up for water infiltration and aeration, and incorporate dead litter and other organic matter into the soil. Also, the animals would graze old decadent plants which then

opened up the root crown to stimulate vigorous regrowth. His observations evolved into a natural resource management philosophy that became known as "Holistic Resource Management", or "HRM". The concept of using livestock for tailings reclamation is a natural extension of this "Holistic" theme.

After some initial success at revegetating copper tailings by incorporating manure into the surface 6 inches at ASARCO Incorporated's Silver Bell mine in the late 1970's, we thought about putting a small livestock feedlot on the top of the tailings to spread manure and incorporate organics into the tailings. Actually, a few years earlier, Ken Ludeke, working on copper tailings revegetation at the Pima Mine, was having success on steep slopes by spraying a slurry of manure and sewage sludge and incorporating the organics by rolling a sheepsfoot roller up and down the slope. Then, in 1989, Noel Gillespie, working with a group of consultants from AZ Ranch Management at the Miami Mine, started to successfully use livestock on copper tailings to stimulate vegetative growth and to stabilize the steep slopes. Since these early beginnings, many other mines have started using livestock for copper tailings reclamation. Livestock have been successfully used at the Pinto Valley Mine, Sierrita Mine, Morenci Mine and Mineral Park Mine in Arizona; as well as several other mines in the western U.S.

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Objective

The main objective of the use of livestock for reclamation of copper tailings is to incorporate enough

organic matter into the tailings to build up a soil-like medium for plant growth. The use of livestock on the steep tailings slopes also stabilizes the slope to control runoff and erosion. The hoof action of the animals contouring the slope as they feed can actually regrade the steep angle of the slope somewhat, creates many small contour benches, and results in numerous depressions that will trap rainfall and enhance plant growth. This is far more preferable than using heavy equipment for regrading that can cause severe compaction. The heavy equipment must also run up and down the steep slopes vertically which can create ruts that can then channel runoff directly downslope. By building up the organic matter in the tailings, and contouring the slopes by hoof action, the need for irrigation is also dramatically reduced. The organic matter helps to increase the infiltration of the water and reduce evaporation losses. With the organic matter and livestock-tilled slopes, plant establishment is enhanced even though the rainfall may be sporadic and undependable. The incorporation of organic matter into the tailings also helps to alleviate any problems with deficiencies in vital plant nutrients and to create the proper habitat necessary for the development of soil micro-organisms that are essential for a well-balanced natural ecosystem. We have referred to the livestock on our copper tailings as "ASARCOw's", others refer to the livestock as "FLOSBies" (Four Legged Organic Soil Builders), and "EMPACT" (Environmental Mine Practices And Cattle Treatment).

Methods

ASARCO Incorporated's "ASARCOw's" program was initiated at the Hayden copper tailings impoundment in December 1994. Prior to bringing the animals onto the tailings, blood samples were analyzed for heavy metals. The livestock sampled were identified so they could be retested later to determine if they had picked up any heavy metals by their exposure to the tailings. We started with a small herd of 66-heifers and steers from Asarco's JI and Rosemont Ranches. The herd was started on a tailings slope we had revegetated in 1990 using the conventional reclamation techniques of soil capping, hydroseeding and irrigation for initial establishment of vegetation. Initial vegetative establishment on this site had suffered a decline in the vigor of the grasses, and there was some erosion taking place. We wanted to see if animal tillage could improve the vegetative ecosystem on this site. We used electric fences to hold the animals in paddocks of approximately 1/4 to 1/2 acre in size. The animals must be concentrated on a

relatively small area for a very short duration to achieve the degree of animal tillage necessary to meet the objectives. Generally this requires from 400 to 700 animal units per acre. This would equate to 100 animals on 1 acre for 4 to 7 days. The Hayden tailings herd soon was increased to approximately 200 head, and was divided into two separate herds.

The animals were fed hay that consisted of mostly sudan grass, bermuda, oats and barley. This diet was supplemented with alfalfa hay for nutrition and growth, as well as salt and other mineral supplements. The bales of hay were broken and spread over the surface of the tailings from the top of the slope to the bottom. Water troughs were also placed at the top of the slope to enhance the movement of the animals up and down as well as contouring on the slopes. Shade was also provided for the animals for relief from the summer sun (although the animals did not seem to utilize the shade as much as might have been expected). The livestock grazed off the dead and decadent vegetation, and more hay was placed on the tailings slope for them to feed on. Over time, we moved the livestock onto raw tailings slope areas that had never been stabilized before, and onto areas that had been revegetated in the mid-1970's. On these old reclamation sites, the trees and shrubs that were originally planted had almost completely died out. These areas were severely eroded and had to have many of the large erosion gullies repaired by heavy equipment. Areas with small erosion cuts were left for the livestock to work with their hooves. The labor and technical assistance needed for this initial project was contracted to the consulting group Arizona Ranch Management (ARM) from Globe, Arizona. They had the experience of working livestock on the Miami and Pinto Valley tailings..

Results

To date, tests have met all our objectives. We got excellent response to previously revegetated tailings slopes, with the vegetation coming back in excellent condition. On never-before reclaimed tailings sites, we have successfully stabilized the tailings slopes from erosion and built the tailings into a "soil-like" growth medium that is sustaining vegetation. We have produced suitable stands of annual barley and oats on the tilled tailings slopes. We have found that, where we have used bermuda hay, we have gotten some establishment of bermuda grass. All of the tailings slopes tilled with cattle are very well stabilized with very little water erosion and no blowing dust.

Building Up Organic Matter

Livestock have now tilled nearly 300 acres on the Hayden copper tailings. Organic matter has been incorporated into the tailings surface to depths of 6-18 inches. Records indicate the cattle were being fed approximately 28 tons of hay per acre. It was estimated by the consultants that approximately 50-60% of this hay gets mulched down into the tailings by the tillage of the animals' hooves. This amounts to over 16 tons/acre of hay mulch that is incorporated into the tailings. In addition, each heifer/steer excretes an estimated 33 lbs. of green manure/day, and each full-sized cow excretes 65 lbs./day (Rice,1996). This amounts to an additional 10-20 tons of manure/acre incorporated into the tailings. This can amount to over 190 lbs. of nitrogen and nearly 58 lbs. of phosphorus added to each acre for plant growth (Eghball & Power, 1994). In addition, there are the enzymes, proteins, minerals, and bacteria added to the tailings (from the urine of the livestock). Despite the fact that all these animals are concentrated on a small area for a short period of time, there is little evidence of any solid manure on the surface. All this organic matter is being incorporated into the tailings to begin decomposing to form the basis of a soil genesis of the copper tailings.

Slope Stabilization

Livestock traverse the slopes on the contour, preparing small benches running perpendicular to the slope which dramatically reduces runoff. Also, their hooves have produced numerous small depressions on the slope to further reduce runoff and improve the infiltration of rainfall. After a 2.25-inch rainfall event at the Hayden copper tailings site in October 1995, the tilled slopes exhibited very little serious erosion. For the most part, erosion gullies resulted from water ponding up on the roads and cutting over the edge of the slope. Even here, the organic matter held the tailings together and the gullies were much narrower and not as deep as gullies on untilled tailings slopes. Preliminary measurements indicate that the angle of repose of the tailings slopes have been reduced by as much as 5-10 degrees of angle. Transects to monitor the ecological responses on the tailings show evidence of vegetation becoming established, beneficial insects thriving in the organic matter, and birds and burrowing animals inhabiting the tilled copper tailings slopes where little life existed prior to treatment. This

indicates that an ecologically balanced and sustainable ecosystem is beginning to develop.

Animal Health

Monitoring of livestock health indicates that there are no heavy metal problems. In fact, blood levels of copper, molybdenum, and zinc show deficiencies of these essential minerals, and we have had to supplement the diet of the cattle with mineral blocks. This data is supported by similar findings from other mine sites that use livestock for reclamation on their copper tailings. In fact, we have had many healthy calves born on the Hayden copper tailings site. Many of these calves were not only born on the tailings, but were also conceived while on the tailings. Steers that have been taken to sale have shown an average weight gain of 0.5 lbs./day.

Summary

The future of copper tailings reclamation with livestock looks very favorable. We have witnessed a vast improvement in the stability and ecological productivity of the copper tailings slopes by using livestock. The steep angle of the slopes has been reduced and there is far less wind and water erosion. We are seeing vegetation becoming established on the natural rainfall where none existed previously. The early stages in the establishment of a healthy, fully functioning viable ecosystem are now appearing where only bare tailings existed a few months ago. We have seen a positive response from the community and public at large and have received valuable positive media exposure. Recently, the Arizona State Mine Inspector honored the Asarco Ray Complex with its Annual Reclamation Award for the innovative use of livestock for copper tailings reclamation. As our use and development of this method of reclamation continues, we can anticipate even more positive accomplishments.

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