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PRELIMINARY ENDANGERMENT ASSESSMENT

EFFECTS OF METALS CONTAMINATION AT OLD WORKS OPERABLE UNIT ON AQUATIC BIOTA OF WARM SPRINGS CREEK, MONTANA

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EXECUTIVE SUMMARY

Warm Springs Creek is a valuable recreational resource in the Upper Clark Fork River basin. In addition to sustaining a resident trout population, which provides significant fishing opportunities, Warm Springs Creek is a major spawning tributary for brown trout from the Clark Fork River.

Mining and smelting waste materials originating from the Old Works Operable Unit are presently located in the Warm Springs Creek floodplain near Anaconda, Montana. This assessment was conducted to evaluate the potential for these wastes to enter Warm Springs Creek and subsequently to impact fish and other aquatic life.

Data summarized in this assessment indicate that there is potential for imminent and substantial endangerment to the aquatic biota of Warm Springs Creek as a result of metals contamination of the floodplain near the Old Works Operable Unit. Zinc and copper concentrations in the tailings along the floodplain of Warm Springs Creek are roughly comparable to concentrations in the Colorado and Mill/Willow Bypass tailings--both of which are impacting aquatic life in Silver Bow Creek and the Mill/Willow Bypass, respectively. Although other heavy metals are present at the Old Works Operable Unit, copper and zinc are most significant from the standpoint of their toxicity to aquatic life.

Water quality data demonstrate that zinc and copper concentrations increase during high streamflow events, at times exceeding acute and chronic toxicity criteria for protection of aquatic life. Metals may also enter the creek via overland runoff following precipitation events, from streambank erosion, and via seepage of bank storage waters. Streambed sediments collected immediately downstream from the Old Works Operable Unit have elevated concentrations of copper and zinc, identifying this area as a source of metals to Warm Springs Creek.

Data indicates that during most years, metals do not enter the stream in sufficient quantities to significantly impair the fishery. However, large quantities of waste materials are located in the floodplain and are accessible to the river should a flood event occur. Such an occurrence would cause large quantities of metals to enter Warm Spring Creek and would likely have a severe impact on the fisheries of both Warm Springs Creek and the Clark Fork River.

INTRODUCTION

This level 1 endangerment assessment is based on a review of available information relating to contamination of flood plain materials originating from smelting and mining wastes from the Old Works Operable Unit of the Anaconda Smelter CERCLA Site. The objectives of this assessment are to:

1. Characterize the types of contaminants available to Warm Springs Creek at the Old Works Operable Unit.
2. Identify possible transport pathways of contaminants present in the 100-year floodplain of the Old Works Site to surface waters of Warm Springs Creek.
3. Determine the extent of contamination of Warm Springs Creek surface waters and sediments.
4. Preliminarily assess the risks posed to aquatic biota of Warm Springs Creek from pollutants originating from the Old Works Operable Unit.

SITE DESCRIPTION

The Old Works Operable Unit is located immediately northeast of the community of Anaconda, Montana, at the western edge of the Deer Lodge valley. This is the site of the original Anaconda Minerals smelting facility which operated between 1884 and 1902. In 1902, most structures at the Old Works Operable Unit (which consisted of two smelter sites, a refinery, and two converters) were abandoned. Subsequently, copper concentrating activities were consolidated at the Washoe Reduction Works located southeast of Anaconda, Montana.

The Old Works Operable Unit contains substantial quantities

of waste materials, particularly metals, that could pose a threat to aquatic life in Warm Springs Creek. This area along with the Washoe Works, Opportunity Ponds, and surrounding contaminated soils comprise the Anaconda Smelter Superfund site.

Five waste deposits (heap-roasting slag, tailings north of the creek, tailings south of the creek, red sands, and black slag) are distributed along approximately 2 miles of Warm Springs Creek (Figure 1). Portions of three of the five deposits (tailings north of the creek, tailings south of the creek, and the red sands) are located within the 100-year floodplain of Warm Springs Creek.

WARM SPRINGS CREEK FISHERY

Warm Springs Creek is an important tributary of the Upper Clark Fork River. Resident trout provide angling opportunities for local fishermen, and perhaps more importantly, the stream is one of the most important spawning tributaries for upper Clark Fork River brown trout.

The reach of Warm Springs Creek upstream from the Old Works site, approximately from the confluence of the Middle Fork of Warm Springs Creek to Meyers Dam, possesses a high quality resident cutthroat and bull trout fishery. The presence of juveniles of both species (collected by electrofishing) indicates that natural reproduction is occurring (MDFWP 1988a). Based on a

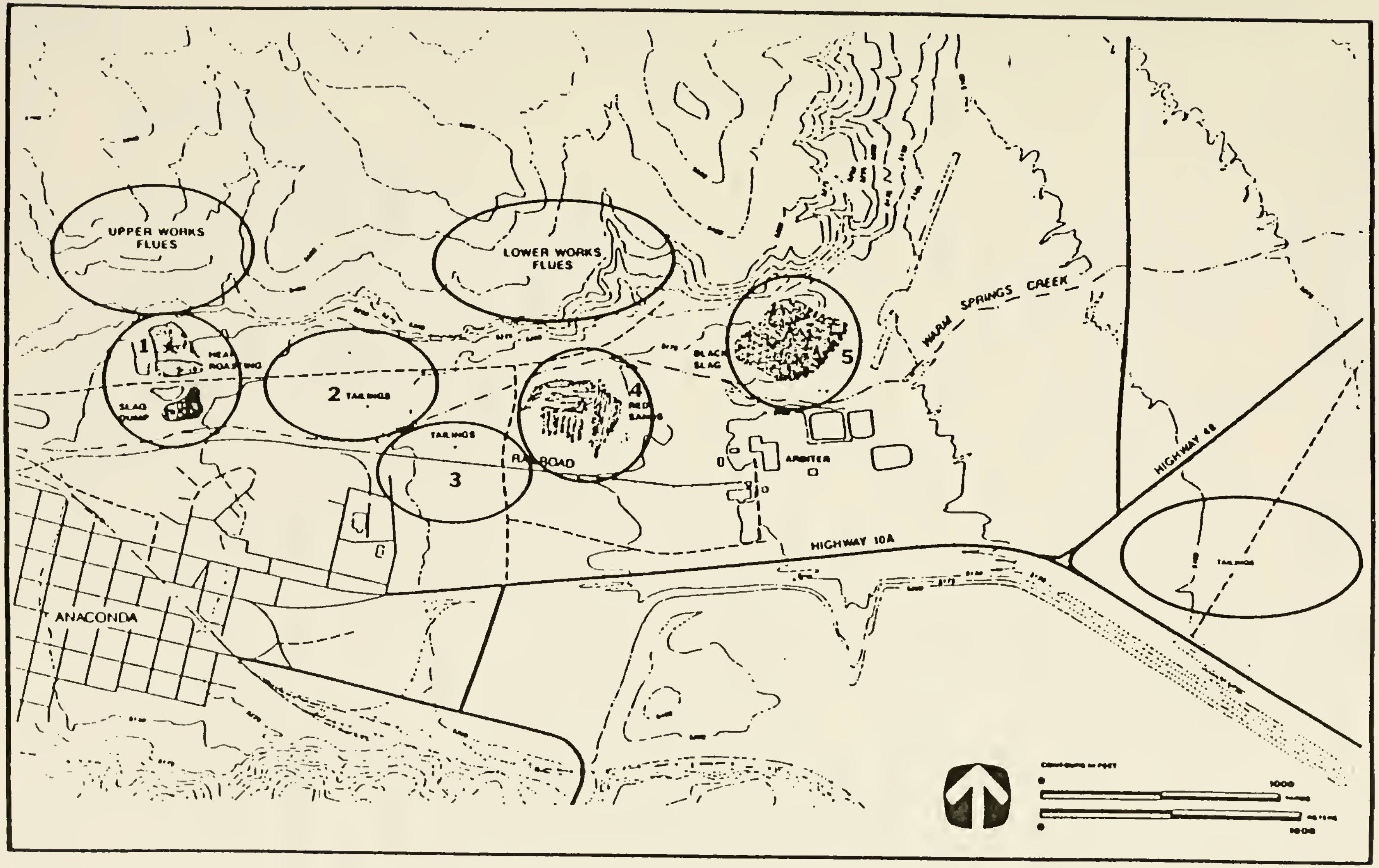


Figure 1. Five waste deposits located on the Old Works Operable Unit (Source: Tetra Tech 1987).

population survey conducted in 1983, the density of cutthroat trout (over six inches total length) was estimated to be 502 per mile of stream.

The resident fishery of the lower reach of Warm Springs Creek (from Meyers Dam to the mouth) changes from bull trout and cutthroat trout to predominantly brown trout. The reason(s) for the change in species composition is not known, but may be related to changes in habitat, stream flows, or spawning access for brown trout from the Clark Fork River. Brown trout numbers were estimated at 1492 fish per stream mile in 1983; a high density for a stream of this size. A few coarsescale suckers and mountain whitefish (both juveniles and adults) were also captured. Juvenile brown trout were common. The Clark Fork River immediately downstream of Warm Springs Creek also supports large number of brown trout (Figure 2). Brown trout densities were estimated at 2,027 per mile in 1987 (MDFWP 1988a).

The MDFWP evaluated spawning migrations of brown trout into Warm Springs Creek during 1983 and 1987. A variety of methods were employed to estimate the size of the spawning population including mark and recapture, electrofishing, and trapping.

Numbers of spawning migrants were not accurately quantified in 1983 because sampling was terminated before the completion of the migration period. Nevertheless, Warm Springs Creek was shown to be a major spawning tributary for Clark Fork River brown trout. Conservatively, 358 brown trout entered Warm Springs Creek in fall of 1983.

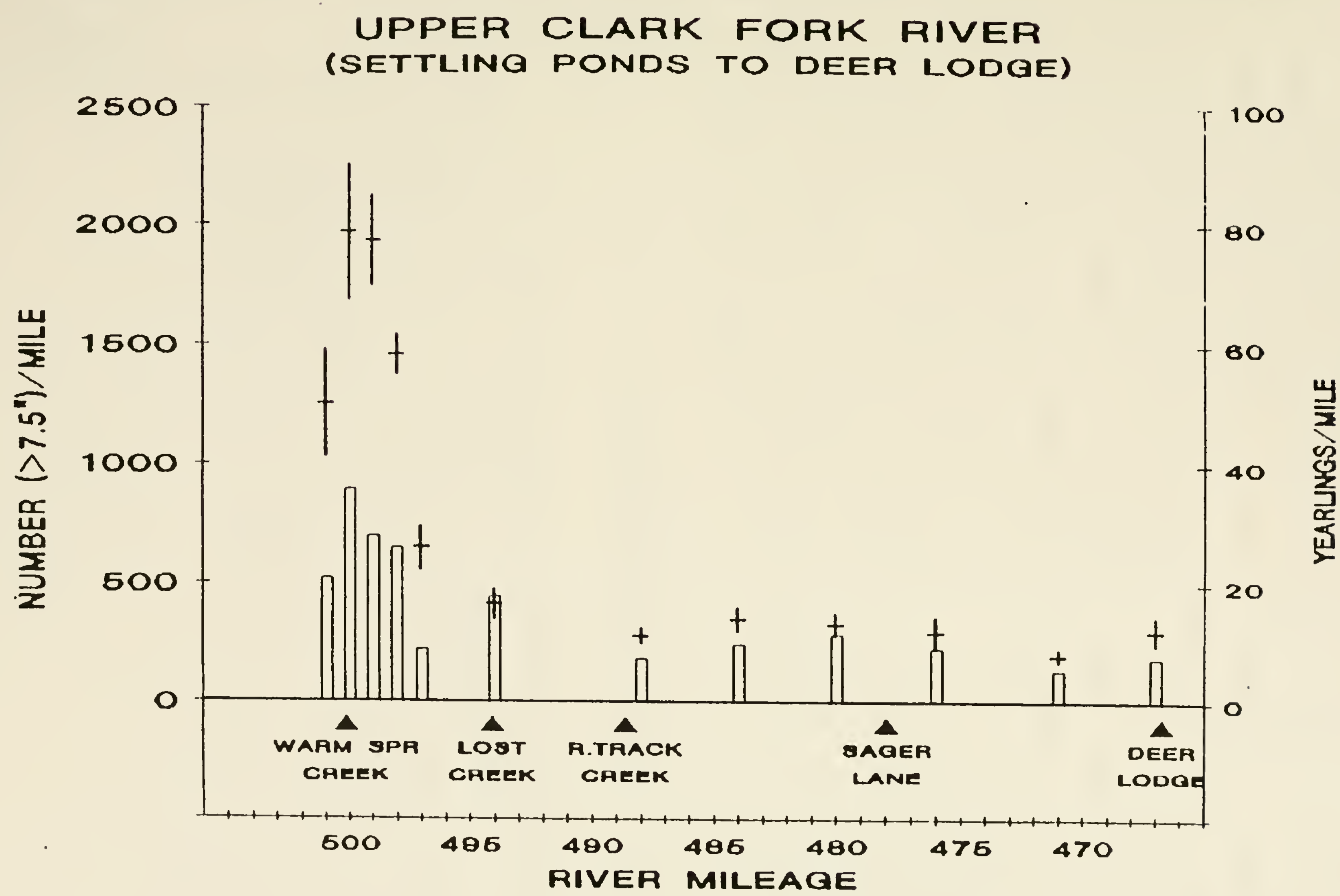


Figure 2. Estimated numbers of adult (± 80% confidence intervals) and yearling brown trout (bars) in 12 sections of the Upper Clark Fork River, spring 1987 (Source: MDFWP 1988a).

During fall 1987, spawning brown trout were sampled in Warm Springs Creek in an effort to recover fish tagged in the Clark Fork River. Large numbers (although not quantified) of spawning fish were present in the lower one mile of stream. Of 127 spawners captured, 11 were previously captured and tagged in the Clark Fork River during spring, 1987. Migrations as far as 43 miles up the Clark Fork River were documented.

Clearly Warm Springs Creek is an important spawning tributary for brown trout migrating out of the Clark Fork River. Subsequent recruitment of young fish to the Clark Fork River from Warm Springs Creek appears to be significant as evidenced by the high density of juvenile trout observed near the mouth of Warm Springs Creek (Figure 2).

CONTAMINANTS FOUND ON SITE

Five major waste deposits located on the Old Works Operable Unit were given consideration in this assessment:

1) Heap-roasting slag dump north of Warm Springs Creek.
2) Tailings deposits north of Warm Springs Creek.
3) Tailings deposits south of Warm Springs Creek.
4) Red sands west of the Arbiter site.
5) Black slag pile north of the Arbiter site.

Estimated surface areas and volumes of the waste deposits are shown in Table 1.

Table 1. Estimated sizes of five waste deposits at the Old Works Operable Unit (Tetra Tech 1985).

Deposit Type	Volume (cubic yds)	Area (acres)
Heap Roasting Slag	84,000	7
Tailings North of Creek	55,000	30
Tailings South of Creek	37,000	30
Red Sands	1,000,000	60
Black Slag	500,000	20

A variety of metals are found in wastes at the Old Works Operable Unit including copper, zinc, iron, arsenic, cadmium, and others (Tetra Tech 1987). This assessment will focus on copper and zinc because these two metals have been found to pose the greatest threat to aquatic life in other mining wastes in the Butte-Anaconda area (Phillips 1985).

Copper and zinc concentrations in the five waste deposits of the Old Works Operable Unit are present in a range similar to those found at other tailings sites (Colorado Tailings and Mill/Willow Bypass) in the upper Clark Fork drainage which are affecting aquatic life (McGuire 1987; MDFWP 1988) and are elevated well above concentrations typical of natural soils (Table 2).

Table 2. A comparison of copper and zinc concentrations in waste deposits located at the Old Works Operable Unit (Tetra Tech 1985; Camp, Dresser and McKee 1986), the Mill-Willow Bypass (Northern Engineering and Testing 1988), the Colorado Tailings (Duaime et al. 1987; Peckham 1979), and in natural soils (Bohn et al. 1979).

Sampling location	Sample type	Metal concentrations (mg/kg) copper	zinc
Old Works Operable Unit			
Heap-roasting slag	grab	6,100	18,000
Tailings N.of Warm Springs Cr.	core	2,450	93
" " "	core	370	14
" " "	trench	455	150
Tailings S.of Warm Springs Cr.	core	726	481
" " "	core	602	608
" " "	trench	701	1,040
" " "	grab	864	870
" " "	grab	626	561
Red Sands	grab	3,170	4,640
Black Slag	grab	6,030	9,460
Mill-Willow Bypass			
Unvegetated portion of channel	average 9 grab	983	1,327
Vegetated portion of channel	average 5 grab	432	777
Unveg. portion-first terrace	average 20 grab	8,154	9,037
Veg. portion-first terrace	average 19 grab	1,067	1,415
Colorado Tailings			
Center field	average 13 cores	1,370	-
West field	average 7 cores	3,055	-
East field	average 8 cores	1,390	-
Tailings	auger hole	1,400	11,000
Tailings	auger hole	500	3,700
Tailings	auger hole	3,900	12,000
Natural Soils			
Typical value	---	20	50
Range of values	---	2 - 100	10 - 300

ENVIRONMENTAL FATE AND TRANSPORT

The fate and transport of contaminants from the Old Works Operable Unit to Warm Springs Creek was evaluated using surface water quality information collected by the Department of Health and Environmental Sciences (Water Quality Bureau 1988), an assessment conducted by the United Stated Geological Survey (Parrett 1988), and information on metals concentrations present in sediments of Warm Springs Creek (Tetra Tech 1987).

Exceedance of Water Quality Criteria: Water quality and stream discharge data collected at the mouth of Warm Springs Creek from 1983 through 1987 (Water Quality Bureau 1988) demonstrate that water quality criteria for protection of aquatic life, particularly for copper, are exceeded. Water quality criteria for copper and zinc vary depending on water hardness. For example, at hardnesses of 100 and 200 ug/l (as Calcium Carbonate), the acute criteria for copper are 18 and 12 ug/l and for zinc 120 and 110 ug/l, respectively.

Standard analytical techniques for metals employed by various agenices are shown in Table 3. It should be noted that State of Montana methods for measuring total recoverable metals concentrations yields equal or lower concentrations than the EPA total recoverable method. Of 83 observations of copper and zinc concentrations in Warm Springs Creek, (measured using the State of Montana total recoverable method) acute toxicity criteria for copper were exceeded ten times.

Table 3. Analytical techniques employed by various agenices for heavy metals analysis (from Johnson and Schmidt 1988).

1. State of Montana Total Recoverable
    1. Acidify sample upon collection to a pH of <2.
    2. Decant off at time of analysis (no filtration).

2. USGS Total Recoverable
    1. Acidify sample upon collection to a pH of <2.
    2. Filter with 0.45u filter at time of analysis.

3. EPA Dissolved
    1. Filter sample with 0.45u filter at time of collection.
    2. Acidify to pH of <2.
    3. Analyze.

4. EPA Total Recoverable
    1. Acidify sample at time of collection to a pH of <2.
    2. Digest in the laboratory using hydrochloric acid.
    3. Filter sample.
    4. Analyze.

5. EPA Total
    1. Acidify sample upon collection to a pH of <2.
    2. Digest in the laboratory using hot nitric acid.
    3. Analyze.

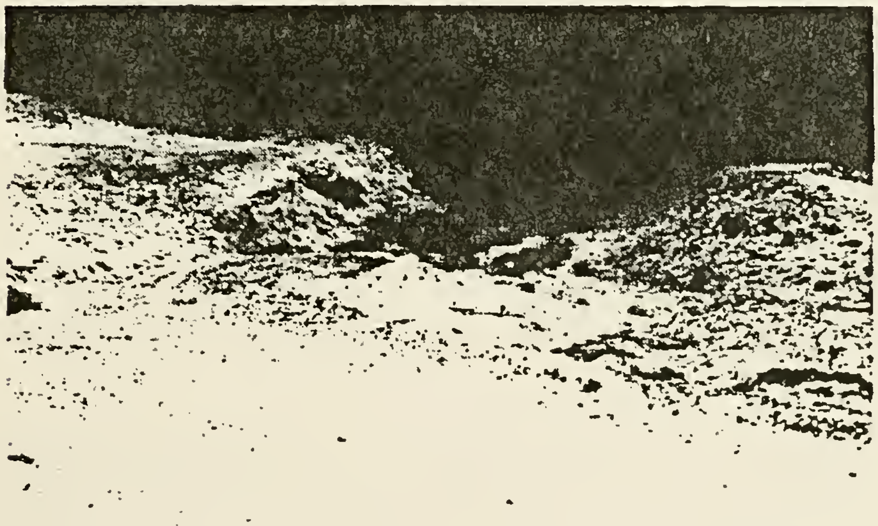
Accessibility of Metals to Warm Springs Creek: Parrett (1988) concludes: "Mine tailings are most accessible to Warm Springs Creek in three general areas of the Old Works Operable Unit -- red sands, north tailings, and south tailings (Figure 1). The two remaining waste deposits, the roasting heap and the black slag, are relatively isolated from the stream channel and have less potential for contaminant transport to Warm Springs Creek." Possible transport pathways of Old Works Site contaminants include: groundwater leaching into surface waters, overland flow during precipitation events, and streambank erosion during flooding.

Groundwater Contamination: Based on test well data, Tetra Tech (1987) tentatively conclude that groundwater contamination resulting from leaching of tailings from the Old Works Operable Unit is insignificant compared to leachate from the Anaconda and Opportunity Ponds. The importance of groundwater as a source of metals to the stream is further downplayed by the fact that Warm Springs Creek decreases in flow as you move downstream in the vicinity of the Old Works Operable Unit (Tetra Tech 1987). Groundwater contamination will be examined further during the RI/FS for the Old Works Site.

Precipitation and Overland Flow: Comparatively, overland flow during precipitation events offers a much greater opportunity for metals to enter the stream. Metals salts tend to concentrate near the surface of tailings deposits during high-evaporation and low-precipitation periods when metals present in standing waters precipitate as sulfates as the water evaporates (Johnson and Schmidt 1988). Tetra Tech (1985) observed a zone of

concentrated metals at the surface of the red sands wastes, and wicking of metals salts to the surface likely occurs at other deposits located on the Old Works Operable Unit. Environmental Protection Agency personnel have observed metals salts accumulating near the surface of moist areas within the red sands (Bishop 1988).

The United States Geological Survey recently evaluated potential for storm caused erosion near the Old Works Operable Unit (Parrett 1988). They conclude: "Tailings deposits north and south of the stream as well as red sands materials could be eroded and transported into Warm Springs Creek from localized rainstorms and subsequent runoff from exposed tailings. The white tailings area has a larger exposed surface drainage area, and hence the greatest potential for tailings transport from localized runoff. A tributary stream channel has cut through the white tailings (north of Warm Springs Creek) near the center of the area and provides evidence that previous erosion and transport to the creek has occurred (Figure 3). The magnitude and frequency of a storm event large enough to erode tailings from the white tailings area into the stream is not precisely known, but any storm large enough to produce overland runoff from this area will likely transport tailings into Warm Springs Creek. Although the volume of localized runoff from a given storm will be less in the red sands area than in the white tailings area, both areas have potential for erosion and possible mass movement into the Warm Springs Creek channel because of unconsolidated



igure 3. Two photographs of white tailings north of Warm Springs Creek showing a tributary channel cut through tailings and draining directly to the stream.

materials which slope steeply toward the stream (Figure 4). A high-intensity, short-duration storm with a 25 to 100-year recurrence interval could trigger a slope failure and mass movement of tailings into the stream particularly in the red sands area."

Data relating precipitation events to discharge and copper concentrations indicate that precipitation events can cause elevated metals levels at moderate stream flows. The highest concentration of copper in surface water was observed after an intense precipitation event (Table 4). Furthermore, a water sample collected June 14, 1988 immediately after a storm from a depression in the heap roasting slag contained 49.4 mg Cu/l and 1.1 mg Zn/l. The depression from which the sample was taken is located in an ephemeral drainage to Warm Springs Creek. Finally, on two occassions (28 November 1984 and 25 February 1986 in late fall or winter) water quality criteria were exceeded during periods of base flow (Table 3). In both instances the exceedance followed a relatively high maximum daily temperature preceeded by snowfall. Snowmelt over tailings followed by subsequent melting and runoff appears to be an additional source of tailings to the stream.

Overbank Flooding: Overbank flooding probably represents the greatest risk of contributing Old Works Site contaminants to Warm Springs Creek. Eight of ten measured exceedances of water quality criteria for copper occurred in the spring when streamflows were high (Table 3; Figures 5-9). According to the United States Geological Survey (Parrett 1988), overbank flooding would cause large quantities of metals to enter the stream.

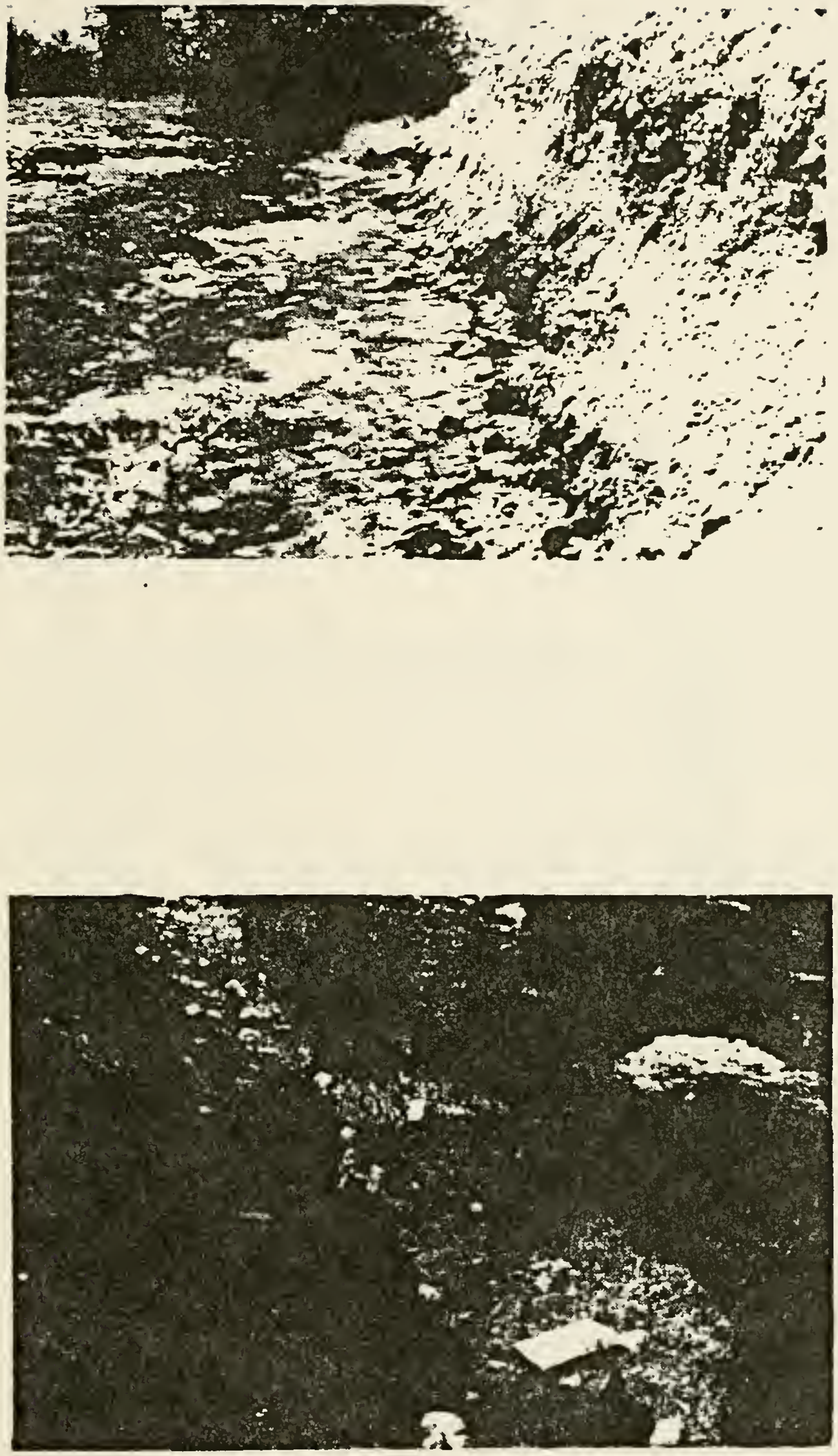


Figure 4. Two photographs of steep-sloping tailings with high potential for erosion to Warm Springs Creek. North bank of white tailings pictured on top, and red sands pictured on bottom.

Table 4. Relationship of total recoverable copper and zinc concentrations (Water Quality Bureau 1983-1986) to stream discharge and precipitation during ten events when copper criteria were exceeded near the mouth of Warm Springs Creek.

Date	Discharge (cfs)	Hardness (mg/l as CaCO3)	Concentration (mg/l)		Precipitation (inches)[a]		
			copper	zinc	Same day	1 Day previous	2 Days previous
05-31-83	296	70	0.05	0.02	0.00	0.00	0.00
05-15-84	167	143	0.17	0.07	0.43	0.01	0.00
05-22-84	179	136	0.03	0.02	0.00	trace	0.04
05-30-84	198	125	0.04	0.02	trace	0.00	0.00
06-12-84	176	127	0.07	0.01	0.08	1.17	0.24
06-19-84	278	86	0.03	0.01	trace	trace	0.00
06-27-84	360	34	0.06	0.02	0.24	0.08	trace
11-28-84	78	176	0.07	0.05	trace	trace	trace[b]
02-25-86	132	208	0.04	0.01	0.00	0.03	0.07[c]
06-02-86	315	73	0.03	0.02	0.00	trace	0.00

[a]National Oceanographic and Atmospheric Administration (1983-1986) Climactic data for Anaconda, Montana.
[b]Maximum daily temperature increased to 43°F causing snowmelt.
[c]Maximum daily temperature increased to 59°F causing snowmelt.

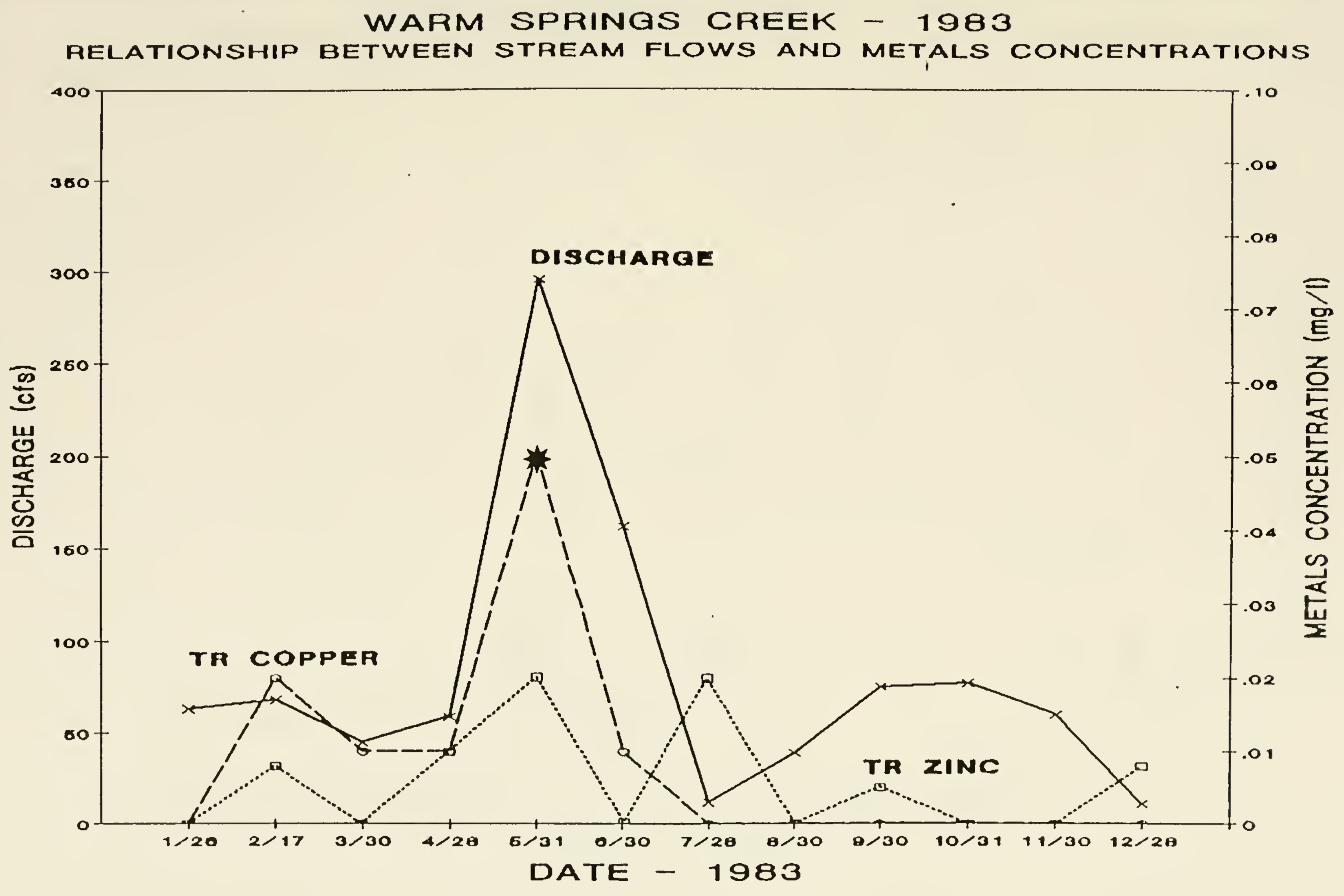


Figure 5. Relationship between stream flow and total recoverable copper and zinc concentrations near the mouth of Warm Springs Creek, 1983 (Water Quality Bureau 1988). * denotes exceedance of acute toxicity criteria.

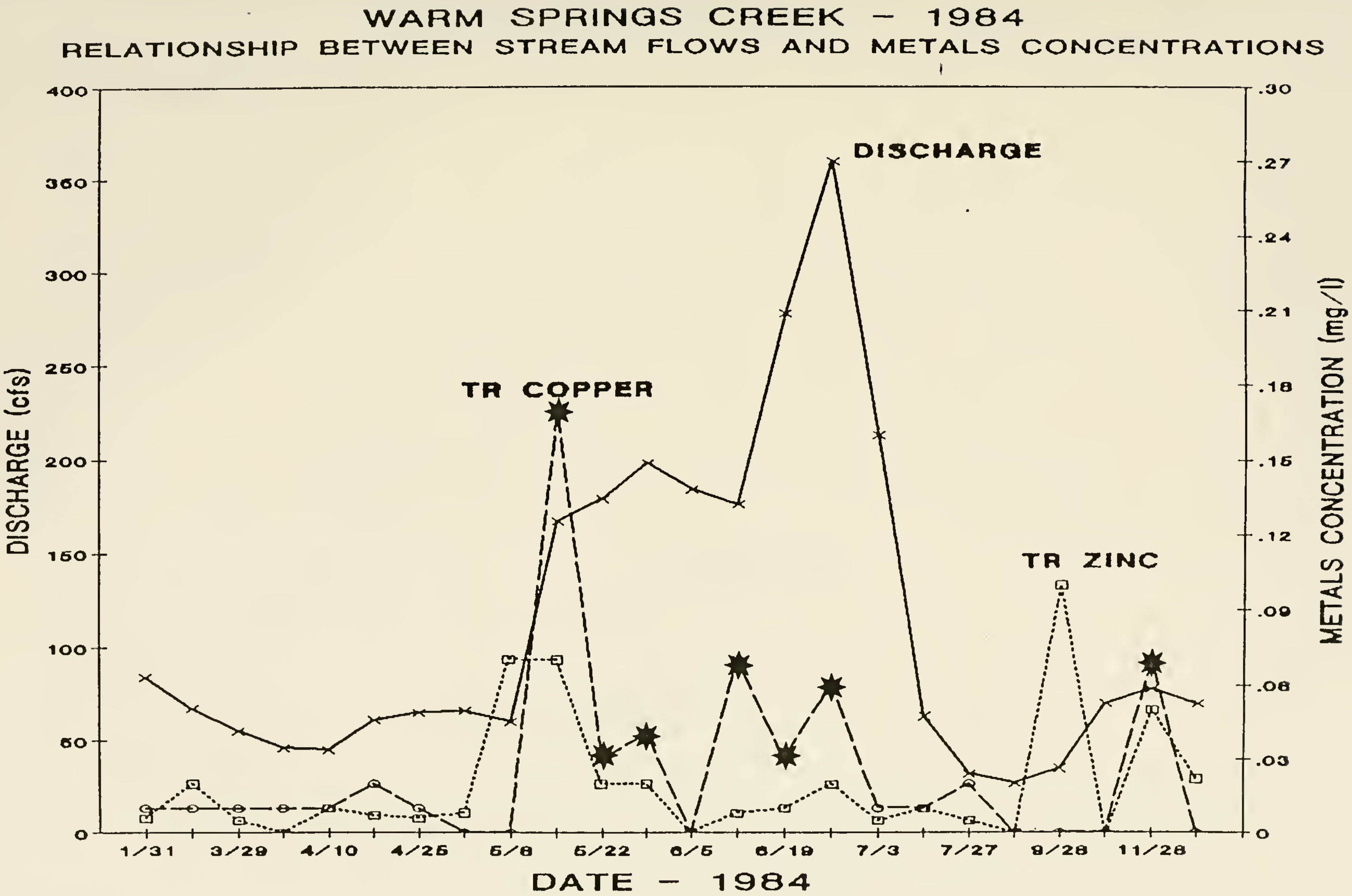


Figure 6. Relationship between stream flow and total recoverable copper and zinc concentrations near the mouth of Warm Springs Creek, 1984 (Water Quality Bureau 1988). * denotes exceedance of acute toxicity criteria.

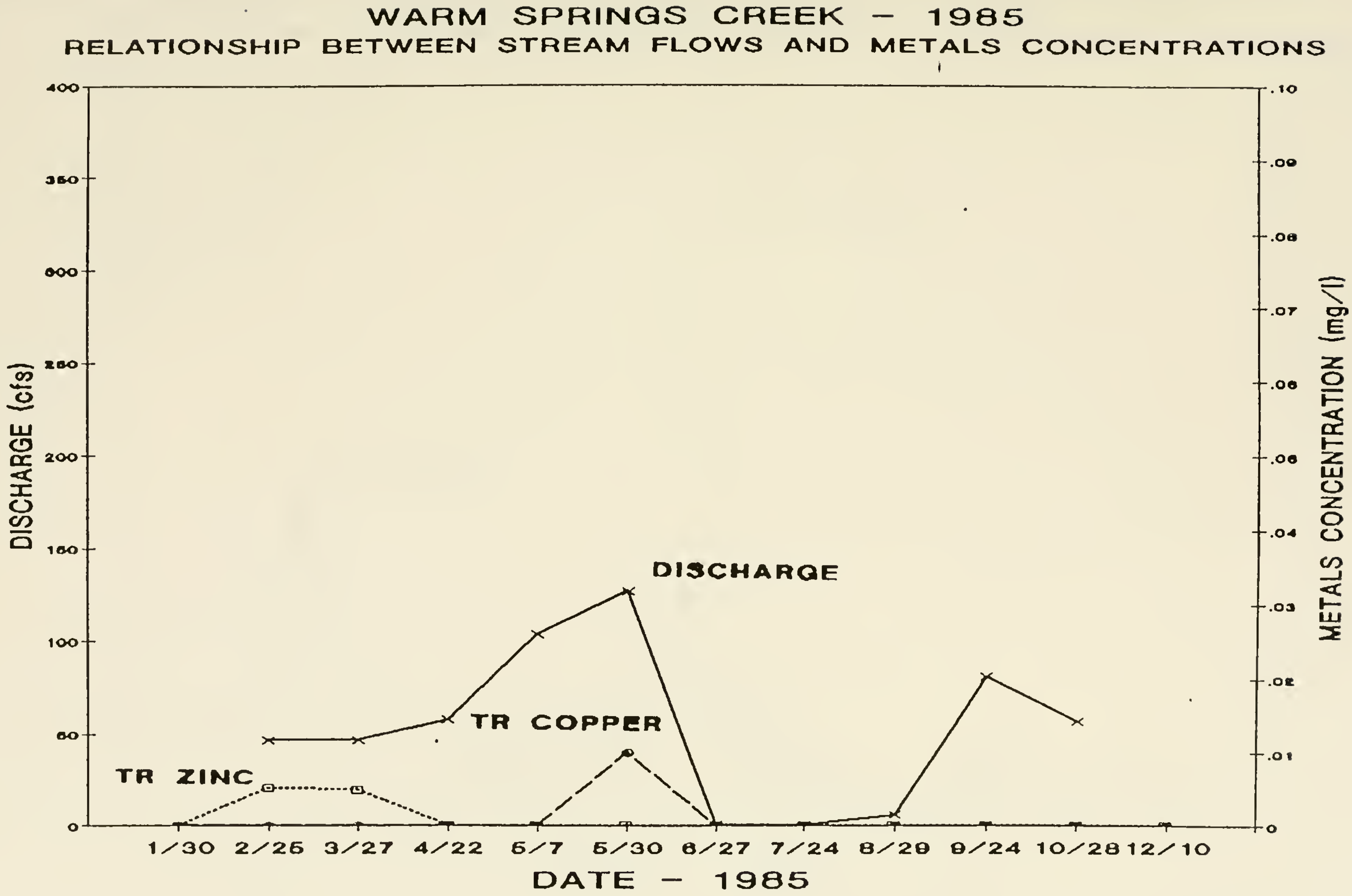


Figure 7. Relationship between stream flow and total recoverable copper and zinc concentrations near the mouth of Warm Springs Creek, 1985 (Water Quality Bureau 1988). * denotes exceedance of acute toxicity criteria.

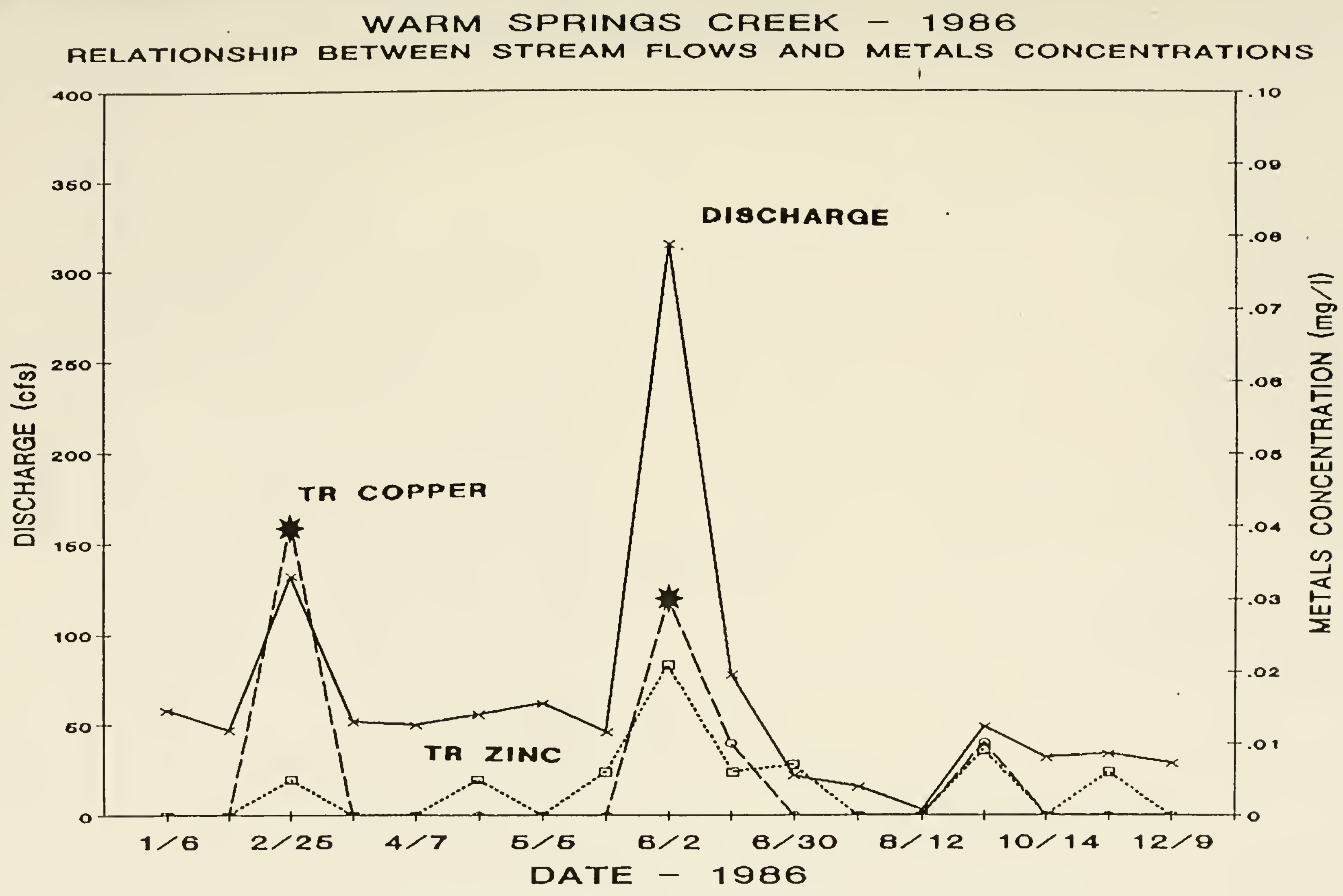


Figure 8. Relationship between stream flow and total recoverable copper and zinc concentrations near the mouth of Warm Springs Creek, 1986 (Water Quality Bureau 1988). * denotes exceedance of acute toxicity criteria.

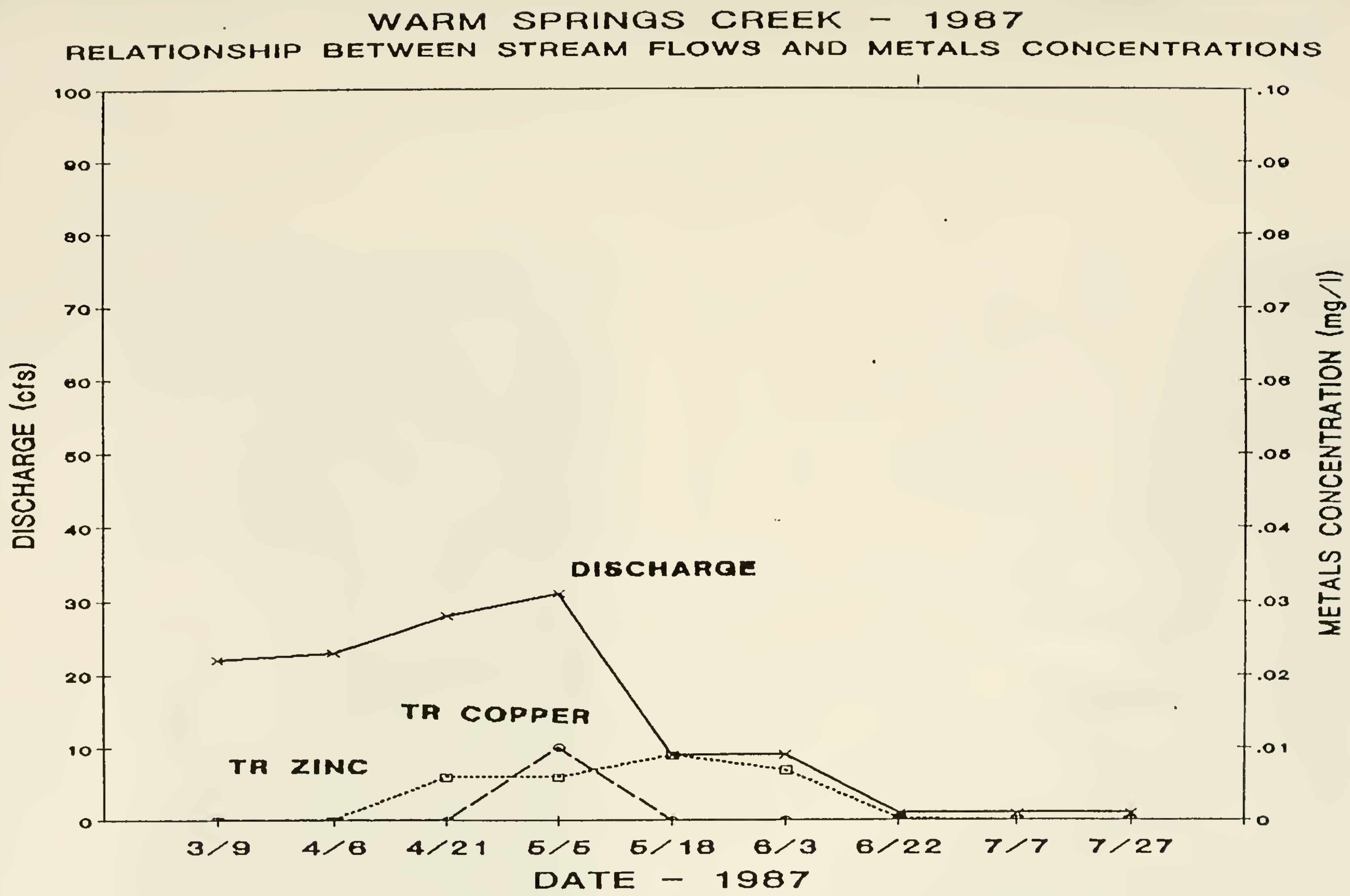
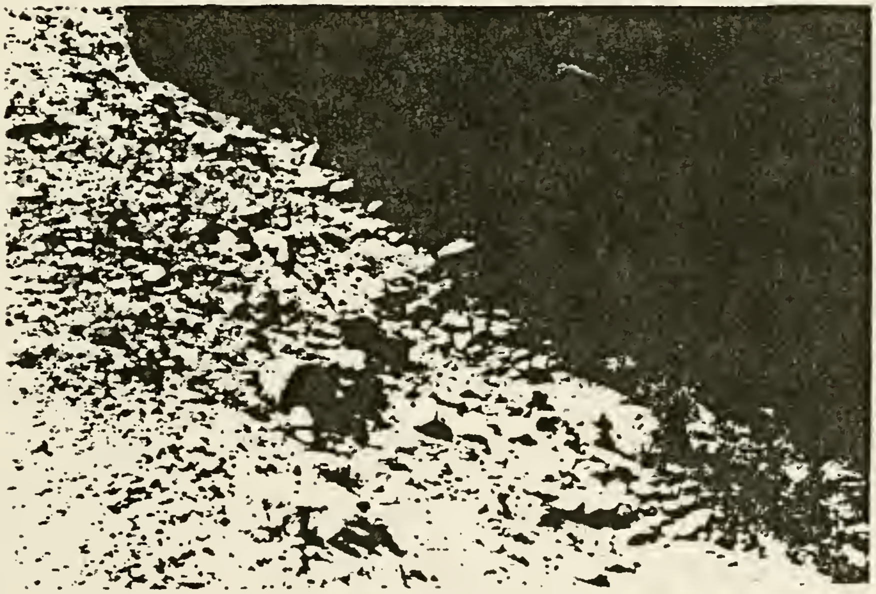


Figure 9. Relationship between stream flow and total recoverable copper and zinc concentrations near the mouth of Warm Springs Creek, 1987 (Water Quality Bureau 1988). * denotes exceedance of acute toxicity criteria.



igure 10. Photographs of white tailings on north bank showing limited riparian zone (top and bottom), and evidence of previous attempt to contain tailings (top).

"Observations of flood debris above waste margins confirm occurrences of overbank flooding. Although portions of all areas are protected by dikes, none of the dikes are continuous, and floods of relatively low recurrence intervals can be expected to reach tailings. In addition, some dikes are partially constructed of tailings materials which are a potential source of contamination during flooding. Areas with the greatest potential for tailings transport to Warm Springs Creek as a result of overbank flooding are the red sands and white tailings areas."

"In the red sands area, the deposits encroach within a few feet of the stream channel; any flows in excess of the existing bank-full channel capacity can be expected to reach and erode tailings. The bank-full channel capacity in the red sands area is estimated to be about the 2-year recurrence interval flood peak. Potential for erosion is also high at the white tailings area because some tailings are directly exposed to Warm Springs Creek (Figure 4). Where tailings are not directly exposed to the creek, the vegetated buffer zone is narrow (typically less than about 5 feet). Previous attempts to contain white tailings have proved inadequate and materials have high potential for erosion (Figure 10)." Five of ten observed exceedances of water quality criteria for copper (Table 4) occurred during high streamflows in the absence of significant precipitation indicating that streambank erosion alone has the potential to deliver significant quantities of metals to Warm Springs Creek."

"A flood-plain delineation study completed by the Soil Conservation Service (1976) indicates that the 10-year flood peak

(845 cfs) would reach an elevation about 4 feet higher than the streambed in the red sands area. Visual observation of the area in May, 1988 indicated that depths greater than 2 feet above the streambed would cause overbank flooding in much of the red sands area."

Copper and zinc concentrations in streambed sediments in Warm Springs Creek provide additional evidence that the Old Works Operable Unit is contributing metals to the stream. Tetra Tech (1987) measured highest concentrations of both metals immediately downstream of the Old Works Operable Unit (Figure 11). Copper concentrations are lowest upstream from the Old Works Operable Unit, peak immediately below it, and gradually decline in the downstream direction (Table 5). Zinc concentrations are also highest immediately below the Old Works Operable Unit and decline as you move downstream (Table 5).

Table 5. Copper and zinc concentrations in Warm Springs Creek streambed sediments at six sample locations (Tetra Tech 1987).

	Average Concentration (mg/kg)	
Station	Copper	Zinc
WS-1	90	398
WS-2	168	481
WS-3	555	744
WS-4	349	349
WS-5	182	252
WS-6	182	245

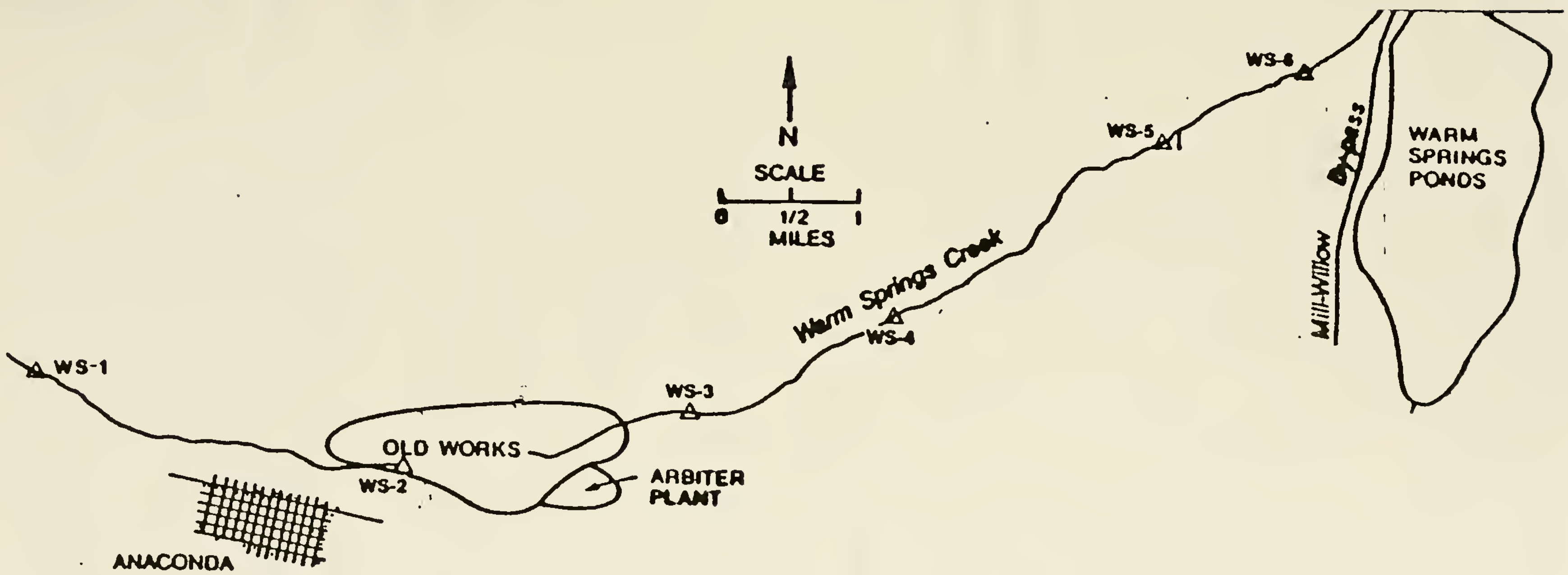


Figure 11. Six sediment sampling stations in Warm Springs Creek (Tetra Tech 1985).

In summary, existing information indicate that flooding and overland flow have the potential to transport significant amounts contaminants from the Old Works Operable Unit to Warm Springs Creek. Streambed sediments and surface waters of Warm Springs are the recipients of these contaminants. Although acute toxicity criteria are occasionally exceeded, it is anticipated that during most years, spring runoff does not erode sufficient waste materials into the stream to severely impact the fishery. However, a major flood event would cause large amounts of waste materials to enter the stream and would likely cause more severe exceedances of water quality criteria.

EXPOSURE ASSESSMENT

High concentrations of copper present in Warm Springs Creek during high flow events and elevated metals concentrations in stream sediments indicate that aquatic organisms in Warm Springs Creek are exposed to contaminants from the Old Works Operable Unit. Aquatic life in the Clark Fork River downstream from the mouth of Warm Springs Creek also receive exposure to Old Works contaminants.

Organisms exposed to contaminants include stream invertebrates, resident fish, and migratory fish from the Clark Fork River. Resident aquatic life are exposed to Old Works contaminants periodically throughout their lives (primarily during spring flow events). Progeny of migratory Clark Fork River brown trout are exposed during egg incubation

(approximately from November through April) and during sensitive rearing stages in the spring (a period when metals concentrations tend to be highest). The severity of exposure is expected to increase with the magnitude of flooding and the intensity of precipitation events.

TOXICITY ASSESSMENT

Toxicity of copper and zinc to aquatic life has been thoroughly reviewed in EPA criteria documents (EPA 1985). These documents were used to determine the potential effects of the copper and zinc concentrations measured in Warm Springs Creek. In addition, toxicity of wastes entering other waters (Mill/Willow Bypass and Silver Bow Creek) in the Upper Clark Fork River drainage were used to assess toxicity of wastes at the Old Works Operable Unit.

In the upper Clark Fork River drainage, five fish kills were documented between 1983 and 1988. All of these kills were associated with thunderstorms and are believed to be a result of metals being transported to the river due to rainfall on mine tailings. During one of these kills, water sampled in the Mill/Willow Bypass immediately after a thunderstorm had a pH near 4.5 and contained copper concentrations of over 100-fold the acute toxicity criteria (MDFWP 1988b). In addition, instream bioassays conducted with early life stages of rainbow trout show that these life stages experience slow mortality upon exposure to Silver Bow Creek and mainstem Clark Fork River water (Phillips

and Hill 1987).

Although fish kills have not been observed in Warm Springs Creek, Old Works Site contaminants contain copper and zinc concentrations that are similar to those present in wastes where fish kills have occurred. Mortality could easily go unnoticed, especially mortality of early life stages. More importantly, an extreme flood would greatly increase the amount of tailings entering the stream. Acute toxicity criteria for copper were exceeded ten times during water sampling from 1983 to 1987 (Table 4). Most of these exceedances occurred during periods of high streamflow in the spring when the most sensitive life stage are present in Warm Springs Creek.

Zinc levels never exceeded criteria for the protection of aquatic life, but were elevated during increased stream flow. Lloyd (1961) and Spraque and Ramsey (1965) showed that mixtures of copper and zinc interacted additively when fish were exposed to concentrations known to be acutely toxic (i.e., the toxicity of the mixture was equal to the sum of the toxicities observed when fish were exposed to each chemical individually). Similarly, Eaton (1973) observed a slight enhancement of toxicity (greater than additive toxicity) when fish were exposed to a bimetal mixture of copper and zinc. Such interaction likely occurs in Warm Springs Creek and in other segments of the Clark Fork River drainage when acute toxicity criteria are exceeded.

RISK AND IMPACT EVALUATION

There is a risk posed to Warm Springs Creek biota as a

result of the potential exposure to acutely and chronically toxic levels of metals (especially copper) in surface waters. Elevated concentrations of copper and zinc in streambed sediments is an additional source of risk to invertebrates which live in the substrate, and to trout eggs and alevins which are present in the intergravel. Although criteria for protection of aquatic life were shown to be exceeded occasionally between 1983 and 1987 (when the magnitude of spring runoff in Warm Springs Creek was near or below normal) these occasional exceedances of criteria probably do not severely impact the fishery. Evidence for the above is demonstrated by the existence of a relatively healthy brown trout fishery downstream from the Old Works Operable Unit. However, the high concentrations of metals, particularly copper, in wastes located in the flood plain at the Old Works Operable Unit suggest that severe flooding would cause large amounts of metals to enter the stream. Such an event is likely to have significant impacts on the fishery of Warm Springs Creek and quite likely on the fishery of the Clark Fork River.

CONCLUSIONS

Metals wastes present in the floodplain of Warm Springs Creek pose a significant risk to the aquatic life in the stream, particularly during high intensity rainstorms and periods of high stream discharge. Floods exceeding bank-full capacity would cause contaminants to enter Warm Springs Creek from the red sands area, the white tailings bordering to the north of the stream,

and the white tailings bordering to the south of the stream.

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