WATER QUALITY STATUS REPORT ● REPORT NO. 70

WATER QUALITY TREND MONITORING FROM 1979-1985 IN THE STIBNITE MINING DISTRICT

Valley County, Idaho

Prepared by
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Department of Health & Welfare
Division of Environment
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ABSTRACT

Water quality monitoring was conducted by the Idaho Department of Health and Welfare, Division of Environment, in cooperation with the U. S. Forest Service, Payette National Forest, in the Stibnite Mining District from 1979 through 1985. The Stibnite Mining District is located in Valley County, Idaho in the drainage of the East Fork South Fork Salmon River. The monitoring program was established to document any changes in water quality associated with the initiation of a large scale open pit mine and cyanide leaching plant. A total of twenty-four stations located on the East Fork South Fork Salmon River and its tributaries were monitored several times per operating season for sediment, turbidity, pH and metals. Short term water quality impacts were apparent in West End Creek, Sugar Creek, and the East Fork South Fork Salmon River both within and below the mine site. Concentrations of arsenic, iron and turbidity were significantly higher in samples collected below the mine as compared to upstream and background samples. These short term impacts were usually associated with storm events. Several more years of water quality monitoring is necessary to estimate long term trends.

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INTRODUCTION

The Stibnite Mining District is located in north-central Valley County 14 miles east of Yellow Pine, Idaho (Figure1) (JMM 1981). This area has been extensively mined for decades. Minerals extracted from the region include gold, silver, antimony, and tungsten.

BACKGROUND

History of Mining in the Stibnite Vicinity

Mineral activity in the Stibnite district began in 1927 when the Bradley Mining Company started an underground mine near Meadow Creek, a tributary to the East Fork South Fork Salmon River (East Fork).

In 1938, the Yellow Pine Open Pit Mine was begun on the East Fork. The pit was located in the river bed and the entire river flow was diverted around the pit and into a tunnel through a mountain north of the river channel. Antimony was the major mineral produced by the mine. Ninety percent of the antimony for World War II came from this mine. The mine also produced tungsten for the war effort. In 1943, the population of Stibnite reached its maximum of about 1500 people. After the war the demand for antimony dropped, and in 1952 the Bradley Mining company closed the operation (JMM 1979). The open pit in the middle of the East Fork river bed still remains and is referred to as "The Glory Hole".

Recent Mining Activities

Rising gold prices in the 1970's promoted a renewed interest in the Stibnite Mining District. However, the grade of gold ore in the area prompted a shift from some of the traditional mining processes. Specifically, a dilute cyanide solution was proposed for dissolution of the gold from the ore in a process known as heap-leaching.

The Canadian Superior Mining Company (Superior) developed the project gradually over a period of nearly 11 years. The following chronological summary highlights the major steps taken in exploration, design and construction of the present day mine and cyanide leach plant. Emphasis is placed on the environmental implications of the developing mine and the steps taken to monitor the activities.

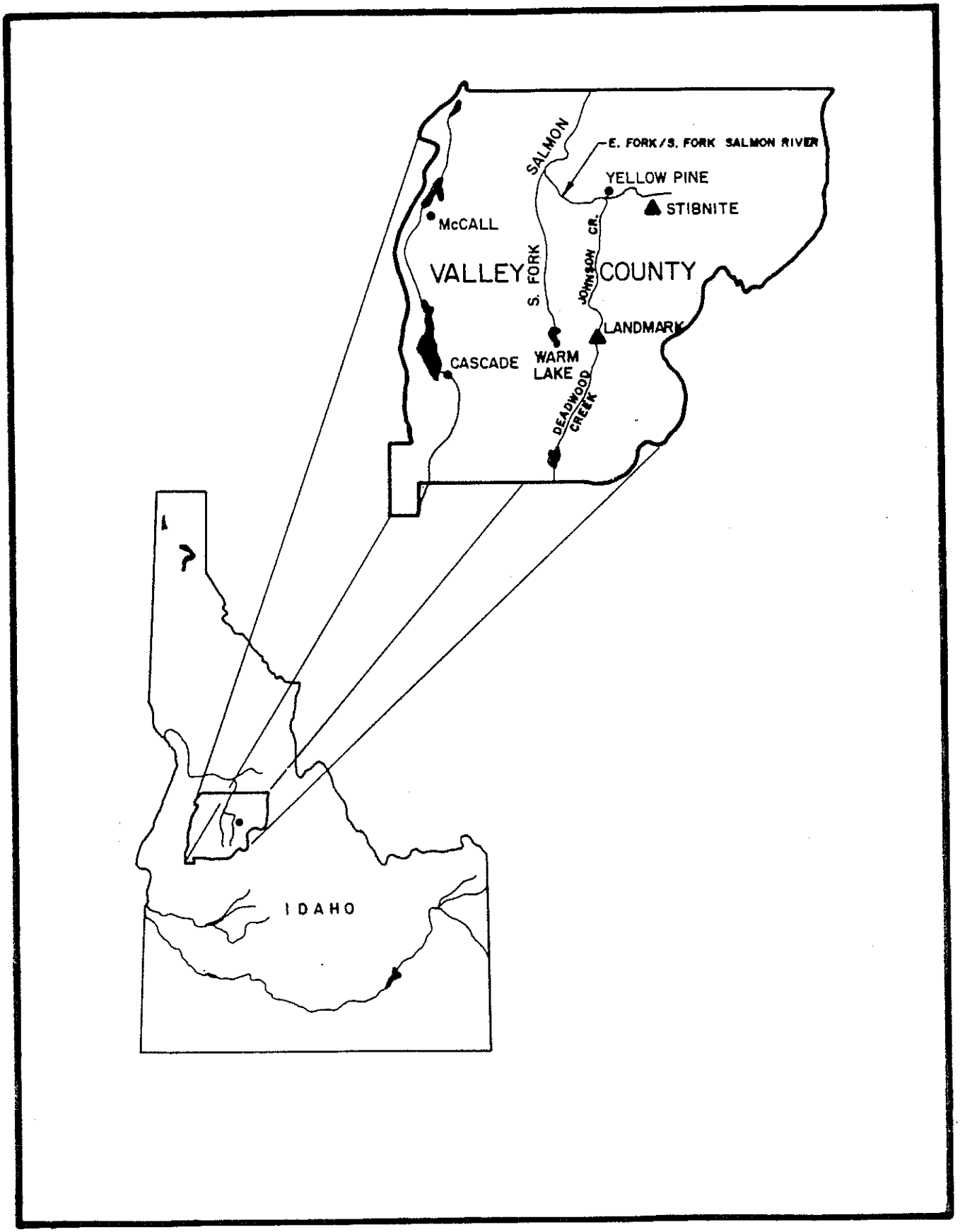


Figure 1. Stibnite Mining Project location map (JMM 1981).

Chronological Development of the Stibnite Cyanide Leach Mine[1]

1974 Superior began an extensive exploration program in the Stibnite Mining District.

1978 Geologic work and drilling showed the existence of significant tonnages of ore grade material. Therefore, Superior began construction and operation of a pilot level cyanide heap leaching plant. The U. S. Forest Service (USFS) prepared an environmental assessment for the pilot plant operation.

WATER QUALITY
Baseline water quality monitoring and impact monitoring in conjuction with the startup of the pilot plant was begun by Superior's contractor, James M. Montgomery, Consulting Engineers (JMM).

1979 Superior filed a "Notice of Intent to Operate" with the Payette and Boise National Forests. The proposal involved two open pit surface mines covering roughly 46 acres, two mine waste dumps involving approximately 31 acres, a processing facility covering approximately 20 acres, and a process waste disposal site involving 35 acres of an existing tailing pile.

WATER QUALITY
The USFS and the Idaho Department of Health and Welfare, Division of Environment (DOE) entered into a Memorandum of Understanding to address water quality monitoring in conjunction with the Stibnite mine project. The objective of this program was to establish a data base independent of that collected by the mine company. The first baseline monitoring conducted by the USFS and DOE was in 1979.

JMM continued baseline water quality monitoring for the mine company.

1980 Baseline water quality data was collected by the agencies and the mine company.

[1] Much of this summary is based on the monitoring report by Barbouletos (1984)

1981 In May, the Final Environmental Impact Statement (EIS) was released by the USFS. Construction was initiated on the mine and mill. Meadow Creek, a tributary to the East Fork, was rerouted around the World War II tailings. Timber was cleared from the Garnet Creek mine area.

WATER QUALITY
An extensive list of mitigation and monitoring measures was included with the Record of Decision. In particular, the EIS required a detailed monitoring plan be jointly developed by the Forest Service and the mine company. The purpose of the monitoring plan was to detect harmful changes in environmental conditions in time to take corrective action.

1982 Full scale operations began. The first ore was leached. Three 35,000-ton heaps of spent ore were placed on the old tailings. Over one million gallons of neutralized process solutions were sprayed on the tailings. Eight groundwater monitoring wells were installed.

WATER QUALITY
Runoff problems began, especially associated with storm events. Sediment from the haul roads was a significant source of turbidity to the East Fork. The box culvert, built over the East Fork to handle the heavy hauling trucks, was a serious source of sediment.

A buffer strip of 50-100 feet is maintained between the open pit mine and West End Creek.

1983 At startup, the mine had a stockpile of 171,000 tons of ore. The USFS recommended the haul road remain closed until the spring runoff had subsided as an effort to protect water quality. Seventeen heaps (600,000 tons) of spent ore were trucked to the tailings disposal area.

WATER QUALITY
This was a very wet year with high spring runoff and several fall storms. Corrective measures taken at the box culvert only shifted the drainage problems to other areas of the road. The 50-100 foot buffer strip between the mine and West End Creek was removed to make way for mineral extraction. Impacts to the creek were substantial. The creek was diverted into culverts. Runoff from exposed mine slopes contributed to the turbidity problem in West End Creek.

On October 25, 1983, the Idaho Department of Health and Welfare entered into a Compliance Schedule Order with Superior Mining Company. The purpose of the order was to provide a mechanism that was acceptable to both the mine company and the Board of Health and Welfare for monitoring and regulating the effects of mining activities, and was based on the turbidity problems in West End Creek, Sugar Creek, and the East Fork.

1984 The permanent diversion of West End Creek was constructed. The Upper West End Dump was finished and construction of the French drain in the Lower West End Dump was initiated.

WATER QUALITY
Violations of the turbidity standard in the Compliance Schedule Order occurred in June, July, August, and September.

1985 The Stibnite mine did not operate during the 1985 season because of the pending sale of the project. However, leaching did occur on ore left on the pads at the end of the 1984 season. Also, routine maintenance was performed.

WATER QUALITY
Based on violations of the Compliance Schedule Order, the Idaho Board of Health and Welfare entered into a Consent Decree with Superior Mining Company in December 1985. The Consent Decree mandated intensive storm event monitoring as well as weekly compliance monitoring. Penalties were stipulated for violations of the order.

The report documenting the results of compliance and storm event monitoring conducted by the Division of Environment during the 1986 operating season is contained in Appendix A.

PURPOSE

The purpose of this report is to publish, for the first time, the results of water quality monitoring conducted by the Idaho Department of Health and Welfare-Division of Environment, in conjunction with the U.S. Forest Service-Payette National Forest, in the Stibnite vicinity. Seven years worth of data from 1979 through 1985 is documented.

In 1984, the Forest Service published a comprehensive monitoring report which documented all types of monitoring conducted in the area, by both the mine company and the agencies (Barbouletos 1984). This report covered the years from 1978-1983, and gave a detailed description of the mining operation, and the associated impacts to each segment of the East Fork drainage. However, this report did not include data or report the results of the cooperative monitoring program.

DRAINAGE DESCRIPTION

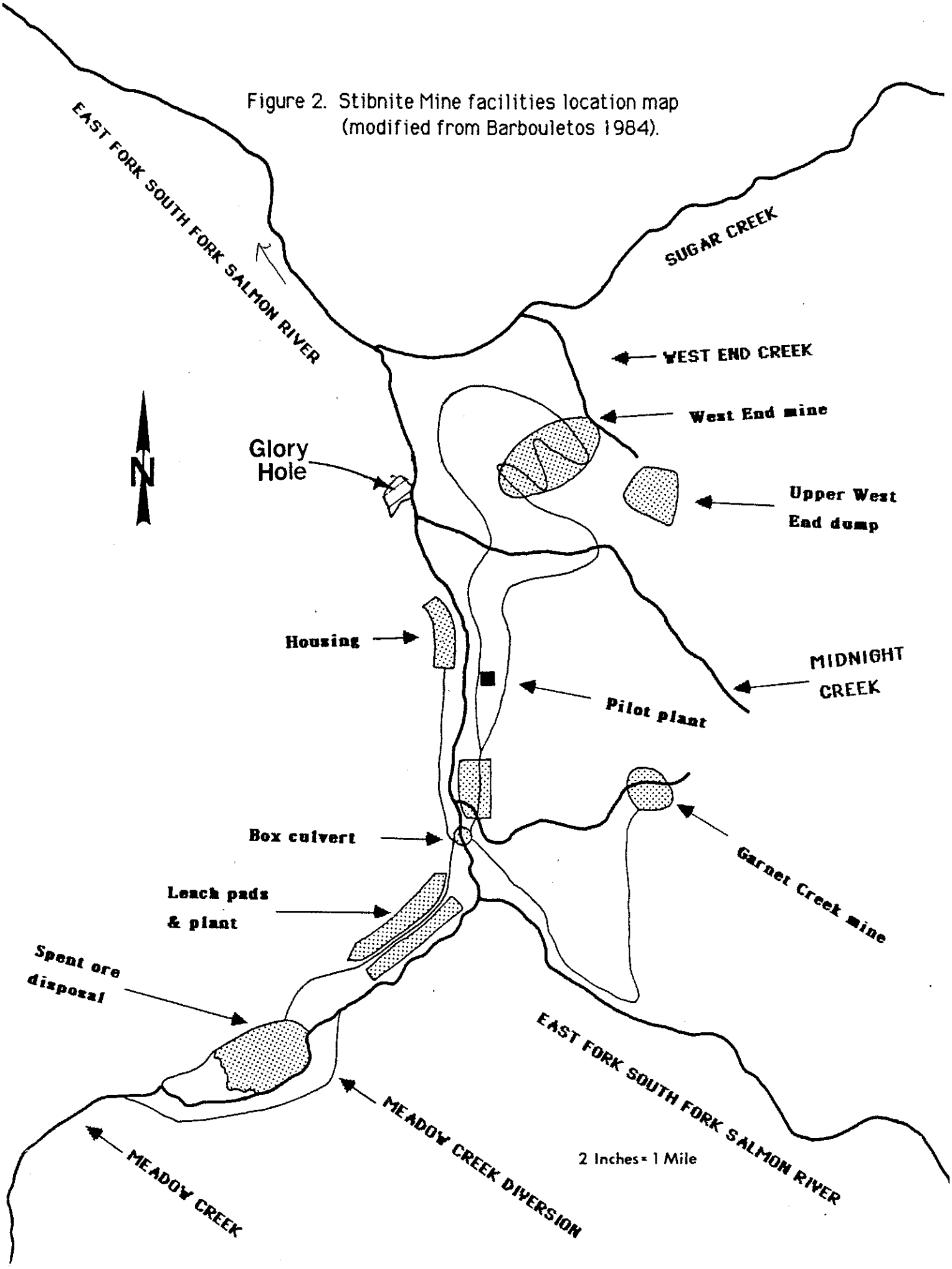
The area impacted by the Stibnite Mining Project lies within the drainage of the East Fork South Fork Salmon River (East Fork). The East Fork is a major tributary to the South Fork Salmon River, a river highly valued for its salmon spawning and rearing habitat. Both the East Fork and the South Fork are designated by the State of Idaho as Special Resource Waters, and protected as salmonid spawning waters.

The mine, the plant, the tailings disposal area, and the haul roads are stretched out along several miles of the East Fork, and also along tributaries to the East Fork: Meadow Creek, Midnight Creek and Sugar Creek (Figure 2). The open pit mine is located in the West End Creek drainage, a tributary to Sugar Creek.

This valley occupied by the mine is characterized by glacial features: narrow, flat-bottomed, surrounded by steep mountains, and filled with glacial outwash deposits consisting of silts, sands, and gravels. Generally, quartz monzonite, an igneous-intrusive rock, underlies the Stibnite area (JMM 1981).

A detailed discussion of the geology, soils, and hydrology of this area is contained in the Final Environmental Impact Statement (JMM 1981).

Figure 2. Stibnite Mine facilities location map (modified from Barbouletos 1984).



METHODS AND MATERIALS

SURVEY DESIGN

Water quality monitoring in the Stibnite vicinity has been a continually evolving project. Initially, the monitoring program was established to collect background or baseline data prior to the startup of the new cyanide leach mine. As the mine expanded, the monitoring program grew and evolved in an attempt to best fit the situation. Stations were added as the mine moved into new territory, and consequently some stations were deleted. The focus of the monitoring program also changed several times. After baseline data was collected and the mine commenced operations, the emphasis switched to trend and compliance monitoring. As a result of this evolution the data base is large, sketchy, and sometimes incomplete.

Sample locations

The monitoring stations for the Stibnite area are shown in Figure 2a. The stations were located above and below areas of operation or impact on the East Fork, Sugar Creek, West End Creek, Fiddle Creek, and Garnet Creek.

Presently, there are 24 monitoring stations established on the STORET data system. STORET is a computerized data base system maintained by the U. S. Environmental Protection Agency for the storage and retrieval of water quality data from across the nation.

Sampling Frequency

Table 1 shows when sampling occurred for 22 stations from 1979-1985. Two stations added in 1986 were not reviewed for this report.

Initially, sampling was to occur four times per operating season. The operating season lasts from approximately late May/early June through late October/early November. Heavy snowfall and lack of road maintenance prohibit access to the mine during the winter months.

In 1984, the USFS and the DOE agreed to conduct trend monitoring twice per year, once during high flow (spring runoff), and again during low flow (fall monitoring).

Compliance monitoring, which was emphasized after mining and leaching began, occurred on an infrequent basis. Storm events, defined in the 1985 Consent Decree as " 0.2 inches or more of rainfall in a 24 hour period" often determined when compliance monitoring occurred. Only 6-8 stations were monitored for compliance purposes.

Figure 2a. Stibnite Mining District water quality monitoring stations (Forest Service 1986).

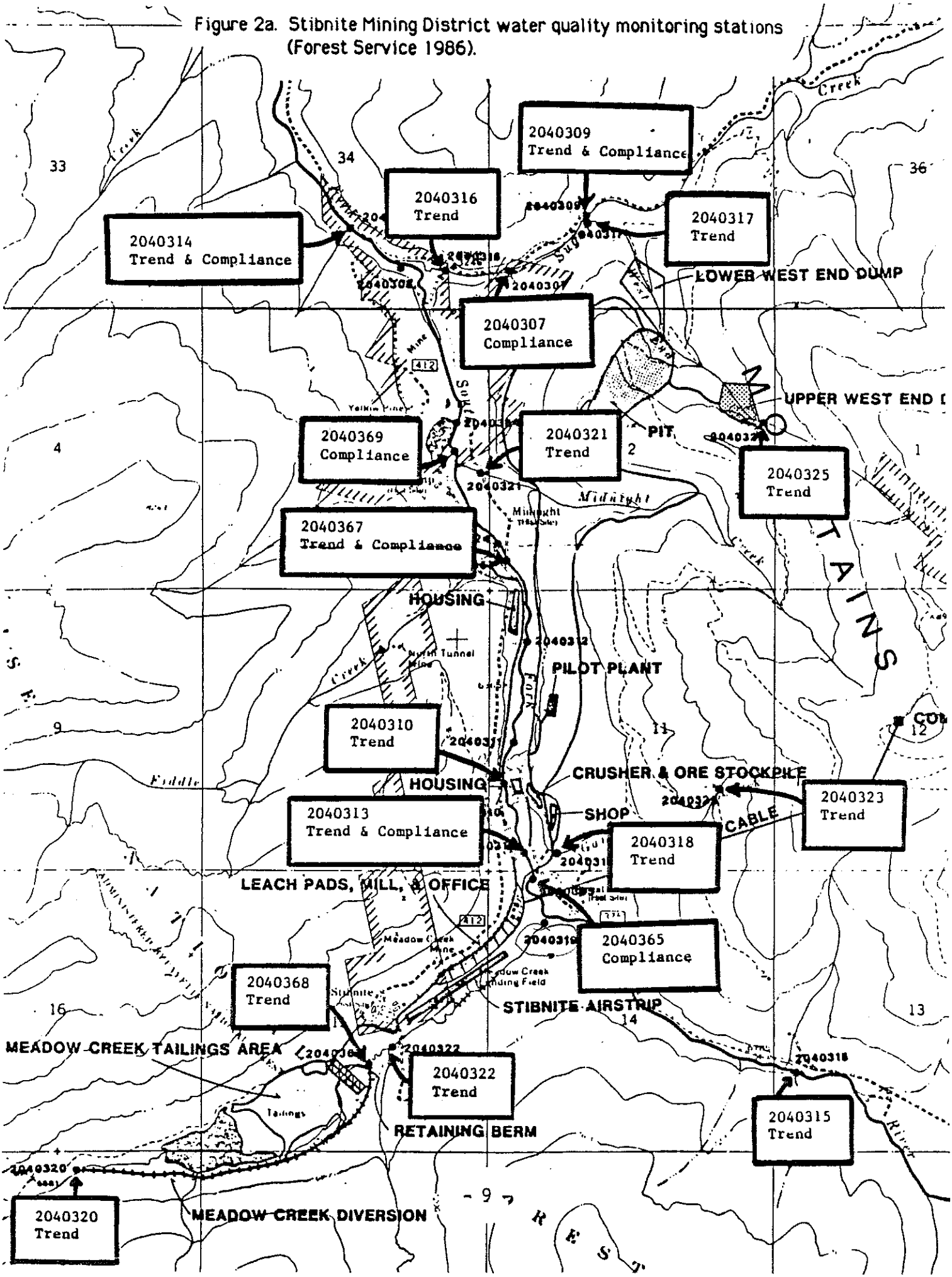


TABLE 1. Surface water quality sampling schedule: 1979 - 1985

Storet No.	Station No.	Station Description	1979 Jn	1979 Jy	1979 Oc	1980 Jn	1980 Oc	1981 Jn	1981 Ag	1981 Oc	1982 Jy	1982 Sp	1983 Jy	1983 Sp	1983 Oc	1983 Nv	1984 My	1984 Ag	1984 Sp	1984 Sp	1985 My	1985 Oc
2040320	11	Meadow Cr. ab. diversion				x	x	x	x	x	x	x	x	x	x	x	x				x	x
2040322	12	Meadow Ck. bl. diversion								x	x	x	x	x			x	x		x	x	x
2040319	9	Meadow Ck. @ mouth		x	x	x	x	x	x	x	x	x	x	x	x	x	x					
2040368	24	Meadow Ck. bl. keyway															x			x	x	x
2040315	13	EFSF ab. Meadow Ck.								x	x	x	x	x	x	x	x	x	x		x	x
2040314	6	EFSF bl. Sugar Ck.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2040365	21	EFSF ab. box culvert													x	x						
2040313	4	EFSF bl. box culvert	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	x	x	x
2040323	15	Upper Garnet Ck.									x		x							x	x	x
2040318	8	Lower Garnet Ck.	x	x	x	x	x	x	x	x	x	x				x			x	x	x	
2040310	1	ESFS @ Adkins Flat	x	x	x	x	x	x	x						x	x	x		x		x	x
2040311	2	EFSF @ Old Log Deck	x	x	x	x	x	x							x	x						
2040312	3	EFSF @ cookshack	x	x	x	x	x	x	x	x					x	x						
2040367	23	EFSF ab. sewerline													x	x	x	x	x	x	x	x
2040321	10	Midnight Ck. @ mouth		x	x	x	x	x	x	x		x	x		x	x	x	x		x	x	
2040324	14	EFSF bl. Fiddle Ck.								x	x	x	x									
2040325	16	Upper West End Ck.									x	x	x	x		x	x			x	x	x
2040317	7	Lower West End Ck.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
2040309	17	Sugar Ck. ab. W. End Ck.											x	x	x	x	x	x	x	x	x	x
2040316	5	Sugar Ck. @ bridge	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x
2040307	19	Sugar Ck. @ comp. point													x			x	x		x	x
2040308	18	EFSF ab. Sugar Ck.												x								

The extent and frequency of water quality monitoring has varied over the last seven years(Table 2).

Table 2. Summary of yearly monitoring frequencies.

YEAR	MONITORING FREQUENCY	AVERAGE NUMBER OF STATIONS MONITORED
1979	3	10
1980	2	11
1981	3	11
1982	3	12
1983	4	14
1984	4	15
1985	2	15

Parameters

Table 3 lists the parameters monitored each year for the past seven years. As seen from this table, the parameter list shrunk considerably over time. Parameters that were found to be consistently nondetectable were eliminated.

Additional types of physical and biological monitoring have been conducted by both the mine company and the USFS. Data is available on groundwater monitoring, fish population surveys, benthic macroinvertebrate densitites, core sampling, and cobble embeddedness.

METHODS

Under the Cooperative Monitoring Agreement, sample collection and transportation to the laboratory was the responsibility of the Forest Service.

Grab samples were collected in new one liter cubitainers. Usually two or three samples were collected per station. Each cubitainer was preserved with the appropiate solution: 1:1 redistilled nitric acid for metals analysis, concentrated sulfuric acid for nutrient analysis and 10N sodium hydroxide solution for cyanide analysis. All samples were kept at 4° C on ice during transportation to the laboratory.

The State of Idaho, Bureau of Laboratories, Boise, analyzed all samples according to Standard Methods (American Public Health Association1980).

TABLE 3. Water quality parameters monitored in the Stibnite vicinity from 1979-1985 (adapted from Barbouletos (1984)).

Parameter	1979	1980	1981	1982	1983	1984	1985
Turbidity	x	x	x	x	x	x	x
Conductivity	x	x	x	x	x	x	x
COD	x						
pH	x	x	x	x	x	x	x
Total Alkalinity ($CaCO_3$)	x	x	x	x	x	x	x
HCO_3 Alkalinity	x	x	x	x			
CO_3 Alkalinity	x	x	x	x			
Total Residue	x	x	x	x	x		x
Total Non-filterable Residue	x				x	x	x
NO_2 - N	x						
NO_3 - N	x	x	x	x			
Total Phosphorus	x	x	x	x	x		
Total Cyanide	x	x	x	x	x	x	x
Total Hardness ($CaCO_3$)	x	x	x	x	x	x	x
Calcium, total	x	x	x	x			
Magnesium, total	x	x	x	x			
Sodium, total	x	x	x	x			
Potassium, total	x	x	x	x			
Chloride, total	x	x	x	x			x
Sulfate, total	x	x	x	x			
Silica, total	x	x	x	x			
Arsenic, dissolved	x	x	x	x			
Arsenic, total	x	x	x	x	x	x	x
Cadmium, dissolved	x						
Cadmium, total	x	x	x	x			
Chromium, dissolved	x						
Chromium, total	x	x	x	x			
Copper, dissolved	x						
Copper, total	x	x	x	x			
Iron, dissolved	x	x	x	x			
Iron, total	x	x	x	x	x	x	x
Lead, dissolved	x						
Lead, total	x	x	x	x			
Manganese, dissolved	x						
Manganese, total	x	x	x	x	x		x
Nickle, dissolved	x						
Nickle, total	x	x	x	x			
Silver, dissolved	x						
Silver, total	x	x	x	x			

TABLE 3. Continued.

Parameter	1979	1980	1981	1982	1983	1984	1985
Zinc, dissolved	x						
Zinc, total	x	x	x	x			
Antimony, dissolved	x	x	x	x			
Antimony, total	x	x	x	x	x	x	
Dissolved Residue	x						
Total Phosphorus (Ortho)	x	x	x	x			
Mercury, dissolved	x						
Mercury, total	x	x	x	x	x	x	x
Suspended Sediment				x		x	

RESULTS AND DISCUSSION

Roughly 12 stations were monitored at least twice per year for 15 different parameters over a 7 year period which resulted in over 2,520 data points. In an attempt to pare the data down to a manageable size, stations and parameters for which there was incomplete data or which were determined to be insignificant were not included in this analysis.

Statistical methods were applied to those parameters and data which had the greatest interest as well as the most extensive and reliable data. The station on the East Fork River above any impacts from the mine(control) was compared with the farthest downstream station on the East Fork, below all mining activity. This station was examined for significant trends and changes. Likewise, the mouths of each of the major tributaries in the drainage. Meadow Creek, Sugar Creek, and West End Creek, were examined for trend changes.

The parameters which had shown the greatest fluctuation following the startup of the mine were examined. These include turbidity, iron, antimony and arsenic.

East Fork South Fork River

The data, in general, tended to exhibit a seasonal effect. This can be attributed to monitoring twice each year, once during high flow and again during low flow. Some parameters, such as turbidity tended to increase with increasing flows and drop with low flows. The metals, especially iron and arsenic, tended to exhibit the opposite effect. They were diluted out under high flow conditions and were more concentrated under low flow conditions. Figure 3 demonstrates that this phenomenon occurred with arsenic concentrations in the East Fork.

The data were deseasonalized to see if any trends became more apparent. This was accomplished by calculating the mean of the observations taken during the same month, but during different years, and subtracting it from each monthly observation. An example of this for the arsenic data is shown in Figure 4. No trends are apparent utilizing this technique, however significant peaks are still obvious.

The data were analyzed to see if a change in water quality was noticed with the startup of the mine. Bauer et al (1984) define a change, sometimes called a "step trend", as a sudden difference in water quality associated with a discrete event. The year full time mine operations first began, 1982, was selected as the discrete event. The pre-operating years from 1979-1981 we.e compared to the period from 1982-1985 to assess the impact of full scale mining and leaching.

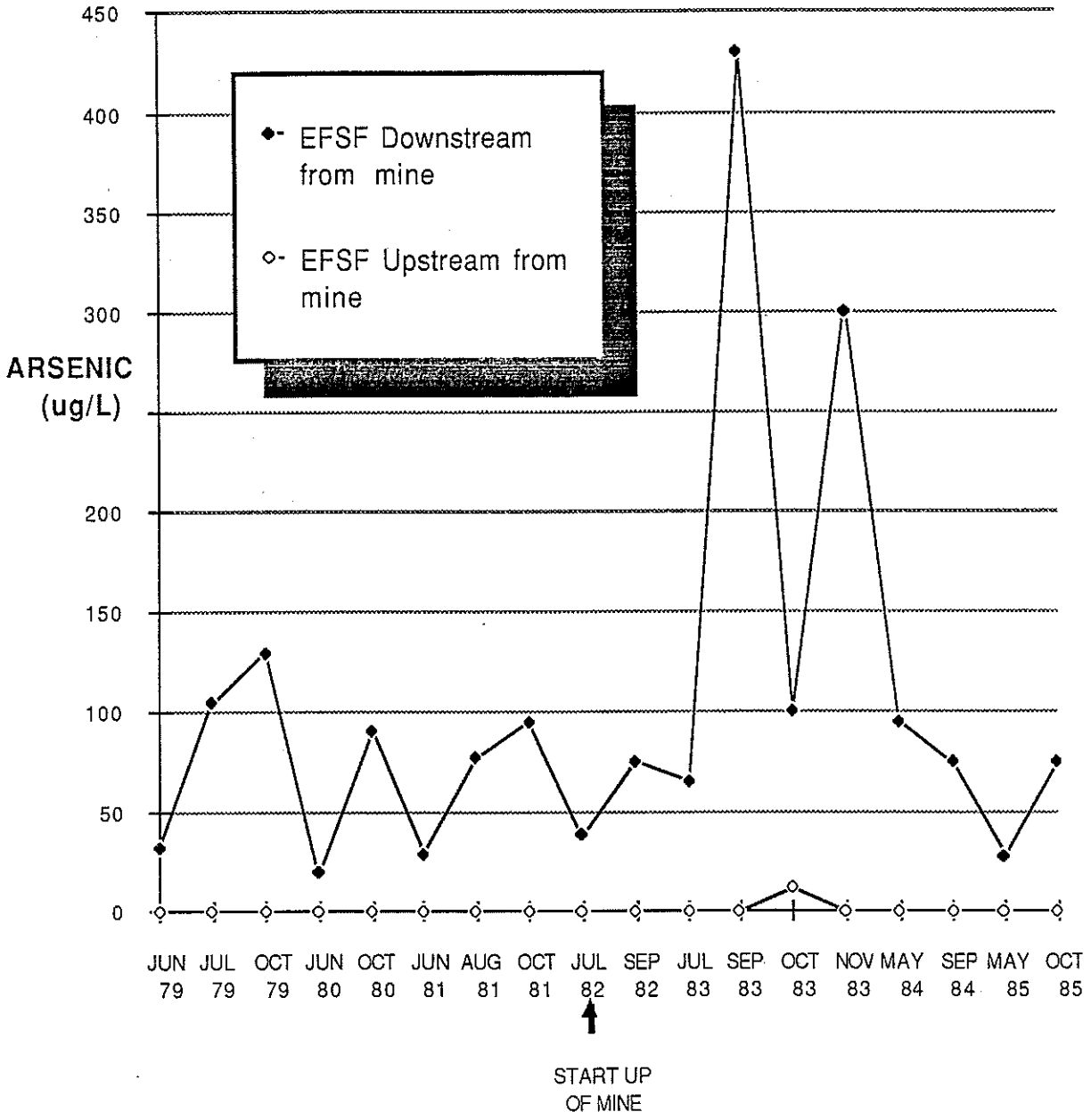


Figure 3. Arsenic concentrations above and below the mine in the East Fork South Fork Salmon River.

*Samples were not collected at the upstream station from JUN 79 through AUG 81.

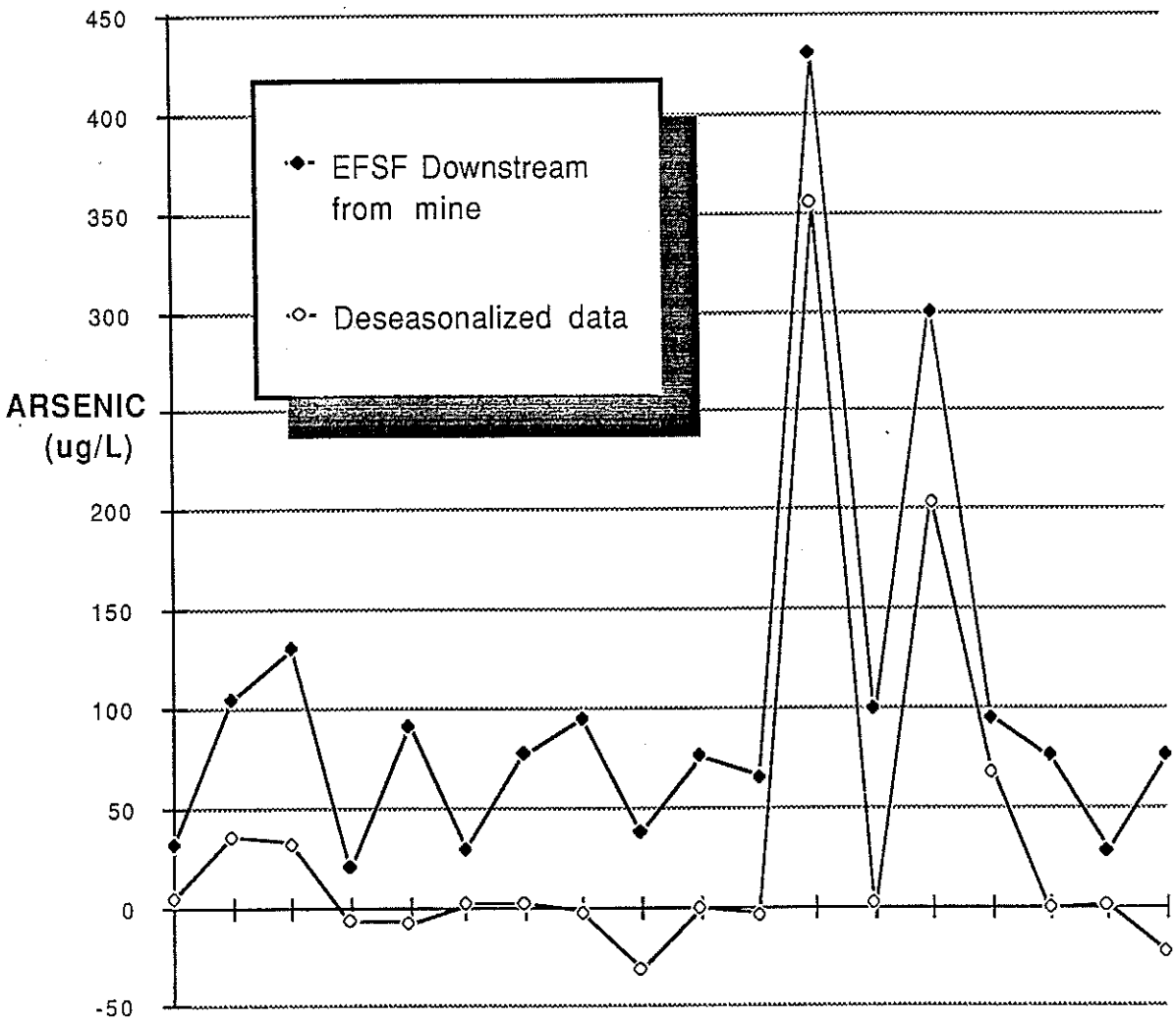


Figure 4. Deseasonalized arsenic concentrations in the East Fork South Fork Salmon River below the Stibnite mine.

Since the distribution of the data was not normal and the variances were not the same, a two-sample t-test could not be utilized. Rather, the Wilcoxon-Mann Whitney two-sample rank test (nonparametric) was used to test the significance of the data.

Arsenic showed a jump in levels after the startup of the mine. However, when this was compared to the pre-mining years, it was not significant at the 5% level. The same situation occurred with turbidity, as plotted in Figure 5. It also was not significant at the 5% level. Iron was similarily effected (Figure 6).

Therefore, a significant change or step trend was not readily apparent in the data. This is to be expected with a project like the Stibnite mine. Numerous years were spent in land-disturbing activities such as road building, exploration work, and plant contruction prior to actual leaching and mining. There was no discrete beginning date with this project.

Long term trend monitoring was conducted in the East Fork drainage to assess for any impacts associated with the mine operation. No trends are apparent in the data. A linear regression could not be used with any confidence since the data do not have a constant variance and are not normally distributed.

Meadow Creek

The station located at the mouth of Meadow Creek was sampled by the USFS and the DOE from 1979 through 1984. It was not sampled in 1985. Figure 7 depicts the key parameters of turbidity, iron, antimony and arsenic plotted over time.

The goal for this drainage was to improve the water quality by rerouting the creek around the World War II tailings disposal area. Prior to the current project, the creek meandered directly through these tailings. The water quality below the tailings area was deteriorated as compared to the water quality above the tailings area. Specifically, the concentrations of antimony, arsenic, and iron were increased in Meadow Creek below the tailings.

The creek was rerouted in 1981. However, this did not eliminate the standing water (Meadow Creek pond) backed up behind the tailings, as was predicted. Numerous springs in the area keep this a natural bog/swamp environment. This ponded water continues to seep through the tailings and drain into Meadow Creek.

Figure 7 shows no apparent improvement or decreasing trend in these parameters. Specifically, there has been no significant decreases in the concentrations of arsenic and antimony at the mouth of Meadow Creek over the four year period following the rerouting. Iron was high in Meadow Creek in the fall of 1983, and this is probably attributable to the intense rain storms occurring during this period.

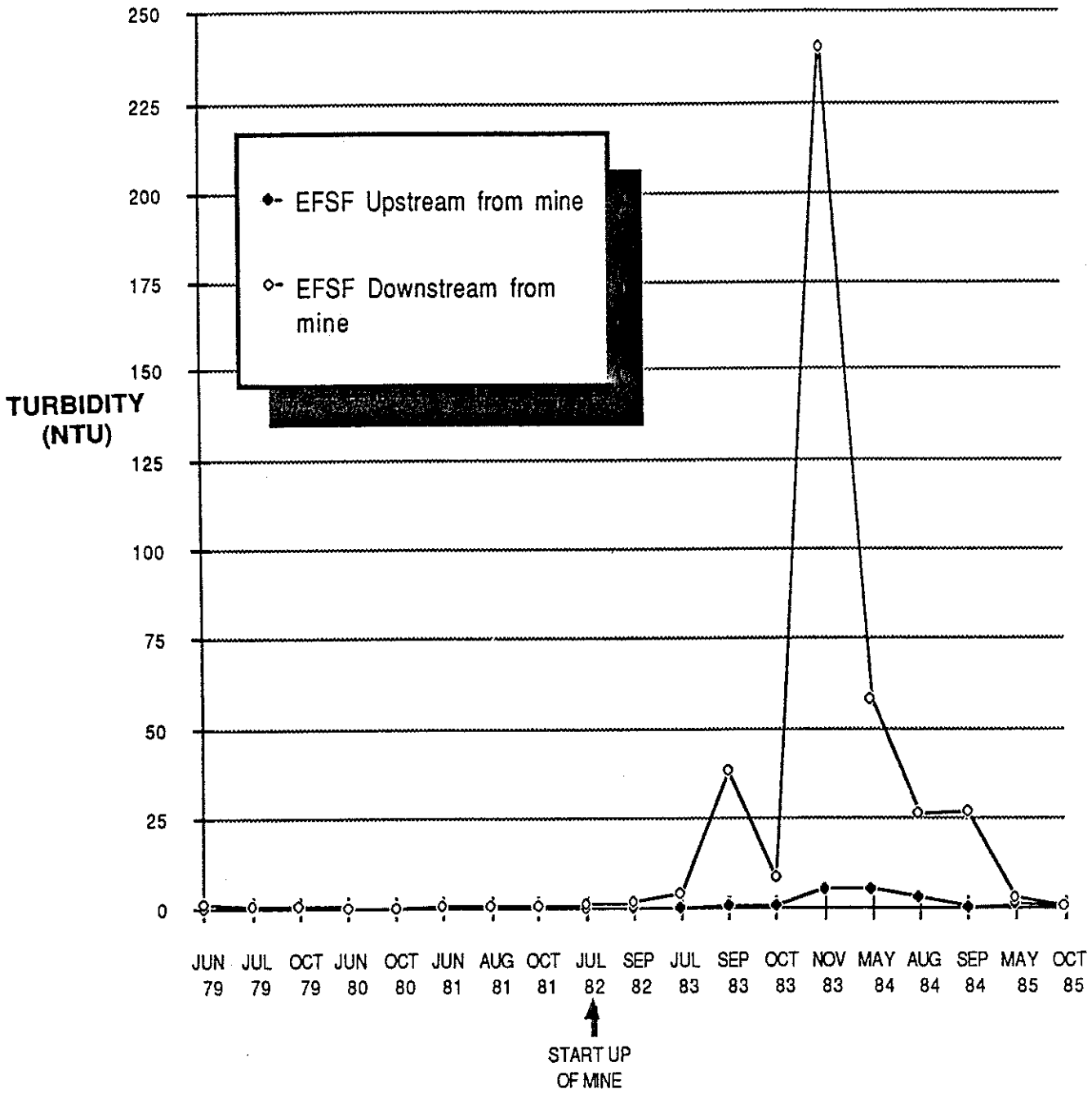


Figure 5. Turbidity concentrations above and below the Stibnite mine in the East Fork South Fork Salmon River.

*Samples were not collected at the upstream station from JUN 79 through AUG 81.

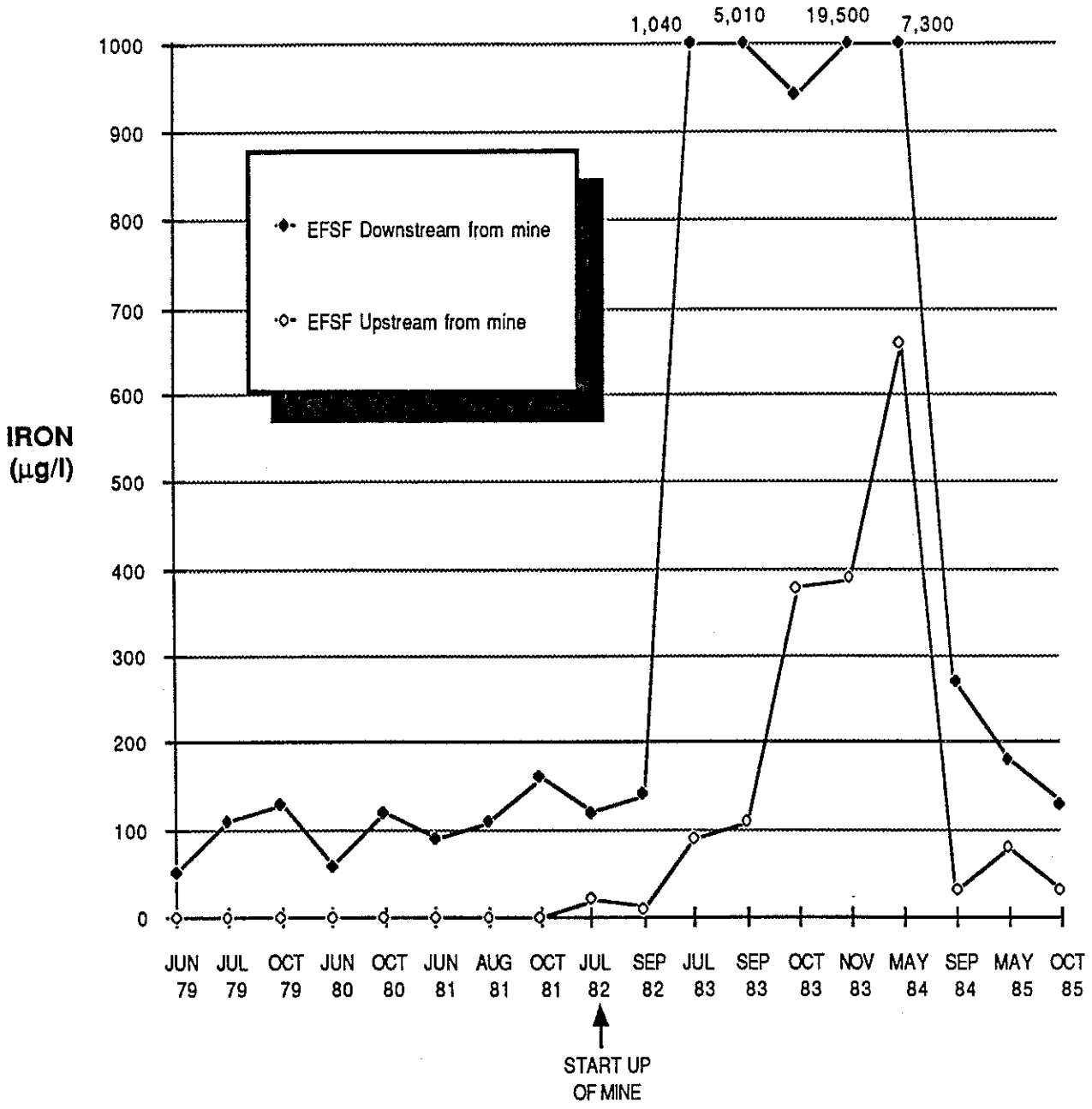


Figure 6. Iron concentrations above and below the Stibnite mine in the East Fork South Fork Salmon River.

*Samples were not collected at the upstream station from JUN 79 through AUG 81.

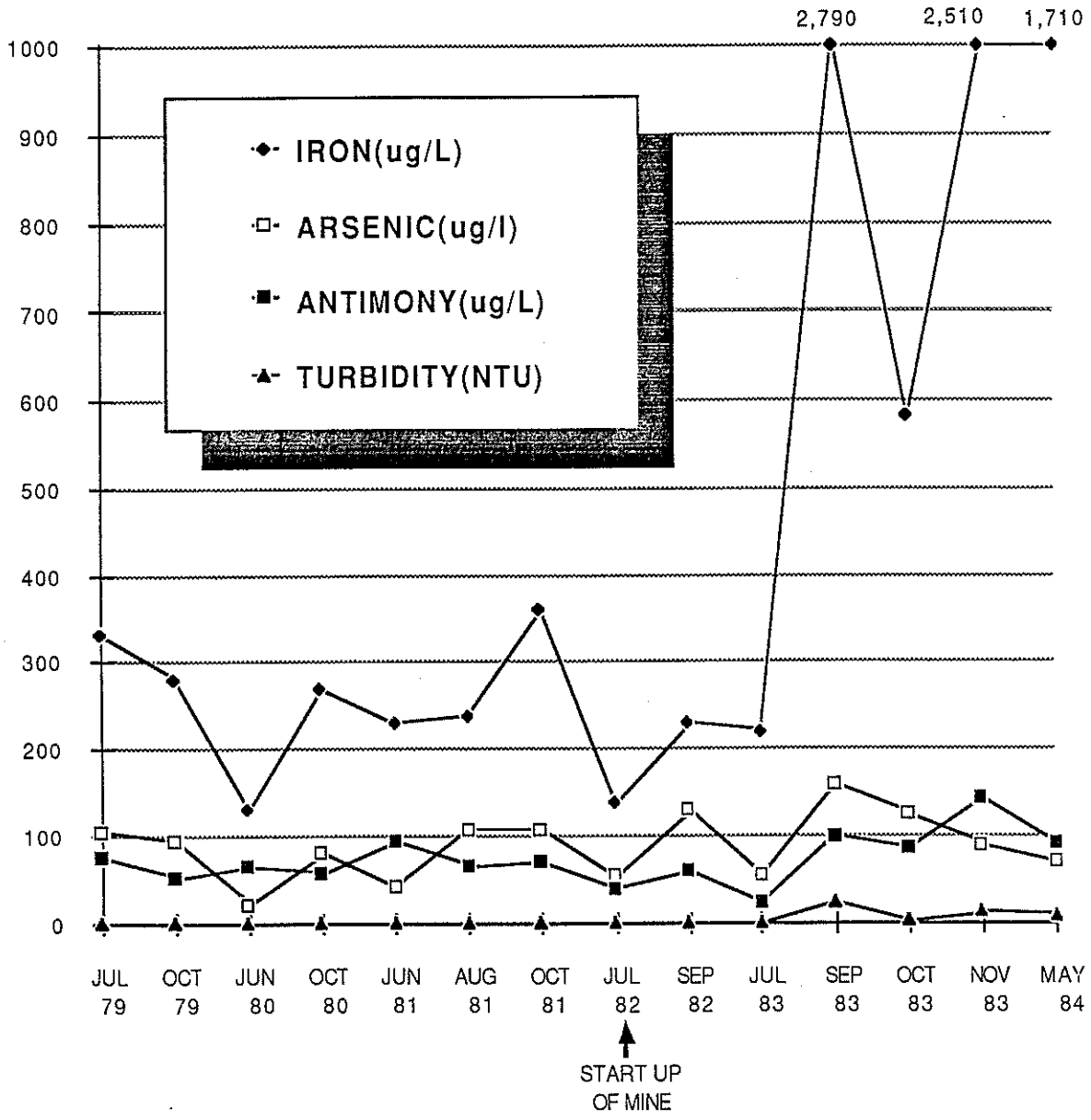


Figure 7. Concentrations of iron, arsenic, turbidity, and antimony in the mouth of Meadow Creek from 1979-1984.

West End Creek

Figure 8 depicts the key parameters of iron, turbidity and arsenic from 1979 through 1985.

There were increases in all parameters during 1982 and 1983. Although there are no apparent trends, the abrupt changes are obvious and dramatic. These changes can be attributed to at least two sources. Erosion from the exposed slopes of the West End mine resulted in increases in turbidity and iron in West End Creek. This was most evident during storm events. Significant impacts also occurred when the 50-100 foot buffer strip between the mine and West End Creek was eliminated.

High spring runoff and heavy fall storms occurred in 1983. Some of the increases in turbidity can be attributed to the fact that it was a wet year. However, Figure 9 depicts the conditions in Upper West End Creek drainage, above the mine site. The parameters at this station showed very little increase as compared to the station located below the mine. The data from the following two dates pointedly depicts the source of runoff.

	SEPTEMBER 30, 1983		NOVEMBER 4, 1983	
	Above the mine	Below the mine	Above the mine	Below the mine
TURBIDITY (NTU)	2.6	132	0.1	3,200
ARSENIC (ug/L)	12	200	15	600
IRON (ug/l)	20	15,500	190	295,000

This strongly indicates the mine was a major contributor to the runoff problems in West End Creek.

The completion of the West End Creek diversion and the French drain in 1984 have greatly reduced the water quality problems associated with erosion and storm events in this drainage.

Sugar Creek

The data for Sugar Creek are depicted in Figure 10. These data closely parallel the data for West End Creek, which is a tributary of Sugar Creek. West End Creek had a significant impact on the water quality of Sugar Creek.

Burns (1985) reported the results of cobble embeddedness monitoring for the Stibnite Mining area. He found the highest level of embeddedness(48%) in Sugar Creek downstream from West End Creek. The level of embeddness in Sugar Creek above West End Creek was 26%.

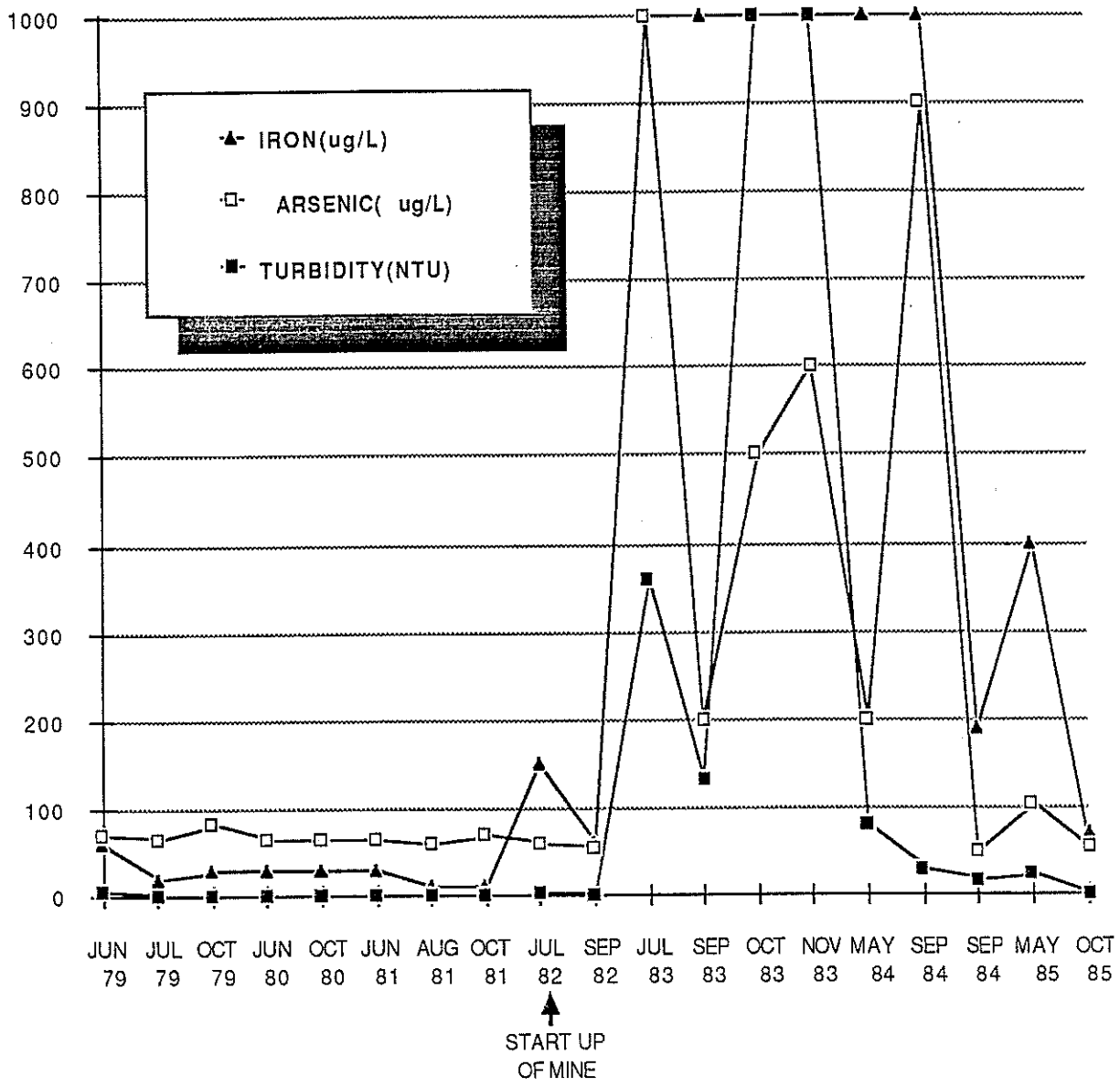


Figure 8. Concentrations of iron, arsenic, and turbidity in the mouth of West End Creek from 1979-1985.

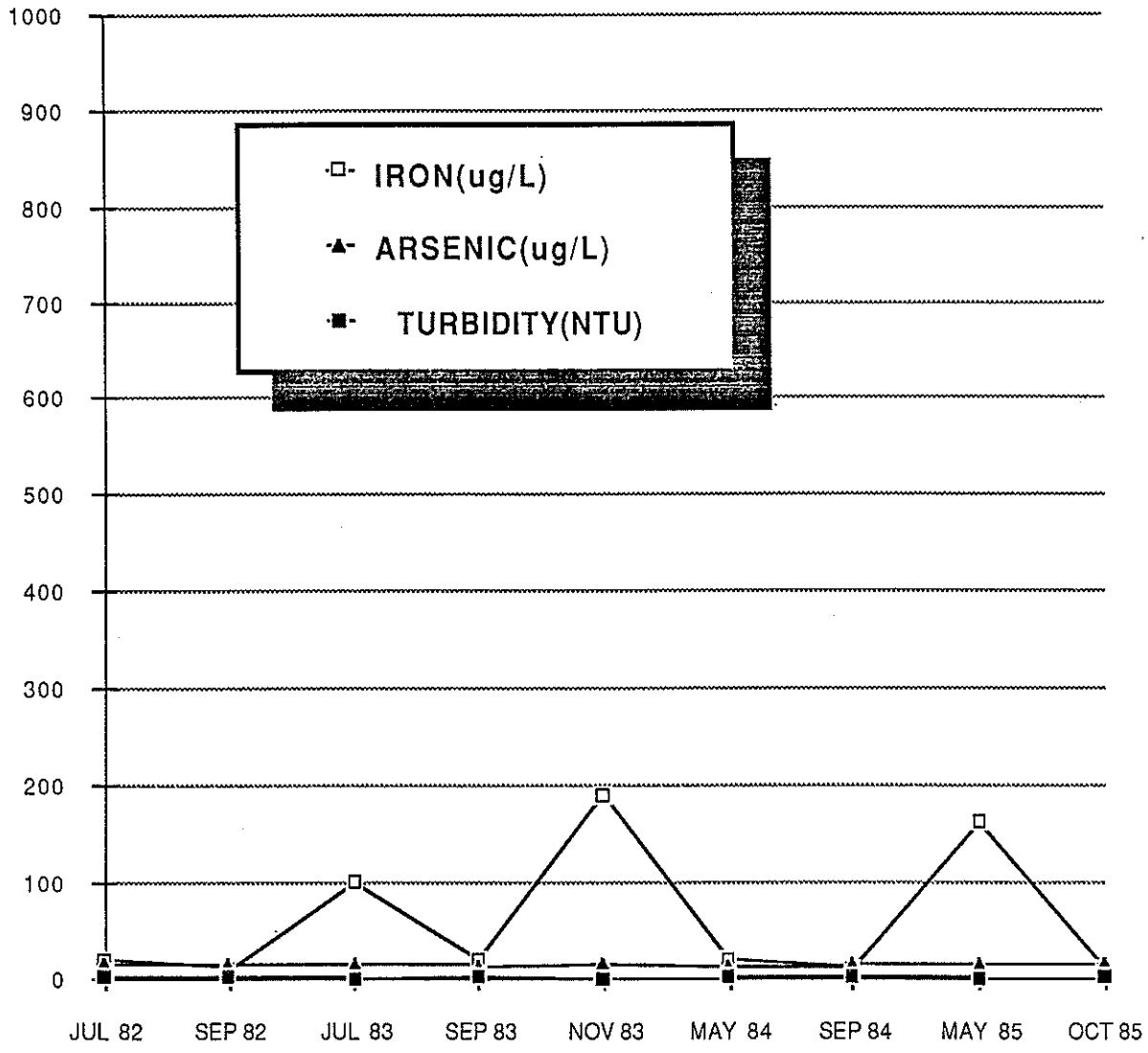


Figure 9. Concentrations of turbidity, arsenic and iron in Upper West End Creek from 1982-1985.

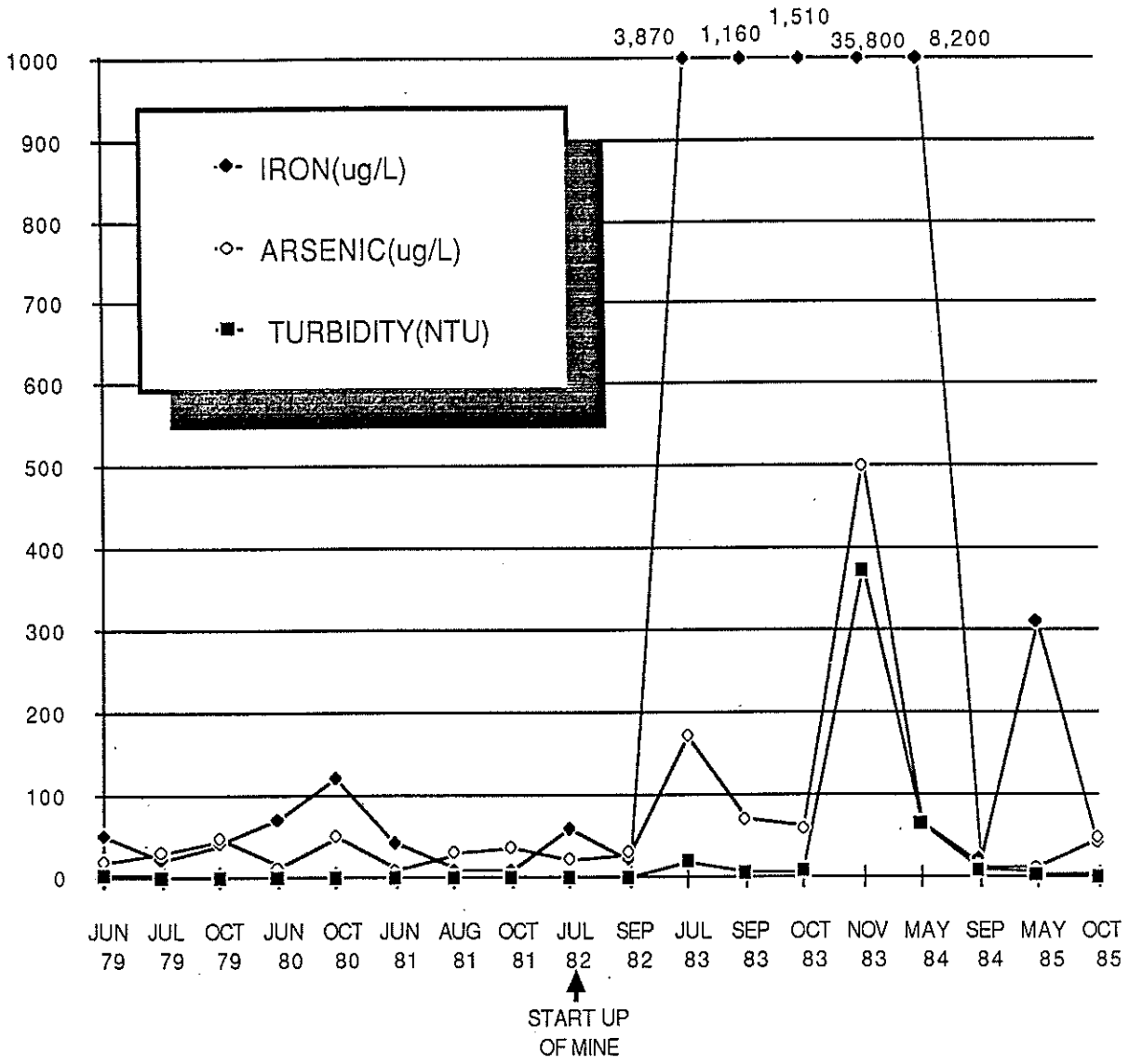


Figure 10. Concentrations or iron, arsenic, and turbidity in the mouth of Sugar Creek from 1979-1985.

CONCLUSIONS

This was an ambitious monitoring program that, effectively as possible, tracked the development of the mine. It is difficult with this type of project to anticipate where monitoring stations will be necessary. In attempting to keep up with the developing mine, and yet maintain a small sampling program, stations were added and deleted frequently. For many stations there is post-operational data, but no pre-operational data. Also, for many stream reaches there are impact or "downstream" data, but there are no background or "upstream" data.

A scan of Table 2 shows the holes in the monitoring program. Out of the 22 stations monitored in the area, only 2 were monitored 100% of the time from 1979 through 1985, and one was monitored 90% of the time. Nine stations were monitored less than 50% of the time.

If the data were complete and continuous, a trend might be able to be determined based on as few as five or six years. At the time of this compilation, there had been three continuous operating seasons: 1982-1984. Several more years of data, at least, are necessary to determine a trend. Even then it may be difficult to distinguish a trend from part of a longer cycle.

However, several conclusions can be made based on the existing data.

- There have been short term water quality impacts associated with the mining operation. Specifically, West End Creek and Sugar Creek were impacted by the open pit mine. The data show that increases in turbidity, iron, and arsenic below the mine were significant as compared to the background levels. This also stresses the importance of collecting background data.

- The East Fork South Fork Salmon River below the mine also showed some short term water quality impacts. There were short term increases in arsenic, turbidity, and iron. These impacts were generally associated with storm events.

- There are no apparent trends in the monitoring data for Meadow Creek. No apparent increases or decreases in the concentrations of antimony and arsenic have been documented in the creek since the start up of the mine.

RECOMMENDATIONS

Water quality monitoring should continue at the mouth of each major tributary to the East Fork South Fork Salmon River for the life of the mine. Likewise, trend monitoring should occur at stations upstream from mining impacts to document background or natural conditions. Also, stations with consistent sampling records from 1979 to the present should be priority monitoring stations. Twice per year sampling is sufficient to document long term trends.

Storm event monitoring should occur annually to document short term impacts. Emphasis should be placed on more frequent sample collection per storm event.

The data should be reviewed annually.

LITERATURE CITED

American Public Health Association. 1980. Standard methods for the examination of water and wastewater. American Public Health Association, American Water Works Association, Water & Pollution Control, Federation, Washington, D. C. 15th Edition. 1,134 pp.

Barbouletos, C. 1984. Stibnite Mining Project comprehensive monitoring report. U.S. Forest Service - Payette National Forest, McCall, ID. 56 pp.

Bauer, K. M., W. D. Glauz, and J. D. Flora. 1984. Methodologies for determining trends in water quality data. EPA Contract No. 68-02-3938. U.S. Enivronmental Protection Agency, Research Triangle Park, NC. 100 pp.

Burns, D. C. and R. E. Edwards. 1985. Embeddedness of salmonid habitat of selected streams on the Payette National Forest. U.S. Forest Service - Payette National Forest, McCall, ID. 39 pp.

JMM. 1979. Environmental background report Stibnite Mining Project. James M. Montgomery Consulting Engineers, Inc. Boise, ID. 41 pp.

JMM. 1981. Final Environmental Impact Statement Stibnite Mining Project gold mine and mill. James M. Montgomery Consulting Engineers, Inc. Boise, ID. 165 pp.

APPENDIX A

WATER QUALITY COMPLIANCE MONITORING IN THE STIBNITE MINING DISTRICT : 1986 OPERATING SEASON

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ABSTRACT

Water quality compliance and storm event monitoring was conducted by the Idaho Department of Health and Welfare, Division of Environment in cooperation with the U. S. Forest Service, Payette National Forest, in the Stibnite Mining District during the 1986 operating season. The Stibnite Mining District is located in Valley County, Idaho in the drainage of the East Fork South Fork Salmon River. The monitoring was conducted to determine compliance with a December 18, 1985 consent decree between the Department of Health and Welfare and the Stibnite Mine owner. Six stations located on the East Fork South Fork Salmon River and its tributaries were monitored for turbidity, total suspended solids, cyanide, pH and temperature five times during the season. No violations of the turbidity standard specified in the consent decree were determined by this monitoring program. The average recovery accuracy for quality control spike samples collected for total suspended solids was 96.2 percent. No detectable levels of cyanide were found during this survey. Future monitoring emphasis should be directed at storm event monitoring.

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INTRODUCTION

BACKGROUND

The Department of Health and Welfare, Division of Environment (the Division) has been monitoring water quality cooperatively with the U. S. Forest Service, Payette National Forest (the Forest) in the Stibnite vicinity since 1979. The monitoring program was undertaken to establish an independent set of baseline and trend data in conjunction with the start up of a new open pit mine and cyanide leaching plant. In 1983, the cooperative study program was expanded to include monitoring for detection of water quality violations associated with the mining project.

As a result of the cooperative compliance monitoring program between the Forest and the Division, numerous violations of the water quality standards were documented in November 1983, and in June, July, August, and September 1984.

On December 18, 1985 the Board of Health and Welfare approved a consent decree between the Department of Health and Welfare and the mine owner. The consent decree stipulated monitoring requirements and standards to be met by the mine owner, and allowed for civil penalty assessment for any violation of these requirements.

The Stibnite mine and plant facilities were purchased by Pioneer Metals Corporation in the spring of 1986. All the monitoring requirements specified in the consent decree were assumed by Pioneer Metals Corporation.

OBJECTIVES

The objectives of the Stibnite Water Quality Cooperative Monitoring Plan for 1986 were:

1) to determine compliance with the December 18, 1985 consent decree between the Department of Health and Welfare and the Stibnite mine owner, and

2) to continue trend monitoring.

To meet these objectives three types of monitoring were conducted by both the mine company and the agencies:

A. Storm event monitoring
B. Compliance monitoring
C. Trend monitoring

PURPOSE

This report documents the results of the compliance monitoring and storm event monitoring portions of the 1986 program.

The results of the trend monitoring program for 1986 will be compiled by the Payette National Forest.

DRAINAGE DESCRIPTION

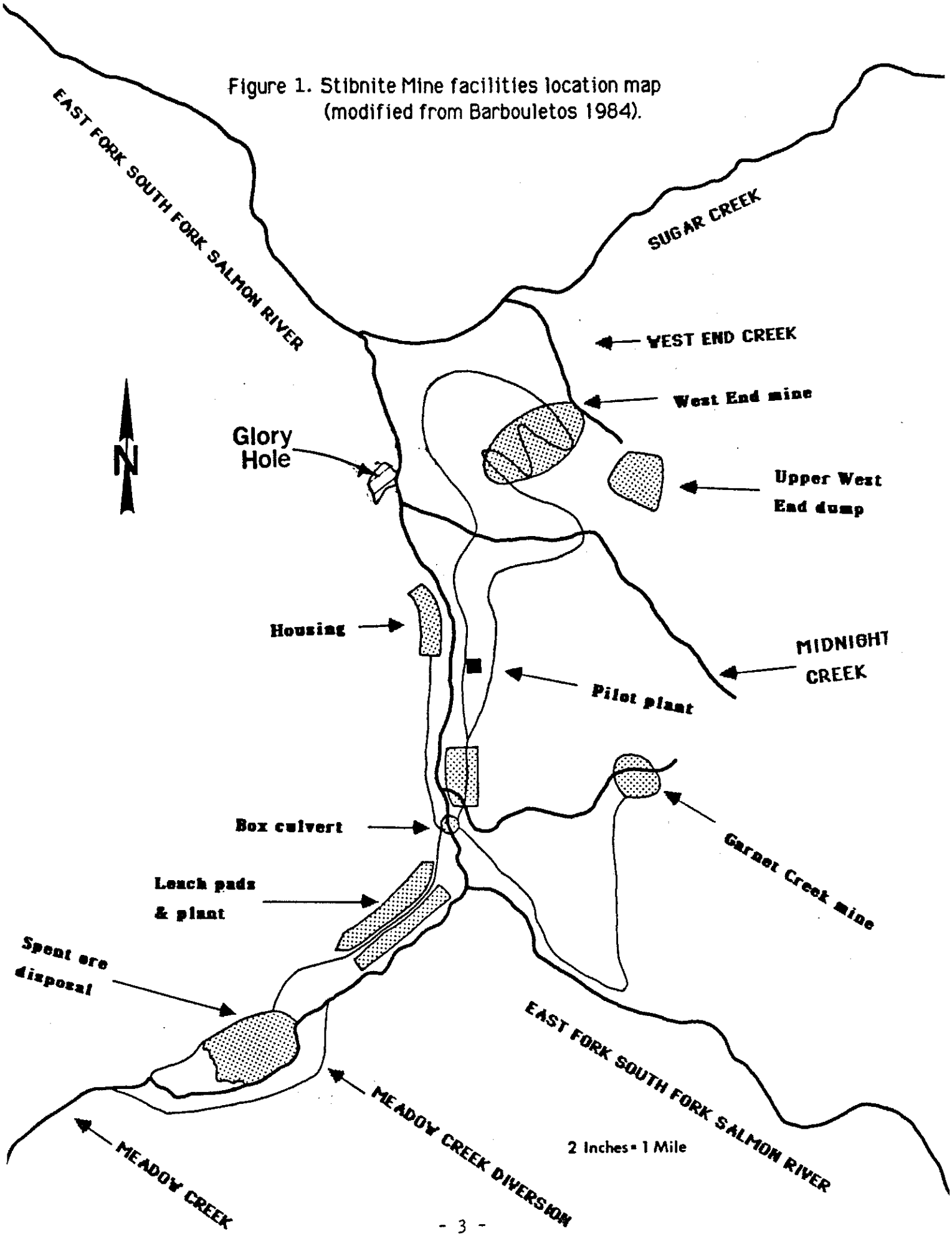
The area impacted by the Stibnite Mining Project lies within the drainage of the East Fork South Fork Salmon River (East Fork). The East Fork is a major tributary to the South Fork Salmon River, a river highly valued for its salmon spawning and rearing habitat. Both the East Fork and the South Fork are designated by the State of Idaho as Special Resource Waters, and protected as salmonid spawning waters.

The mine, the plant, the tailings disposal area, and the haul roads are stretched out along several miles of the East Fork, and also along tributaries to the East Fork: Meadow Creek, Midnight Creek and Sugar Creek (Figure 1). The open pit mine is located in the West End Creek drainage, a tributary to Sugar Creek.

This valley occupied by the mine is characterized by glacial features: narrow, flat-bottomed, surrounded by steep mountains, and filled with glacial outwash deposits consisting of silts, sands, and gravels. Generally, quartz monzonite, an igneous-intrusive rock, underlies the Stibnite area (JMM 1981).

A detailed discussion of the geology, soils, and hydrology of this area is contained in the Final Environmental Impact Statement (JMM 1981).

Figure 1. Stibnite Mine facilities location map (modified from Barbouletos 1984).



MATERIALS AND METHODS

METHODS

Under the 1986 Cooperative Monitoring Agreement, storm event sample collection and transportation to the laboratory was the responsibility of the Forest Service; compliance sample collection and transportation to the laboratory was the responsibility of the Division of Environment.

Grab samples were collected in new one liter cubitainers. All samples were kept on ice during transportation to the laboratory.

The State of Idaho, Bureau of Laboratories, Boise, analyzed all samples according to Standard Methods (American Public Health Association 1980).

STATIONS

The stations monitored for compliance and storm event purposes are listed in Table 1.

TABLE 1. Storm event and compliance monitoring stations.

STORET NUMBER	STATION LOCATION
2040309	Sugar Creek above the confluence with West End Creek
2040307	Sugar Creek below the confluence with West End Creek
2040365	East Fork South Fork above the box culvert
2040313	East Fork South Fork below the box culvert
2040367	East Fork South Fork above confluence with Midnight Creek
2040369	East Fork South Fork below confluence with Midnight Creek

FREQUENCY

A. Storm Event Monitoring

A storm event was defined in the consent decree as "0.2 inches or more of rainfall in a 24 hour period." This determined when monitoring was to begin. The mine company conducted storm event monitoring eleven times during the 1986 season. At the request of the agencies, the mine company notified the Forest when storm monitoring was initiated. If possible, the Forest would collect samples at the same time. Due to manpower and travel constraints, the Forest Service conducted storm event monitoring once during the 1986 season.

B. Compliance Monitoring

The consent decree required the mine company to conduct routine compliance monitoring for turbidity, total suspended solids, and cyanide.
Turbidity and cyanide samples were to be collected once every seven days, while total suspended solids were to be monitored once every thirty days.

The Division of Environment conducted compliance monitoring as part of routine site inspections of the mine. These compliance samples also served as a check on the mine's monitoring program.

Compliance monitoring was conducted five times during the operating season from July through October.

PARAMETERS

A. Storm Event Monitoring

The parameters monitored during storm events were turbidity and total suspended solids.

B. Compliance Monitoring

The parameters monitored for compliance purposes, as specified by the consent decree, were turbidity, total suspended solids, and cyanide. For informational purposes, pH and temperature were monitored several times throughout the season.

QUALITY ASSURANCE

Monitoring for accuracy is critically important to compliance monitoring (Bauer 1986). Field spiked samples were collected for suspended solids at all six compliance stations twice during the season.

Celite was used for suspended solids spiking. The celite and its polypropylene vial were dropped into a cubitainer containing 900ml of sample water. The percent recovery is calculated by substracting the background value, determined by the analysis of a split unspiked sample, from the spiked sample. This result can be compared to the known amount of spike added.

RESULTS AND CONCLUSIONS

Turbidity

The turbidity standard defined in the consent decree stated that "the turbidity at the lower monitoring station shall not exceed the turbidity at the upper monitoring station by: 1) more than five (5) NTU (Nephelometric Turbidity Units) over background turbidity when background is fifty (50) NTU or less; or 2) more than ten percent (10%) when background turbidity is more than fifty (50) NTU, not to exceed a maximum increase of twenty-five (25) NTU."

No violations of this turbidity standard were determined by this monitoring program. On one occasion there was high turbidity in West End Creek. A sample collected from the mouth of the creek on July 1, 1986 contained 60 NTU. However, the samples collected fom the compliance stations on Sugar Creek did not exceed the specified standard.

The results of the compliance and storm event monitoring for turbidity are presented in Figures 2,3,4, and 5. Out of 30 compliance samples collected 23, or 76.6% were analyzed as nondetectable. The Forest Service monitored one storm event, and 2 out of 6 samples collected (33.3%) were nondetectable.

Quality Assurance

The average recovery accuracy of non-filterable residue from the spiked samples was 96.2 percent.

Total suspended solids

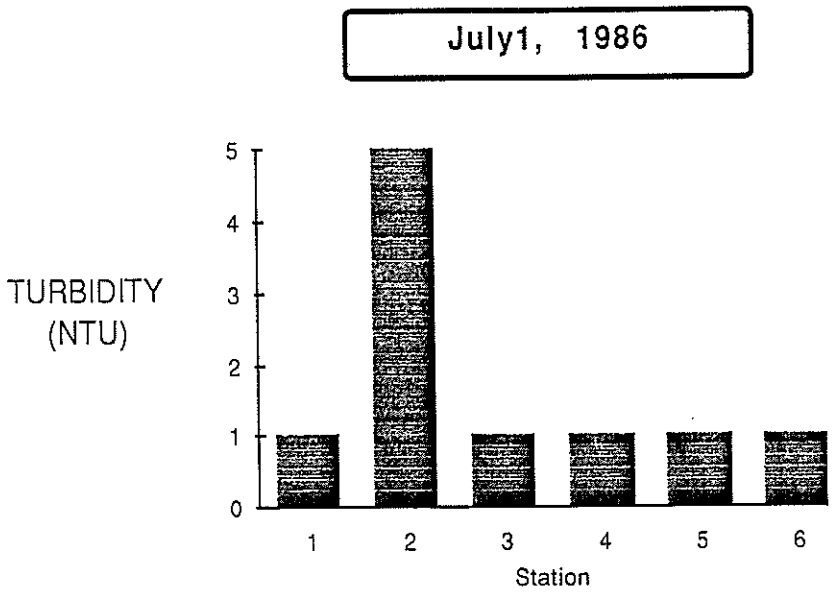
The consent decree did not specify a standard for total suspended solids. For the most part the solids fluctuated with the turbidity results and ranged form a high of 140 mg/L in the mouth of West End Creek on July 1, 1986 to a low of less than 2 mg/L.

pH

The pH of the streams in this area during the entire monitoring season was well within the range (6.5-9) required by the State of Idaho (IDHW 1985).

Cyanide

No detectable levels of cyanide were found at the specified monitoring station during the course of this survey.



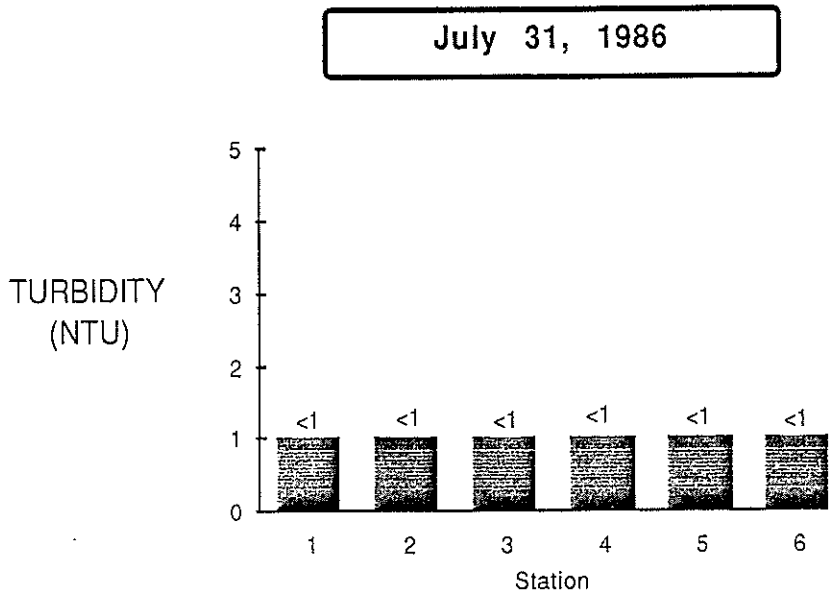
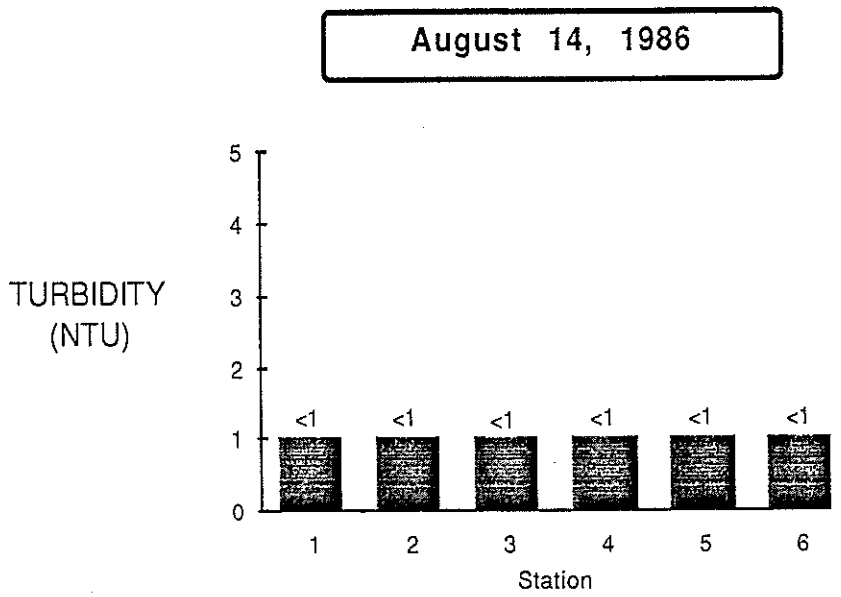


Figure 2. Results of compliance monitoring for turbidity (Station 1: 2040309, Station 2: 2040307, Station 3: 2040365, Station 4: 2040313, Station 5: 2040367, Station 6: 2040369).

For graphic purposes, values reported as less than one (<1) were entered as one (1).



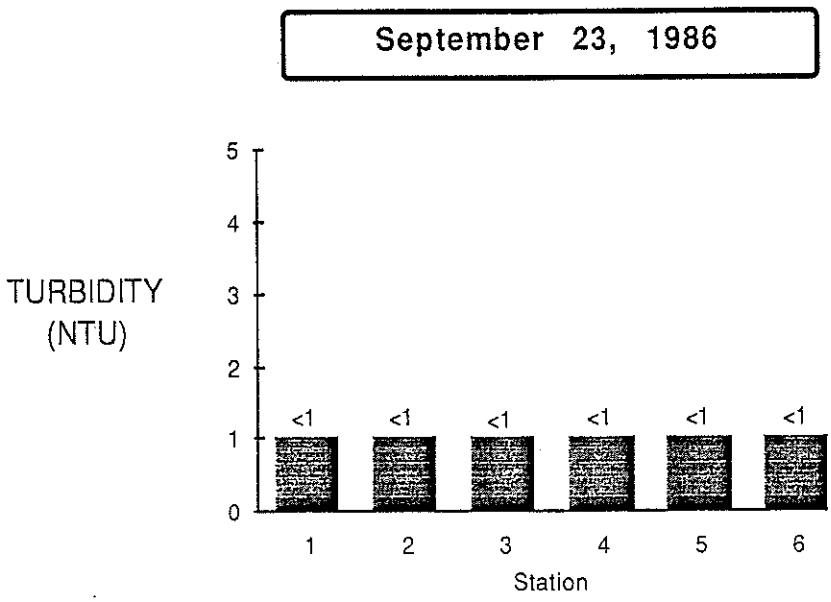


Figure 3. Results of compliance monitoring for turbidity (Station 1: 2040309, Station 2: 2040307, Station 3: 2040365, Station 4: 2040313, Station 5: 2040367, Station 2040369).

For graphic purposes, values reported as less than one (<1) were entered as one (1).

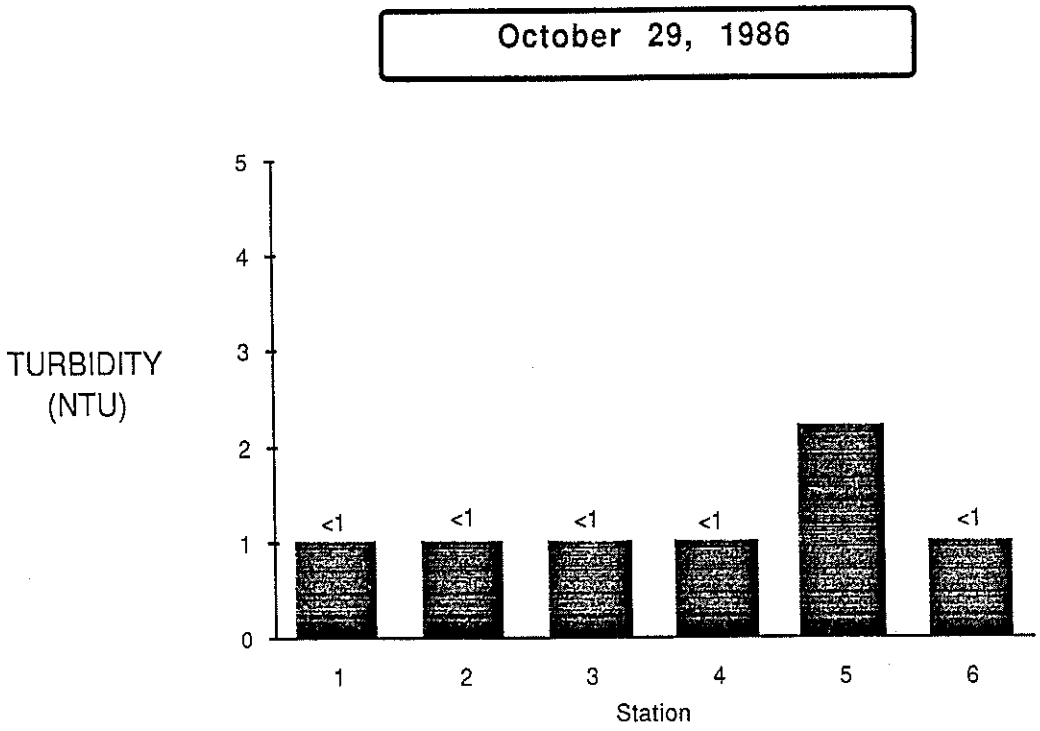


Figure 4. Results of compliance monitoring for turbidity (Station 1: 2040309, Station 2: 2040307, Station 3: 2040365, Station 4: 2040313, Station 5: 2040367, Station 6: 2040369).

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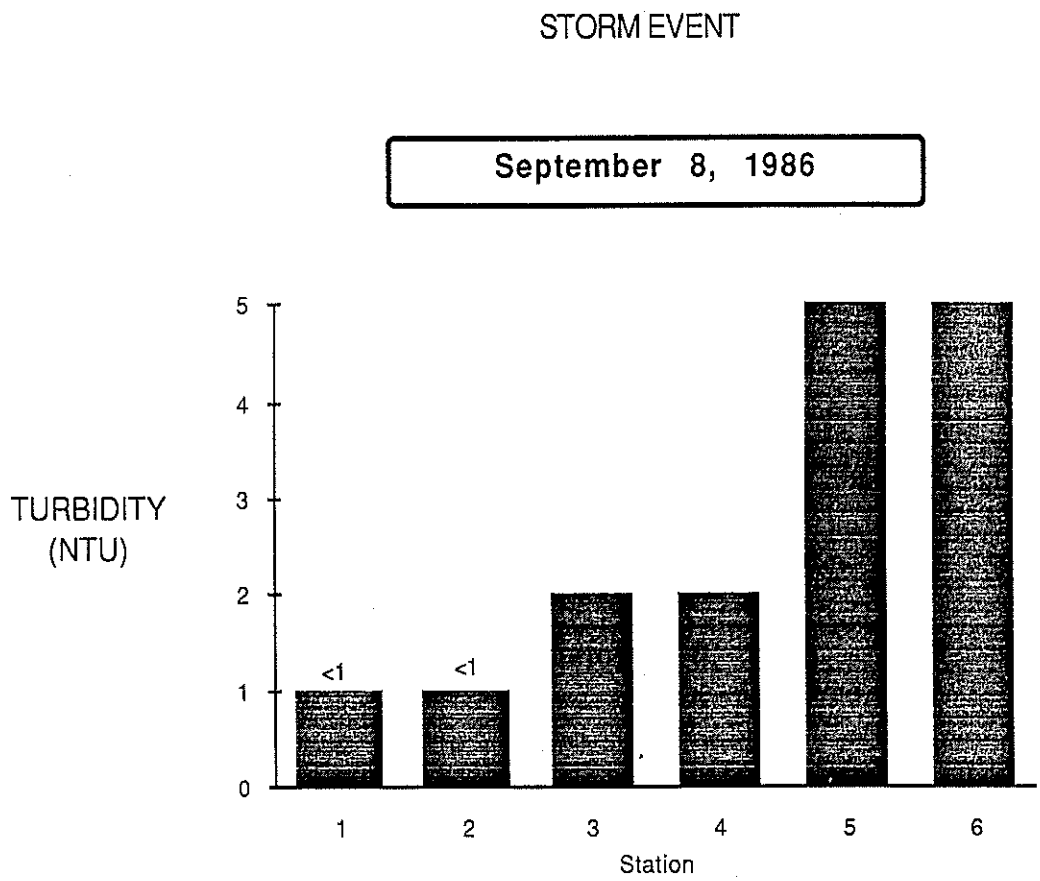

Figure 5. Results of storm event monitoirng for turbidity (Station 1: 2040309, Station 2: 2040307, Station 3: 2040365, Station 4: 20403123, Station 5: 2040367, Station 6: 2040369).

For graphic purposes, values reported as less than one (<1) were entered as one (1).

CONCLUSIONS AND RECOMMENDATIONS

Water quality monitoring in the Stibnite Mining District has shown the highest concentrations of turbidity occur in the rivers during periods of heavy runoff and/or storm events (Klahr 1986). This has also been reported by the mine company (Russell 1985 and Russell 1986).

There were no violations of the turbidity standard, as defined in the December 18, 1985 consent decree, detected by this monitoring program.

The only incident of higher than normal turbidity documented during this survey was not the result of a storm event. Turbid water in West End Creek and Sugar Creek on July 1, 1986 was readily apparent to the inspectors. It was determined that the mine company's contractor was end dumping waste rock to widen a haul road. A portion of this waste rock and debris was falling in West End Creek.

Under normal flow conditions, the rivers in the Stibnite Mining district are clear. Turbidity samples are generally below the detection limit of one (1) NTU, as supported by the results of this survey. Any change from this level of clarity is apparent to the naked eye. The turbidity generated by the road widening activities was very visible, both in West End Creek and in Sugar Creek below West End Creek. The sample results also bore this out.

In summary, when activities occur that generate higher than normal turbidity in the rivers, it is generally apparent to the naked eye. When these conditions are noted, compliance samples should be collected. Otherwise, turbidity monitoring is not necessary when the rivers are clear.

RECOMMENDATIONS

Compliance monitoring should be conducted only as part of site inspections and if prompted by noticeable turbidity levels in the rivers.

Future monitoring emphasis should be placed on storm event monitoring, as this has been documented as the problem area. Storm event monitoring is an aid to both the Division of Environment and the mine company in pinpointing runoff points which should be diverted, buffered or stabilized.

More storm events should be monitored each season to improve the reliability of the monitoring data . Also, the sampling interval for storm events should be increased from once every four hours to once per hour. Turbidity should be the only parameter emphasized. Split sample analysis should be incorporated for precision.

LITERATURE CITED

American Public Health Association. 1980. Standard methods for the examination of water and wastewater. American Public Health Association, American Water Works Association, Water & Pollution Control, Federation, Washington, D. C. 15th Edition. 1,134 pp.

Barbouletos, C. 1984. Stibnite Mining Project comprehensive monitoring report. U.S. Forest Service - Payette National Forest, McCall, ID. 56 pp.

Bauer, S. B. 1986. Pilot study of quality assurance sample procedures. Idaho Department of Health and Welfare, Division of Environment, Boise, ID. 16pp.

Idaho Department of Health and Welfare. 1985. Idaho Water Quality Standards and Wastewater Treatment Requirements. IDHW-Division of Environment. 72pp.

Klahr, P. C. 1987. Stibnite Mining District water quality monitoring report. Idaho Department of Health and Welfare, Division of Environment, Boise, ID. 28 pp.

JMM. 1981. Final Environmental Impact Statement Stibnite Mining Project gold mine and mill. James M. Montgomery Consulting Engineers, Inc. Boise, ID. 165 pp.

Russell, L. J. and JMM Consulting Engineers, Inc. 1985. Stibnite Mine and Mill Project environmental monitoring report. Superior Mining Company, Boise, ID. 53 pp.

Russell, L. J. 1986. Stibnite Mine and Mill Project Water Management Plan Phase III Water Management Report. Superior Mining Company, Boise, ID. 19 pp.