U.S. DEPARTMENT OF AGRICULTURE

REFERENCE SLIP

DATE 9/1/92

TO

Mary Ann Wright, Administrator
Abandoned Mine Reclamation
~~3 Triad Center, Suite 350~~
Salt Lake City, UT, 84180-1203

- [ ] ACTION
- [ ] APPROVAL
- [ ] AS REQUESTED
- [ ] FOR COMMENT
- [x] FOR INFORMATION
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REMARKS

RECEIVED
JUN 15 1992
DIVISION OF
OIL GAS & MINING

FROM

Paul H. Stabeland
Uinta N.F.

USGPO 1985-525-216

FORM AD-514 (8-64)

cc Frank

UINTA NATIONAL FOREST

JUN 01 1992

→ orig → Am Fk. file

UNIVERSITY OF WYOMING

Department of Plant, Soil and Insect Sciences

College of Agriculture

P.O. Box 3354
Laramie, WY 82071-3354
Phone: (307) 766-3103
Fax: (307) 766-3379

American Fork Hydro contract

30 May 1992

Uinta National Forest Supervisor's Office
Paul Skablund
Forest Hydrologist
88 West 100 North
Provo UT 84601

Dear Mr. Skablund:

Here is your part of the year-end report on the mitigation of heavy metal mine effluent by wetlands, that I promised you. I hope you will find the data I gathered at the Pacific and Mary Ellen mines informative. If you need any more information, please call me.

If it is all right with you, I would like to visit the Pacific Mine sometime in late August or September to gather seed heads off of the plants up there. I am going to grow larger amounts of these plants in the greenhouse for use in wetland mock-up studies. I will send you the data I gather from these studies.

I hope you will gain some insight from this report. The beaver pond at the Pacific Mine is doing a great deal to mitigate flow-through of heavy metals into the North Fork of the American Fork River. I am glad to hear that you are trying to keep people off of the mine tailings. They are heavily laced with a variety of heavy metals and probably would not be good for the health of anybody who spent a lengthy period of time on them, especially on a windy day.

Thank-you for your consideration,

Nancy Culp

Nancy Kastning-Culp
Research Associate

Year End Report

On Mitigation Systems for Hard Rock Mine Effluent

In Utah

Investigators:
Nancy Kastning-Culp
Larry DeBrey
Jeff Lockwood
of the
Department of Plant, Soil and Insect Sciences
University of Wyoming

30 May 1992

Abstract/Summary of All Mines Studied

This study shows that wetlands can be used very effectively to prevent release of heavy metals into stream systems. Both abiotic and biotic factors act to prevent the movement of heavy metals. Soils, especially those high in organic matter, and of fine particle size, chelate heavy metals and hold them in place. Notable in our study was the fact that the soils found directly under the plants contained higher levels of heavy metals, than those soils which were bare (a minimum of 2:1 at the Ontario Mine, maximum 24:1 at Ferris-Haggarty). Plants also uptake these metals, preventing their escape.

In this study, many plants were shown to accumulate various heavy metals to a great degree. All species accumulated significant amounts of heavy metals in comparison to the amounts found in water. For copper the best accumulators as compared to background levels in water and available in soil, were Pohlia annotina (a moss) accumulating 3,032 times the amount in water, and 48 times the amount in soil, Deschampsia cespitosa (a grass) accumulating 1,979 times the level in water, and 31 times the soil, Pohlia wahlenbergii (a moss) accumulating 14,813 times the level of copper in the water, and 7.0 times the background soil level, and Senecio fremontii (a forb) accumulating 31 times the level in water and 5 times the soil level.

For zinc, the best accumulators were Pohlia wahlenbergii (a moss) accumulating 3,814 times the level in water and 10 times the soil level, Equisetum arvense (a horsetail) accumulating 1,120 times the amount of zinc in the water and 7.5 times the amount in the soil, Poa interior (a grass) accumulating 2,128 times the level in the water and 5.7 times the soil background level, and Agrostis exarata (a grass) accumulating 261 times the zinc level in the water, and 4.5 times the soil level.

The best lead accumulators were Carex microptera (a sedge) accumulating 5,954 times the level in the water, and 2,977 times the soil, and Poa interior (a grass) accumulating 5,347 times the amount in the water, and 2,674 times the soil level.

Arsenic accumulated best in Pohlia wahlenbergii (a moss). It accumulated 3,221 times the level of arsenic in the water, and 1,073 times the soil level, Bryum lisae (a moss) contained 6,443 times the amount in the water, and 1,073 times the level in the soil, Epilobium glaberrimum (a forb) accumulated 5,814 times the amount in the water, and 969 times the soil level, and Carex scopulorum (a sedge) accumulated 26,432 times the amount in the water and 113 times the soil level. Cadmium was accumulated best by Pohlia wahlenbergii (a moss) at 6,393 times the level in the water, and 1.7 times the level in the soil.

All of these plants were capable of accumulating multiple metals. The best overall accumulator was Pohlia wahlenbergii. Plants were able to uptake arsenic most effectively followed by lead, copper, zinc and then cadmium. Different species vary in their ability to accumulate different heavy metals, so a mix of different species would be best for introduction into man-made wetlands, where a range of contaminants is present.

Deschampsia cespitosa was common on all of the copper sites. Carex aquatilis, and Pohlia nutans tolerated both zinc and copper sites. Carex microptera was common on sites which were high in zinc, and Carex rostrata appeared on zinc, lead and arsenic sites.

Field and Lab Methods

In the field, community and habitat analyses were undertaken. The Daubenmire quadrat method was used to identify the first and second most dominant species. Diversity was quantified by counting number of species per site. The site was mapped on a 7.5 minute quad. Slope and aspect were determined with a clinometer and compass. The topographic position of the site was determined (crest, upper slope, mid-slope, lower slope, valley bottom, bench or terrace, saddle or gap). It was determined whether lighting was open, partial, filtered, or shaded on the site. Soil moisture was described as inundated (hydric), saturated (wet-mesic), moist (mesic), dry-mesic, dry (xeric). Elevation was determined using a topographic map. The environment of the site was described (sand or gravel bar; wet meadow dominated by grasses; marsh dominated by sedges or rushes; swamp dominated by shrubs or trees; bog mire [mosses in acidic, wet peat soil]; fen mire with vascular plants in alkaline, wet peat soil; swale with moist surface soil; seep; terrace within three vertical feet or 100 feet of running surface water; snow catchment area; floating or quaking vegetation mat). We collected soil to quantify pH, N, P, K and heavy metal composition. We also collected soil for mycological sampling (10 samples from the most heavily impacted site). We tested the pH of the water on the site before collecting it for heavy metal analysis in the lab.

Voucher specimens were collected of all the different species on the site. Vigor was described for each species. The reproductive fitness of each species in the most heavily impacted area was ascertained. We looked for evidence of hybridity, disease, and symbiotic or parasitic relationships. We then collected plants for heavy metal analysis and live-plant greenhouse studies.

Vascular plants were identified using the microscopes at the Rocky Mountain Herbarium. Mosses were sent to the Clinton Herbarium in Buffalo, New York, to be identified by Patricia Eckel, a western moss specialist. The pH, N, P, and K of the soil was determined by using a LaMotte soil testing kit. Plant available heavy metals were extracted from the soils using the ABDTPA method (Soltanpour, 1977). Heavy metals were extracted from the plants via nitric acid digests (Havlin, 1980). The University of Wyoming soil-testing lab analyzed duplicate samples of the water, soil and plant samples for Cu, Zn, Cd, Pb, Hg and As using an inductively coupled plasma spectrometer.

Mycological soil samples from Kirwin Mine and Ferris-Haggarty Mine in Wyoming, McClaren's Mine in Montana, and the Pacific Mine in Utah were diluted 1:100 in sterile, deionized water, and 1 ml each of each sample was dispensed onto three plates of 10, 100, and 1000 ppm copper-enriched Martin's Medium. Colonies were counted and hyphal tip picks were made from the 100 ppm copper-enriched Martin's into 100 ppm copper enriched potato-dextrose agar tubes.

Fungi were grown to maturity and sorted to individual species. These species were analyzed for frequency and dominance. Sterile mycelial specimens were grown on cornmeal agar to induce sporulation. The dominant species were given to mycological experts on the University of Wyoming campus for identification. These species were grown in a shaken liquid potato-dextrose medium amended with 100 ppm of copper for get the amounts needed for heavy metal analysis for determining copper accumulation. Both the medium and the fungi were analyzed.

Summary of Report Order

Following is a description of the mines and their microsites (separate study sites, located in a logical manner around the mines), along with heavy metal compositions of the water, soil and the plants in the most heavily impacted areas. Plants containing over 500 ppm of heavy metals are compared to background levels of heavy metals in soil and water. Plant copper levels are compared with background levels at all mines. Toxicity tests on dominant plant species and results of mycological analyses are reported.

The format for each report (microsite) includes: microsite code, site location, habitat and community information, soil and water chemistry (including water and soil pH and N, P and K), dominant plants (including species name, collection date, vigor, % cover, % frequency, and ecological notes), dominant fungi, heavy metal chemistry for plants, fungi (Cu only), soil and water (including collecting date, code, location, and metal concentrations for Cu, Zn, Cd, Pb, Hg and As), and assessment of plant bioaccumulation of heavy metals.

Utah

Mary Ellen Mine - Wasatch Mountains - ~~Wasatch~~ Utah County

The Mary Ellen mine is 2.1 miles up a four wheel drive road. It is in a cirque basin surrounded by peaks of the Wasatch mountains. The Mary Ellen gulch area was extensively mined. Mine effluent originates from the side of a hill, flows past tailings piles and into Mary Ellen Creek. Forest service tests in 1981 and 1982 show zinc to be the main contaminant followed by copper. The soil around and under the effluent is stained a bright orange-red. Several plants grow directly in and by the effluent including a moss, Epilobium (a willow-wort), Mimulus (also called monkey-flower), Carex (a sedge), and Juncus (a rush). See Figure 3 for the map of the Mary Ellen microsite.

Glacial Trough or valley

Microsite Information:

Microsite Code: ME1

UT : Utah County. Wasatch Mountains ca 20 air miles north of Provo, ca 1 air mile east-south-east of East Twin Peak at the Mary Ellen Mine seep (T3S R3E S22). From Provo: Go to American Fork Canyon. Follow road to Dutchmans Flat. Go up the center 4 wheel drive road into Mary Ellen Gulch. You should be on the right side of the creek. Turn left at all forks. The road dead ends into the mine.

Habitat and Community Information:

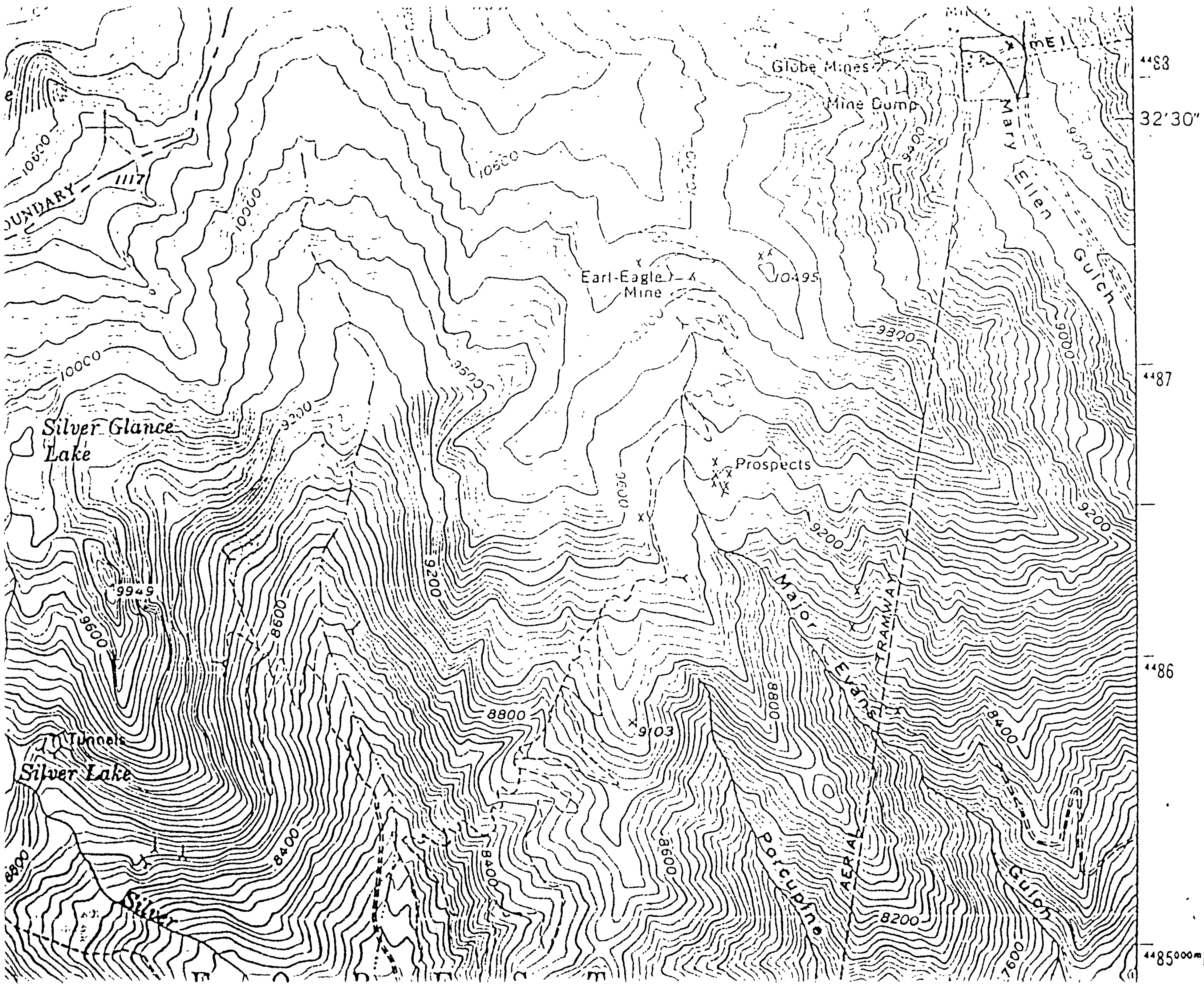
This site is located at mid-slope by a seep. The elevation is 9,500 ft. The slope is facing south-east. Lighting is full.

Basic soil and water chemistry:
pH of Water: 6 Soil pH: 6 N: 5ppm P: 50ppm K: <50ppm

The dominant species is Bryum lisae var. cuspidatum (a moss) and Poa interior (a grass) is subdominant. Nine species were sampled by quadrat on this site.

Figure 3

Map of Mary Ellen Microsite



Globe Mines
Mine Dump
MEI
Mary Ellen Gulch
4483
32'30"
4487
4486
4485000mN
9000
9400
9800
9200
10495
Earl-Eagle Mine
Prospects
Major Evans
AERIAL TRAMWAY
Porcupine
Gulch
8800
8400
8200
7600
8600
9103
9600
10000
10600
BOUNDARY
1117
Silver Glance Lake
9949
Tunnels
Silver Lake
Silver

Individual Species Information:

Chem Code: ME1BL
Species: _Bryum lisae_ var. _cuspidatum_ Date collected: 07/30/91
Vigor: Exceptionally vigorous Cover: 65 % Frequency: 90 %

Chem Code: ME1CC
Species: _Corydalis caseana_ Date collected: 07/30/91
Vigor: vigorous Cover: 0 % Frequency: 0 %
Comments: This species did not appear in thrown quadrats.

Chem Code: ME1CM
Species: _Carex microptera_ Date collected: 07/30/91
Vigor: vigorous Cover: 0 % Frequency: 0 %
Comments: This species did not appear in thrown quadrats.

Chem Code: ME1EG
Species: _Epilobium glaberrimum_ Date collected: 07/30/91
Vigor: Vigorous Cover: 0 % Frequency: 0 %
Comments: This species did not appear in thrown quadrats.

Chem Code: ME1PI
Species: _Poa interior_ Date collected: 07/30/91
Vigor: Normal Cover: 6 % Frequency: 20 %

Heavy Metal Chemistry (mg/kg):

Plants:

Date: 07/30/91 Code: ME1BL *Bryum lisae*

Cu	Zn	Cd	Pb	Hg	As
256.5	1249.5	17.66	191.5	<5	644.2

Date: 07/30/91 Code: ME1CC *Corydalis caseana*

Cu	Zn	Cd	Pb	Hg	As
39	295.5	2.475	39.05	<5	87

Date: 07/30/91 Code: ME1CM *Carex microptera*

Cu	Zn	Cd	Pb	Hg	As
101	332	2.975	54.55	<5	70.95

Date: 07/30/91 Code: ME1EG *Epilobium glaberrimum*

Cu	Zn	Cd	Pb	Hg	As
186.5	1047	13.65	99.3	<5	581.35

Soil:

Date: 06/25/91 Code: ME1S By Mary Ellen seep

Cu	Zn	Cd	Pb	Hg	As
30.76	435.96	3.84	<.2	<.2	.6

Water:

Date: 06/25/91 Code: ME1W Mary Ellen mine effluent

Cu	Zn	Cd	Pb	Hg	As
.02	1.55	<.01	<.1	<.1	<.1

These plants accumulated high levels of both zinc and arsenic.

Bryum lisae (a moss) accumulated 806 times the amount of zinc in the water, and 2.9 times the amount of zinc in the soil. It accumulated 6,442 times the amount of arsenic in the water and 1,074 times the amount of arsenic in the soil. It also accumulated copper at a rate 8.3 times the level in the soil, and 12,825 times the level in the water.

Epilobium glaberrimum (a willow-wort) accumulated 675 times the amount of zinc in the water and 2.4 times the amount of zinc in the soil. This plant accumulated 5,814 times the amount of arsenic as in the water, and 969 times the amount of arsenic in the soil. It also contained 6.06 times the amount of copper in the soil and 9,325 times the level in the water.

Pacific Mine - Wasatch Mountains

The Pacific Mine is located on the left fork of the main dirt road originating from Tibble Fork Reservoir. The mine effluent originates from a hillside, pools in a flat area, and flows through a tailings pile before entering into a beaver-caused wetlands complex. This area is a perfect study site in which to test the hypothesis that wetlands systems which include heavy metal tolerant or accumulating species of plants would mitigate heavy metal effluent. In fact, University of Wyoming water quality studies indicate that water quality increases dramatically after running through the wetlands and beaver dam. This site also yielded the species which accumulated the most heavy metals. Pohlia wahlenbergii var. glaciale (a moss) accumulated 13,004 ppm of zinc. This is 3,813 times the background water level and 10 times the background soil levels. This moss also accumulated 1,185 ppm of copper, which is 1,481 times the background level of water and 7 times the background level of the soil. All of the metals for which we tested were accumulated by this plant. The area impacted by the mine drainage is rich in vegetation, including two species of Carex (a sedge), a species each of Juncus (a rush), Poa (a grass), and Epilobium (a willow-wort), and a species of moss. The main contaminant in the effluent is zinc. See Figure 4 for map of Pacific Mine microsites.

Microsite Information:

Microsite Code: PM1

UT : Utah County. Wasatch Mountains ca 20 air miles north-north-east of Provo, ca 1 air mile west of Miller Hill at the Pacific Mine (T3S R3E S22). From Provo: Go to American Fork Canyon. Follow the road to its main fork above all named flats and go left. The Pacific Mine is on the left approximately 1 mile up the road. This microsite is the seep mouth on the Pacific Mine.

Habitat and Community Information:

This site is located on a lower slope by a seep. The elevation is 7,800 ft. The slope is east-facing. Lighting is Full.

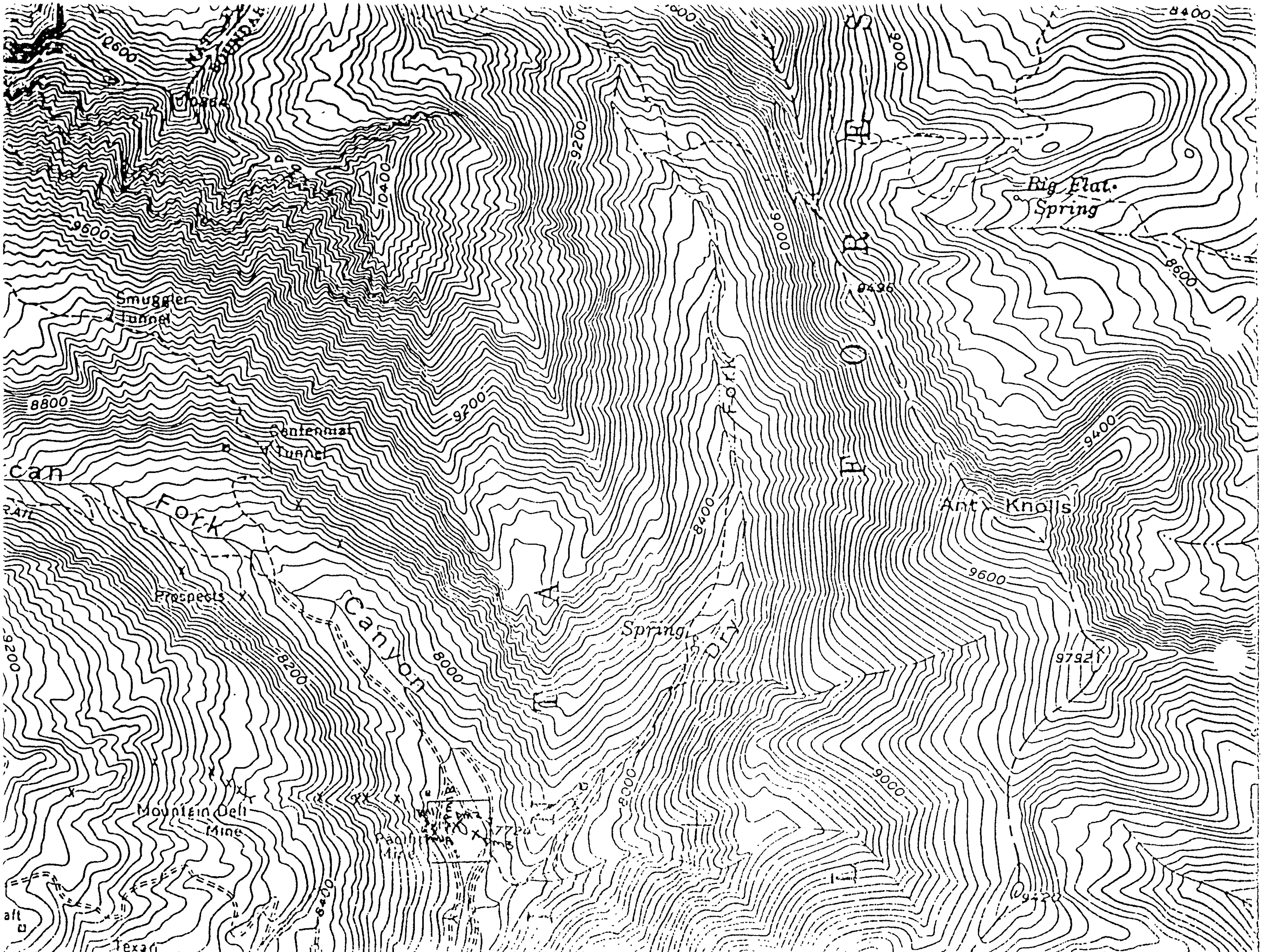
Basic soil and water chemistry:
pH of Water: 6 Soil pH: 7 N: 20ppm P: 25ppm K: 150ppm

The dominant plant species is Carex microptera (a sedge), and Juncus ensifolius (a rush) is subdominant. Seven species were sampled by quadrat on this site.

The dominant soil microfungi is

Figure 4

Map of Pacific Mine Microsites



Big Flat
Spring
Ant Knolls
9792
9436
Smuggler
Tunnel
Centennial
Tunnel
Prospects
Mountain Dell
Mine
Canyon
Fork
Dry
Fork
Spring
Texan
8000
8200
8400
8600
8800
9000
9200
9400
9600
10400

Individual Species Information:

Chem Code: PM1CM
Species: _Carex microptera_ Date collected: 07/31/91
Vigor: Vigorous Cover: 37 % Frequency: 40

Chem Code: PM1JE
Species: _Juncus ensifolius_ Date collected: 07/31/91
Vigor: Vigorous Cover: 26 % Frequency: 30 %

Chem Code: PM1PW
Species: _Pohlia wahlenbergii_ var. _glaciale_ Date collected: 07/31/91
Vigor: exceptionally vigorous Cover: 3.4% Frequency: 20 %
Comments: This moss is especially loaded with heavy metals.

Chem Code: PM1PI
Species: _Poa interior_ Date collected: 07/31/91
Vigor: Vigorous Cover: 8 % Frequency: 20 %

Heavy Metal Chemistry (mg/kg):

Plants:

Date: 07/31/91 Code: PM1CM Carex microptera

Cu	Zn	Cd	Pb	Hg	As
556.5	5403	69.97	595.35	<5	305.15

Date: 07/31/91 Code: PM1JE Juncus ensifolius

Cu	Zn	Cd	Pb	Hg	As
237	2662.5	28.64	242.35	<5	171.85

Date: 07/31/91 Code: PM1PI Poa interior

Cu	Zn	Cd	Pb	Hg	As
724.5	7259	79.83	534.7	<5	489.9

Date: 07/31/91 Code: PM1PW Pohlia wahlenbergii

Cu	Zn	Cd	Pb	Hg	As
1185	13004	127.86	388.05	<5	644.25

Soil:

Date: 07/31/91 Code: PM1S Pacific mine seep

Cu	Zn	Cd	Pb	Hg	As
166.96	1261.96	74.99	<.2	<.2	.6

Water:

Date: 06/25/91 Code: PM1W At effluent mouth

Cu	Zn	Cd	Pb	Hg	As
.12	4.64	<.01	<.1	<.1	<.1

Date: 07/31/91 Code: PM1W At effluent mouth

Cu	Zn	Cd	Pb	Hg	As
.08	3.41	.02	.1	<.1	.2

Date: 07/31/91 Code: PM1WA effluent pool below mouth

Cu	Zn	Cd	Pb	Hg	As
.08	3.32	.01	.1	.1	.1

Date: 07/31/91 Code: PM1WB Below tailings before dam

Cu	Zn	Cd	Pb	Hg	As
.58	14.7	.11	.6	.4	<.1

The Pacific Mine had unusually high amounts of copper, zinc, lead and cadmium. Some arsenic and mercury were also present.

Pohlia wahlenbergii (a moss) accumulated notable levels of copper, zinc and arsenic. It accumulated 14,813 times the background level of copper in the water, and 7.1 times the amount in the soil. It also accumulated 3,814 times the amount of zinc in the water and 10.3 times more than the amount in the soil. Arsenic was accumulated at 3,221 times what was in the water and 1,074 times the amount in the soil.

Carex microptera (a sedge) accumulated notable levels of copper, zinc and lead. It accumulated 6,956 times the amount of copper as was in the water, and 3.33 times what was in the soil. Zinc was accumulated at 1,584 times what was in the water, and 4.28 times what was in the soil. Lead accumulated at 5,954 times the amount in the water and at least 2,977 times what was in the soil.

Juncus ensifolius (a rush) accumulated 781 times the amount of zinc in the water and 2.11 times the amount in the soil. Copper accumulated at 2,962 times the level in the water, and 1.42 times the amount available in the soil.

Poa interior (a grass) accumulated copper, zinc and lead. Copper was accumulated at 9,056 times what was in the water, and 4.34 times the amount in the soil. Zinc was accumulated at 2,128.74 times the amount in the water, and 5.7 times the amount in the soil. Lead was accumulated at 5,347 times the amount in the water, and at least 2,674 times the amount in the soil.

Mycology:

Pacific Mine: Microhabitat samples A-C were predominantly silty to sandy and were orangish in color. Microhabitat samples D-J were high in partially decayed organic matter and were dark brown in color. No growth occurred on the 1000 ppm copper-amended medium. Growth was slow but with many colonies on the 100 ppm copper-amended medium. Growth was so profuse on the 10 ppm medium at the 1:100 dilution that separation of colonies for counting and picking for most of the different soil samples was impossible. Three species were isolated from the 100 ppm P-D-A copper-amended tube slants and were identified. There was an average of 39.3 colonies/plate on the 100 ppm copper-amended Martin's medium. The dominant species is an undescribed *Penicillium*. The description is being developed by Christianson and Tuthill. They are presently characterizing it as *Penicillium* sp. nov. "A", and have also discovered it in iron rich mine tailings. Its frequency was 78% (Table 1). Another undecribed *Penicillium* (sp. #1) from the raistickii series was present, along with *P. janthinellum*. Quantitative analysis of the fungi showed that it accumulated an average of 1572 ppm of copper. The liquid medium in which the fungi was grown showed no drop in copper in solution during the duration of the experiment. It is felt that this is an artifact resulting from dehydration of the medium. Quantitative analysis for copper is going to be repeated.

Table 1. Average colony counts and frequency of identified and unknown species from Pacific Mine growing on 100 ppm Martin's Medium.

	Penicillium sp. #1	Penicillium janthinellum	Penicillium sp. nov. "A"
Colony counts	4	4	28
Frequency	11%	11%	78%

Table 2. Analysis of fate of copper in potato-dextrose shake cultures amended with copper and innoculated with dominant species of fungi from the Pacific Mine.

Rep #	Sp.	Site	ppm Cu pre	ppm Cu post	Dif.	% dif.	g. fun.	ppm Cu fun.	pH med aft
10		PM1	84	83.5	0.5	1%	.517	1655	3.4
11			82	82	0.0	0%	.513	1541	3.3
12			82	84.5	-2.5	-3%	.507	1519	3.2

Rep # = Replicate #; Sp. = Species; Site = Site where species was collected; ppm Cu pre = original parts per million of copper in solution before innoculating with the fungus; ppm Cu post = parts per million of copper after nine days of fungal growth in the shake culture; Dif. = ppm Cu pre - ppm Cu post; % dif. = (dif./ppm Cu pre)100; g. fun. = grams dry weight of fungus used to analyze ppm Cu in the fungus; ppm Cu fun. = parts per million of copper in the fungus; pH med aft = pH of the medium after 9 days of fungal growth; Con. = control with no fungus added.

Microsite Code: PM2

UT : Utah County. Pacific Mine swamp (T3S R3E S22). See PM1 for directions. This microsite is the beaver pond where the seep feeds in.

Habitat and Community Information:

This site is located in a valley bottom in a marsh. The elevation is 7,800 ft. The slope is east-facing. Lighting is full.

Basic soil and water chemistry:
pH of Water: 7 Soil pH: 7 N: 5ppm P: 50ppm K: 60ppm

The dominant species is Carex rostrata (a sedge), and Equisetum arvense (a horsetail) is subdominant. Two species were sampled by quadrat on this site.

Individual Species Information:

Chem Code: PM2CR
Species: Carex rostrata Date collected: 07/31/91
Vigor: exceptionally vigorous Cover: 91 % Frequency: 100%

Chem Code: PM2EA
Species: Equisetum arvense Date collected: 07/31/91
Vigor: vigorous Cover: 9 % Frequency: 20 %

Heavy Metal Chemistry (mg/kg):

Plants:

Date: 07/31/91 Code: PM2CR *Carex rostrata*

Cu	Zn	Cd	Pb	Hg	As
102	1309.5	10.71	149.35	<5	47.3

Date: 07/31/91 Code: PM2EA *Equisetum arvense*

Cu	Zn	Cd	Pb	Hg	As
179	4079	49.7	265.9	<5	93.7

Soil:

Date: 07/31/91 Code: PM2S Pacific mine beaver pond

Cu	Zn	Cd	Pb	Hg	As
28.16	545.96	23.79	29.24	<.2	.5

Water:

Date: 06/25/91 Code: PM2W In beaver pond.

Cu	Zn	Cd	Pb	Hg	As
.14	3.64	.04	<.1	<.1	<.1

Carex rostrata (a sedge) and *Equisetum arvense* (a horsetail) both accumulated zinc from the beaver pond. *Carex rostrata* accumulated 360 times the amount of zinc in the water, and 2.4 times the amount in the soil. *Equisetum arvense* accumulated 1,121 times the amount of zinc in the water and 7.5 times the amount of zinc in the soil. It also accumulated 6.4 times the amount of copper in the soil and 1,279 times the amount of copper in the water.

Microsite Code: PM3

UT : Utah County. Pacific Mine below pond (T3S R3E S22). See PM1 for directions. This microsite is where the water exits the Beaver Dam, before it enters the North Fork of the American Fork River.

Habitat and Community Information:

This site is located in a valley bottom on a terrace. The elevation is 7,800 ft. The slope is east-facing. Lighting is full.

Heavy Metal Chemistry (mg/kg):

Water:

Date: 07/31/91 Code: PM3W effluent-creek confluence

Cu	Zn	Cd	Pb	Hg	As
.03	1.76	<.01	.1	<.1	<.1

Bibliography

Havlin, J. L. & P. N. Soltanpour. 1980. A nitric acid plant tissue digest method for use with inductive coupled plasma spectrometry. Comm. Soil Sci. and Plant Anal. 11: 969-980

Skabelund, P. 1989. Uinta National Forest water quality data. Unpubl. 5 pp

Soltanpour, P. N. & A. P. Schwab. 1977. A new soil test for simultaneous extraction of macro and micro nutrients in alkaline soils. Comm. Soil Sci. and Plant Anal. 8: 195-297