Hydrology of the Colorado Tailings Area, Butte, MT

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Abstract

During the past 7 to 8 years, the Colorado Tailings have been the site of numerous studies on potential heavy metal contribution to Silver Bow Creek (SBC).

Three years ago the Montana Department of State Lands-Abandoned Mine Lands Bureau (DSL-AML) initiated, through the Montana Bureau of Mines and Geology (MBMG), a study of reclamation and removal alternatives for this site. Since that time the tailings have received increased interest with the placement of SBC on the Environmental. Protection Agency's Superfund.

Numerous studies predate the ongoing Superfund and MBMG studies, with contradictory results. Loading rates in SBC have been reported to vary from 0 to 36 lb/day for copper and 300 to 320 lb/day for zinc from above to below the tailings (4). Since the initiation of the MBMG study, numerous changes have taken place upstream which complicate comparisons with historic data; those being the Anaconda Minerals Company zero discharge for the Weed Concentrator and the suspension of mining in Butte.

Results from the MBMG study show a substantial degradation of ground water quality from outside (upgradient) of the tailings through the tailings, as do surface water results, but to a lesser degree, from above to below the tailings.1

Tailings Origin and Location

The Colorado Tailings are the waste products of the Colorado and Montana Smelting Company's smelter and concentrator, which was located to the south of the tailings area (fig.1) (2). The facility, operating from 1879 to 1905, was enlarged and owned by numerous parties (7). The waste products (tailings) from the facility were deposited north of the facility in a marshy area adjacent to Silver Bow Creek (SBC).

Since the initial preparation of this manuscript and final editing, a calibration error was found in Butte-Silver Bow's Metro Sewer Treatment Plant's discharge rates. Modifying data to compensate for this has led to moderate changes in some data from that presented at the April conference.

The Colorado Tailings are located west of Butte and north of Interstate Highways 15-90, T. 3 N., R. 8 W., sec. 23, and lie between the Butte-Silver Bow Metro Sewer Treatment Plant to the east, and Ranchland Packing Company to the west. Silver Bow Creek forms the east, north, and west boundaries of the tailings (fig.2). The site consists of approximately 30 acres.

Materials and Methods

The initial study plan was designed with the assumption that the tailings would be removed and deposited at a predetermined site (1). Since that time, the reclamation plan was modified due to the suspension of mining in the Butte area.

Twenty-eight shallow, 2-inch observation wells were placed through the center (east-west) east and west (north-south) portions of the tailings area (fig. 2). These were installed by hand via a Giddings Core Barrel to a maximum depth of 5 feet in an attempt to determine thickness and volume of material to be moved. These wells were used also for static water level (swl), specific conductance (sc), and pH measurements.

Twenty 4-inch wells were installed outside and within the main tailings area via the MBMG Mobil 50 auger drill rig (fig. 2). The primary purpose of these installations was to document existing ground water quality conditions, upgradient, within, and downgradient of the tailings area. They were used for water quality sampling, swl, sc, and pH measurements.

In addition to the well drilling, sites were selected for surface water sampling locations above and below the tailings in order to help quantify the effect of the tailings on SBC water quality (fig. 2).

All water quality sampling followed standard sampling and handling procedures, while trace metal samples were field filtered through a 0.45 filter and preserved with nitric acid (1)

Results and Discussion

Drilling results showed the presence of an organic layer underlying the tailings, which appears to act as a semi-confining layer, based on swl measurements (fig. 3). This layer does not exist beyond the north or south perimeters of the tailings.

Ground water flow direction is from the southeast to the northwest, as shown in figure 4. Water quality deteriorates from the south to the north and from the east to the west. Water from wells within the tailings most often exceeded recommended or permissible limits (8,9) for iron, manganese, sulfate, cadmium, copper, zinc, and arsenic, while well water outside (upgradient) the tailings generally exceeded manganese and sulfate standards as shown in figures 5 and 6.

Surface water samples have been collected four times since July 1983 for comparison of water quality above the tailings and below the tailings. (All above-the-tailings samples include the addition of the Butte-Silver Bow Metro Sewer Treatment Plant discharge.

Samples collected were grab, and handling procedures followed that for the ground water sampling. In conjunction with the sample collection, discharge (flow) measurements were performed at the same location.

In most cases, concentration levels of metals were greater below the tailings than above (figs. 7. 8. 9); the exception being a single occurrence for iron where the opposite was true. For the same sampling periods, flow rates varied from a 10% loss to a 35% increase, as shown in figure 10.

Knowing concentration levels and flow, loading rates, in kilograms per day (kg/d), were calculated showing changes once again from above the tailings to below them (figs. 11, 12, 13). This showed the same trend as did concentration (mg/L) only with sulfate being the one exception where loading above was greater than below on one occasion. The average loading rate increases varied from 15% for iron to greater than 70% for copper and zinc, with the greatest increases occurring during the May period, which was also the time of highest flow (spring runoff).

As was done with ground water, a comparison was made with recommended or permissible limits (mg/L), but in this instance included instream concentrations (1) along with drinking water standards. Instream quantification is somewhat harder to compare because certain standards are based on lethal concentrations (LC) or tolerance limits; i.e., copper, 0.1 x 96 hr LC50. Manganese was the only constituent, which exceeded limits for drinking and instream concentrations, while copper and zinc exceeded the concentration limit for instream limits below the tailings.

In an effort to make sure that trends shown by the MBMG sampling were actual, a comparison was made with data collected by the Montana Department of Health and Environmental 5ciences-Water Quality Bureau (WQB) (6) during an April 1983 sampling run and that collected by the MBMG during May 1984, which were both during high flows (fig. 10A). All comparisons were made using dissolved concentration results for calculating loading rates. Values compared were the percentage change from above to below for flow (Q), sulfate (504), copper (Cu), and zinc (Zn). Trends and the percentage change (increase) for the period of comparison were quite comparable and similar.

Conclusions

The Colorado Tailings site contains highly mineralized and oxidized material, which is highly erodable and has a high ground water table. These conditions lead to the degradation of the local ground water quality as it flows through the tailings area before discharging into Silver Bow Creek, thereby also affecting surface water quality. While the exceedance levels of the surface water were not as extreme as those shown in the ground water. The tailings are capable of long-term and severe heavy metal addition to SBC.

In order to mitigate the tailings impact on surface and ground water quality, the reclamation plan must reduce the amount of water, which passes both through and over the tailings area.

Acknowledgements

Bob Bergantino, Herman Moore and Fred Schmidt provided valuable assistance with the installation of the monitoring network and collection and interpretation of the data while Tom Satterly aided in the preparation of the figures. Finally, this investigation would not have taken place without the funding received from the Department of State Lands. A special thanks to Dick Juntunen and Ben Mundie of DSL for their assistance.

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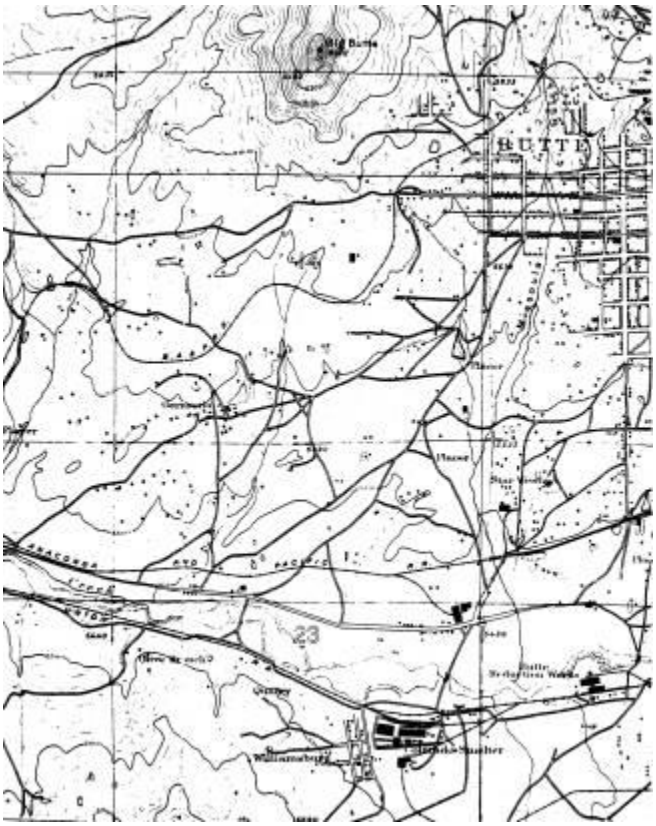
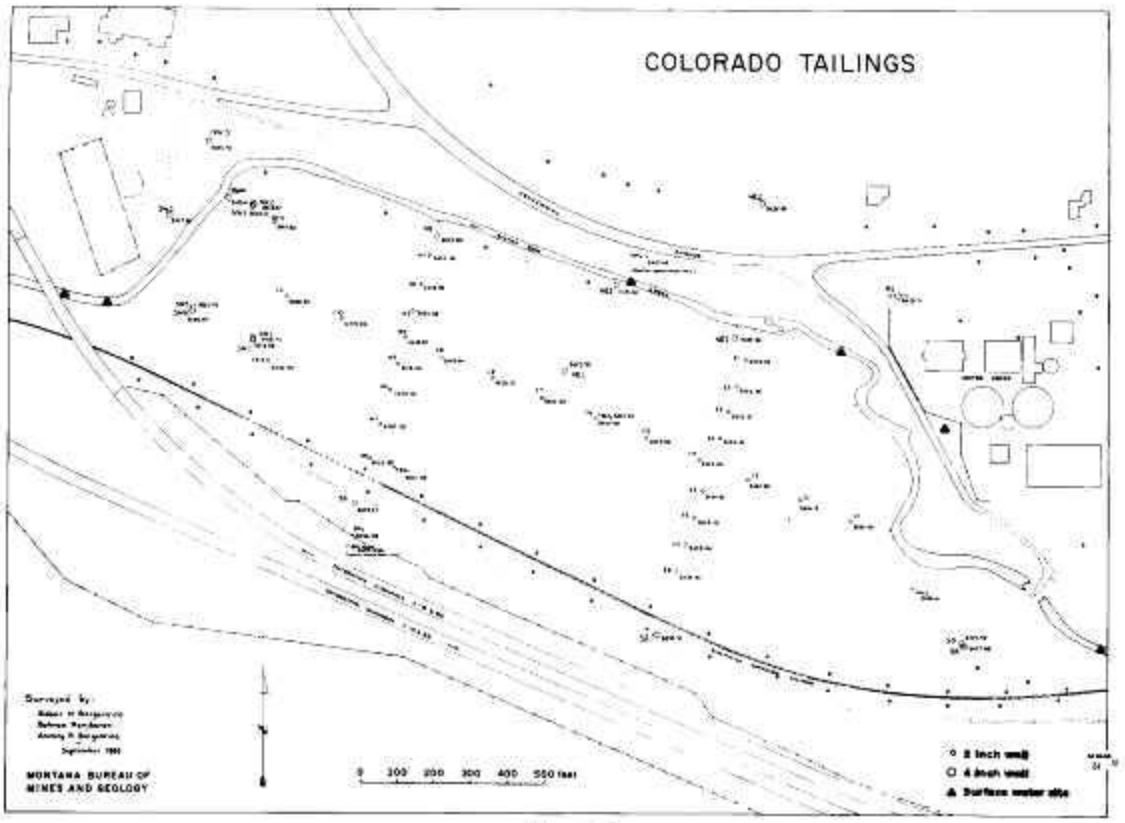
9. 40CFR Part 143. 1979. Federal Register, Vol. 44, No.140.

Figure 1





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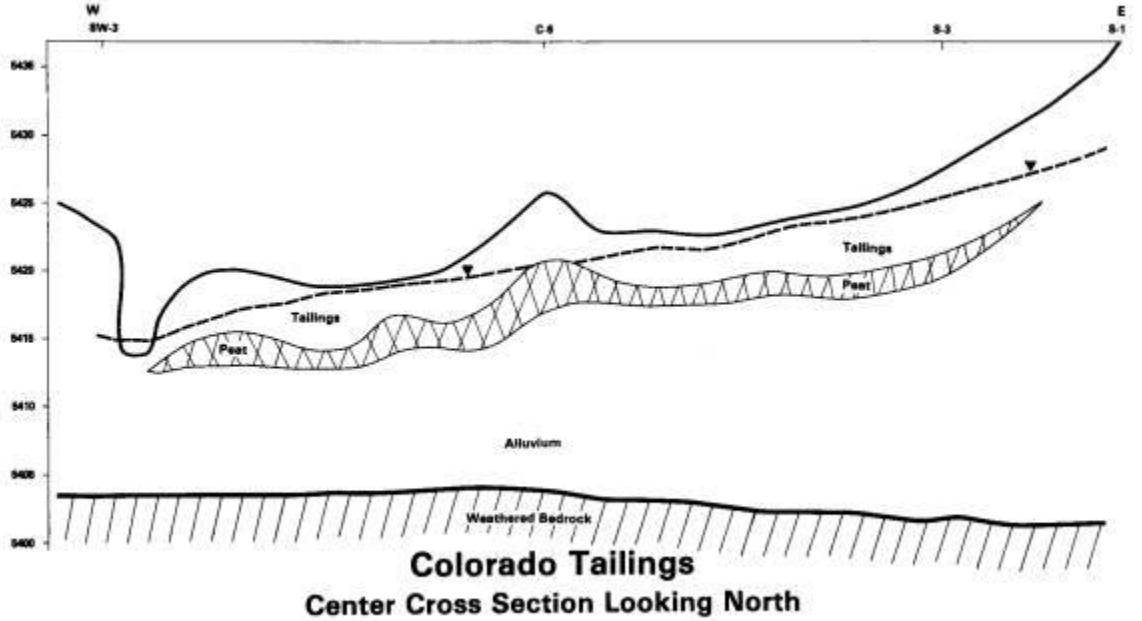

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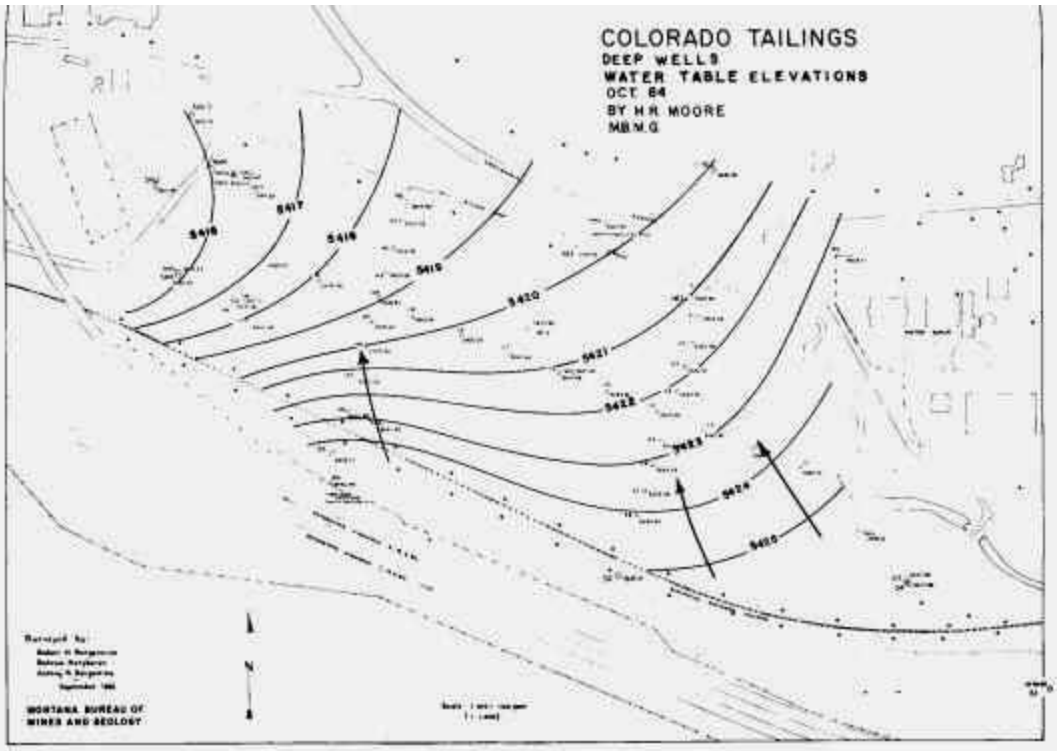

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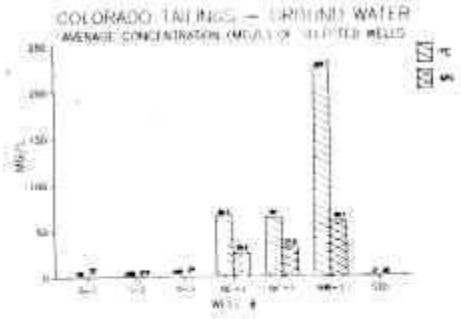

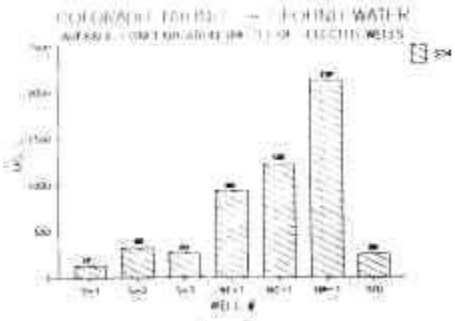

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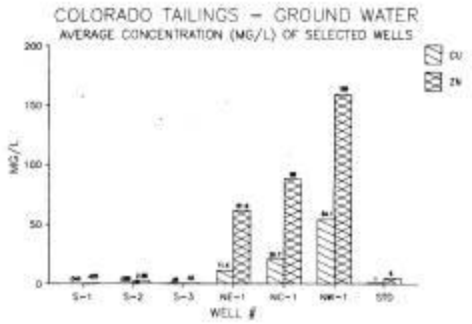

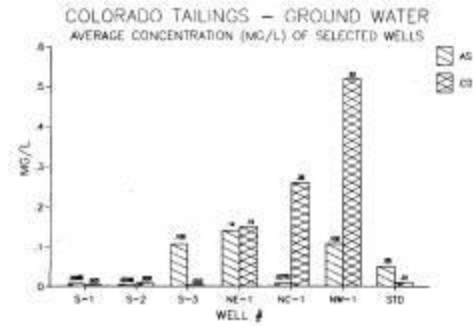

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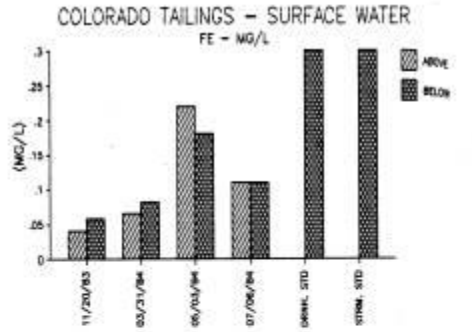

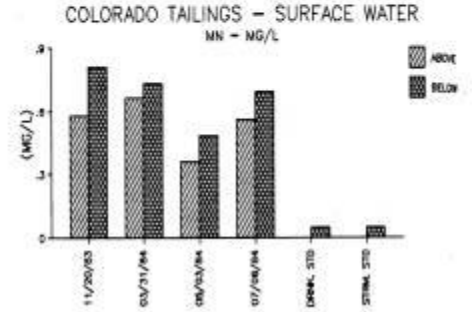

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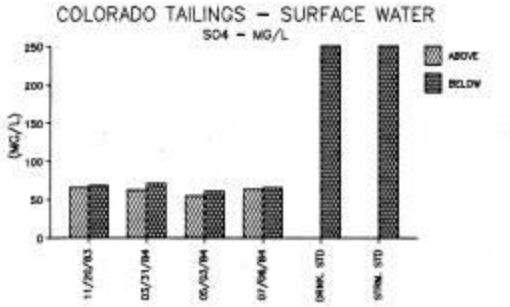

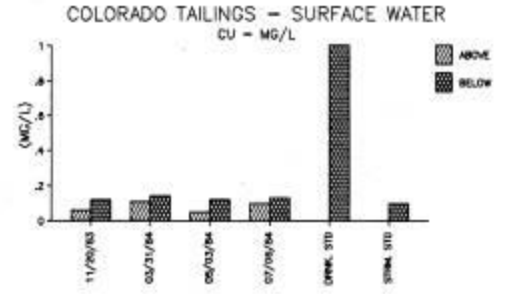

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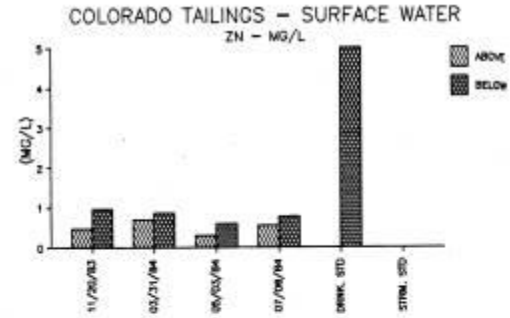

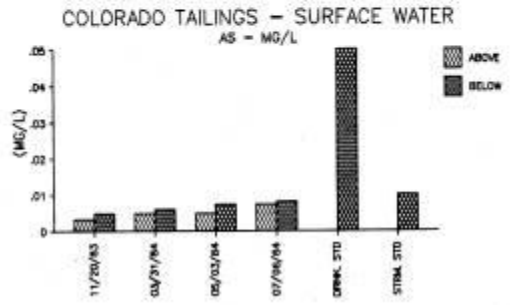

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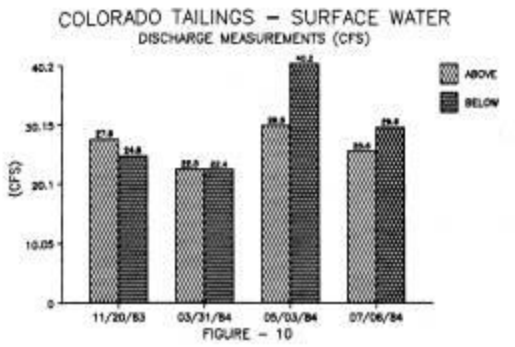


FIGURE – 10

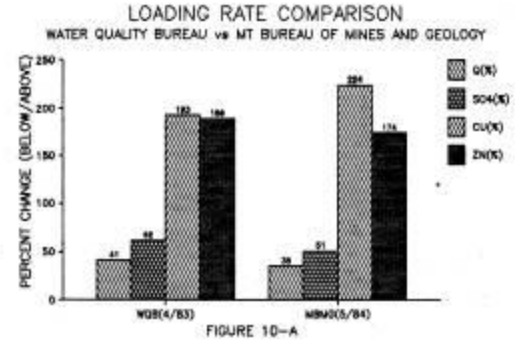
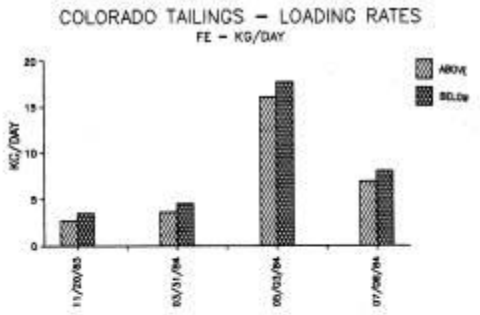
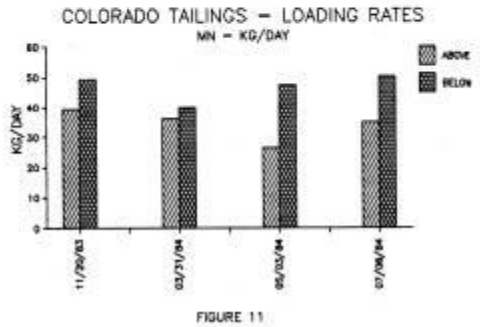


FIGURE 10-A





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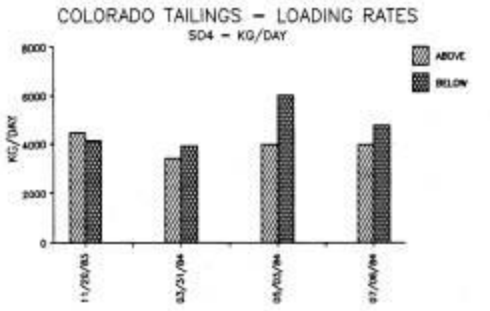

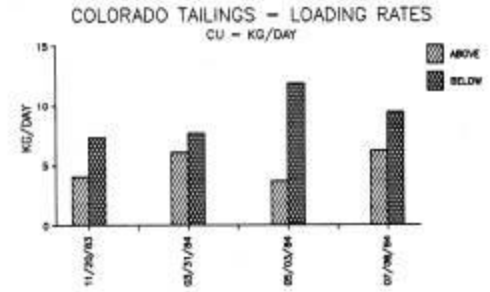

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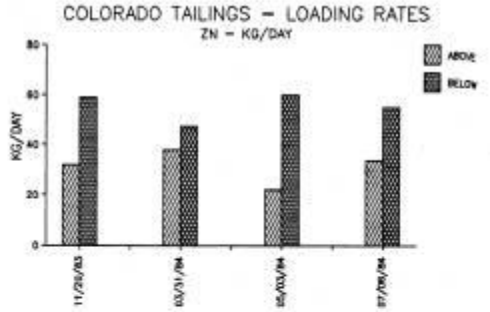

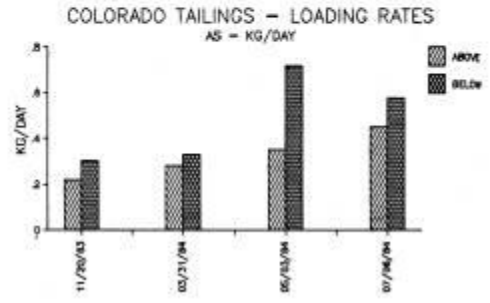

FIGURE 13