CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
602-771-1601
http://www.azgs.az.gov
inquiries@azgs.az.gov

The following file is part of the Arimetco, Inc. Mining Collection

ACCESS STATEMENT

These digitized collections are accessible for purposes of education and research. We have indicated what we know about copyright and rights of privacy, publicity, or trademark. Due to the nature of archival collections, we are not always able to identify this information. We are eager to hear from any rights owners, so that we may obtain accurate information. Upon request, we will remove material from public view while we address a rights issue.

CONSTRAINTS STATEMENT

The Arizona Geological Survey does not claim to control all rights for all materials in its collection. These rights include, but are not limited to: copyright, privacy rights, and cultural protection rights. The User hereby assumes all responsibility for obtaining any rights to use the material in excess of “fair use.”

The Survey makes no intellectual property claims to the products created by individual authors in the manuscript collections, except when the author deeded those rights to the Survey or when those authors were employed by the State of Arizona and created intellectual products as a function of their official duties. The Survey does maintain property rights to the physical and digital representations of the works.

QUALITY STATEMENT

The Arizona Geological Survey is not responsible for the accuracy of the records, information, or opinions that may be contained in the files. The Survey collects, catalogs, and archives data on mineral properties regardless of its views of the veracity or accuracy of those data.

Completion Report
Preliminary
Phase I
Zonia Evaluation

March 1993

John Petersen

Between 1/05/93 and 2/04/93 a condemnation drilling program and a leach dump trenching program were conducted on the Zonia property. This preliminary report covers all drilling results and roughly two-thirds of trenching results.

DRILLING:

Nine holes were drilled on the Zonia property to permit evaluation of certain mine facilities and/or to provide long-term ground water monitor wells. Results are discussed below. (See also graphic/assay logs, attached.)

Holes A-1 and A-3, each 500 feet deep, were drilled to assess depth and grade of mineralization extending from the pit area to beneath the Leach Basin I. The holes encountered 40 to 100 ft of quartz mica schist over a sequence of chlorite schists. Major zones of silicification were encountered in both holes with the heaviest zones localized in the bottom 100 feet.

Hole A-1 cut two zones of ore grade copper. One at 320'-350' (.23% TCu .14% OxCu; 61% oxide) and the second 430'-500' (TD) (.22% TCu .17 OxCu; 75% oxide). Only minor sulfides were observed and it is possible that the relatively low oxide copper reported is due to silica encapsulation.

Hole A-3 did not encounter ore grade copper in bedrock to total depth, and in fact was essentially barren.

Strongly silicified zones in both holes were assayed for precious metals. No detectable gold was found and only weak silver (up to 0.09 opt) was assayed in both holes, being strongest in the copper mineralized zone of A-1.

Holes A-8 and A-10 were drilled to test the Southwestern edge of the waste dump area near the base of Red Hill. Both holes intersected alternating quartz mica and chlorite schists in the top 200 to 300 feet above variably silicified chlorite schists. Hole A-8 cut about 50 ft of heavily epidotized rock beginning at 150 ft. Although epidote is frequently observed in drill cuttings, this zone with more

than 50% epidote represents an unusual situation of unknown significance.

Hole A-8 cut 150 ft of mineralization from 450 ft to 600 ft (TD). By including two low grade zones in the calculation this represents 150' of .25 % TCu/.23% OxCu; 91% oxide.

Hole A-10 penetrated only weakly mineralized material to total depth of 500 ft.

It is possible that holes A-1 and A-8 penetrated the same mineralized zone along strike. This interpretation fits with previous geologic models. If true, it is likely that ore grade mineralization extends down dip beneath Leach Basin I and the Southwestern end of the waste dump, but is apt to be quite deep under most of the area (i.e. more than 500ft).

Holes A-12 and A-14 were drilled midway along the length of the waste dump to evaluate ore potential under the waste dump. A-12 cut 60ft of quartz mica schist at the top, otherwise both A-12 and A-14 cut greenstone complexes including massive chloritic quartz-feldspar porphyry and chlorite schist. Silicified zones were cut in both holes.

A-12 cut 236 feet of significant mineralization 170 ft to 406 ft (TD). Including four intervals of low grade material, this zone contains .22% TCu. 19% OxCu; 88% oxide.

A-14, which was established as a permanent ground water monitor well, was drilled only to 315 ft where two cones were left in the hole, and it was abandoned.

These results, in combination with McAlester and Homestake drill results indicate that ore is likely to underlie a significant portion of the waste dump from the In Situ area and Northeastward. The depth to mineral is moderate along the Southeastern foot of the waste dump (130 to 170 ft) and may well be of economic significance. Further Northwest, in the vicinity of the present plant facilities,

the depth to ore may increase significantly. If present, ore grade mineral would likely be more than 500 feet deep.

Holes A-5 and A-17 were drilled within the area of In Situ "Basin 5" to evaluate whether or not substantial ore-grade copper remains after leaching. Hole A-5 encountered quartz-mica Schist from surface to TD (400 ft) although the basal 140 ft was quartz-rich to silicified and chloritic.

Several 10 foot to 30 foot zones contain ore grade mineral, but alternate with low-grade mineral. Compared to the nearest pre-leach holes (F 58 and F 59) it appears that substantial leaching may have occurred in the uppermost 150 ft in this area. This roughly corresponds to a 140 foot zone in A-5 which has a "bleached/leached" appearance. A-5 carries an average 0.10% total copper in this interval compared to an average .44% in F-58 and F-59.

As a second check on deep leaching in "Basin V" hole A-17 was drilled to 200' in a position intermediate between pre-leach holes F44, F45 and F52. Within the interval tested by A-17 the three pre-leach holes cut several 5 to 60 foot

intervals containing .27% to .67% total copper. A-~~5~~17 cut more than 100 ft of ore grade mineral including 20 feet of .95% TCu. This appears to contrast sharply with results from A-5 and indicates that either leaching or the distribution of mineralization in this area was quite erratic.

A tabulation has been prepared to illustrate the copper content of various "pre-leach" and "post-leach" holes in the In Situ area. Arimetco and Nerco drill hole assays are compared to the nearest McAlester holes.

Table I: Deep copper content in In Situ Leach Basins

BASIN 5

PRE-LEACH GRADE	POST-LEACH GRADE	APPARENT % COPPER LEACHED
F-128 F-60 .3914 F-114	Nerco 5-3-1 .2963	24.31%
F-58 F-59 .3048	Arimetco A-5 .1083	64.46%
F-44 F-45 .2565 F-52	Arimetco A-17 .2385	7.02%

BASIN 6

PRE LEACH GRADE	POST LEACH GRADE	APPARENT % COPPER LEACHED
F-144 H-362 .3002	Nerco 6-2 .2086	30.52%
F-191 .2920	Nerco 6-2 .2580	11.64%
F-192 .3569	Nerco 6-3 .6138	0%

The table above indicates more extensive, but erratic leaching in Basin 5 than in Basin 6. Average leaching in both basins may be about 20 to 25%.

Hole A-16 was drilled as a permanent ground water monitor well. It was located to test a conglomerate unit which appears to underlie Leach Basin III. Water was not encountered until 290 ft, or 130 ft below the conglomerate, in fractured granitic rock. The absence of water in the conglomerate indicates that leachate from Basin III has not made it's way into bedrock. Water obtained from the underlying granite had a moderately high TDS (1700), and a high pH (7.9). The hole was unmineralized.

TABLE II: Drill hole data (primary):

Hole No	Elev	TD	Driller's Water Level	Driller's Water Pumped	TDS	pH
A-1	4695	500'	304'	20-25gpm	NA	NA
A-3	4675	500'	340'	25 gpm	NA	NA
A-5	4580	400'	340'	10 gpm	NA	NA
			220'	-	NA	NA
A-8	4620	600'	280'	-	NA	NA
			460'	25 gpm	NA	NA
A-10	4625	500'	280'	15 gpm	1050	7.2
A-12	4450	400'	120'	-		
			260'	25 gpm	1600	7.8
A-14	4610	315'	210'	-		
			300'	25 gpm	3100	6.8
A-16	4735	400'	290'	-		
			400'	5 gpm	1700	7.9
A-17	4590	200'	Dry Hole			

Conclusions and Recommendations:

A total of 3815 feet were drilled out of the 4380 feet authorized by AFE. The difference arises because one condemnation, and four geotechnical holes were deemed to be unnecessary. One additional hole in the In-Situ area was thought to be required as a result of initial assay returns.

As anticipated, ore grade material does extend beneath Leach Basin I and the waste dump. Clearly, the economic significance of this mineral must be judged in the light of all available information. However, there are sufficient indications of ore grade material that additional drilling is

warranted especially NE of the In-Situ area. In particular, holes A-1 and A-3 should be deepened to 700 feet, and additional drilling along the waste dump should be undertaken to define potential ore reserves.

Evaluation of the leached cap in the In-Situ area will most likely require a fair amount of shallow (150 - 200 ft) close-spaced drilling (100 - 200 ft centers). Results of In-Situ area trenching may prove to be useful in evaluating patterns of leaching (see below).

TRENCHING:

The objectives of the trenching program were:

1. To obtain information relating to the character of the materials in Leach Basins I and III. Notes were made on fragment size, stratification, degree of sorting, evidence of reworking, evidence of mineralization, leaching, etc.
2. To obtain representative samples for assay in order that material might subsequently be selected for column testing.
3. To examine where ever possible the leach basin liner, and to determine it's character and integrity.

The equipment available were adequate to meet objectives 1 and 2, but not 3. The program requisition called for an excavator with a 24-25 foot reach. An excavator with a 21 foot reach was provided through the corporate office. As a result, sufficient pit depth was not obtained and an important program objective was compromised. It was possible to excavate to adequate depth in only one trench, T-3-12. In

this case, the leach rock-soil interface was seen approximately 23 feet below the leach dump surface (i.e. about 13 feet below the floor of the pre-dug dozer trench). Here a 6" ± diffuse band of dark colored material occurred at the top of the soil. This material contained substantial vegetable matter, had a fetid and possibly petroliferous odor; but was not a cohesive asphaltic material.

It is possible that leach rock has overlapped the liner by more than 100 ft on the SW end of Leach Basin III. About 1 foot of water filled the bottom of the excavation. With the failure to provide adequate equipment for liner evaluation, other means of exposing the liner have to be considered. Available equipment will be used to dig as deeply as possible in likely locations around the edge of Leach Basin III.

Full evaluation of objectives 1 and 2 pend return of all assay data. A few interesting relationships can be reported, however. It was found that a zone of uniform, brown apparently well-leached material occurs in the surface in both Basins I and III. It has similar appearance to the material exposed in the relatively shallow Basin II trench, previously evaluated (See my memo dated November, 1992). The base of this upper horizon may be undulatory and its thickness ranges from about 6 feet to about 15 feet. It overlies the main volume of leach material consisting of pervasively limonite stained leach rock. The intensity of iron stain varies from place to place and with depth. At time a complex shape and orientation of variably stained material appears to reflect local "micro-hydrologic" regimes in the leach dump. Frequently, more intense iron staining is associated with layers, lenses or pockets of relatively coarse leach rock with substantial cavernous porosity (e.g. Trench 1-3). It is within such strongly limonitic pockets that remnant copper mineralization is more intense.

In many trenches there is ample evidence by stratification or lensing that leach rock was not uniformly crushed, if crushed at all, and that once laid down was not subsequently disturbed by ripping or systematic reworking by other means.

Samples have been systematically taken from all excavations to determine if there is a predictable relationship between copper content and location or the appearance of the leach rock. Also, copper content by size fraction is being determined.

The sampling procedure followed was designed to obtain representative samples. In dozer trenches, vertical channels were cut with a shovel through representative and undistributed material in the walls. Approximately 60 pound samples were taken of all material in the channels. In deeper excavations, separate piles were made of material from the upper ten feet and lower ten feet. These piles were split with a backhoe and a channel sample taken through the center of each pile, again obtaining all material cut. Fragments which, due to size, bridged the channel were broken by hammer and a representative fraction was taken. Using this methodology all material from fines to plus-one-foot were bagged.

Leach basin samples were screened at Johnson Camp to minus 1/4", plus 1/4" to minus 1". and plus 1". All samples were submitted for analysis of Total copper % and Oxide copper %.

By including NERCO Leach Dump drill sampling the number of sample sites in Basins I and III is increased-markedly. Although there appears to be a tendency for NERCO results to be generally higher in total copper and lower in oxide copper than Arimetco results, the differences are not so extreme that the data cannot be combined.

The resulting data are spread with fair uniformity over both Leach Basins. Basin I has 28 sample sites and Basin III has 19. The data are adequate for the top 30 to 40 feet of

leach rock and sparse for deeper material. Since the average thickness of leach rock in the basins is about 56 feet nearly two thirds of the volume of leach rock may be adequately appraised.

Tables III and IV show average grades by depth in Leach Basins I and III.

TABLE III: NERCO Drilling Copper Content VS. Depth

Basin I

No. of Samples	Depth	TCu%	OxCu%
16	0-10	.1288	.0444
16	10-20	.1738	.0625
16	20-30	.2363	.1169
15	30-40	.1837	.0590
10	40-50	.1450	.0490
5	50-60	.1620	.0600
3	60-70	.2267	.0733
Average		.1795	.0664

Basin III

No. of Samples	Depth	TCu%	OxCu%
7	0-10	.2229	.0829
7	10-20	.2014	.0814
7	20-30	.1486	.0486
6	30-40	.2233	.0933
6	40-50	.1583	.0550
4	50-60	.1725	.0500
Average		.1889	.0685

TABLE IV: Arimetco Trenching: Copper Content VS Depth
(64% of data)

Basin I

No. of Sites	Depth	TCu%	OxCu%
12	0-10	.12	.10
4	10-20	.16	.12
4	20-30	.14	.11
Average		.13	.10

Basin III

No. of Sites	Depth	TCu%	OxCu%
12	0-10	.13	.10
6	10-20	.14	.12
6	20-30	.15	.13
Average		.14	.12

There appears not to be any uniform relationship between depth in the leach dump and grade other than the upper ten feet having been more substantially leached on average and that perhaps it contains less oxide copper.

NERCO (Mountain States R & D) reported that there was no appreciable difference in copper content by size fraction. However, the sampling technique employed would have rejected oversize material. Therefore Arimetco samples were screened (+1"; +1/4"; -1/4") to reassess this possibility. Visual examination of trenches indicates that +6" material comprises between 5% and 20% of Zonia leach rock and that material between 1 and 4 feet in longest dimension is not uncommon. Furthermore, where copper minerals remain in leach rock it is invariably in +6" material. Therefore an important economic parameter is the quantity and grade of such oversized

material. It must be noted that far less than half of the oversized rock contains obvious copper mineral even though it has generally a fresh, unleached appearance.

Table V shows a breakdown of copper distributions in Arimetco trench samples (based upon currently available data 64%)

As shown in the table there is a slight tendency for coarse material at certain levels in Basin I to contain less copper, and an equally slight tendency toward the reverse situation in Basin III. This relationship is in accord with visual estimation, whereby unleached copper was found more frequently in Basin III trenches than in Basin I. Clearly, the differences are so slight in average that for purposes of economic evaluation all three leach basins might be considered together.

TABLE V: Arimetco Trenching; Copper Distribution by Size Fraction

Basin I

Depth	+1"		+1/4"		-1/4"	
	TCu	OxCu	TCu	OxCu	TCu	OxCu
0-10	.12	.10	.11	.09	.12	.10
10-20	.16	.13	.16	.13	.16	.12
20-30	.13	.10	.14	.11	.14	.11
Averages	.14	.11	.13	.11	.14	.11

Basin III

Depth	+1"		+1/4"		-1/4"	
	TCu	OxCu	TCu	OxCu	TCu	OxCu
0-10	.10	.08	.10	.09	.12	.09
10-20	.15	.13	.12	.10	.14	.11
20-30	.15	.13	.15	.13	.15	.12
Averages	.13	.11	.12	.11	.14	.11
Overall Averages:	.14	.11	.13	.11	.14	.11

Weight percent distribution averages as follows

(100% of data):

Location	Weight % +1"	+1/4"	-1/4"	
Basin I	33.5%	26.2%	40.3%	
Basin III	34.6%	29.2%	36.2%	
Average	34.1%	27.8%	38.1%	
[Basin II		36.2%	20.8%	43.0%]

The combined results of NERCO and Arimetco sampling (64% of data) indicate that the average copper content of Leach Basin I is .15% TCu and .08% OxCu; and of Leach Basin III is .16% TCu and .09% OxCu. Previous sampling of Leach Basin II indicated average copper was .18% TCu and .15% OxCu. The overall weighed average is .16% TCu and .09% OxCu.

On the basis of size distribution, of the total copper remaining in the leach dumps approximately 34% will be in +1" 28% in +1/4"-1"; and 38% in -1/4". Visual estimates of plus 6" material range from about 5% to about 20%. Local pockets and lenses exist where oversized material constitutes more than 50%, but it is likely that for the entire volume of the heaps a 10-15% average would not be too far off.

Excavations were also made on In-Situ basins V and VI. Samples from the top 10' and bottom 10' of each 20 foot pit were submitted for analysis. Based upon results received to date (86%) it is apparent that Basin VI (6 pits) has been less thoroughly leached than Basin V (12 pits) and that within Basin V the upper terraces have been leached to greater extent than lower terraces. Table VI shows average values for both basins. It would appear that ore grade material exists at relatively shallow depth in both In-Situ areas.

TABLE IV: In Situ Trenching

	TCu% Range/Average	OxCu% Range/Average	% Oxide
Basin V			
0-10	.07-.35/.1420	.04-.29/.1020	71.8%
10-20	.05-.60/.2230	.03-.58/.1840	82.5%
Basin VI			
0-10	.09-.39/.2283	.05-.32/.1900	79.7%
10-20	.16-.50/.2840	.13-.41/.2300	81.0%
Average			
0-10	.1781	.1350	75.8%
10-20	.2433	.1993	81.9%
Overall Average	.2107	.1672	79.3%

oxide is recoverable, the contained leachable resource is about 13,350,000 pounds. If NERCO (Mountain States R & D) estimate of 39% acid leachable copper is used a little over 8,650,000 pounds is available.

Clearly, column testing will be required to obtain some idea of the ultimate practical recovery. Toward that end it is suggested that three columns be run of Zonia leach rock. The recommended sample sites are as follows:

T-1-3-3 (10-20') with .15% TCu and .13% OxCu;
T-3-11-4 (20-30') with .14% TCu and .10% OxCu; and
T-3-9-4 (20-30') with .24% TCu and .21% OxCu.

Column testing of this material would simulate stripping and ripping of existing leach dumps followed by application of Johnson Camp type leachate. Approximately 700 pounds of each sample (55 gallon drum full) will be required.

Also suggested early on were pilot heap leach tests on 10-ton lots of ore. It is recommended at this point that a single pilot heap test be conducted on pit run ore without crushing. A comparison with results from column tests which approximates a test on undersized ore at minus 1 foot and which are in progress may indicate whether further study of a new-ore crushing option is justified.

Results to date tend to indicate 70% recovery of head grade (here taken to be approximately 0.5% total copper) from ore leached by McAlester. Whilst column testing of leach rock may indicate that a small additional amount of the original copper may be recovered by scalping and ripping the economics of crushing new or old ore to further enhance this limited additional recovery may be suspect. Also the production of fines by crushing may ultimately prove to be detrimental. Especially since the dumps contain nearly 40% --1/4" material at the outset.

ZONIA
HOLE A-1
Comp. 1/6/93
TD = 500'
-90°

COORDS: Ft N Ft E

ELEV. =

LITHOLOGY

100 -
200 -
300 -
400 -
500 -

10 fill
30 Conglomerate (?)
qtz-mica Schist
mod. to hvy FeOx
qtz as sub-rnd grains
130 mixed qtz-mica + chlorite Schist
150
Chlorite Schist
± qtz grains
incr. silicification
to bottom
280 Silicified zone
320 Chlorite Schist
330
340 mixed qtz mica + Chlorite Schist
Chlorite schist, patchy silicification
370-380 poss. micro bx
410
Silicified Chlorite Schist
brick red by hvy FeOx incl. hem. alt.
mica 470-490 tarnished py

TCu	Ox Cu	
.15	.13	
.01		
.04		
.01		
<.01		
.01		
.01		
.02		
<.01		
.01		
.03		
.01		
.02		
.11		
.13		
.07		
.08		
.06		
.06		
.08		
.14		
.09		
.34	.21	} .23/.14 41%
.15	.09	
.20	.12	
.09		
.13		
.07		
.02		
.03		
.04		
.03		
.04		
.03		
.03		
.04		
.04		
.04		
.06		
.04		
.09		
.06		
.04		
.18	.14	} .22/.17 75%
.17	.12	
.14	(.10)	
.21	.15	
.23	.25	
.22	.16	
.30	.24	

CARBONATE

1" = 100'

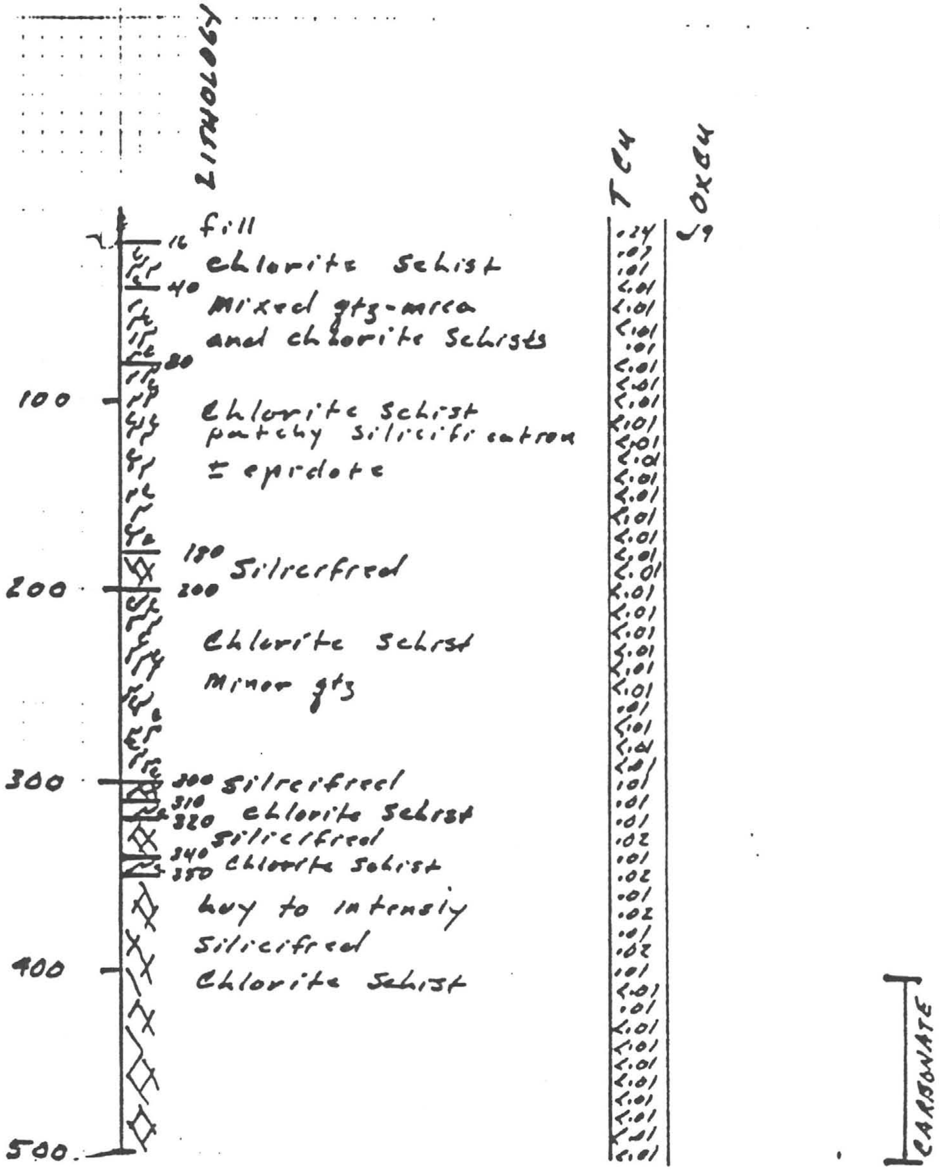
ZONIA
HOLE A-3

Comp. 1/8/93

TD = 500'
-90°

COORDS: ftN ft

ELEV. =



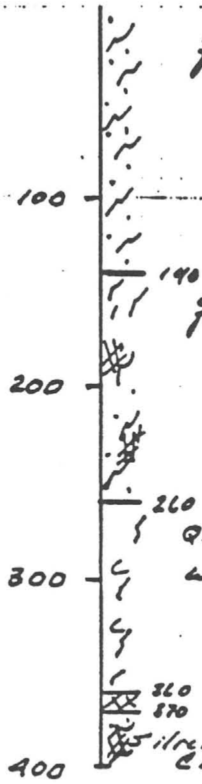
1" = 100'

ZONIA
HOLE A-5

COMP. 1/19/93
TD = 400'
-90°

COORDS ft N ft E

ELEV. =



quartz - mica schist with bleached/leached appearance

140 quartz mica schist patchy silicification v. hvy FeOx + qtz

260 Quartz rich zone, chloritic with mica schist

360 370 silicified zone

silicified mica schist with chloritic qtz

CARBONATE

TCu	OxCu
.09	
.09	
.06	
.08	
.07	
.06	
.05	
.07	
.09	
.08	
.21	.11
.22	.18
.13	
.14	
.09	
.09	
.07	
.05	
.15	.08
.10	
.04	
.09	
.08	
.28	.25
.35	.34
.15	.13
.11	
.03	
.05	
.08	
.13	
.07	
.07	
.09	
.16	.12
.14	
.24	.21
.08	
.11	
.13	

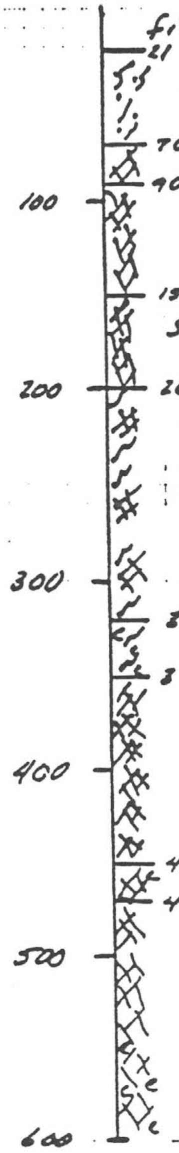
1" = 100'

ZONIA
HOLE A-8
Comp. 1/14/93
TD = 600 ft
-90°

COORDS #N #E

ELEV. =

LITHOLOGY



fill
21 qtz-mica schist
mod FeOx
patchy silicification
50-60 clayey
70 silicified rock
90
Silicified mica
schist, chloritic
150 blue-grey altered rock
Silicified mica schist ?
(poss. chlorite schist)
hvy epidote (up to 50%)
200
Silicic mica schist
~10% epidote
320 chlorite schist
mod to hvy Si, mod FeOx
350 ± epidote ± magnetite
Silicified zone
minor mica schist
hvy clear qtz
rare tourmaline rare epidote
450 chlorite schist with
470 hvy silicification
Silicified rock
intermittent clots
of chlorite becoming
heavy in bottom
40'

TCu	OXCU
.11	
.06	
.06	
.02	
.05	
.03	
.12	
.01	
.03	
.05	
.06	
.02	
.03	
.07	
.04	
.02	
.01	
.02	
.01	
.01	
.08	
.12	
.09	
.14	
.03	
.02	
.02	
.06	
.05	
.02	
.09	
.14	
.12	
.14	
.15	.10
.07	
.06	
.07	
.11	
.08	
.06	
.05	
.11	
.10	
.12	
.33	.28
.34	.29
.57	.26
.12	(~.11)
.12	(~.11)
.17	.14
.28	.26
.13	(~.12)
.18	.16
.28	.26
.24	.21
.37	.35
.55	.53
.21	.19
.19	.16

CARBONATE

/

.25/.23

91% OXIDE

1" = 100'

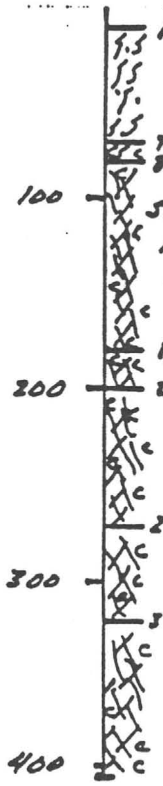
ZONIA
HOLE A-12
RomA. 1/21/93

TD = 406'
-90°

COORDS. ftN ftE

ELEV. =

LITHOLOGY



10 fill

Mica Schist, 10-20% qtz grains, mod FeOx
Mod. Si, minor chlorite

70
80 Mica schist and chloritic rock

Silicified chloritic rock
hvy chlorite
mod to hvy calcite

180 clear to milky qtz
200 clots of chlorite

Silicified rock, hvy chlorite with large qtz eyes, mod calcite

270

qtz or intensely silicified rock whisps and clots of chlorite ± mt ± epidote

320

Silicified rock, dark green qtz + felds phens in chloritic matrix
Tr calcite

TCu	OxCu
.11	
.14	
.05	
.07	
.04	
.05	
.07	
.06	
.05	
.04	
.04	
.07	
.07	
.04	
.08	
.09	
.11	
.20	.12
.10	
.20	.16
.18	.12
.16	.11
.20	.13
.27	.19
.47	.38
.31	.24
.43	.31
.22	.14
.13	(~.11)
.21	.15
.25	.15
.16	.10
.13	(~.11)
.34	.24
.13	(~.11)
.12	(~.10)
.20	.14
.21	.14
.15	.10
.22	.14
.44	.30

CARBONATE

226' .24/.19 88%

1" = 100'

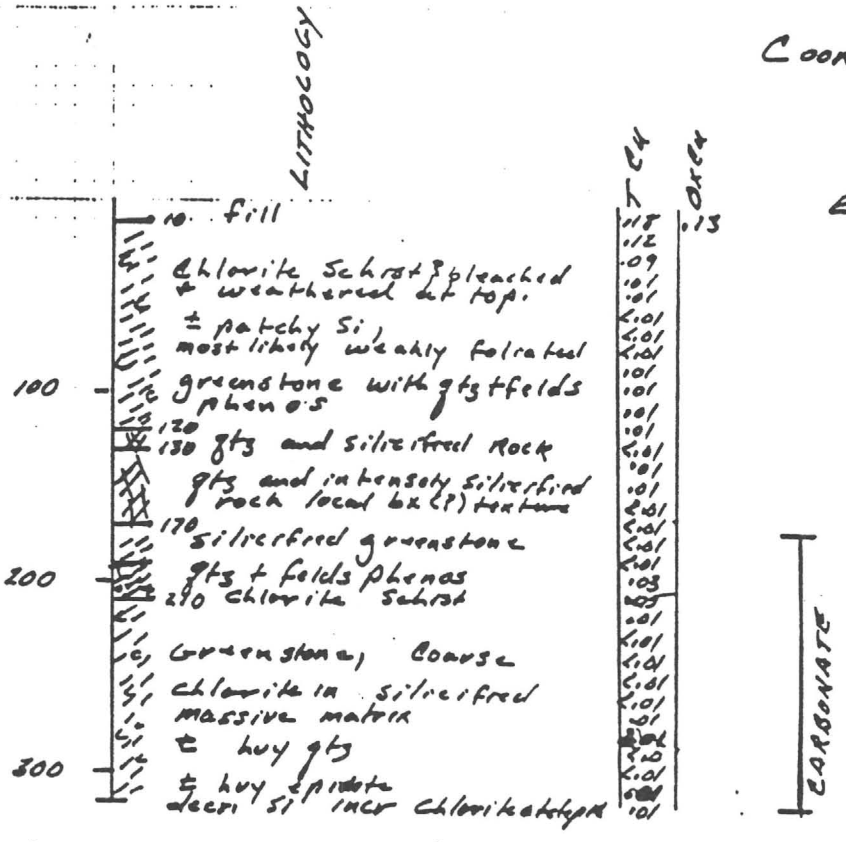
NOTE HOLE ABANDONED at 406'
Caving at Surface

MONITOR WELL

ZONIA
HOLE - A - 14
Comp. 1/27/93
TD 315'
-90°

COORDS!
ft N
ft E

ELEV. =



1" = 100'

NOTE: LOST 2 Cones in Hole, Abandoned at 315'

18' of 8" Casing Installed at Surface with 1' Stickup.

MONITOR. WELL

ZONIA
HOLE A-16
Comp. 1/28/93
T.D = 400'
-90°

COORDS ft N ftE

ELEV. =

fill
10-15'
purple-gray aphanite
with ~10% pyroxene + felds phenos Tr qtz phenos
70 Basal 10' vitric with oxidized biotite & phenos

100
Clasts of qtz, qtz-mica schist and qtz-felds
rock (gr?) in a red silty (mica) clayey
matrix Prob. Tert Conglomerate

160
Holocrystalline qtz + plag + Kspar
200
gr-qtz monzonite

230
diabase
243

granite or qtz monzonite
290-330 hvy qtz
300
mod to hvy calcite, minor chlorite

chlorite schist

granite or qtz monzonite Chloritic
400
390-400 hvy qtz

CARBONATE

1" = 100'

NOTE: DRILLED AS MONITOR WELL
NOT ASSAYED 0-230
230-400 <.01% Tcu
11 ft of 8" casing installed at surface
with 1' stickup

ZONIA

HOLE A-17

Comp: 8/28/93

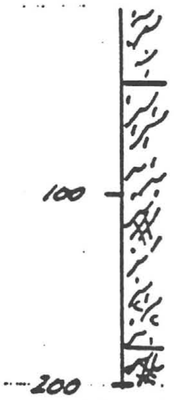
TD = 200'

-90°

COORDS: ft N ft E

ELEV.' =

LITHOLOGY



qtz-mica schist
bleached/leached appearance

qtz-mica schist
local patchy silicification

150-170
weakly chloritic

silicified mica schist

TCu	ASCu
.06	
.03	
.09	
.07	
.16	.14
.76	.72
1.14	1.08
.23	.21
.29	.25
.14	(~.13)
.15	.11
.47	.43
.10	(~.09)
.17	.13
.27	.24
.05	
.18	
.17	
.11	
.13	

110'/.34/~.31 90% OXIDE

1" = 200'

NOTE: DRY HOLE

Completion Report
Preliminary
Phase I
Zonia Evaluation

Copy: AC/tw

March 1993

John Petersen

Between 1/05/93 and 2/04/93 a condemnation drilling program and a leach dump trenching program were conducted on the Zonia property. This preliminary report covers all drilling results and roughly two-thirds of trenching results.

DRILLING:

Nine holes were drilled on the Zonia property to permit evaluation of certain mine facilities and/or to provide long-term ground water monitor wells. Results are discussed below. (See also graphic/assay logs, attached.)

Holes A-1 and A-3, each 500 feet deep, were drilled to assess depth and grade of mineralization extending from the pit area to beneath the Leach Basin I. The holes encountered 40 to 100 ft of quartz mica schist over a sequence of chlorite schists. Major zones of silicification were encountered in both holes with the heaviest zones localized in the bottom 100 feet.

Hole A-1 cut two zones of ore grade copper. One at 320'-350' (.23% TCu .14% OxCu; 61% oxide) and the second 430'-500' (TD) (.22% TCu .17 OxCu; 75% oxide). Only minor sulfides were observed and it is possible that the relatively low oxide copper reported is due to silica encapsulation.

Hole A-3 did not encounter ore grade copper in bedrock to total depth, and in fact was essentially barren.

Strongly silicified zones in both holes were assayed for precious metals. No detectable gold was found and only weak silver (up to 0.09 opt) was assayed in both holes, being strongest in the copper mineralized zone of A-1.

Holes A-8 and A-10 were drilled to test the Southwestern edge of the waste dump area near the base of Red Hill. Both holes intersected alternating quartz mica and chlorite schists in the top 200 to 300 feet above variably silicified chlorite schists. Hole A-8 cut about 50 ft of heavily epidotized rock beginning at 150 ft. Although epidote is frequently observed in drill cuttings, this zone with more

than 50% epidote represents an unusual situation of unknown significance.

Hole A-8 cut 150 ft of mineralization from 450 ft to 600 ft (TD). By including two low grade zones in the calculation this represents 150' of .25 % TCu/.23% OxCu; 91% oxide.

Hole A-10 penetrated only weakly mineralized material to total depth of 500 ft.

It is possible that holes A-1 and A-8 penetrated the same mineralized zone along strike. This interpretation fits with previous geologic models. If true, it is likely that ore grade mineralization extends down dip beneath Leach Basin I and the Southwestern end of the waste dump, but is apt to be quite deep under most of the area (i.e. more than 500ft).

Holes A-12 and A-14 were drilled midway along the length of the waste dump to evaluate ore potential under the waste dump. A-12 cut 60ft of quartz mica schist at the top, otherwise both A-12 and A-14 cut greenstone complexes including massive chloritic quartz-feldspar porphyry and chlorite schist. Silicified zones were cut in both holes.

A-12 cut 236 feet of significant mineralization 170 ft to 406 ft (TD). Including four intervals of low grade material, this zone contains .22% TCu. 19% OxCu; 88% oxide.

A-14, which was established as a permanent ground water monitor well, was drilled only to 315 ft where two cones were left in the hole, and it was abandoned.

These results, in combination with McAlester and Homestake drill results indicate that ore is likely to underlie a significant portion of the waste dump from the In Situ area and Northeastward. The depth to mineral is moderate along the Southeastern foot of the waste dump (130 to 170 ft) and may well be of economic significance. Further Northwest, in the vicinity of the present plant facilities,

the depth to ore may increase significantly. If present, ore grade mineral would likely be more than 500 feet deep.

Holes A-5 and A-17 were drilled within the area of In Situ "Basin 5" to evaluate whether or not substantial ore-grade copper remains after leaching. Hole A-5 encountered quartz-mica Schist from surface to TD (400 ft) although the basal 140 ft was quartz-rich to silicified and chloritic.

Several 10 foot to 30 foot zones contain ore grade mineral, but alternate with low-grade mineral. Compared to the nearest pre-leach holes (F 58 and F 59) it appears that substantial leaching may have occurred in the uppermost 150 ft in this area. This roughly corresponds to a 140 foot zone in A-5 which has a "bleached/leached" appearance. A-5 carries an average 0.10% total copper in this interval compared to an average .44% in F-58 and F-59.

As a second check on deep leaching in "Basin V" hole A-17 was drilled to 200' in a position intermediate between pre-leach holes F44, F45 and F52. Within the interval tested by A-17 the three pre-leach holes cut several 5 to 60 foot

intervals containing .27% to .67% total copper. A-5 cut more than 100 ft of ore grade mineral including 20 feet of .95% TCu. This appears to contrast sharply with results from A-5 and indicates that either leaching or the distribution of mineralization in this area was quite erratic.

A tabulation has been prepared to illustrate the copper content of various "pre-leach" and "post-leach" holes in the In Situ area. Arimetco and Nerco drill hole assays are compared to the nearest McAlester holes.

Table I: Deep copper content in In Situ Leach Basins

BASIN 5

PRE-LEACH GRADE	POST-LEACH GRADE	APPARENT % COPPER LEACHED
F-128 F-60 .3914 F-114	Nerco 5-3-1 .2963	24.31%
F-58 F-59 .3048	Arimetco A-5 .1083	64.46%
F-44 F-45 .2565 F-52	Arimetco A-17 .2385	7.02%

BASIN 6

PRE LEACH GRADE	POST LEACH GRADE	APPARENT % COPPER LEACHED
F-144 H-362 .3002	Nerco 6-2 .2086	30.52%
F-191 .2920	Nerco 6-2 .2580	11.64%
F-192 .3569	Nerco 6-3 .6138	0%

The table above indicates more extensive, but erratic leaching in Basin 5 than in Basin 6. Average leaching in both basins may be about 20 to 25%.

Hole A-16 was drilled as a permanent ground water monitor well. It was located to test a conglomerate unit which appears to underlie Leach Basin III. Water was not encountered until 290 ft, or 130 ft below the conglomerate, in fractured granitic rock. The absence of water in the conglomerate indicates that leachate from Basin III has not made it's way into bedrock. Water obtained from the underlying granite had a moderately high TDS (1700), and a high pH (7.9). The hole was unmineralized.

TABLE II: Drill hole data (primary):

Hole No	Elev	TD	Driller's Water Level	Driller's Water Pumped	TDS	pH
A-1	4695	500'	304'	20-25gpm	NA	NA
A-3	4675	500'	340'	25 gpm	NA	NA
A-5	4580	400'	340'	10 gpm	NA	NA
			220'	-	NA	NA
A-8	4620	600'	280'	-	NA	NA
			460'	25 gpm	NA	NA
A-10	4625	500'	280'	15 gpm	1050	7.2
A-12	4450	400'	120'	-		
			260'	25 gpm	1600	7.8
A-14	4610	315'	210'	-		
			300'	25 gpm	3100	6.8
A-16	4735	400'	290'	-		
			400'	5 gpm	1700	7.9
A-17	4590	200'	Dry Hole			

Conclusions and Recommendations:

A total of 3815 feet were drilled out of the 4380 feet authorized by AFE. The difference arises because one condemnation, and four geotechnical holes were deemed to be unnecessary. One additional hole in the In-Situ area was thought to be required as a result of initial assay returns.

As anticipated, ore grade material does extend beneath Leach Basin I and the waste dump. Clearly, the economic significance of this mineral must be judged in the light of all available information. However, there are sufficient indications of ore grade material that additional drilling is

warranted especially NE of the In-Situ area. In particular, holes A-1 and A-3 should be deepened to 700 feet, and additional drilling along the waste dump should be undertaken to define potential ore reserves.

Evaluation of the leached cap in the In-Situ area will most likely require a fair amount of shallow (150 - 200 ft) close-spaced drilling (100 - 200 ft centers). Results of In-Situ area trenching may prove to be useful in evaluating patterns of leaching (see below).

TRENCHING:

The objectives of the trenching program were:

1. To obtain information relating to the character of the materials in Leach Basins I and III. Notes were made on fragment size, stratification, degree of sorting, evidence of reworking, evidence of mineralization, leaching, etc.
2. To obtain representative samples for assay in order that material might subsequently be selected for column testing.
3. To examine where ever possible the leach basin liner, and to determine it's character and integrity.

The equipment available were adequate to meet objectives 1 and 2, but not 3. The program requisition called for an excavator with a 24-25 foot reach. An excavator with a 21 foot reach was provided through the corporate office. As a result, sufficient pit depth was not obtained and an important program objective was compromised. It was possible to excavate to adequate depth in only one trench, T-3-12. In

this case, the leach rock-soil interface was seen approximately 23 feet below the leach dump surface (i.e. about 13 feet below the floor of the pre-dug dozer trench). Here a 6" ± diffuse band of dark colored material occurred at the top of the soil. This material contained substantial vegetable matter, had a fetid and possibly petroliferous odor; but was not a cohesive asphaltic material.

It is possible that leach rock has overlapped the liner by more than 100 ft on the SW end of Leach Basin III. About 1 foot of water filled the bottom of the excavation. With the failure to provide adequate equipment for liner evaluation, other means of exposing the liner have to be considered. Available equipment will be used to dig as deeply as possible in likely locations around the edge of Leach Basin III.

Full evaluation of objectives 1 and 2 pend return of all assay data. A few interesting relationships can be reported, however. It was found that a zone of uniform, brown apparently well-leached material occurs in the surface in both Basins I and III. It has similar appearance to the material exposed in the relatively shallow Basin II trench, previously evaluated (See my memo dated November, 1992). The base of this upper horizon may be undulatory and its thickness ranges from about 6 feet to about 15 feet. It overlies the main volume of leach material consisting of pervasively limonite stained leach rock. The intensity of iron stain varies from place to place and with depth. At time a complex shape and orientation of variably stained material appears to reflect local "micro-hydrologic" regimes in the leach dump. Frequently, more intense iron staining is associated with layers, lenses or pockets of relatively coarse leach rock with substantial cavernous porosity (e.g. Trench 1-3). It is within such strongly limonitic pockets that remnant copper mineralization is more intense.

In many trenches there is ample evidence by stratification or lensing that leach rock was not uniformly crushed, if crushed at all, and that once laid down was not subsequently disturbed by ripping or systematic reworking by other means.

Samples have been systematically taken from all excavations to determine if there is a predictable relationship between copper content and location or the appearance of the leach rock. Also, copper content by size fraction is being determined.

The sampling procedure followed was designed to obtain representative samples. In dozer trenches, vertical channels were cut with a shovel through representative and undistributed material in the walls. Approximately 60 pound samples were taken of all material in the channels. In deeper excavations, separate piles were made of material from the upper ten feet and lower ten feet. These piles were split with a backhoe and a channel sample taken through the center of each pile, again obtaining all material cut. Fragments which, due to size, bridged the channel were broken by hammer and a representative fraction was taken. Using this methodology all material from fines to plus-one-foot were bagged.

Leach basin samples were screened at Johnson Camp to minus 1/4", plus 1/4" to minus 1". and plus 1". All samples were submitted for analysis of Total copper % and Oxide copper %.

By including NERCO Leach Dump drill sampling the number of sample sites in Basins I and III is increased-markedly. Although there appears to be a tendency for NERCO results to be generally higher in total copper and lower in oxide copper than Arimetco results, the differences are not so extreme that the data cannot be combined.

The resulting data are spread with fair uniformity over both Leach Basins. Basin I has 28 sample sites and Basin III has 19. The data are adequate for the top 30 to 40 feet of

leach rock and sparse for deeper material. Since the average thickness of leach rock in the basins is about 56 feet nearly two thirds of the volume of leach rock may be adequately appraised.

Tables III and IV show average grades by depth in Leach Basins I and III.

TABLE III: NERCO Drilling Copper Content VS. Depth

Basin I

No. of Samples	Depth	TCu%	OxCu%
16	0-10	.1288	.0444
16	10-20	.1738	.0625
16	20-30	.2363	.1169
15	30-40	.1837	.0590
10	40-50	.1450	.0490
5	50-60	.1620	.0600
3	60-70	.2267	.0733
Average		.1795	.0664

Basin III

No. of Samples	Depth	TCu%	OxCu%
7	0-10	.2229	.0829
7	10-20	.2014	.0814
7	20-30	.1486	.0486
6	30-40	.2233	.0933
6	40-50	.1583	.0550
4	50-60	.1725	.0500
Average		.1889	.0685

TABLE IV: Arimetco Trenching; Copper Content VS Depth (64% of data)

Basin I

No. of Sites	Depth	TCu%	OxCu%
12	0-10	.12	.10
4	10-20	.16	.12
4	20-30	.14	.11
Average		.13	.10

Basin III

No. of Sites	Depth	TCu%	OxCu%
12	0-10	.13	.10
6	10-20	.14	.12
6	20-30	.15	.13
Average		.14	.12

There appears not to be any uniform relationship between depth in the leach dump and grade other than the upper ten feet having been more substantially leached on average and that perhaps it contains less oxide copper.

NERCO (Mountain States R & D) reported that there was no appreciable difference in copper content by size fraction. However, the sampling technique employed would have rejected oversize material. Therefore Arimetco samples were screened (+1"; +1/4"; -1/4") to reassess this possibility. Visual examination of trenches indicates that +6" material comprises between 5% and 20% of Zonia leach rock and that material between 1 and 4 feet in longest dimension is not uncommon. Furthermore, where copper minerals remain in leach rock it is invariably in +6" material. Therefore an important economic parameter is the quantity and grade of such oversized

material. It must be noted that far less than half of the oversized rock contains obvious copper mineral even though it has generally a fresh, unleached appearance.

Table V shows a breakdown of copper distributions in Arimetco trench samples (based upon currently available data 64%)

As shown in the table there is a slight tendency for coarse material at certain levels in Basin I to contain less copper, and an equally slight tendency toward the reverse situation in Basin III. This relationship is in accord with visual estimation, whereby unleached copper was found more frequently in Basin III trenches than in Basin I. Clearly, the differences are so slight in average that for purposes of economic evaluation all three leach basins might be considered together.

TABLE V: Arimetco Trenching; Copper Distribution by Size Fraction

Basin I

Depth	+1"		+1/4"		-1/4"	
	TCu	OxCu	TCu	OxCu	TCu	OxCu
0-10	.12	.10	.11	.09	.12	.10
10-20	.16	.13	.16	.13	.16	.12
20-30	.13	.10	.14	.11	.14	.11
Averages	.14	.11	.13	.11	.14	.11

Basin III

Depth	+1"		+1/4"		-1/4"	
	TCu	OxCu	TCu	OxCu	TCu	OxCu
0-10	.10	.08	.10	.09	.12	.09
10-20	.15	.13	.12	.10	.14	.11
20-30	.15	.13	.15	.13	.15	.12
Averages	.13	.11	.12	.11	.14	.11
Overall Averages:	.14	.11	.13	.11	.14	.11

Weight percent distribution averages as follows

(100% of data):

Location	Weight %			
	+1"	+1/4"	-1/4"	
Basin I	33.5%	26.2%	40.3%	
Basin III	34.6%	29.2%	36.2%	
Average	34.1%	27.8%	38.1%	
[Basin II		36.2%	20.8%	43.0%]

The combined results of NERCO and Arimetco sampling (64% of data) indicate that the average copper content of Leach Basin I is .15% TCu and .08% OxCu; and of Leach Basin III is .16% TCu and .09% OxCu. Previous sampling of Leach Basin II indicated average copper was .18% TCu and .15% OxCu. The overall weighed average is .16% TCu and .09% OxCu.

On the basis of size distribution, of the total copper remaining in the leach dumps approximately 34% will be in +1" 28% in +1/4"-1"; and 38% in -1/4". Visual estimates of plus 6" material range from about 5% to about 20%. Local pockets and lenses exist where oversized material constitutes more than 50%, but it is likely that for the entire volume of the heaps a 10-15% average would not be too far off.

Excavations were also made on In-Situ basins V and VI. Samples from the top 10' and bottom 10' of each 20 foot pit were submitted for analysis. Based upon results received to date (86%) it is apparent that Basin VI (6 pits) has been less thoroughly leached than Basin V (12 pits) and that within Basin V the upper terraces have been leached to greater extent than lower terraces. Table VI shows average values for both basins. It would appear that ore grade material exists at relatively shallow depth in both In-Situ areas.

TABLE IV: In Situ Trenching

	TCu% Range/Average	OxCu% Range/Average	% Oxide
Basin V			
0-10	.07-.35/.1420	.04-.29/.1020	71.8%
10-20	.05-.60/.2230	.03-.58/.1840	82.5%
Basin VI			
0-10	.09-.39/.2283	.05-.32/.1900	79.7%
10-20	.16-.50/.2840	.13-.41/.2300	81.0%
Average			
0-10	.1781	.1350	75.8%
10-20	.2433	.1993	81.9%
Overall Average	.2107	.1672	79.3%

CONCLUSIONS AND RECOMMENDATIONS:

To the extent they have been sampled Zonia leach basins appear to contain an average of .16% Total copper of which 60% reports to the oxide Cu assay (Arimetco plus NERCO data).

Early on a crushing option was suggested to facilitate liberation of unleached copper in oversized material. On the basis of trenching and assay results it would appear that the material that would benefit from such treatment is limited in volume and irregular in distribution. Furthermore, the average grade of such material is generally not superior to middlings or fines, despite sometimes spectacular examples of unleached copper. A crushing option appears to be economically unfavorable for leached rock and may be suspect for new ore if size control is attainable through shot design.

Although many areas exist in the heaps where leaching has been less complete due to channelling or development of impervious capping the distribution of such pockets (taken here to contain greater than .2% total copper) is sporadic and unpredictable.

Approximately 20% of the samples representing 10' depth increments have returned values in excess of .2% total copper. Such intervals were more common by far in the NERCO sampling then in samples taken by Arimetco. The most optimistic estimate of grade within leach dumps is here taken to be that one fifth of the material will carry an average of .30% total copper whilst the balance of the material will carry about .12% total copper.

Given that 7,130,249 tons of material (McAlester) was placed in the three leach basins, 1,426,000 tons at .3% grade and 5,704,200 tons at .12% grade represent about 22,250,000 pounds of total copper. If a substantial portion of the 60%

oxide is recoverable, the contained leachable resource is about 13,350,000 pounds. If NERCO (Mountain States R & D) estimate of 39% acid leachable copper is used a little over 8,650,000 pounds is available.

Clearly, column testing will be required to obtain some idea of the ultimate practical recovery. Toward that end it is suggested that three columns be run of Zonia leach rock. The recommended sample sites are as follows:

T-1-3-3 (10-20') with .15% TCu and .13% OxCu;
T-3-11-4 (20-30') with .14% TCu and .10% OxCu; and
T-3-9-4 (20-30') with .24% TCu and .21% OxCu.

Column testing of this material would simulate stripping and ripping of existing leach dumps followed by application of Johnson Camp type leachate. Approximately 700 pounds of each sample (55 gallon drum full) will be required.

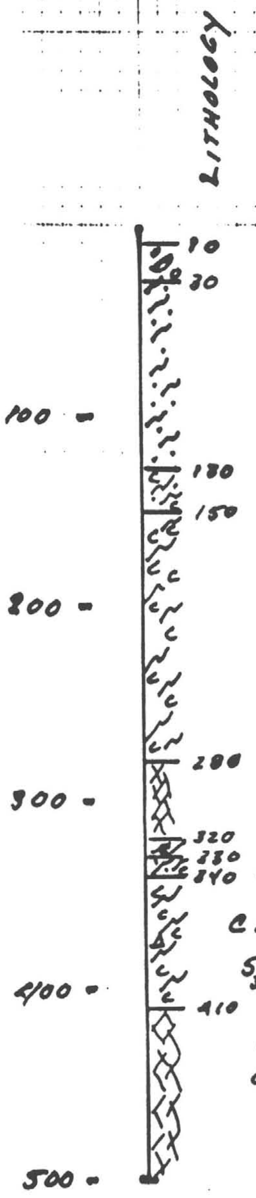
Also suggested early on were pilot heap leach tests on 10-ton lots of ore. It is recommended at this point that a single pilot heap test be conducted on pit run ore without crushing. A comparison with results from column tests which approximates a test on undersized ore at minus 1 foot and which are in progress may indicate whether further study of a new-ore crushing option is justified.

Results to date tend to indicate 70% recovery of head grade (here taken to be approximately 0.5% total copper) from ore leached by McAlester. Whilst column testing of leach rock may indicate that a small additional amount of the original copper may be recovered by scalping and ripping the economics of crushing new or old ore to further enhance this limited additional recovery may be suspect. Also the production of fines by crushing may ultimately prove to be detrimental. Especially since the dumps contain nearly 40% --1/4" material at the outset.

ZONIA
HOLE A-1
Comp. 1/6/93
TD = 500'
-90°

COORDS: Ft N Ft E

ELEV. =



fill
Conglomerate (?)
qtz-mica Schist
mod. to hvy FeOx
qtz as sub-rnd
grains
Mixed qtz-mica + Chlorite
Schists
Chlorite Schist
± qtz grains
incr. Silicification
to bottom
Silicified zone
Chlorite Schist
mixed qts mica + Chlorite Schist
Chlorite schist, patchy
Silicification
370-380 poss. micro bx
Silicified
Chlorite Schist
brick red by hvy
FeOx incl. hm. alt.
mica 470-490 tarnished
py

TCu	Ox Cu
.15	.13
.01	
.04	
.01	
<.01	
.01	
.01	
.02	
<.01	
.01	
.03	
.01	
.02	
.11	
.13	
.07	
.08	
.06	
.06	
.08	
.14	
.09	
.34	.21
.15	.09
.20	.12
.09	
.13	
.07	
.02	
.03	
.04	
.03	
.04	
.03	
.03	
.04	
.04	
.04	
.06	
.04	
.09	
.06	
.04	
.18	.14
.17	.12
.14	(.10)
.21	.15
.33	.25
.22	.16
.30	.34

CARBONATE

} .23/.14 61%

} .26/.17 75%

1" = 100'

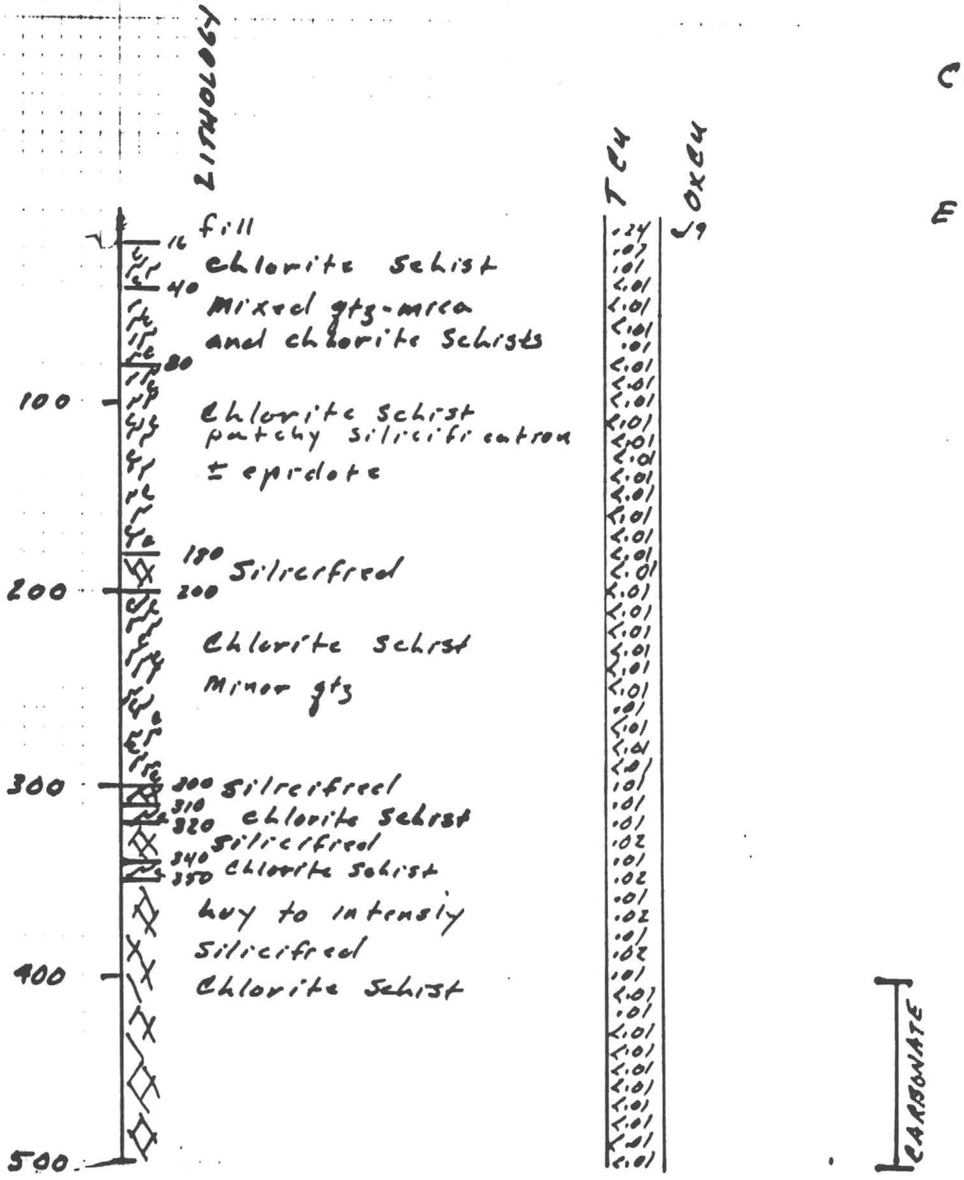
ZONIA
HOLE A-3

Comp. 1/8/93

TD = 500'
-90°

COORDS: ftN ftE

ELEV. =

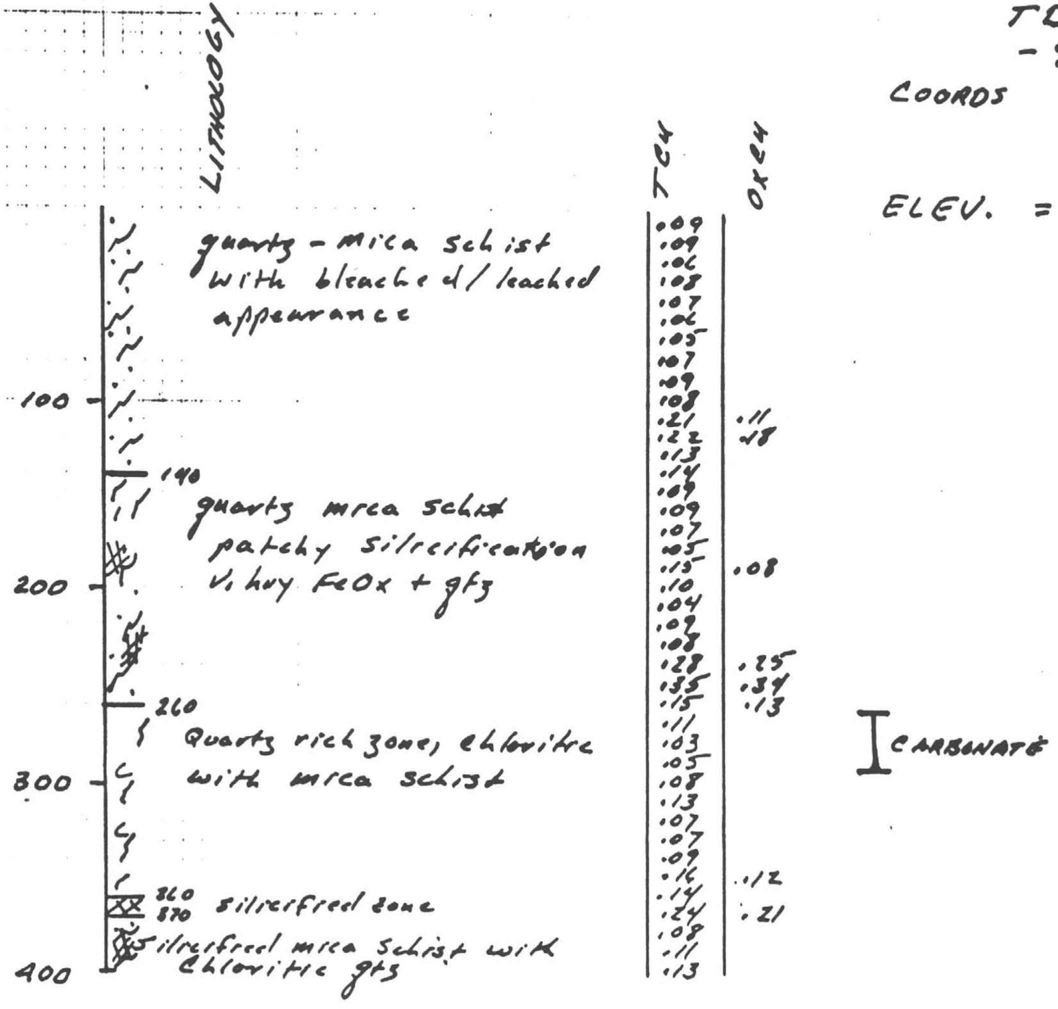


1" = 100'

ZONIA
HOLE A-5
COMP. 1/19/93
TD = 400'
-90°

COORDS ft N ft E

ELEV. =



quartz - mica schist with bleached/leached appearance

140 quartz mica schist patchy silicification v. hvy FeOx + qtz

260 Quartz rich zone, chloritic with mica schist

360 370 silicified zone

silicified mica schist with chloritic qtz

TCu	OxCu
.09	
.09	
.06	
.08	
.07	
.06	
.05	
.07	
.09	
.08	
.21	.11
.22	.08
.13	
.14	
.09	
.09	
.07	
.05	
.15	.08
.10	
.04	
.09	
.08	
.28	.25
.35	.34
.15	.13
.11	
.03	
.05	
.08	
.13	
.07	
.07	
.09	
.16	.12
.14	
.24	.21
.08	
.11	
.13	

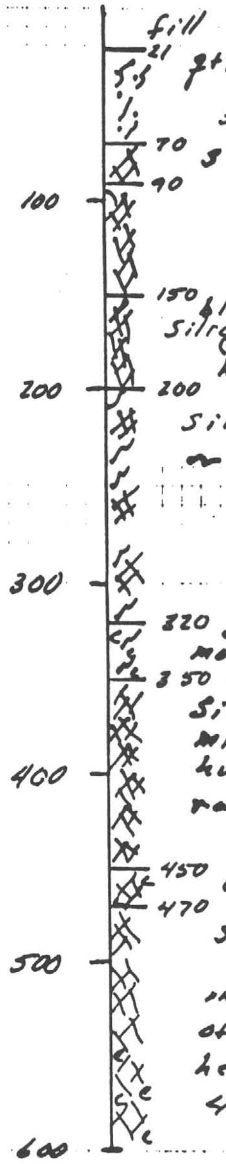
1" = 100'

ZONIA
HOLE A-8
COMP. 1/14/93
TD = 600 ft
-90°

COORDS ft N ft E

ELEV. =

LITHOLOGY



fill
21 qtz-mica schist
mod FeOx
patchy silicification
50-60 clayey
70 silicified rock
90
Silicified mica
Schist, chloritic
150 blue-gray altered rock
Silicified mica Schist ?
(poss. chlorite schist)
hvy epidote (up to 50%)
200
Silicic mica schist
~10% epidote
320 chlorite Schist
mod to hvy Si, mod FeOx
350 ± epidote ± magnetite
Silicified zone
Minor mica Schist
hvy clear qtz
rare tourmaline rare epidote
450 chlorite Schist with
470 hvy Silicification
Silicified rock
intermittent clots
of chlorite becoming
heavy in bottom
40'

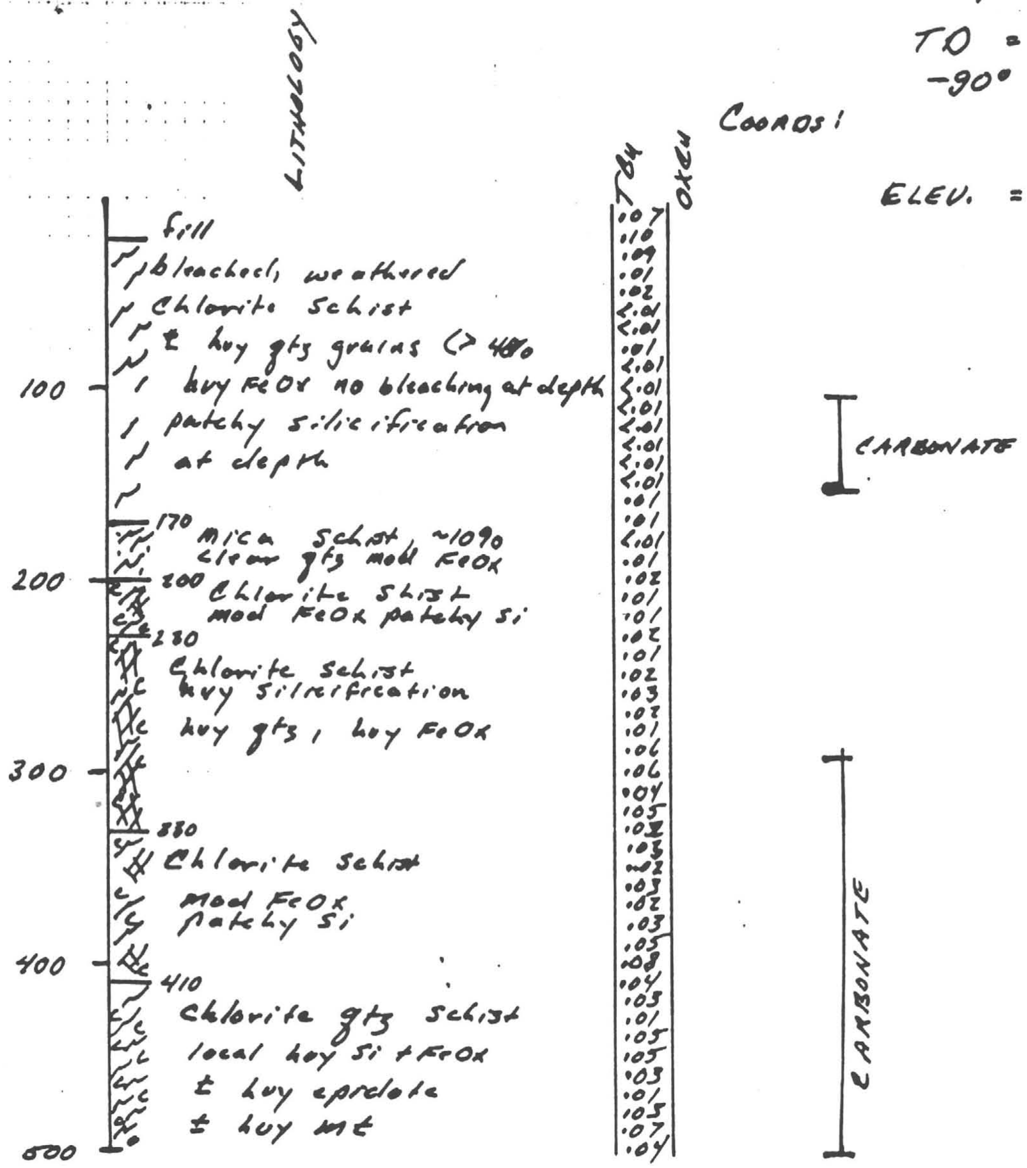
TCu	OXCU
.11	
.06	
.06	
.02	
.05	
.03	
.12	
.01	
.03	
.05	
.06	
.02	
.03	
.07	
.04	
.02	
.01	
.02	
.01	
.01	
.08	
.12	
.09	
.14	
.03	
.02	
.02	
.06	
.05	
.02	
.09	
.14	
.12	
.14	
.15	.10
.07	
.06	
.07	
.11	
.08	
.06	
.05	
.11	
.10	
.12	
.33	.28
.34	.29
.37	.26
.12	(~.11)
.12	(~.11)
.17	.14
.28	.26
.13	(~.12)
.18	.16
.28	.26
.24	.21
.37	.35
.55	.53
.21	.19
.19	.16

CARBONATE

.25/.23 91% OXIDE

1" = 100'

ZONIA
HOLE A-10
Comp. 1/11/93
TD = 500'
-90°
COORDS: ft N ft E
ELEV. =



1" = 100'

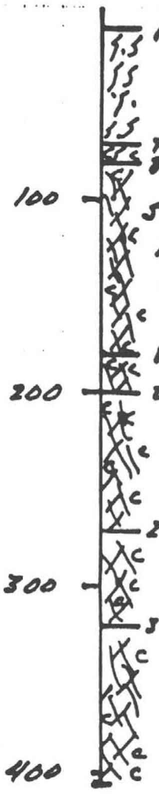
ZONIA
HOLE A-12
RomA. 1/21/93

TD = 406'
-90°

COORDS. ftN ftE

ELEV. =

LITHOLOGY



10 fill

Mica Schist, 10-20% qtz grains, mod FeOx Mod. Si, minor chlorite

70
80 Mica schist and chloritic rock

Silicified chloritic rock hvy chlorite mod to hvy calcite

180 clear to milky qtz
200 clots of chlorite

Silicified rock, hvy chlorite with large qtz eyes, mod calcite

270 qtz or intensely silicified rock whisps and clots of chlorite ± mt ± epidote

320 silicified rock, dark green qtz + felds phens in chloritic matrix

Tr calcite

TCu	OxCu
.11	
.14	
.05	
.07	
.04	
.05	
.07	
.06	
.05	
.04	
.04	
.07	
.07	
.04	
.08	
.09	
.11	
.20	.12
.10	
.20	.16
.18	.12
.14	.11
.20	.13
.27	.19
.47	.38
.31	.24
.43	.31
.22	.14
.13	(~.11)
.21	.15
.23	.15
.16	.10
.13	(~.11)
.34	.24
.13	(~.11)
.12	(~.10)
.20	.14
.21	.14
.15	.19
.22	.14
.44	.30

CARBONATE

216' .24/.19 88%oc

1" = 100'

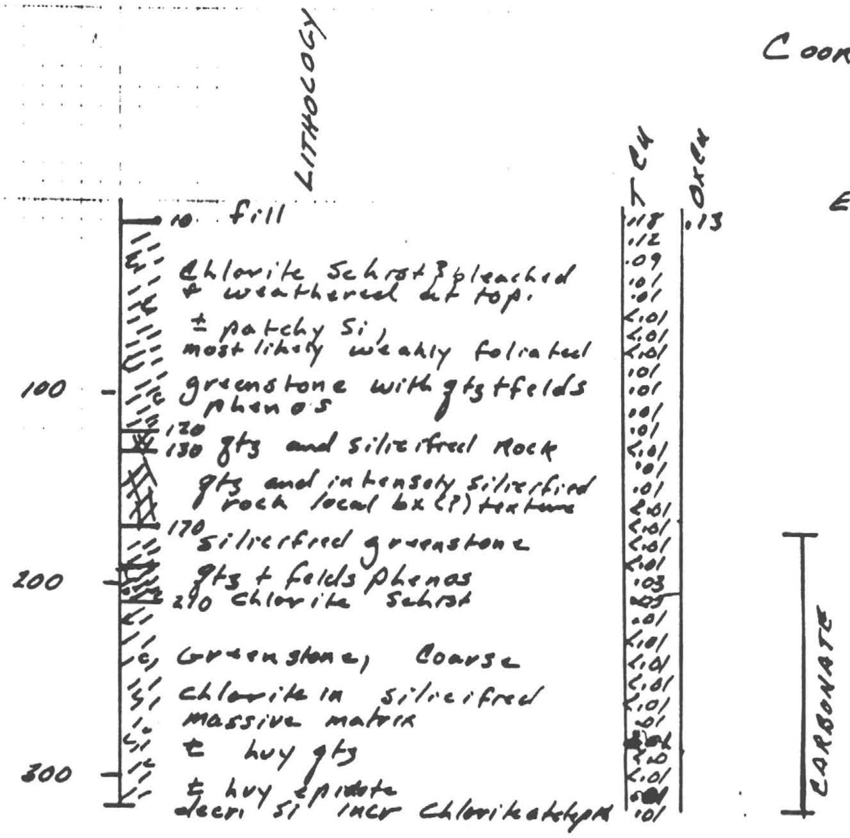
NOTE HOLE ABANDONED at 406'
Caving at Surface

MONITOR WELL

ZONIA
HOLE - A - 14
Comp. 1/27/93
TD 315'
-90°

COORDS: ftN ftE

ELEV. =



1" = 100'

NOTE: LOST 2 Cones in Hole, Abandoned at 315'

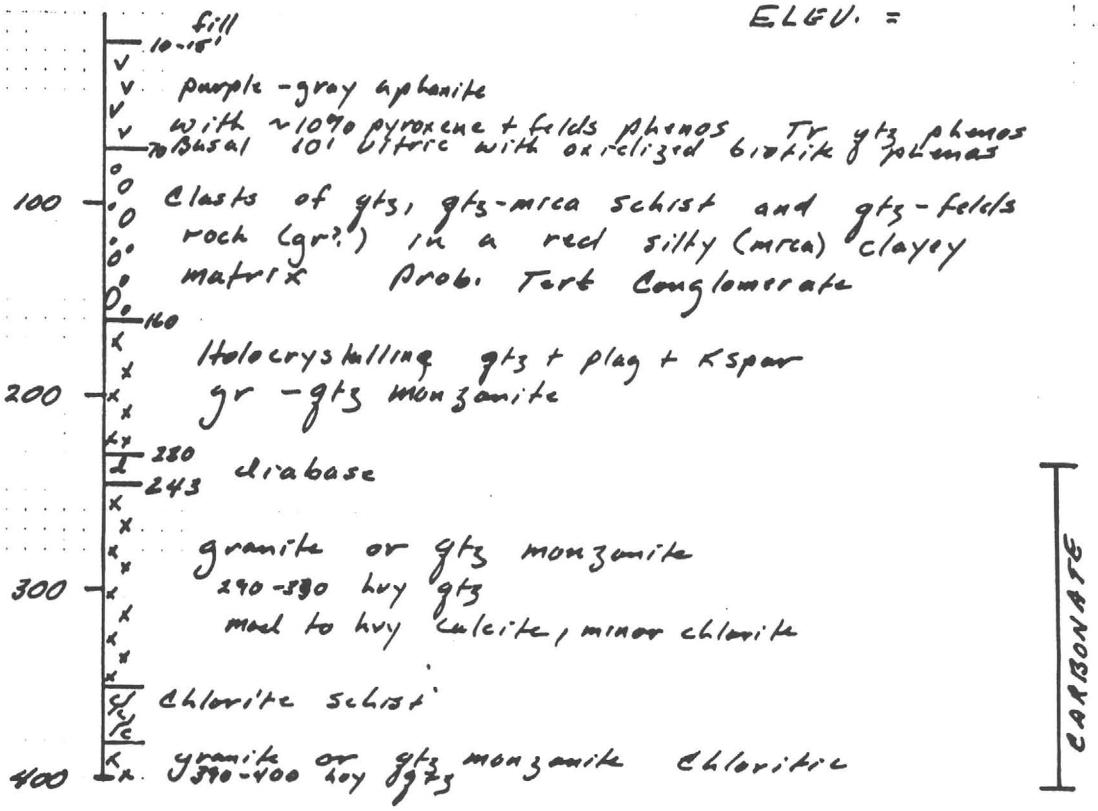
18' of 8" Casing Installed at Surface with 1' Stickup.

MONITOR WELL

ZONIA
HOLE A-16
Comp. 1/28/93
T.D = 400'
-90°

COORDS ft N ftE

ELEV. =



purple-gray aphanite
with ~10% pyroxene + felds phenos Tr qtz phenos
Basal 10' vitric with oxidized biotite & phenos

Clasts of qtz, qtz-mica schist and qtz-felds
rock (gr?) in a red silty (mica) clayey
matrix Prob. Tert Conglomerate

Holocrystalline qtz + plag + Kspar
gr-qtz monzonite

diabase

granite or qtz monzonite
290-330 hvy qtz
mod to hvy calcite, minor chlorite

chlorite schist

granite or qtz monzonite chloritic
390-400 hvy qtz

1" = 100'

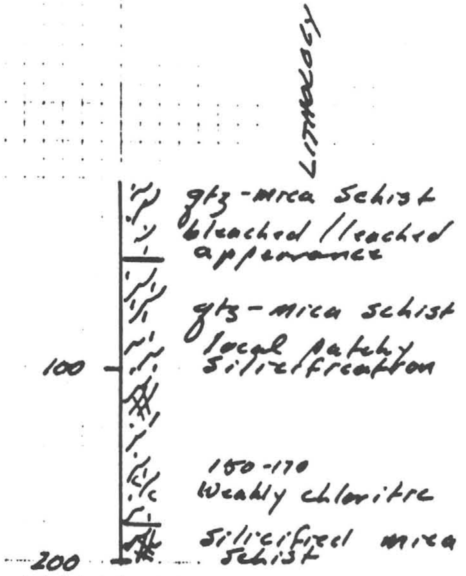
NOTE: DRILLED AS MONITOR WELL

NOT ASSAYED 0-230
230-400 <.01% Tcu
11 ft of 8" casing installed at surface
with 1' stickup

ZONIA
HOLE A-17
Comp: 8/28/93
TD = 200'
-90°

COORDS: ft N ft E

ELEV. ' =



TCu	OxCu
.04	
.03	
.09	
.07	
.16	.14
.76	.72
1.14	1.08
.23	.21
.29	.25
.14	(~.13)
.15	.11
.47	.43
.10	(~.09)
.17	.13
.27	.34
.05	
.18	
.17	
.11	
.13	

110' / .34 / ~.31 90% OXIDE

1" = 200'

NOTE: DRY HOLE

Copy - Dll's

FINAL REPORT

IX - FY90 - 27

ZONIA COMPANY MINE

YAVAPAI COUNTY, ARIZONA

Prepared for:

Zonia Company

P. O. Box 4434

Prescott, Arizona 86303

Prepared by:

Envirotec Solutions, Inc.
212 South Marina Street
Prescott, Arizona 86302

Don L. Ferris, Jr., P.E.

DON L FERRIS, JR
6/20/91

ENVIROTEC SOLUTIONS, INC.
Engineers, Geologists and Environmental Scientists

June 14, 1991

Mr. Steve Fuller (W-4-1)
Chief Compliance Section
U.S. Environmental Protection Agency
Region IX
1235 Mission Street
San Francisco, California 94103

RE: IX-FY90-27
Zonia Company Mine
Yavapai County, Arizona

Dear Mr. Fuller:

Enclosed is a Final Report on the above referenced project. We have been working with the current owners of this inactive copper oxide mine over the past ten months to not only comply with your order, but to totally eliminate any further chance that future Findings of Violations could occur. Since there is little benefit in spending time and funds to monitor a problem when it is possible to totally remove the potential offending system, our efforts were focused on remediation to a level greater than that required.

This report contains numerous photographs taken during the period from November 1990 to present. We felt it important that the concepts we propose be documented by actual photos of those measures taken in the field. While this does not replace an actual site inspection, it does provide documentation as to efforts and dates of critical compliance items.

If there are any questions in regard to this report or its conclusions, please do not hesitate to call us at (602) 778-2100.

Respectfully Submitted,

ENVIROTEC SOLUTIONS, INC.

Don L Ferris Jr

Don L. Ferris, Jr., P.E., R.L.S.
Partner

DLF/spd
cc: Salley Mapes, A.D.E.Q.
Manager - Compliance Section

212 South Marina Street • Prescott, Arizona 86302 • (602) 778-2100 • FAX (602) 778-9249

INTRODUCTION

This report was prepared at the request of The Zonia Company of Prescott, Arizona, in response to a Finding and Order dated July 13, 1990, reference number IX-FY90-27, from United States Environmental Protection Agency, Region IX (Section I, Attachment A). The Finding and Order relates to violation of Section 301 (a) of the Clean Water Act [33 U.S.C. Section 1311(a)] found at Zonia Mine, in which a discharge of leachate from three broken pipes was observed by E.P.A. inspector Shirin Tolle.

Based on the Finding and Order, The Zonia Company has filed a Correction Plan (Section I, Attachment B) and Quarterly Compliance Progress Reports (Section I, Attachment C). At the request of The Zonia Company, Envirotec Solutions, Inc. has prepared this Final Report which includes results and recommendations relating to remediation at the Zonia Company Mine.

This report addresses the Finding and Order, as well as provides additional information and recommends improvements at The Zonia Company Mine. While a significant amount of physical construction has already been completed, a few minor concerns are being designed or are currently under construction. A completion date has been recommended for these remaining items.

To aid in the review of this report and the response to each item of concern, we have provided copies of the Finding and Order, Correction Plan and Quarterly Progress reports in Section I. Background information, previous studies and results of research are contained in Section II. Additional recommendations and remediation measures are itemized and discussed in Section III.

TABLE OF CONTENTS

SECTION I

Response to Order For Compliance

Attachment A is a copy of a Finding of Violation and Order of Compliance dated July 13, 1990. It identifies several items to be addressed immediately, and other items of possible concern depending on the outcome of an A.D.E.Q. Water Quality Investigation currently being conducted.

The Correction Plan, dated August 8, 1990 (Attachment B) addresses each item in the Order For Compliance, and identifies several actions underway to comply with the order. It lists corrective measures in the same numbering system as the Order For Compliance.

Quarterly Compliance Reports were prepared by the owner as required and sent to Region IX. The three reports are dated August 1, 1990; November 1, 1990, and February 1, 1991 (Attachment C).

Also included in Attachment C is a response from Steve Fuller, Chief, Permits and Compliance Branch, Water Management Division (Region IX), to items in the Correction Plan and the first Quarterly Report.

SECTION II

Background Information

The following text includes descriptions of site history, previous studies, and the general geology and hydrogeology of the site. The proposed monitoring well program is presented and described. Additional site specific data and information from studies by Halpenny, 1972; Halpenny and Clark, 1982; and Schmidt, 1989 has been included as Section II, Attachments A, B, and C, respectively.

Location

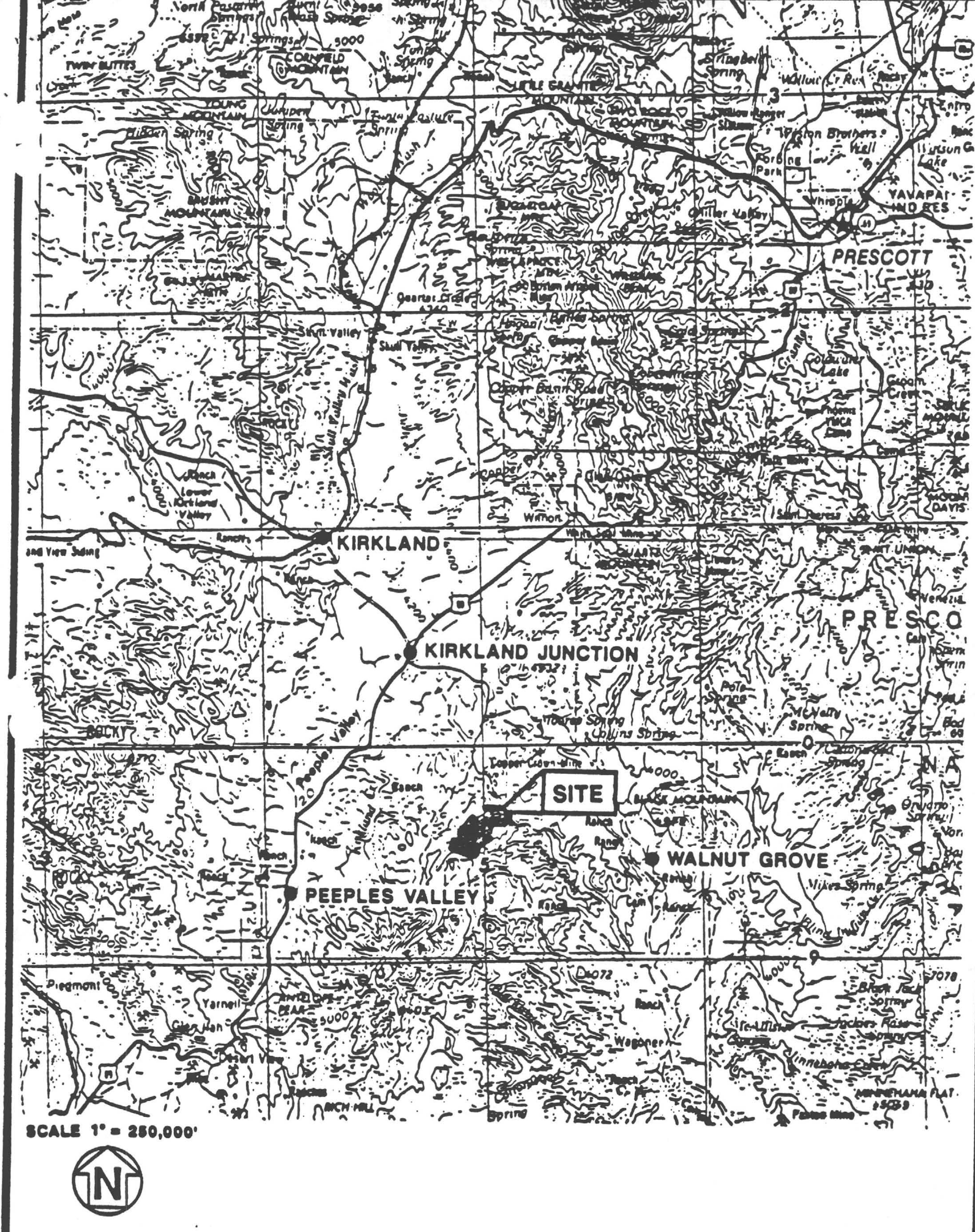
The Zonia mining property is within the Walnut Grove Mining District, Township 11 North, Range 3 and 4 West, Latitude 34 18' 30" North and Longitude 112 37' 30" West. The property is shown on the Walnut Grove, Arizona, 1969, 7.5 feet and Peeples Valley, Arizona, 1969, 7.5 U.S.G.S. topographic quadrangles. (Please refer to Figures 1 and 2).

A. Historical Land Use

Mining and exploration prospecting in the Walnut Grove District is recorded back to the 1860's and has continued to the present time. Both lode and placer mining has been carried out in the district, and presently several mines are being operated to some degree.

Mining in the Zonia area began in the late 1860's and extended intermittently to 1975. As high-grade oxide reserves were depleted, underground mining was replaced by open-pit heap-leach mining methods of low-grade copper-oxide ores. The present extent of the open pit mine was attained by approximately 1972.
The following is a summary of past mining activity on portions of the Zonia property and surrounding area:

1862/1900 -	Various freelance prospectors explored the surface mineralization for precious and base materials. Several patented properties within the mining District were evaluated, but there are no known production records available. A small smelter was erected in French Gulch and operated for an unknown period of time.



LOCATION MAP

REFERENCE: USGS 15 MINUTE QUADRANGLE MAP
PRESCOTT 1954, REVISED 1970.

BY **Dames & Moore** Figure 1

1910/1911 - Shannon Copper Company, Clifton, Arizona drilled six exploratory holes.

1911/1935 - Initial development concentrated on high grade ores in hopes of establishing copper production. This work was carried on by the Zonia Syndicate, including the Inspiration Consolidated Copper Company, Globe, Arizona, and Hammon Copper Company, Los Angeles, CA. Placer mining was conducted in portions of French Gulch and Placerita Gulch.

1942 - 1943 Over 2,000 feet of trenching and 2,960 feet of diamond drilling in eleven shallow drill holes across the strike of the Cuprite ore zone was undertaken by the U.S. Bureau of Mines.

1947/1948 - A portion of the property was leased to Mr. Gottbehut of Los Angeles and eleven railroad cars of 4-5 percent ore was shipped.

1955/1956 - Miami Copper Company conducted extensive exploration of the property and staked additional claims. Aerial photography was flown and a topographic map was produced.

1966/1975 - McAlester Fuel Company of McAlester, Oklahoma, obtained the property, conducted extensive exploration and initiated open pit mining of the oxide-copper ores present. McAlester produced 33,500,000 pounds of copper from low grade oxide ores. All mining ceased in 1975.

1976/1988 - Exploration and promotion of the property by several lessees including Phelps-Dodge Corporation, Homestake Mining Company, NERCO and Antioch Resources. These efforts did not produce encouraging results as a sulphide ore zone was not encountered.

1988/1989 - The Zonia Company of Prescott, Arizona, acquired the property from Antioch Resources in 1988. The company conducted an evaluation of the mining potential and has determined the property to be marginally viable, dependent on copper prices. The company will attempt to farm-out the property to an established mining concern.

1989/Present - Zonia Landfill, Inc. acquired 200 of the 700 patented acres and has prepared preliminary geologic and hydrologic studies to determine the site's suitability for a landfill. Based on studies by Kenneth Schmidt and Associates, and Dames & Moore, environmental consultants, the company has filed an Aquifer Protection Permit and Operations Plan for a proposed landfill. Yavapai County's Board of Supervisors granted a landfill Use Permit in February, 1990.

B. Previous Investigations

As stated above, numerous mining companies conducted geological exploration programs at the Zonia Mine from the 1950's through the 1970's, including the Miami Copper Company (Allen et al, 1956), the Bunker Hill Mining Company (1963-1964), McAlester Fuel Company (Ford, 1965, 1970), Homestake Mining Company (Cameron, 1972, 1975), Cominco (date unknown), Phelps Dodge Corporation (date unknown), and Queenstake Resources (1983). Three studies have been conducted on the ground-water hydrology of the site; Halpenny, 1972; Halpenny and Clark, 1982; and Schmidt, 1989. In combination, these reports provide a detailed understanding of the geologic/hydrogeologic conditions at the site. The following discussions are based on a review of these studies, particularly Halpenny, 1972; Halpenny and Clark, 1982; and Schmidt, 1989. (See Attachments A, B, and C; reproductions of the original hydrogeologic reports.)

All reports prior to the Schmidt report (1989), elevations were based on the Zonia Mine Datum. This datum differs from the U.S. Geological Survey sea level datum indicated on quadrangle maps of the area and as used for detailed topographic maps prepared for the landfill design. The Zonia Mine Datum is approximately 380 feet lower than the U.S. Geological Survey sea level datum as noted from a 1989 aerial survey conducted by Kenney Aerial Mapping, as commissioned by the Zonia Company. Historical data reported here have been corrected for this discrepancy.

C. Physical Constraints

1. Topography

The Zonia Mine is situated within the drainage basin of French Gulch, a tributary of the Hassayampa River. French Gulch and the Hassayampa River converge approximately 6 miles downgradient of the mine near the townsite of Wagoner.

The general topography of the site is characterized as consisting of moderate relief. Elevations range from 4,810 feet above mean sea level (AMSL) at the head of Zonia Gulch to 4,280 feet AMSL at the confluence of Zonia Gulch and French Gulch.

The drainage area of French Gulch including the tributary of Placerita Gulch is just under 14 square miles. The length of the major drainage course as developed from U.S.G.S. topographic maps is 8.71 miles. Drainage density as developed from the topographic maps is 1.20 miles per square mile. The average basin slope for French Gulch is in the order of 150 feet per mile.

2. Climate

The climate at the Zonia Mine is characterized by relatively mild temperatures and low precipitation typical of desert regions in the southwestern United States. Climatic data is available locally 12 miles west of Kirkland at the National Weather Service station Hillside 4 NNE and at Walnut Grove. The average monthly temperature from 1970 through 1979 ranged from 41.4° F in January to 80.1° F in July. Temperature extremes range from below freezing to above 100° F. The average annual precipitation in the area is approximately 16 inches. Most precipitation occurs in July and August. According to the data published by the Arizona State University Laboratory of Climatology, average annual lake evaporation is approximately 75 inches. Using a figure of 16.27 inches as normal annual precipitation for the study area, average net annual evaporation is approximately 60 inches.

In 1978, the area received the largest recorded annual precipitation, approximately 31 inches, almost twice the annual average. In addition, the period 1978 to 1983 was characterized by higher-than-normal precipitation. A more detailed discussion of climatic conditions at the Zonia Mine is included in Halpenny and Clark, 1982; pages 3-3 to 3-6.

3. Soils

Wendt, et al (1976) mapped topsoil in the vicinity of Kirkland Junction and the Zonia Mine. Soils of the Moano series predominate at the site. They are well drained, relatively thin, and developed over metamorphic rocks, primarily schist. The subsurface layer is normally a foot thick, usually underlain by hardrock. The soils at the Zonia Mine are classified as Moano very rocky loam. Soils of this type are normally about 70 percent gravelly loam and 20 percent rock outcrops. Narrow areas of the vicinity along drainageways where alluvium is present are covered by Lynx soils. In addition, Arp gravelly clay loam is present in small areas (Schmidt, 1989).

4. General Geology

The geology of the mine has been extensively investigated as it pertains to copper ore mineralization. The following brief description of the geology is based on work conducted by J.W. Cameron, Homestake Mining Co. (1975) and by Queenstake Resources (1983).

"Three principal rock types comprise the formations exposed at the Zonia Mine; phyllite, quartz monzonite, and greenstone-andesite. In addition, less common rock types exposed in the area include Precambrian Limestone, quartz-monozonite porphyry, schist, undifferentiated mafic intrusive rocks, Tertiary alluvium, Quarternary Basalt, and Quarternary Alluvium. The distribution of these rock types is presented in Figure 3, a geologic map prepared by Ford, 1964.

The lithologic units exposed at the Zonia Mine are believed to represent a subaqueous, volcanogenic deposit. The copper mineralization was formed in a submarine environment from metal-rich hydrothermal brines and gases discharged from the sea floor vents and fissures associated with shallow intrusive activity (Queenstake Resources, 1983). Gold has been identified widely scattered across the copper ore body. Economic quantities of gold were not located.

The structural fabric of the Precambrian rock units at the mine is characterized by northeast-trending planes of schistosity. The strike of the planes within the Precambrian units average N40°E and dip 50° to 80° West. No major faults or shear zones traverse this fabric within the open pit, although small tensional fractures trending northwest can be found. Numerous exploration borings were made in the area of the open pit; however, structural data from rock core was not recorded nor was the core preserved. The nature of geologic structures in the open pit is well represented by exposures of fresh rock in the pit."

5. Surface Water

Halpenny and Clark (1982) discussed streamflow in the vicinity of the Zonia Mine. The Zonia Mine is located within the French Gulch drainage, and the Hassayampa River is about six miles downstream of the mine, near the townsite of Wagoner. The drainage area of French Gulch is just under fourteen square miles. The length of the major drainage course of French Gulch is almost nine miles. Near the Zonia Mine, both French Gulch and Zonia Gulch are fed by springs from andesite-greenstone dikes. These springs are reported to be perennial, but discharge from the springs is variable, depending on the precipitation. The largest of these springs is along French Gulch just upstream of Zonia Gulch, and small springs are present throughout the area. There is substantial spring inflow to streamflow in French Gulch downstream of Zonia Gulch. Halpenny and Clark (1982) indicated that the greenstone-andesite dikes serve as dams, and force groundwater moving along fractures and structural features to the surface. The limited discharge of these springs was reported to be indicative of the low transmissivity of the hardrock.

Observations and measurements made by Halpenny and Clark (1982) indicate variable amounts of streamflow in French Gulch. On June 11, 1980, flow in French Gulch was reported downstream from Copper Camp in Section 20, T11N, R3W. On December 10, 1980, the surface flow in French Gulch ended near the section line between Section 17 and 18, T11N R3W.

Halpenny and Clark (1982) measured streamflow in French and Zonia Gulches, commencing in September 1980. A series of three 90° V-notch weirs were placed along French and Zonia Gulches at the following locations:

- o French Gulch above the Zonia Gulch confluence (Weir No. FG-3)
- o Mouth Zonia Gulch (Weir No. ZG-4)
- o French Gulch above Placerita Gulch confluence (Weir No. FG-5)

Locations of these streamflow measuring locations are shown on Figure 4.

Flow measurements for September 26, 1980, through December 10, 1980,are presented in Table 1 (Halpenny & Clark, 1982). These measurements indicated a decreasing trend in streamflow during this period, except for the readings taken December 10, 1980. The slight increase in flow observed in the last round of measurements was attributed to a precipitation event on December 6 and 7. These measurements also indicate a substantial increase in streamflow between the upper weirs and the lower weir. These measurements also indicate that the flow from Zonia Gulch contributed no more than ten to twenty-five percent of the total flow in the upper reach of French Gulch (Schmidt, 1989).

TABLE 1

STREAMFLOW IN FRENCH AND ZONIA GULCHES

Date (1980)	French Gulch Above Zonia Gulch Confluence (Weir FG-3) (gpm)	Mouth of Zonia Gulch (Weir ZG-4) (gpm)	French Gulch Above Placertia Gulch Confluence (Weir FG-5) (gpm)
09/26	34	9	70
10/24	34	9	-
10/27	34	6	60
10/28	34	9	70
11/06	34	9	70
11/13	30	4	-
11/14	26	4	-
11/17	30	4	50
11/20	28	3	50
12/02	22	2	50
12/03	22	2	50
12/10	28	3	60

Date from Halpenny and Clark (1981).

D. Hydrogeology

1. Well Inventory

An inventory of wells was conducted by Schmidt (1989) for a radius of 1 1/2 miles from the Zonia Mine. In addition a complete well inventory is provided in Tables 2 and 3. Groundwater in the area is used for stock watering, irrigation and domestic purposes.

2. Aquifer Characteristics

One pumping test was conducted at the mine site in well S-2 by Halpenny (1972). Well S-2 was 500 feet deep with an eight-inch diameter casing. Prior to initiation of the pumping test, the water depth in well S-2 was reported to be 104.4 feet. After one week of pumping at an average rate of 21.4 gpm, the depth of water in well S-2 was 165.3 feet. The specific capacity of the well was 0.3 gpm per foot and the calculated transmissivity was 300 gpd per foot with a storage coefficient of 0.15.

3. Historical Groundwater Levels

Historical water level data for wells located within the Zonia property are presented in Table 4.

The Schmidt report indicates a southwest to northeast direction of flow, from measurements in January-February, 1989. The measured water levels shown correspond to a depth-to-water ranging from 95 to 130 feet.

Groundwater downgradient of the Zonia Mine is discharged from intermittent springs along French Gulch unrelated to mine activities. These springs are associated with greenstone-andesite dikes as described by Halpenny and Clark (1982).

4. Historical Groundwater Quality

The quality of groundwater was reviewed by Schmidt (1989). The following discussion is reproduced from pages 14 to 16 of Schmidt's report (1989).

"A number of water samples were collected from wells at the Mine in 1980 during an investigation by Halpenny and Clark (1982). In addition, one other sample was collected in January 1989 as part of this investigation. The results of chemical analyses of groundwater are presented in Table 5.

TABLE 2

WATER LEVEL MEASUREMENTS FOR WELLS LOCATED INSIDE PROPERTY BOUNDARIES

LOCATION T R S Q Q Q	ADWR NUMBER	LOCAL NO.	OWNER	MEASURING POINT ELEV. (feet)	DATE OF MEASUREMENT	DEPTH TO WATER (feet)	WATER-LEVEL ELEVATION (feet)
11N 04W 12 C A C	624650	S-2	McCALISTER FUEL CO	4,435.0 **	N/A	40.9	4,394.1
11N 04W 12 C A D	624655	Z-606 RD	McCALISTER FUEL CO	4,440.0 **	12/10/80	65.1	4,374.9
				4,440.0 **	4/23/81	68.5	4,371.5
11N 04W 12 C B A	624647	Instrument Shack Well	McCALISTER FUEL CO	4,481.6	12/10/80	70.0 R	4,411.6
				4,481.6	2/01/89	50.0	4,431.6
11N 04W 12 C B D	624649		McCALISTER FUEL CO	4,560.0 **	N/A	83.2	4,476.8
11N 04W 12 C C C	624656	Z-607 RD	McCALISTER FUEL CO	4,740.4	12/10/80	320.2	4,420.2
				4,740.4	4/23/81	323.6	4,416.8
				4,740.4	8/11/81	325.9	4,414.5
				4,740.4	2/01/89	318.0	4,422.4
11N 04W 12 C C D	624648	Z-603 RD	McCALISTER FUEL CO	4,690.1	12/10/80	248.0	4,442.1
				4,690.1	4/23/81	248.3	4,441.8
				4,690.1	8/11/81	251.0	4,439.1
				4,690.1	2/01/89	262.0	4,428.1
11N 04W 12 C C D	624654	Cuprite Shaft Well	McCALISTER FUEL CO	4,604.5	12/10/80	178.4	4,426.1
				4,604.5	4/23/81	179.4	4,425.1
				4,604.5	8/11/81	181.3	4,423.2
				4,604.5	2/01/89	177.2	4,427.3
				4,604.5	12/08/89	183.2	4,421.3
04W 14 D A B	624646	Old Mill Well	McCALISTER FUEL CO	4,654.6	12/10/80	110.0	4,544.6
				4,654.6	4/23/81	109.2	4,545.4
				4,654.6	2/01/89	106.4	4,548.2
				4,654.6	12/08/89	138.4	4,516.2
		* LB-5-1		4,466.1	2/01/89	81.3	4,384.8
				4,466.1	12/08/89	88.1	4,378.0
		* LB-5-2		4,465.2	2/01/89	80.4	4,384.8
		* LB-5-3		4,598.8	2/01/89	204.2	4,394.6
		* LB-5-4		4,598.5	2/01/89	195.7	4,402.8
		* LB-5-8		4,559.9	2/01/89	173.9	4,386.0
		* LB-5-10		4,411.8.	2/01/89	27.5	4,384.3
		* LB-5-11		4,411.6	2/01/89	27.8	4,383.8
		* LB-6-1		4,519.5	2/01/89	110.5	4,409.0
		* LB-6-2		4,519.7	2/01/89	110.5	4,409.2
		* LB-6-3		4,518.1	2/01/89	108.8 u	4,409.3
				4,518.1	12/08/89	121.0	4,397.1
		* LB-6-4		4,513.4	2/01/89	95.0	4,418.4
		* LB-6-5		4,513.3	2/01/89	94.2	4,419.1
		* LB-6-6		4,518.6	2/01/89	109.4	4,409.2
				4,518.6	12/08/89	122.3	4,396.3
		* LB-6-7		4,518.2	2/01/89	109.1	4,409.1
		* LB-6-8		4,518.4	2/01/89	109.3	4,409.1

N/A - Not Available
R - reported depth to water
* - water level measurements for wells in leach basins no. 5 and no. 6
estimated surface elevations from topographic map

TABLE 3

WATER LEVEL MEASUREMENTS FOR WELLS OUTSIDE OF PROPERTY BOUNDARIES

LOCATION T R S Q Q Q	ADWR NUMBER	OWNER	MEASURING POINT ELEV. (feet)	DATE OF MEASUREMENT	DEPTH TO WATER (feet)	WATER-LEVEL ELEVATION (feet)
11N 03W 05 A B A			3,995.0	4/28/78	8.70	3,986.3
11N 03W 05 B A A	614633	ARIZONA STATE LAND DEPT.	4,000.0 *	-	30.00	3,970.0
11N 03W 05 B B A	649183	CURRIE	4,160.0 *	-	15.00	4,145.0
11N 03W 07 B C A	601438	WHITEHEAD RANCH	4,400.0 *	-	120.00	4,280.0
11N 03W 07 B D	801563	BUREAU OF LAND MANAGEMENT	4,400.0 *	-	-	-
11N 03W 09 C C B	622262	GOULDER	4,110.0 *	-	100.00	4,010.0
11N 03W 10 B C C	506299	TK BAR RANCH	3,800.0 *	-	L.S.	-
11N 03W 10 C C C	622261	GOULDER	3,740.0 *	-	100.00	3,640.0
11N 03W 10 C C C	622264	GOULDER	3,740.0 *	-	8.00	3,732.0
11N 03W 15 B B A			3,720.0	-	22.00	3,698.0
11N 03W 15 B D D			3,690.0	-	-	-
11N 03W 15 D B B			3,685.0	-	-	-
11N 03W 17 C D A	614634	ARIZONA STATE LAND DEPT.	4,000.0 *	-	5.00	3,995.0
11N 03W 18 A D	601428	WHITEHEAD RANCH	4,120.0 *	-	80.00	4,040.0
11N 03W 18 A D C	601429	WHITEHEAD RANCH	4,080.0 *	-	25.00	4,055.0
11N 03W 19 C D A	614635	ARIZONA STATE LAND DEPT.	4,360.0 *	-	-	-
11N 03W 20 A C A	622263	GOULDER	4,330.0 *	-	110.00	4,220.0
11N 03W 27 C C D	601437	WHITEHEAD RANCH	3,660.0 *	-	40.00	3,620.0
11N 03W 28 B A	601430	WHITEHEAD RANCH	3,840.0 *	-	15.00	3,825.0
11N 03W 29 D A A	601431	WHITEHEAD RANCH	3,880.0 *	-	10.00	3,870.0
11N 03W 30 D A	601439	WHITEHEAD RANCH	4,280.0 *	-	15.00	4,265.0
11N 03W 30 D D C	601432	WHITEHEAD RANCH	4,200.0 *	-	20.00	4,180.0
11N 04W 01 B B B	601372	WHITEHEAD LTD PARTNER	4,398.0	-	140.00	4,258.0
11N 04W 09 A B A	625508	QUINIF. FISHER & KNAPP	4,240.0 *	-	80.00	4,160.0
11N 04W 09 A B A	625507	QUINIF. FISHER & KNAPP	4,240.0 *	-	80.00	4,160.0
11N 04W 11 C B B	614637	ARIZONA STATE LAND DEPT.	4,560.0 *	-	100.00	4,460.0
11N 04W 11 D A A		BARD WELL (LOCAL #)	4,508.0	12/10/80	54.80	4,453.2
			4,508.0	2/01/89	52.00	4,456.0
			4,508.0	12/08/89	61.00	4,447.0
11N 04W 12 B C	634090	BUREAU OF LAND MANAGEMENT	4,560.0 *	-	76.00	4,484.0
11N 04W 12 D B A	624653	McCALISTER FUEL CO	4,300.4	2/01/89	8.00	4,292.4
11N 04W 12 D B A		Z-601-D (LOCAL #)	4,302.5	12/10/80	L.S.	Q
			4,302.5	2/01/89	L.S.	-
11N 04W 15 D C D	622506	QUINIF. FISHER & KNAPP	4,640.0 *	-	100.00	4,540.0
11N 04W 21 A A C	609602	COUGHLIN	4,640.0 *	-	140.00	4,500.0
11N 04W 21 A D B	614639	ARIZONA STATE LAND DEPT.	4,660.0 *	-	240.00	4,420.0
11N 04W 24 A A D	617608	HAYS RANCH	4,840.0 *	-	15.00	4,825.0
12N 03W 32 C	651157	KEEHNER	4,040.0 *	-	75.00	3,965.0
12N 03W 32 C C D	503046	WARREN	4,040.0	6/04/82	FLOWING	-
12N 03W 32 C D D			4,000.0	4/28/78	9.60	3,990.4

* - estimated surface elevations from topographic map
L.S. - land surface (flowing well)

TABLE 4

WATER LEVELS IN WELLS AND DRILL HOLES AT THE ZONIA MINE (T11N/R4W)

Elevation/Water in Feet

		Measuring Point	Depth to Water							
Location	Local No.	Elevation	12/80	4/81	8/11/81	2/89	12/89	7/90	1/91	5/91
12ccc	Z-607 R	4,740.4	320.2	323.6	325.9	318	332	328	330	329
12ccd	Z-603 RD	4,690.1	248	248.3	251	262	276	270	269	267
12ccd	Cuprite Shaft	4,604.5	178.4	179.4	181.3	177.2	183	188	184	184
14dab	Old Mill	4,654.6	110.0	109.2	---	106.4	121	137	128	124
12cdb	LB-5-1	4,466.1	83.2	---	---	---	86	90	89	87
12cac	LB-5-10	4,411.6	---	---	---	27.8	36	45	43	37
12cda	LB-6-3	4,518.1	---	---	---	108.8	113	122	120	114
12cdc	LB-6-6	4,518.6	---	---	---	109.4	114	123	121	113
12cdc	LB-6-7	4,518.2	---	---	---	109.1	114	123	121	113

1980 and 1981 measurements are from Halpenny and Clark (1982), and 1989 measurements were made by Kenneth D. Schmidt and Associates.

1990 and 1991 measurements are from Zonia Landfill, Inc. records.

Table 5

CHEMICAL ANALYSES OF GROUND WATER

Constituent (mg/1)	MCL/ Standard	Z-601-D	Z-601-D	Cuprite Shaft	Old Mill	Instrument Shack	Bard Well
Calcium	-	28	26	47	640	300	125
Magnesium	-	19	17	20	210	65	36
Sodium	-	70	76	15	88	29	33
Potassium	-	3	3	2	4	2	6
Carbonate	-	0	0	0	0	0	0
Bicarbonate	-	337	329	178	367	427	578
Sulfate	250.0	26	20	64	2,250	700	6
Chloride	250.0	3	5	10	40	14	32
Nitrate	10.0	<1	<1	10	<1	3	<1
Ammonia-Nitrogen	-	-	0.2	-	-	-	-
Kjeldahl Nitrogen	-	-	0.4	-	-	-	-
Fluoride	2.0	0.4	<0.1	0.3	0.2	0.3	0.2
Boron	-	-	<0.1	-	-	-	-
Iron	0.3	8.2	<0.05	-	-	-	-
Manganese	0.05	0.07	0.02	-	-	-	-
pH	6.5-8.5	7.9	6.9	7.3	6.9	7.3	7.5
Electrical Conductivity (micromhos/cm @ 25°C)		530	550	450	3,500	1,500	940
Total Dissolved Solids (@ 180°C)	500.0	343	375	287	3,537	1,220	560
Arsenic	0.050	<0.01	<0.01	-	-	-	-
Barium	1.000	<1.0	0.1	-	-	-	-
Cadmium	0.010	0.02	<0.005	-	-	-	-
Chromium	0.050	0.02	<0.01	-	-	-	-
Lead	0.050	0.01	<0.01	-	-	-	-
Mercury	0.002	<0.0002	<0.0002	-	-	-	-
Selenium	0.010	<0.01	<0.005	-	-	-	-
Silver	0.050	<0.01	<0.01	-	-	-	-
Copper	1.000	0.03	0.08	0.34	7.1	0.55	0.03
Zinc	5.000	-	<0.01	0.01	-	-	-
Cobalt	-	-	<0.05	-	-	-	-
Nickel	-	-	<0.05	-	-	-	-
Date		11/3/80	1/31/89	12/11/80	12/11/80	12/11/80	12/11/80

Analyses by BC Laboratories, Inc. of Bakersfield, California. 1980 analyses from Halpenny and Clark (1981).

The locations of the sampled wells are shown in Figure 2. Two types of groundwater can be delineated. The first is groundwater not associated with the mineralized zone (the Cabin Well, Drill Hole Z-601-D, the Cuprite Shaft Well, and Bard Well). Total dissolved solids (TDS) contents in samples from these wells or holes ranged from about 300 to 560 mg/l. Water from the Cabin Well and Drill Hole Z-601-D was of the sodium bicarbonate type, with sulfate contents less than 30 mg/l. Water from the Cuprite Shaft Well was of calcium-magnesium bicarbonate type, with a sulfate content of 64 mg/l. The chemical quality of water from this well is apparently not influenced significantly by the calcium bicarbonate type, with a sulfate content of only 6 mg/l. Iron content was not determined in all of the samples, but was 8.2 mg/l in water from Drill Hole Z-601-D. Copper contents ranged from 0.03 to 0.34 mg/l in water from these wells. Groundwater unaffected by the mineralized zone at the mine is generally of suitable quality for drinking water, except possibly for high iron and copper contents in some areas.

The chemical quality of the water sample from the Old Mill Well was strongly influenced by the mineralized zone. TDS content was about 3,500 mg/l, and contents of calcium and sulfate indicated saturation with respect of gypsum. The copper content in water from this well was 7.1 mg/l. Water from the Instrument Shack Well had a TDS content of about 1,200 mg/l, and was also apparently influenced to a lesser extent by the mineralized zone. Water from this well was of calcium sulfate type, and the copper content was 0.55 mg/l. Groundwater in the mineralized zone is generally not suitable for drinking water due to high sulfate, hardness, and copper content."

Tables 6 through 8 represent water sample results complied since 1980 from Upper French Gulch, Zonia Gulch and Lower Gulch. It can be noted from these results that the natural buffering capacity of French Gulch has helped restore the water quality of the mineralized stream water.

TABLE 6

ZONIA MINE WATER SAMPLES

ZONIA GULCH

DATE	LABORATORY	SO4	Mn	Cu	Zn	PH
04-Sep-80	Arizona Testing Lab	1950	--	0.20	--	4 7.1
25-Sep-80	Arizona Testing Lab	2230	--	0.47	--	--
10-Oct-80	Arizona Testing Lab	2250	13.00	0.46	--	--
16-Oct-80	Arizona Testing Lab	2000	1.60	0.48	--	--
04-Nov-80	Arizona Testing Lab	2580	1.50	0.47	--	--
20-Nov-80	Arizona Testing Lab	2250	--	0.05	--	6.9
17-Nov-80	B.C. Labs (W.D.C.)	2440	1.10	0.57	0.64	7.0
26-Nov-80	B.C. Labs (W.D.C.)	2350	--	0.45	--	7.1
06-Jan-81	Arizona Testing Lab	2630	1.10	0.62	--	7.3
03-Feb-81	Arizona Testing Lab	2430	--	0.62	--	7.1
23-Feb-81	Arizona Testing Lab	2700	--	0.59	--	6.8
16-Jun-81	Arizona Testing Lab	2530	2.00	0.76	--	6.3
15-Jul-81	Arizona Testing Lab	2450	3.00	0.83	--	7.2
30-Nov-81	B.C. Labs (W.D.C.)	2650	2.30	1.20	1.00	6.5
12-Jul-82	B.C. Labs (W.D.C.)	2560	3.00	1.10	1.00	6.4
20-Oct-82	B.C. Labs (W.D.C.)	2540	3.00	0.95	1.10	6.4
21-Jan-83	B.C. Labs (W.D.C.)	2400	2.30	0.48	1.20	7.0
06-May-83	B.C. Labs (W.D.C.)	2300	2.80	1.00	1.10	6.9
24-Oct-83	McKesson Lab	2600	4.90	0.70	0.97	8.0
02-Nov-83	McKesson Lab	2500	4.90	0.75	1.02	7.6
29-Apr-86	Arizona Testing Lab	2310	9.20	1.00	2.10	6.0
29-Jun-89	B.C. Labs (K.S.A.)	2700	21.50	1.40	4.80	6.6
20-Jun-89	B.C. Labs (K.S.A.)	2700	21.30	1.50	5.30	6.4
06-Jul-89	B.C. Labs (K.S.A.)	2650	22.30	0.90	5.20	6.6
14-Jul-89	B.C. Labs (K.S.A.)	2500	21.00	0.32	3.80	7.2
21-Jul-89	A.D.E.Q.	2600	22.90	1.60	4.60	6.1
04-Apr-91	Anaytical Tech. (D.M.)	2700	42.50	0.85	13.20	8.5

4

W.D.C. = Water Development Corporation
K.S.A. = Kenneth Schmidt Associates
D.M. = Dames & Moore

All sample results are reported in mg/l.
=====

TABLE 7

ZONIA MINE WATER SAMPLES

LOWER FRENCH GULCH

DATE	LABORATORY	SO4	Mn	Cu	Zn	PH
02-Sep-80	Arizona Testing Lab	2180	--	0.05	7.60	7.1
14-Oct-80	Arizona Testing Lab	2000	1.60	0.48	--	--
17-Nov-80	Arizona Testing Lab	1420	3.40	0.03	0.02	7.8
18-Nov-80	Arizona Testing Lab	1400	--	0.05	--	8.3
06-Jan-81	Arizona Testing Lab	1440	2.00	0.05	--	7.8
27-Jan-81	Arizona Testing Lab	1440	1.20	0.05	0.05	8.1
17-Feb-81	Arizona Testing Lab	1380	--	0.05	--	8.0
16-Jun-81	B.C. Labs (W.D.C.)	1300	0.05	0.05	--	7.7
15-Jul-81	B.C. Labs (W.D.C.)	1430	0.05	0.05	--	7.9
01-Dec-81	B.C. Labs (W.D.C.)	1350	11.00	0.08	0.13	7.9
12-Jul-82	B.C. Labs (W.D.C.)	1420	0.01	0.03	0.02	7.9
20-Oct-82	B.C. Labs (W.D.C.)	1440	0.02	0.02	0.02	7.8
21-Jan-83	B.C. Labs (W.D.C.)	1250	0.25	0.02	1.00	7.0
06-May-83	B.C. Labs (W.D.C.)	1330	0.20	0.04	0.02	7.8
24-Oct-83	McKesson Lab	1400	3.80	0.21	0.13	8.3
02-Nov-83	McKesson Lab	1400	3.90	0.21	0.14	8.3
29-Apr-86	Arizona Testing Lab	1320	0.05 *	0.05 *	0.05 *	7.9
29-Jun-89	B.C. Labs (K.S.A.)	1660	0.01	0.01	0.03	8.1
20-Jun-89	B.C. Labs (K.S.A.)	1780	0.01	0.02	0.03	8.1
06-Jul-89	B.C. Labs (K.S.A.)	1720	N.D.	0.01	0.14	8.1
14-Jul-89	B.C. Labs (K.S.A.)	1680	0.02	0.01	0.03	8.3

* = less than
N.D. = None Detected
W.D.C. = Water Development Corporation
K.S.A. = Kenneth Schmidt Associates

All sample results are reported in mg/l.
=====

TABLE 8

ZONIA MINE WATER SAMPLES

UPPER FRENCH GULCH

DATE	LABORATORY	SO4	Mn	Cu	Zn	PH
04-Sep-80	Arizona Testing Lab	2180	--	0.05	--	7.6
25-Sep-80	Arizona Testing Lab	2150	--	0.20	--	--
10-Oct-80	Arizona Testing Lab	2180	26.00	0.10	--	--
16-Oct-80	Arizona Testing Lab	2050	27.00	0.10	--	--
04-Nov-80	Arizona Testing Lab	2300	32.00	0.08	--	--
17-Nov-80	B.C. Labs (W.D.C.)	2200	24.00	0.15	0.18	7.0
17-Nov-80	Arizona Testing Lab	2300	25.00	0.11	--	7.1
06-Jan-81	Arizona Testing Lab	2350	16.00	0.05	--	7.6
03-Feb-81	Arizona Testing Lab	2350	--	0.05	--	7.4
23-Feb-81	Arizona Testing Lab	2300	9.20	0.05	--	7.0
16-Jun-81	Arizona Testing Lab	2030	4.70	0.05	--	6.9
15-Jul-81	Arizona Testing Lab	2150	10.00	0.05	--	7.7
30-Nov-81	B.C. Labs (W.D.C.)	2075	0.01	0.05	0.01	7.6
12-Jul-82	B.C. Labs (W.D.C.)	2100	9.90	0.04	0.06	7.3
20-Oct-82	B.C. Labs (W.D.C.)	1900	10.60	0.02	0.06	7.5
21-Jan-83	B.C. Labs (W.D.C.)	2300	16.00	0.10	0.09	7.3
06-May-83	B.C. Labs (W.D.C.)	1950	14.60	0.01	0.17	7.5
24-Oct-83	McKesson Lab	2300	29.00	0.96	0.72	7.7
02-Nov-83	McKesson Lab	2100	28.00	0.93	0.73	7.5
29-Apr-86	Arizona Testing Lab	2100	15.00	0.26	0.38	6.6
29-Jun-89	B.C. Labs (K.S.A.)	2100	11.20	0.05	* 0.20	7.2
20-Jun-89	B.C. Labs (K.S.A.)	2210	11.50	0.04	0.23	7.0
06-Jul-89	B.C. Labs (K.S.A.)	2100	11.10	0.06	0.21	7.0
14-Jul-89	B.C. Labs (K.S.A.)	2120	11.20	0.13	0.17	7.2
02-Aug-89	A.D.E.Q.	2260	9.60	0.08	0.46	6.6
04-Apr-91	Anaytical Tech. (D.M.)	2100	34.60	0.40	0.70	7.1

* = less than
W.D.C. = Water Development Corporation
K.S.A. = Kenneth Schmidt Associates
D.M. = Dames & Moore

All sample results are reported in mg/l.
=====

BIBLIOGRAPHY

Allen, J.W. and Spencer, J.J., 1957, "Report on the Geology and Exploration of the Zonia Property; Yavapai County, Arizona," 25 p.

Cameron, J.W., 1975, "Final Report, Zonia Copper Deposit, Yavapai County, Arizona", Homestake Mining Company, 25 p.

Chadwick, R.H.W., 1964, "Final Report, Zonia Copper Mine, Gillingham & McMahan Properties, Yavapai County, Arizona", 44 p.

Halpenny, L.C., 1972, "Groundwater Conditions in the Vicinity of the Zonia Mine, Yavapai County, Arizona", report prepared for McAlester Fuel Company, Kirkland, Arizona, 32 p.

Halpenny, L.C. and S.D. Clark, 1982, "Investigation of Water Quality, French Gulch, Yavapai County, Arizona, report prepared for McAlester Fuel Company, Kirkland, Arizona.

Homestake Mining Company, 1972, "Proposed Phase II Exploration Program for the Zonia Property, Yavapai County, Arizona", Draft report, 25 p.

Queenstake Resources (USA), 1983, "Preliminary Report on the Zonia Mine, Yavapai County, Arizona".

Wendt, G.E., et al, 1976, "Soil Survey of Yavapai County, Arizona, Western Part", U.S. Department of Agriculture, Soil Conservation Service and Forest Service, 121 p.

Schmidt, K., 1989. "Hydrogeologic Conditions at the Proposed Zonia Landfill", 33 p.

Laboratory of Climatology, 1975, Evaporation of Evapotranspirtion: Arizona Resources Information Systems Cooperative Publication No. 5, Arizona State University

Wilson, E.D., 1961, Gold placers and placering in Arizona: Arizona Bureau of Mines Bulletin No. 168, University of Arizona.

SECTION III

Remediation Measures

Future Property Uses

The Zonia property has been the subject of numerous geologic and engineering reports, some dating back to the turn-of-the-century. These reports, as well as past mining and development/exploration records, have been made available during this evaluation. Although it is beyond the scope of this report to discuss the mineral potential of the project, the future of the property will be dependent, at least in part, on the ability of mining operations to resume. It is the opinion of the Zonia Company that future operations will be dependent on new reserves being delineated, favorable economic conditions and technological advances.

Since the termination of mining operations in 1975, the property has been evaluated by several mining concerns in an effort to establish sufficient mineral reserves that would warrant renewed mining operations. The past and present owners have maintained the property on a "standby status" during this period in the hopes that the existing infrastructure could be utilized should an operation become feasible.

During this inactive period, the current owners have maintained, replaced and repaired many of the past pollution abatement and mitigation components established by prior owners. In the summer of 1990, Envirotec Solutions, Inc. was retained by the Zonia Company to assist in the establishment of Best Management Practice's (BMP'S) at the site, as well as prepare this report in response to the Finding and Order, dated July 13, 1990. The following text describes in detail the BMP'S which have been proposed and are being implemented by the Zonia Company.

A. Surface Water Hydrology

1. Run off Diversion

One of the primary remedial measures established at the Zonia Mine, and possibly the measure having the greatest overall significance in terms of pollution abatement, has been the construction of ditches and berms to provide positive surface water run off drainage diversion. These measures divert surface water away from the leach basins to minimize the potential infiltration and thus reduces solution discharge. Exhibit I identifies these various improvements, which were made over a period of ten weeks (October 1990 to December 1990).

Table 1 lists significant rainfall amounts since the installation of rain gauges in August, 1990. During a 5 inch rain on September 20, 1990 several of the leach basins experienced a significant increase in discharge within hours of the actual storm. Upon visual inspection it was observed that many of the older diversion ditches and berms were not handling the run off and much of this water was flowing to the leach basin surfaces and/or perimeters, infiltrating directly onto the imperious asphalt liners and hence into the collection systems.

A concentrated effort to control this run off around the perimeters of the leach basins was established as seen in Exhibit 1. A series of retention/detention basins and evaporation ponds now collect much of this run off. Since the annual evaporation rate exceeds the average annual precipitation in the area, this will be an effective system. On March 2, 1991 a 4.5 inch storm event was experienced at the site and no immediate increase in discharge from the leach beds was noted, (only a slight increase was noted after several days.)

a. Evaporation Ponds

There are several existing evaporation ponds in use at the Zonia Mine (Exhibit 1). These were tested for suitability by Gellhaus in September, 1990, and the results are reported in Appendix C. These ponds provide for adequate water retention and resultant evaporation.

2. Erosion Prevention

a. Revegetation

The Zonia Company has sampled the various soils as seen in the Appendix A and B. Several hundred pounds of material were submitted for vegetation studies at the University of Arizona, Tucson, Arizona. Dr. J. L. Stroehlein, Associate Professor, Department of Soils, Water and Engineering is evaluating this soil for vegetation response. Dr. Stroehlein has authored several

TABLE 1

RAINFALL AMOUNT*
(In Inches)

DATE	AMOUNT	DURATION
09/15/90	0.75	24 hours
09/20/90	5.00	48 hours
11/21/90	0.45	24 hours
01/10/91	1.35	24 hours
02/28/91	1.25	24 hours
03/02/91	4.50	48 hours
03/15/91	0.50	24 hours
03/29/91	2.75	36 hours

*Taken by onsite rain gauges.

research papers involving revegetation and utilization of copper by-products. Based on the results of this study, test plots may be constructed on the various heap leach surfaces and slopes. This reclamation could offer an excellent opportunity to improve forage, erosion control and other future land use values on the site.

In addition to the soils work being conducted by Dr. Stroehlein, Zonia Company has had correspondence with Cyprus Miami Mining Corporation, Claypool, Arizona, as well as a visit to their mine tailings reclamation project. This has assisted Zonia Company in finding potential uses of holistic resource management as implemented by the C.M.M.C. Consultants, Arizona Ranch Management. This unique effort in revegetation and soil generation of mine spoils is accomplished through a cattle grazing program confined to a specific area. The animals break up the surface and deposit seed through their manure. The various components of the animals waste combined with surface disturbance create a micro-environment conducive to seed germination. The work being carried out by Cypress is unique and initial results are encouraging. Zonia Company has been working with a local rancher to coordinate a similar holistic management program for the leach heaps. Presently forty head of cattle graze at the Zonia site.

Lastly, the Zonia Company has conducted research pertaining to the site's grape growing potential. The College of Agriculture, University of Arizona, Cooperative Extension Bulletin 8836, July 1988, has included the areas of Peeples Valley and Kirkland as having similar natural viticultural potential compared to Sonoita, Arizona, the center of the state's first wine district. Initial site studies have been conducted on soils, climate, water and economics. Table grapes are presently grown in the region, and provided that soil amendments and adequate water can be established, this may provide a unique reclamation project. Of particular interest in the development of grape vine growth would be the potential utilization of the low-grade copper sulfate waters contained at the Zonia Mine site. Copper sulfate solution is widely used in agriculture as an algae and fungi retardant, i.e. water canals and lakes, etc., and as a frost inhibitor in orange groves. Copper sulfate is also abundantly used in grape vineyards as protection from root rot. Zonia has contacted Kocide Corporation, Houston, Texas in an attempt to better understand the chemistry and available markets for copper sulfate. Kocide manufacturers and markets copper sulfate worldwide, primarily for agricultural uses. It is hoped that a the viability for commercial crop production can be demonstrated.

b. Chemical Stabilization

All of the leach basin surfaces have formed an impermeable crust to some degree. Leach basins 5 and 6 have a 6 to 12 inch top layer of hardened crust as a result of the finer-grained materials exposure to the chemical compounds used for copper leaching. This top crust reduces the potential for water and wind erosion.

3. Stream Flow

Stream flow measurements will be taken monthly in conjunction with water level measurements. Figure 4, Section II, shows the location of four stream flow measurement devices (steel weirs) installed along Zonia Gulch and its tributaries. Table 2 lists the dimensions of each weir. Monthly readings will be logged at the same time as well depth and pressure gauge readings are taken in order to establish any corresponding relationship of precipitation to depth of water and stream flow. An example of a suggested reporting form is attached as Exhibit II. From previous studies (see Section II, Attachment B), weirs were used in similar locations. Current flows will be compared with those taken in the 1980's by Halpenny and Clark.

Stream measurements are meaningful only during periods of steady-state flows. Those times where storm run off drastically and immediately increase the height of water over the weirs are not indicative of any flows from springs, and therefore measurements need not be taken.

B. Sub-Surface Hydrology

Based on the effectiveness of the surface water run off diversion ditches and berms, and the impervious nature of the leach basin surfaces only minor amounts of water can infiltrate the leach basins. Leach basins 1-4, 7, 8 and 9 were constructed by McAlester Fuel Company and blueprints and pictures (Exhibit III) of this

TABLE 2

THE ZONIA COMPANY

ZONIA MINE
ROUTE 1
KIRKLAND, ARIZONA

GENERAL OFFICE
212 S. MARINA ST.
PRESCOTT ARIZONA 86303
(602) 778-2100

MEMORANDUM

TO: Don Ferris

FROM: John Rubel

DATE: May 23, 1991

RE: Water Weir Specifications

---

1. French Gulch Spring

L - 36" W - 1/8" H - 12"
Notch Size: 1' long - 3" deep

2. Zonia Gulch Spring

L - 34" W - 1/8" H - 12"
Notch Size: 1' long - 3" deep

3. North Canyon Spring

L - 36" W - 1/8" H - 8"
Notch Size: 1' long - 3" deep

4. Cabin Spring

L - 5' W - 1/8" H - 12"
Notch Size: 3' long - 4" notch

Footnote: Notch 1" intervals

ENVIROTEC SOLUTIONS, INC.
Engineers, Geologists and Environmental Scientists

EXHIBIT II

STATIC WATER AND STREAM FLOW DATA

Date: ______________ **Time:** ____________ **Sampler:** _______________

Well Location

Bard Well ________________
Instrument Well ________________
Cuprite Well ________________
Old Mill Well ________________
LB - 6 - 1 ________________
LB - 6 - 2 ________________
Pump Hole - LB - 6 ________________
LB - 5 ________________
LB - 5 Pump Station ________________
LB - 9 - 1 ________________
LB - 9 - 2 ________________
Mercer Hill Hole (Z-607) ________________
Red Hill Hole (Z-603) ________________

Valve Pressure

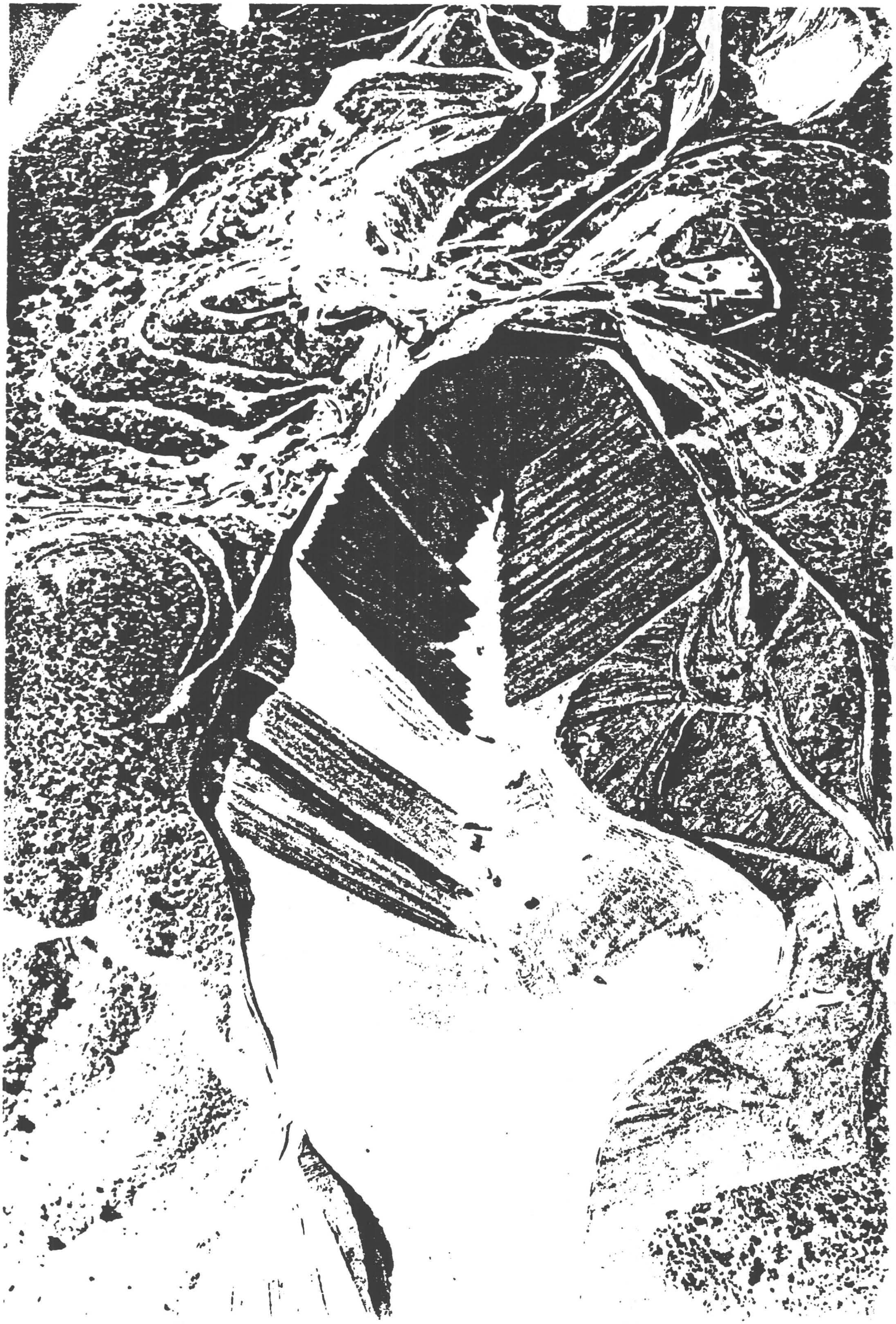
LB 1 & 2 ________________
LB 3 & 4 ________________
LB - 9 - 1 ________________
LB - 9 - 2 ________________
LB - 8 ________________

Stream Flow Data

French Gulch ________________
Zonia Weir ________________
North Canyon Weir ________________
Cabin Spring Weir ________________

212 South Marina Street • Prescott Arizona 86302 • (602) 778-2100 • FAX (602) 778-9249

EXHIBIT III



Photography taken in 1960.

construction show that these basins were built by smoothing the topography and covering the flanks and bases with two layers of impervious material (asphalt) separated by compacted fill. These basins can act as solution impoundments or retention basins capable of storing the solution at the source.

The volume of retained water could approach 6% to 10% of the saturated portion of the leach beds. This volume could be monitored and estimated by valving the leach bed and installing the necessary pressure gauge assembly. With the low Ph of the discharge solution, standard brass gauges would fail over time; therefore, special gauges or protective devices would be required. The primary storage of these leach basins solution is now in the leach basins themselves. Table 3 shows the volume and surface area of each bed. With the installation of the valving and pressure monitoring systems, the pressure readings equate to feet of head, which indicate depth of saturated material. Using a coefficient of approximately 8% of this saturated volume, the total gallons of solution can be estimated.

The valving and pressure monitoring apparatus also allows for the leach basin solutions to be pumped back to the top of the leach basin surface for evaporation or recycling through the leach beds. This pump back feature would only be employed to control the potential rise of solutions in the leach basins as indicated by the pressure gauges. The pumped solutions will be contained in the evaporation ponds per Exhibit 1.

1. <u>L.B. 7, 8, 9</u>

In the past leach basin solutions were controlled by discharge pipes moving solution from L.B. 7, 8 and 9 via gravity to the collection pond at the mill through French Gulch. This system of transporting the leach basin solution presented several potential problems, i.e. high maintenance, susceptible to damage and potential discharge, and the pipes location in French Gulch. In an effort to control the leach basin solution at its source, and since a majority of the surface water run off has been diverted around the leach basins thereby reducing infiltration, three solution control/monitoring apparatus were installed on the discharge lines of leach basins 7, 8 and 9. This was done on December 13, 1990.

To date, these solution control/monitoring apparatuses have contained the leach basin solutions and Table 4 shows the pressure readings since installation. Readings will be done monthly.

TABLE 3

LEACH BED DATA

Pressure = 0.77 YD. HEAD
% Water = 8.00%

LEACH BED #	SURFACE AREA (IN S.Y.)	VOLUME OF MATERIAL (IN C.Y.)	PRESSURE AT GAUGE (P.S.I.)	DEPTH OF SATURATION (IN YDS.)	APPROXIMATE VOLUME OF WATER (IN GALLONS)
1A	4,500	80,750	0.0	0.0	0
1B	6,600	138,000	0.0	0.0	0
2	15,975	287,888	0.0	0.0	0
3	15,088	406,938	0.0	0.0	0
4	9,800	273,350	0.0	0.0	0
4A	5,600	155,750	0.0	0.0	0
5	IN - SITU				
6	IN - SITU				
7	1,600	13,200		0.0	0
8	12,750	195,375	3.0	2.3	11,756
9A1	26,400	499,800	13.0	10.0	4 299,978
9A2	25,013	414,863		4.0	47,721
9B1	21,250	301,500	10.0	7.7	155,161
9B2	21,600	266,400		0.0	0
9B3	36,000	351,000		0.0	0
	-------	---------			-------
	202,175	3,384,813			514,617

TABLE 4

LEACH BED PRESSURE TABLE

	LEACH BED NUMBERS		
	9-1	9-2	8
December 1990	10#	10#	2#
January 1991	11#	11#	2#
February 1991	12#	11#	2#
March 1991	12#	12#	3#
April 1991	12#	12#	3#
May 1991	13#	10#*	3#

*Experiment with different gauge.

As discussed earlier should solutions rise in the leach basins a pump will move the solution back to the leach basin surface to an evaporation pond. The evaporation pond to be located on top of LB 9 is a clay lined structure approximately 210' x 210' in area. The pond will have built up, compacted sides, using the existing undisturbed soils with high clay content as bottom material. A portable 10 horsepower pump will transport solution from the valves to the evaporation pond and will discharge into a cast metal energy dissipation system, as seen in cross section in Exhibit IV. A rubberized diffusion device will be attached to the discharge pipe with stainless steel clamps. This system will protect the evaporation pond floor from any potential scour or erosion from the high velocity discharge lines.

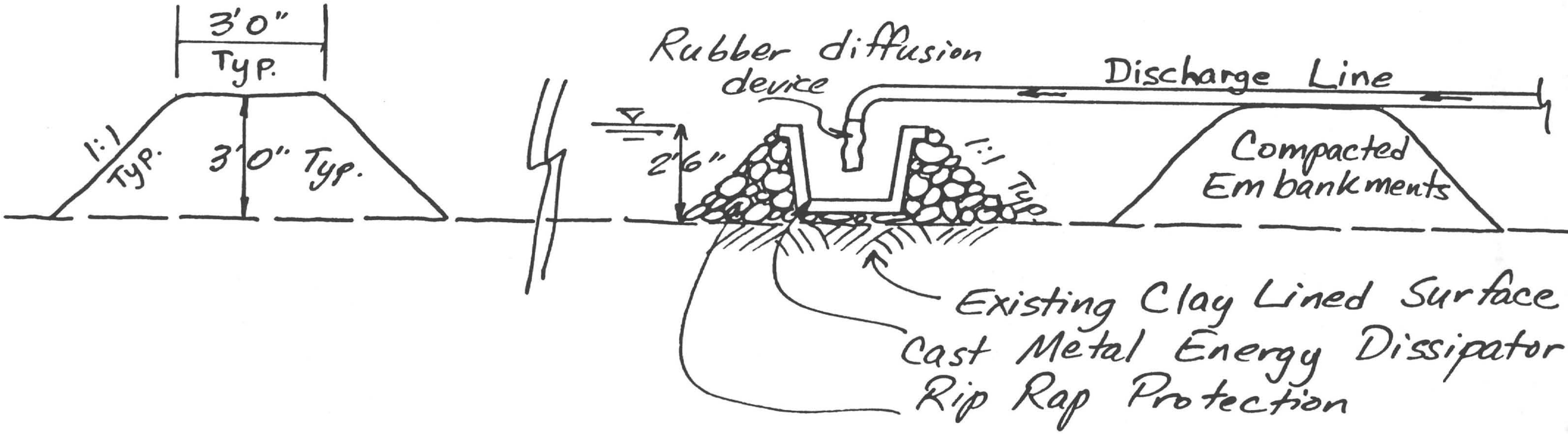
Evaporation rates were estimated in the Halpenny Study at 75" per year average; with an annual rainfall of 16", the net evaporation is 59", or nearly 5 feet. The height of compacted embankment on the sides of the retention basins is 3 feet. Using a 6" free board, 2.5 feet of storage is thereby provided on each basin, or slightly over 2.5 acre-feet of volume. Since nearly 5' of evaporation is expected in an average year, each basin can be filled and dried two times if needed. This provides for approximately 1,630,000 gallons of evaporation.

As the evaporation pond is situated within a contained system, any potential infiltration of pumped solutions in the leach basin will be recirculated and contained.

2. <u>L.B. 1 - 4</u>

Valving and pressure monitoring systems are being considered for leach basins 1 - 4. Currently, basin solution, estimated at three gallons per minute gravity flow to the two existing 84' x 32' concrete holding bays, which have a total capacity of 116,000 gallons. Solution which does not evaporate in the holding bays feeds directly to the clay lined collection pond, located at the plant site. This collection pond has an estimated capacity of less than two millon gallons. Both the holding bays and collection pond retain surface water run off from the plant area. Run off and leach basin 1 - 4 solutions can be pumped from either the holding bay or collection pond to the clay lined barren solution pond. (See Exhibit V for original plans for construction of the barren solution pond.)

Evaporation Pond Details and X-Section



No Scale

EXHIBIT IV

3. L.B. 5 and 6

Leach basins 5 and 6 were created when ore bearing formations in the area were rubblized in place in 1972. After blasting the surface of the leach basins were contoured into a series of stepped terraces and both sprinkler and injection well leach systems were utilized for copper recovery. As was the case with the other leach basins, a high clay content and poor solution penetration through the leach beds resulted in poor copper recovery and the operation was terminated in 1975.

Halpenny and Clark (1982, page 6 -3) report: "owing to the manner in which the blast charges were placed, the shattered zone has a nearly flat bottom and nearly vertical side. It can be considered a box contained shattered rock with comparatively high permeability resting in undisturbed bedrock of much lower permeability. The blasting was planned to shatter the rock to a depth of 250 feet below the highest point of the hill which was at an elevation of [4,600 feet AMSL]. Thus, the bottom of the shattered zone is at an elevation of about [4,350 feet AMSL], which was approximately 10 to 20 feet above the water table which prevailed at that time."

Halpenny and Clark (1982) and past mine records point out that approximately 22,000,000 gallons of solution have been removed from these basins and that the solutions were not acid solutions from the prior operation but rather water recharge that occurred from several exceptionally wet years (1978-1980). These solutions were pumped from wells in L.B. 5 and L.B. 6 by using 15 horsepower, 225 gpm stainless steel pumps. The solution was pumped from the leach basins via an 8" pipeline to the plant and then to the discard solution reservoir, at a distance of approximately 2.5 miles. This pumping ceased in July 1983 as the leach basin fluid levels dropped below the pump intake and water levels remained constant in the basins. Table 4, Section II, provides historical water table measurements.

The precipitation events during the years 1978 - 1980 created a situation whereby water levels rose 42 and 62 feet in leach basin 5 and 6 respectively. It is believed that the rise in water levels can be attributed to an estimated 3 acre feet of surface water run on in leach basin 5 and 25 acre feet of run on during the 100 year events experienced during this time. There were no surface water diversion ditches or berms around the perimeter of these leach basins and much of the surface water apparently infiltrated the surfaces. Antioch Resources constructed a diversion ditch to the east of leach basin 6 in 1985 and the Zonia Company has repaired this ditch as well as constructed several hundred feet of additional ditches and berms and built several retention basins per Exhibit 1. These diversion and retention components will greatly reduce any future potential infiltration and will provide adequate protection from rising fluid levels in the basins.

The relative high levels of mineralization found in Zonia Gulch is believed to be the product of many years of influence from surface water run off from the upper portions of Zonia Gulch through leach basins 5 and 6. As pointed out earlier (Section II) stream flows will be measured monthly from this vicinity and this information may provide a correlation.

In addition to the surface water controls measures constructed, the pumps from leach basins 5 and 6 have been removed and are being completely overhauled. The pumps will be reinstated and will provide additional control of potential rising water tables if necessary. Solutions will be pumped to and contained in the evaporation pond located on the surface of leach basin 6. This evaporation pond will be constructed similar to the evaporation pond on leach basin 9.

C. Other Measures

1. General Cleanup

As seen in the attached photographs in C., 4., a great deal of general cleanup has been made over the past ten months. Specific areas of improvements include:

a) Unused pipe systems removed
b) Concrete tanks painted
c) French Gulch cleaned

As mentioned previously, all unnecessary pipe systems in French Gulch are being removed.

2. Fencing

Four-strand barbed wire has been installed around the barren solution and discard ponds in order to keep cattle or deer from ingesting any of the solution contained in these ponds. Full size "plastic owls" have been attached to discourage migrating or local water fowl from landing in these ponds as well. Metal posts were used throughout, and 5" diameter steel piping was set in concrete for corner posts.

3. Photographic Documentation

4. Capital Improvement Expenditures

Capital improvement expenditures, Exhibit VI contains itemization and costs incurred by the Zonia Mine for the construction of ditches and berms, and effluent containment and transport systems since the acquisition of the Zonia Mine by the Zonia Company in 1988. This total of $96,500-plus represents a substantial outlay of capital for a facility that was designed, permitted and operated in full compliance with all federal and state regulations during its operating life.

Much of the remedial work was done in the fall of 1990, under the direct supervision of Envirotec Solutions, Inc. staff. No construction plans were prepared due to the extensive nature of the ditching/berming. Construction plans and specifications for such "linear" earthwork would have been too costly; therefore, only "as-built" plans are used, as shown in Exhibit 1 of this report.

The cost data for this exhibit was obtained from records supplied by the Zonia Company. However, there are additional ongoing costs which are not reflected.

D. Conclusion

Due primarily to significant improvements to surface water handling and, to a lesser extent, to the installation of the valving/gauges and monitoring system, there is no longer a danger of any discharge. The solution stored underground in asphalt lined basins present no influence on springs or groundwater, and is in such diminishing strength as to be equal or less than that of naturally occurring groundwater (mineralized due to the natural geology of the region). Since the mine is no longer active, time will only further reduce solution concentrations. Therefore, no significant adverse impacts to surface or groundwater are expected by the current owners; conversely, with the monitoring systems currently implemented and detailed in this report, significant improvements to both surface and groundwater can be expected.

EXHIBIT VI

TABLE OF RECLAMATION EXPENSES

EQUIPMENT			
a) D-8 Cat			
1. Surface Hydrology	196 hours @ $110.00/hour	=	$21,560.00
2. Road Repairs	50 hours @ $110.00/hour	=	5,500.00
b) Rented			
Backhoe	2 days @ $300.00/day	=	600.00
Blade	2 days @ $325.00/day	=	650.00
c) Electric		=	2,400.00
WELLS AND PUMPS	McGee, Gilbert	=	3,540.00
GENERAL MONITORING & REPAIRS			
a) Pipeline repair & replacement	250 materials; 12 days @ $200	=	2,650.00
Paint and maintenance	100 materials; 2 days @ $200	=	500.00
b) Paint, upkeep			
WATER SAMPLING	per BC Laboratories invoices	=	9,200.00
FENCES	1,320 L.F. @ $1.50/L.F.	=	1,980.00
ENGINEERING			
a) Soil	Dames & Moore	=	5,000.00
b) Soil/Permeability	Gellhaus Engineer & Test	=	675.00
c) Water	Ken Schmidt & Associates	=	25,006.00
d) Site Restoration/ Ditching/Berming	Envirotec Solutions	=	5,000.00
SURVEY			
a) Topograph & boundary	M. Haywood & Associates	=	5,860.00
b) Kenny Aerial	Kenny Aerial	=	6,380.00
	TOTAL		$96,501.00

K Bradley

Completion Report
Preliminary
Phase I
Zonia Evaluation

March 1993

John Petersen

Between 1/05/93 and 2/04/93 a condemnation drilling program and a leach dump trenching program were conducted on the Zonia property. This preliminary report covers all drilling results and roughly two-thirds of trenching results.

DRILLING:

Nine holes were drilled on the Zonia property to permit evaluation of certain mine facilities and/or to provide long-term ground water monitor wells. Results are discussed below. (See also graphic/assay logs, attached.)

Holes A-1 and A-3, each 500 feet deep, were drilled to assess depth and grade of mineralization extending from the pit area to beneath the Leach Basin I. The holes encountered 40 to 100 ft of quartz mica schist over a sequence of chlorite schists. Major zones of silicification were encountered in both holes with the heaviest zones localized in the bottom 100 feet.

Hole A-1 cut two zones of ore grade copper. One at 320'-350' (.23% TCu .14% OxCu; 61% oxide) and the second 430'-500' (TD) (.22% TCu .17 OxCu; 75% oxide). Only minor sulfides were observed and it is possible that the relatively low oxide copper reported is due to silica encapsulation.

Hole A-3 did not encounter ore grade copper in bedrock to total depth, and in fact was essentially barren.

Strongly silicified zones in both holes were assayed for precious metals. No detectable gold was found and only weak silver (up to 0.09 opt) was assayed in both holes, being strongest in the copper mineralized zone of A-1.

Holes A-8 and A-10 were drilled to test the Southwestern edge of the waste dump area near the base of Red Hill. Both holes intersected alternating quartz mica and chlorite schists in the top 200 to 300 feet above variably silicified chlorite schists. Hole A-8 cut about 50 ft of heavily epidotized rock beginning at 150 ft. Although epidote is frequently observed in drill cuttings, this zone with more

than 50% epidote represents an unusual situation of unknown significance.

Hole A-8 cut 150 ft of mineralization from 450 ft to 600 ft (TD). By including two low grade zones in the calculation this represents 150' of .25 % TCu/.23% OxCu; 91% oxide.

Hole A-10 penetrated only weakly mineralized material to total depth of 500 ft.

It is possible that holes A-1 and A-8 penetrated the same mineralized zone along strike. This interpretation fits with previous geologic models. If true, it is likely that ore grade mineralization extends down dip beneath Leach Basin I and the Southwestern end of the waste dump, but is apt to be quite deep under most of the area (i.e. more than 500ft).

Holes A-12 and A-14 were drilled midway along the length of the waste dump to evaluate ore potential under the waste dump. A-12 cut 60ft of quartz mica schist at the top, otherwise both A-12 and A-14 cut greenstone complexes including massive chloritic quartz-feldspar porphyry and chlorite schist. Silicified zones were cut in both holes.

A-12 cut 236 feet of significant mineralization 170 ft to 406 ft (TD). Including four intervals of low grade material, this zone contains .22% TCu. 19% OxCu; 88% oxide.

A-14, which was established as a permanent ground water monitor well, was drilled only to 315 ft where two cones were left in the hole, and it was abandoned.

These results, in combination with McAlester and Homestake drill results indicate that ore is likely to underlie a significant portion of the waste dump from the In Situ area and Northeastward. The depth to mineral is moderate along the Southeastern foot of the waste dump (130 to 170 ft) and may well be of economic significance. Further Northwest, in the vicinity of the present plant facilities,

the depth to ore may increase significantly. If present, ore grade mineral would likely be more than 500 feet deep.

Holes A-5 and A-17 were drilled within the area of In Situ "Basin 5" to evaluate whether or not substantial ore-grade copper remains after leaching. Hole A-5 encountered quartz-mica Schist from surface to TD (400 ft) although the basal 140 ft was quartz-rich to silicified and chloritic.

Several 10 foot to 30 foot zones contain ore grade mineral, but alternate with low-grade mineral. Compared to the nearest pre-leach holes (F 58 and F 59) it appears that substantial leaching may have occurred in the uppermost 150 ft in this area. This roughly corresponds to a 140 foot zone in A-5 which has a "bleached/leached" appearance. A-5 carries an average 0.10% total copper in this interval compared to an average .44% in F-58 and F-59.

As a second check on deep leaching in "Basin V" hole A-17 was drilled to 200' in a position intermediate between pre-leach holes F44, F45 and F52. Within the interval tested by A-17 the three pre-leach holes cut several 5 to 60 foot

intervals containing .27% to .67% total copper. A-5 cut more than 100 ft of ore grade mineral including 20 feet of .95% TCu. This appears to contrast sharply with results from A-5 and indicates that either leaching or the distribution of mineralization in this area was quite erratic.

A tabulation has been prepared to illustrate the copper content of various "pre-leach" and "post-leach" holes in the In Situ area. Arimetco and Nerco drill hole assays are compared to the nearest McAlester holes.

Table I: Deep copper content in In Situ Leach Basins

BASIN 5

PRE-LEACH GRADE	POST-LEACH GRADE	APPARENT % COPPER LEACHED
F-128 F-60 .3914 F-114	Nerco 5-3-1 .2963	24.31%
F-58 F-59 .3048	Arimetco A-5 .1083	64.46%
F-44 F-45 .2565 F-52	Arimetco A-17 .2385	7.02%

25%
Cut

BASIN 6

PRE LEACH GRADE	POST LEACH GRADE	APPARENT % COPPER LEACHED
F-144 H-362 .3002	Nerco 6-2 .2086	30.52%
F-191 .2920	Nerco 6-2 .2580	11.64%
F-192 .3569	Nerco 6-3 .6138	0%

The table above indicates more extensive, but erratic leaching in Basin 5 than in Basin 6. Average leaching in both basins may be about 20 to 25%.

Hole A-16 was drilled as a permanent ground water monitor well. It was located to test a conglomerate unit which appears to underlie Leach Basin III. Water was not encountered until 290 ft, or 130 ft below the conglomerate, in fractured granitic rock. The absence of water in the conglomerate indicates that leachate from Basin III has not made it's way into bedrock. Water obtained from the underlying granite had a moderately high TDS (1700), and a high pH (7.9). The hole was unmineralized.

TABLE II: Drill hole data (primary):

Hole No	Elev	TD	Driller's Water Level	Driller's Water Pumped	TDS	pH
A-1	4695	500'	304'	20-25gpm	NA	NA
A-3	4675	500'	340'	25 gpm	NA	NA
A-5	4580	400'	340'	10 gpm	NA	NA
			220'	-	NA	NA
A-8	4620	600'	280'	-	NA	NA
			460'	25 gpm	NA	NA
A-10	4625	500'	280'	15 gpm	1050	7.2
A-12	4450	400'	120'	-		
			260'	25 gpm	1600	7.8
A-14	4610	315'	210'	-		
			300'	25 gpm	3100	6.8
A-16	4735	400'	290'	-		
			400'	5 gpm	1700	7.9
A-17	4590	200'	Dry Hole			

Conclusions and Recommendations:

A total of 3815 feet were drilled out of the 4380 feet authorized by AFE. The difference arises because one condemnation, and four geotechnical holes were deemed to be unnecessary. One additional hole in the In-Situ area was thought to be required as a result of initial assay returns.

As anticipated, ore grade material does extend beneath Leach Basin I and the waste dump. Clearly, the economic significance of this mineral must be judged in the light of all available information. However, there are sufficient indications of ore grade material that additional drilling is

warranted especially NE of the In-Situ area. In particular, holes A-1 and A-3 should be deepened to 700 feet, and additional drilling along the waste dump should be undertaken to define potential ore reserves.

Evaluation of the leached cap in the In-Situ area will most likely require a fair amount of shallow (150 - 200 ft) close-spaced drilling (100 - 200 ft centers). Results of In-Situ area trenching may prove to be useful in evaluating patterns of leaching (see below).

TRENCHING:

The objectives of the trenching program were:

1. To obtain information relating to the character of the materials in Leach Basins I and III. Notes were made on fragment size, stratification, degree of sorting, evidence of reworking, evidence of mineralization, leaching, etc.

2. To obtain representative samples for assay in order that material might subsequently be selected for column testing.

3. To examine where ever possible the leach basin liner, and to determine it's character and integrity.

The equipment available were adequate to meet objectives 1 and 2, but not 3. The program requisition called for an excavator with a 24-25 foot reach. An excavator with a 21 foot reach was provided through the corporate office. As a result, sufficient pit depth was not obtained and an important program objective was compromised. It was possible to excavate to adequate depth in only one trench, T-3-12. In

this case, the leach rock-soil interface was seen approximately 23 feet below the leach dump surface (i.e. about 13 feet below the floor of the pre-dug dozer trench). Here a 6" ± diffuse band of dark colored material occurred at the top of the soil. This material contained substantial vegetable matter, had a fetid and possibly petroliferous odor; but was not a cohesive asphaltic material.

It is possible that leach rock has overlapped the liner by more than 100 ft on the SW end of Leach Basin III. About 1 foot of water filled the bottom of the excavation. With the failure to provide adequate equipment for liner evaluation, other means of exposing the liner have to be considered. Available equipment will be used to dig as deeply as possible in likely locations around the edge of Leach Basin III.

Full evaluation of objectives 1 and 2 pend return of all assay data. A few interesting relationships can be reported, however. It was found that a zone of uniform, brown apparently well-leached material occurs in the surface in both Basins I and III. It has similar appearance to the material exposed in the relatively shallow Basin II trench, previously evaluated (See my memo dated November, 1992). The base of this upper horizon may be undulatory and its thickness ranges from about 6 feet to about 15 feet. It overlies the main volume of leach material consisting of pervasively limonite stained leach rock. The intensity of iron stain varies from place to place and with depth. At time a complex shape and orientation of variably stained material appears to reflect local "micro-hydrologic" regimes in the leach dump. Frequently, more intense iron staining is associated with layers, lenses or pockets of relatively coarse leach rock with substantial cavernous porosity (e.g. Trench 1-3). It is within such strongly limonitic pockets that remnant copper mineralization is more intense.

In many trenches there is ample evidence by stratification or lensing that leach rock was not uniformly crushed, if crushed at all, and that once laid down was not subsequently disturbed by ripping or systematic reworking by other means.

Samples have been systematically taken from all excavations to determine if there is a predictable relationship between copper content and location or the appearance of the leach rock. Also, copper content by size fraction is being determined.

The sampling procedure followed was designed to obtain representative samples. In dozer trenches, vertical channels were cut with a shovel through representative and undistributed material in the walls. Approximately 60 pound samples were taken of all material in the channels. In deeper excavations, separate piles were made of material from the upper ten feet and lower ten feet. These piles were split with a backhoe and a channel sample taken through the center of each pile, again obtaining all material cut. Fragments which, due to size, bridged the channel were broken by hammer and a representative fraction was taken. Using this methodology all material from fines to plus-one-foot were bagged.

Leach basin samples were screened at Johnson Camp to minus 1/4", plus 1/4" to minus 1". and plus 1". All samples were submitted for analysis of Total copper % and Oxide copper %.

By including NERCO Leach Dump drill sampling the number of sample sites in Basins I and III is increased-markedly. Although there appears to be a tendency for NERCO results to be generally higher in total copper and lower in oxide copper than Arimetco results, the differences are not so extreme that the data cannot be combined.

The resulting data are spread with fair uniformity over both Leach Basins. Basin I has 28 sample sites and Basin III has 19. The data are adequate for the top 30 to 40 feet of

leach rock and sparse for deeper material. Since the average thickness of leach rock in the basins is about 56 feet nearly two thirds of the volume of leach rock may be adequately appraised.

Tables III and IV show average grades by depth in Leach Basins I and III.

TABLE III: NERCO Drilling Copper Content VS. Depth

Basin I

No. of Samples	Depth	TCu%	OxCu%
16	0-10	.1288	.0444
16	10-20	.1738	.0625
16	20-30	.2363	.1169
15	30-40	.1837	.0590
10	40-50	.1450	.0490
5	50-60	.1620	.0600
3	60-70	.2267	.0733
Average		.1795	.0664

Basin III

No. of Samples	Depth	TCu%	OxCu%
7	0-10	.2229	.0829
7	10-20	.2014	.0814
7	20-30	.1486	.0486
6	30-40	.2233	.0933
6	40-50	.1583	.0550
4	50-60	.1725	.0500
Average		.1889	.0685

TABLE IV: Arimetco Trenching; Copper Content VS Depth (64% of data)

Basin I

No. of Sites	Depth	TCu%	OxCu%
12	0-10	.12	.10
4	10-20	.16	.12
4	20-30	.14	.11
Average		.13	.10

Basin III

No. of Sites	Depth	TCu%	OxCu%
12	0-10	.13	.10
6	10-20	.14	.12
6	20-30	.15	.13
Average		.14	.12

There appears not to be any uniform relationship between depth in the leach dump and grade other than the upper ten feet having been more substantially leached on average and that perhaps it contains less oxide copper.

NERCO (Mountain States R & D) reported that there was no appreciable difference in copper content by size fraction. However, the sampling technique employed would have rejected oversize material. Therefore Arimetco samples were screened (+1"; +1/4"; -1/4") to reassess this possibility. Visual examination of trenches indicates that +6" material comprises between 5% and 20% of Zonia leach rock and that material between 1 and 4 feet in longest dimension is not uncommon. Furthermore, where copper minerals remain in leach rock it is invariably in +6" material. Therefore an important economic parameter is the quantity and grade of such oversized

material. It must be noted that far less than half of the oversized rock contains obvious copper mineral even though it has generally a fresh, unleached appearance.

Table V shows a breakdown of copper distributions in Arimetco trench samples (based upon currently available data 64%)

As shown in the table there is a slight tendency for coarse material at certain levels in Basin I to contain less copper, and an equally slight tendency toward the reverse situation in Basin III. This relationship is in accord with visual estimation, whereby unleached copper was found more frequently in Basin III trenches than in Basin I. Clearly, the differences are so slight in average that for purposes of economic evaluation all three leach basins might be considered together.

TABLE V: Arimetco Trenching; Copper Distribution by Size Fraction

Basin I

Depth	+1"		+1/4"		-1/4"	
	TCu	OxCu	TCu	OxCu	TCu	OxCu
0-10	.12	.10	.11	.09	.12	.10
10-20	.16	.13	.16	.13	.16	.12
20-30	.13	.10	.14	.11	.14	.11
Averages	.14	.11	.13	.11	.14	.11

Basin III

Depth	+1"		+1/4"		-1/4"	
	TCu	OxCu	TCu	OxCu	TCu	OxCu
0-10	.10	.08	.10	.09	.12	.09
10-20	.15	.13	.12	.10	.14	.11
20-30	.15	.13	.15	.13	.15	.12
Averages	.13	.11	.12	.11	.14	.11
Overall Averages:	.14	.11	.13	.11	.14	.11

Weight percent distribution averages as follows

(100% of data):

Location		Weight %		
	+1"	+1/4"	-1/4"	
Basin I	33.5%	26.2%	40.3%	
Basin III	34.6%	29.2%	36.2%	
Average	34.1%	27.8%	38.1%	
[Basin II		36.2%	20.8%	43.0%]

The combined results of NERCO and Arimetco sampling (64% of data) indicate that the average copper content of Leach Basin I is .15% TCu and .08% OxCu; and of Leach Basin III is .16% TCu and .09% OxCu. Previous sampling of Leach Basin II indicated average copper was .18% TCu and .15% OxCu. The overall weighed average is .16% TCu and .09% OxCu.

On the basis of size distribution, of the total copper remaining in the leach dumps approximately 34% will be in +1" 28% in +1/4"-1"; and 38% in -1/4". Visual estimates of plus 6" material range from about 5% to about 20%. Local pockets and lenses exist where oversized material constitutes more than 50%, but it is likely that for the entire volume of the heaps a 10-15% average would not be too far off.

Excavations were also made on In-Situ basins V and VI. Samples from the top 10' and bottom 10' of each 20 foot pit were submitted for analysis. Based upon results received to date (86%) it is apparent that Basin VI (6 pits) has been less thoroughly leached than Basin V (12 pits) and that within Basin V the upper terraces have been leached to greater extent than lower terraces. Table VI shows average values for both basins. It would appear that ore grade material exists at relatively shallow depth in both In-Situ areas.

TABLE IV: In Situ Trenching

	TCu% Range/Average	OxCu% Range/Average	% Oxide
Basin V			
0-10	.07-.35/.1420	.04-.29/.1020	71.8%
10-20	.05-.60/.2230	.03-.58/.1840	82.5%
Basin VI			
0-10	.09-.39/.2283	.05-.32/.1900	79.7%
10-20	.16-.50/.2840	.13-.41/.2300	81.0%
Average			
0-10	.1781	.1350	75.8%
10-20	.2433	.1993	81.9%
Overall Average			
	.2107	.1672	79.3%

CONCLUSIONS AND RECOMMENDATIONS:

To the extent they have been sampled Zonia leach basins appear to contain an average of .16% Total copper of which 60% reports to the oxide Cu assay (Arimetco plus NERCO data).

Early on a crushing option was suggested to facilitate liberation of unleached copper in oversized material. On the basis of trenching and assay results it would appear that the material that would benefit from such treatment is limited in volume and irregular in distribution. Furthermore, the average grade of such material is generally not superior to middlings or fines, despite sometimes spectacular examples of unleached copper. A crushing option appears to be economically unfavorable for leached rock and may be suspect for new ore if size control is attainable through shot design.

Although many areas exist in the heaps where leaching has been less complete due to channelling or development of impervious capping the distribution of such pockets (taken here to contain greater than .2% total copper) is sporadic and unpredictable.

Approximately 20% of the samples representing 10' depth increments have returned values in excess of .2% total copper. Such intervals were more common by far in the NERCO sampling then in samples taken by Arimetco. The most optimistic estimate of grade within leach dumps is here taken to be that one fifth of the material will carry an average of .30% total copper whilst the balance of the material will carry about .12% total copper.

Given that 7,130,249 tons of material (McAlester) was placed in the three leach basins, 1,426,000 tons at .3% grade and 5,704,200 tons at .12% grade represent about 22,250,000 pounds of total copper. If a substantial portion of the 60%

oxide is recoverable, the contained leachable resource is about 13,350,000 pounds. If NERCO (Mountain States R & D) estimate of 39% acid leachable copper is used a little over 8,650,000 pounds is available.

Clearly, column testing will be required to obtain some idea of the ultimate practical recovery. Toward that end it is suggested that three columns be run of Zonia leach rock. The recommended sample sites are as follows:

T-1-3-3 (10-20') with .15% TCu and .13% OxCu;
T-3-11-4 (20-30') with .14% TCu and .10% OxCu; and
T-3-9-4 (20-30') with .24% TCu and .21% OxCu.

Column testing of this material would simulate stripping and ripping of existing leach dumps followed by application of Johnson Camp type leachate. Approximately 700 pounds of each sample (55 gallon drum full) will be required.

Also suggested early on were pilot heap leach tests on 10-ton lots of ore. It is recommended at this point that a single pilot heap test be conducted on pit run ore without crushing. A comparison with results from column tests which approximates a test on undersized ore at minus 1 foot and which are in progress may indicate whether further study of a new-ore crushing option is justified.

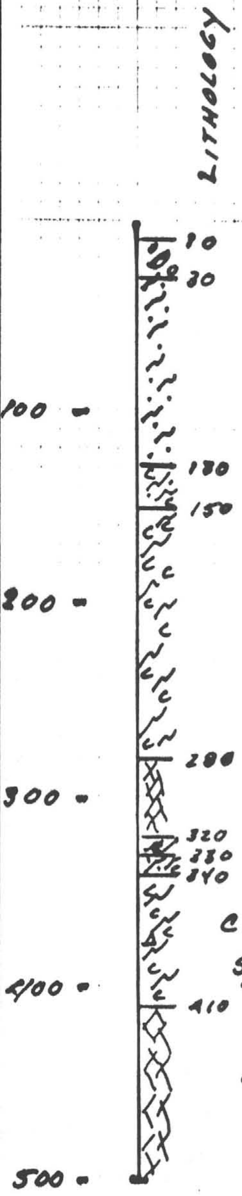
Results to date tend to indicate 70% recovery of head grade (here taken to be approximately 0.5% total copper) from ore leached by McAlester. Whilst column testing of leach rock may indicate that a small additional amount of the original copper may be recovered by scalping and ripping the economics of crushing new or old ore to further enhance this limited additional recovery may be suspect. Also the production of fines by crushing may ultimately prove to be detrimental. Especially since the dumps contain nearly 40% --1/4" material at the outset.

ZONIA
HOLE A-1
Comp. 1/6/93
TD = 500'
-90°

COORDS: Ft N Ft E

ELEV. =

LITHOLOGY



10 fill
30 Conglomerate (?)
qtz-mica Schist mod. to hvy FeOx qtz as sub-rnd grains
130 mixed qtz-mica + chlorite schist
150 Chlorite Schist ± qtz grains incr. silicification to bottom
280 Silicified zone
320 Chlorite Schist
330
340 mixed qtz mica + chlorite schist
Chlorite schist, patchy silicification 370-380 poss. micro bx
410 Silicified Chlorite Schist brecciated by hvy FeOx incl. hm. alt. mica 470-490 tarnished py

Tcu	Ox Cu
.15	.13
.01	
.04	
.01	
<.01	
.01	
.01	
.02	
<.01	
.01	
.03	
.01	
.02	
.11	
.13	
.07	
.08	
.06	
.06	
.08	
.14	
.09	
.34	.21
.15	.09
.20	.12
.09	
.13	
.07	
.02	
.03	
.04	
.03	
.04	
.03	
.03	
.04	
.04	
.04	
.06	
.04	
.09	
.06	
.04	
.18	.14
.17	.12
.14	(.10)
.21	.15
.33	.25
.22	.16
.30	.24

CARBONATE

} .23/.14 61%

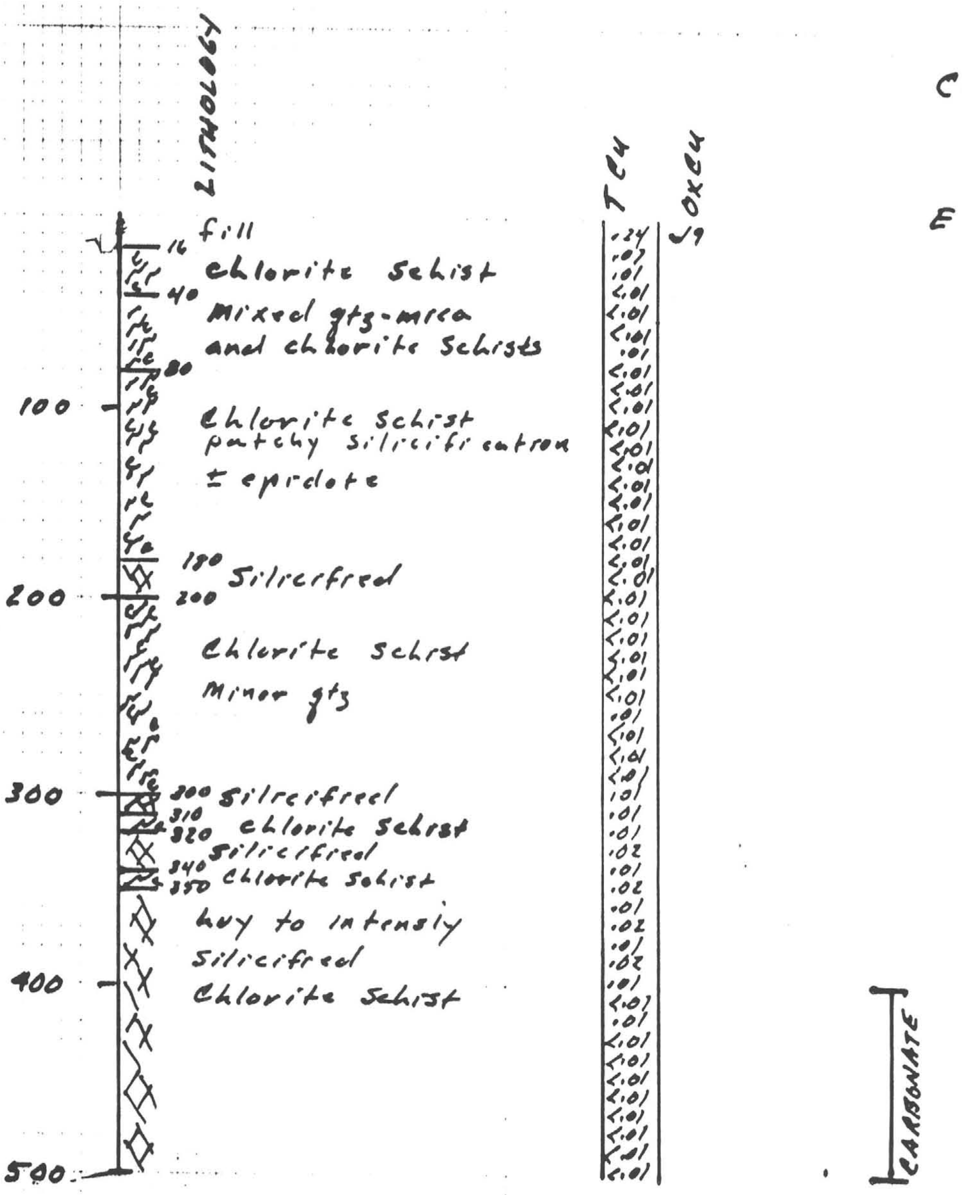
} .22/.17 75%

1" = 100'

ZONIA
HOLE A-3
COMP. 1/18/93
TD = 500'
-90°

COORDS: ftN ftE

ELEV. =



1" = 100'

ZONIA
HOLE A-5
COMP. 1/19/93
TD = 400'
-90°

COORDS ft N ft E

ELEV. =

quartz-mica schist with bleached/leached appearance

quartz mica schist patchy silicification v. hvy FeOx + qtz

Quartz rich zone, chloritic with mica schist

silicified zone

silicified mica schist with chloritic qtz

TCu	OxCu
.09	
.09	
.06	
.08	
.07	
.06	
.05	
.07	
.09	
.08	
.21	.11
.22	.18
.13	
.14	
.09	
.09	
.07	
.05	
.15	.08
.10	
.04	
.09	
.08	
.28	.25
.35	.34
.15	.13
.11	
.03	
.05	
.08	
.13	
.07	
.07	
.09	
.16	.12
.14	
.24	.21
.08	
.11	
.13	

CARBONATE

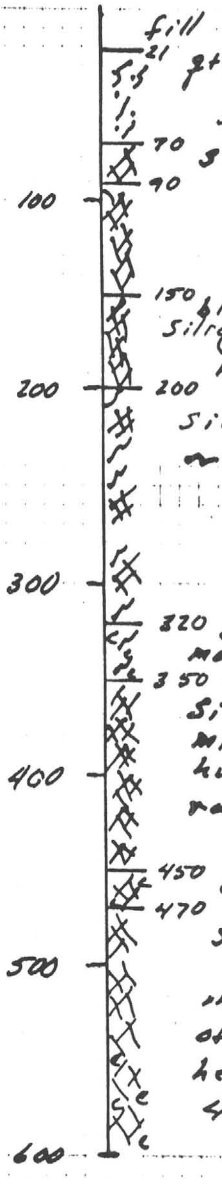
1" = 100'

ZONIA
HOLE A-8
Comp. 1/14/93
TD = 600 ft
-90°

COORDS ft N ft E

ELEV. =

LITHOLOGY



fill
21 qtz-mica schist
mod FeOx
Patchy silicification
50-60 clayey
70 Silicified rock
90
Silicified mica
Schist, chloritic
150 blue-gray altered rock
Silicified mica Schist ?
(poss. Chlorite Schist)
hvy epidote (up to 50%)
200
Silicic mica schist
~10% epidote
320 Chlorite Schist
mod to hvy Si, mod FeOx
350 ± epidote ± magnetite
Silicified zone
minor mica schist
hvy clear qtz
rare tourmaline rare epidote
450 Chlorite Schist with
470 hvy Silicification
Silicified rock

intermittent clots
of Chlorite becoming
heavy in bottom
40'

TCu	OxCu
.11	
.04	
.06	
.02	
.05	
.03	
.12	
.01	
.03	
.05	
.06	
.02	
.03	
.07	
.04	
.02	
.01	
.02	
.01	
.01	
.08	
.12	
.09	
.14	
.03	
.02	
.02	
.06	
.05	
.02	
.09	
.14	
.12	
.14	
.15	.10
.07	
.06	
.07	
.11	
.08	
.06	
.05	
.11	
.10	
.12	
.33	.28
.34	.29
.37	.36
.12	(~.11)
.12	(~.11)
.17	.14
.28	.26
.13	(~.12)
.18	.16
.28	.26
.24	.21
.37	.35
.55	.53
.21	.19
.19	.16

CARBONATE

.25/.23 91% OXIDE

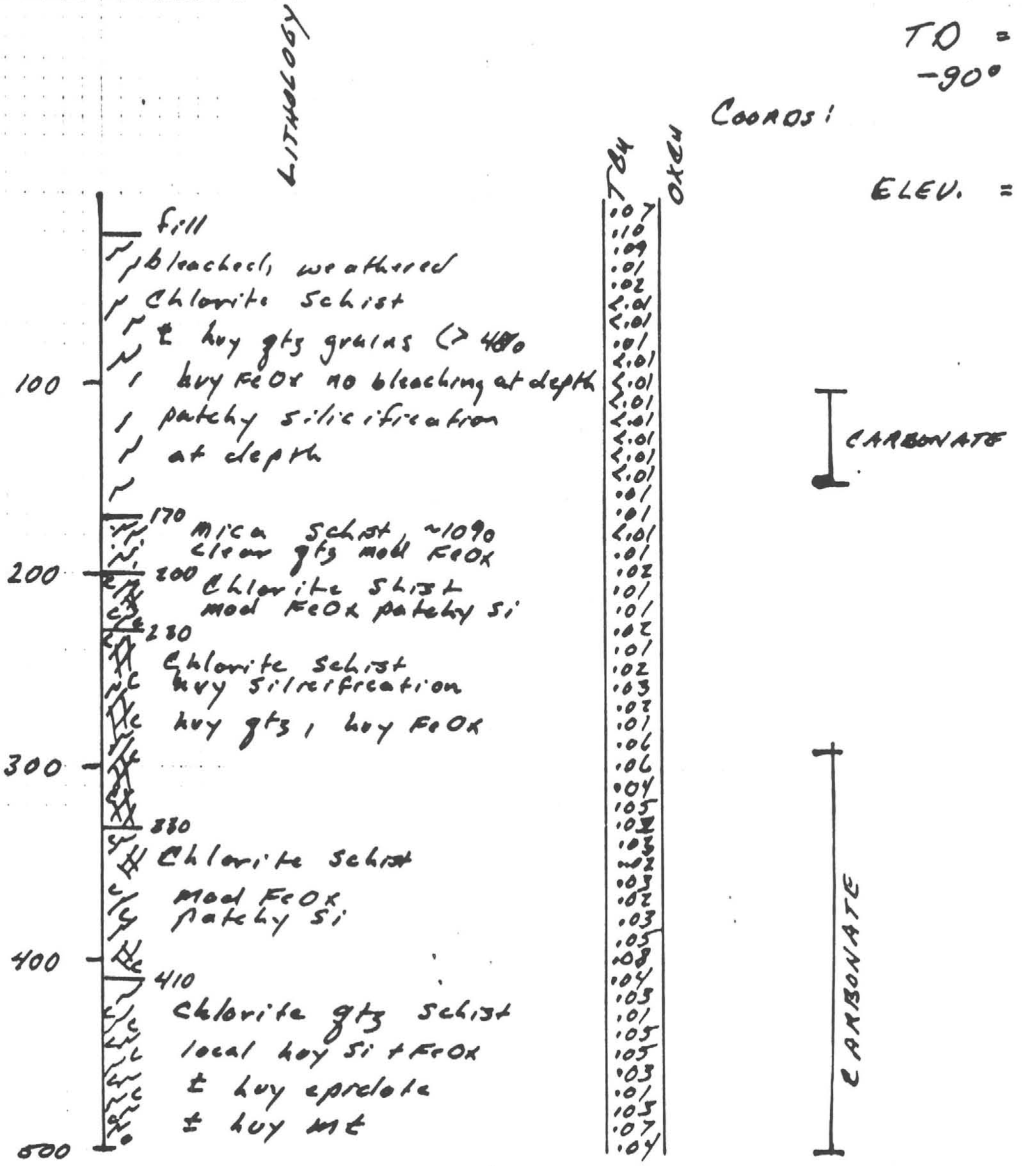
1" = 100'

ZONIA
HOLE A-10
Comp. 1/11/93

TD = 500'
-90°

COORDS: ftN ftE

ELEV. =



fill
bleached, weathered
Chlorite Schist
± hvy qtz grains (> 40%)
hvy FeOx no bleaching at depth
patchy silicification
at depth

170 mica schist, ~10% clear qtz mod FeOx

200 Chlorite Shist
mod FeOx patchy si

230
Chlorite schist
hvy silicification
hvy qtz, hvy FeOx

330 Chlorite schist
Mod FeOx
patchy si

410
Chlorite qtz schist
local hvy si + FeOx
± hvy epidote
± hvy mt

TCu	OXCu
.07	
.10	
.09	
.01	
.02	
<.01	
<.01	
.01	
<.01	
<.01	
<.01	
<.01	
<.01	
<.01	
<.01	
.01	
.01	
<.01	
.01	
.02	
.01	
.01	
.02	
.01	
.02	
.03	
.02	
.01	
.06	
.06	
.04	
.05	
.02	
.03	
.02	
.03	
.02	
.03	
.05	
.08	
.04	
.03	
.01	
.05	
.05	
.03	
.01	
.05	
.07	
.04	

1" = 100'

ZONIA
HOLE A-12
Rom A. 1/21/93

TD = 406'
-90°

COORDS. ftN ftE

ELEV. =

LITHOLOGY

10 fill
Mica Schist, 10-20% qtz grains, mod Feox
Mod. Si, minor chlorite

70
80 Mica schist and chloritic rock

100

Silicified chloritic rock
hvy chlorite
mod to hvy calcite

180 clear to milky qtz
clots of chlorite

200
200

Silicified rock, hvy
chlorite with large
qtz eyes, mod calcite

270

qtz or intensely silicified
rock whisps and clots
of chlorite ± mt ± epidote

300

320

Silicified rock, dark green
qtz + felds phenos in chloritic
matrix
Tr calcite

400

TCu	OXCu
.11	
.14	
.05	
.07	
.04	
.05	
.07	
.06	
.05	
.04	
.04	
.07	
.07	
.04	
.08	
.09	
.11	
.20	.12
.10	
.20	.16
.18	.12
.14	.11
.20	.13
.27	.19
.47	.38
.31	.24
.43	.31
.22	.14
.13	(~.11)
.21	.15
.25	.15
.16	.10
.13	(~.11)
.34	.24
.13	(~.11)
.12	(~.10)
.20	.14
.21	.14
.15	.19
.22	.16
.44	.30

CARBONATE

236' .24/.19 88%00.

1" = 100'

NOTE HOLE ABANDONED at 406'
Caving at Surface

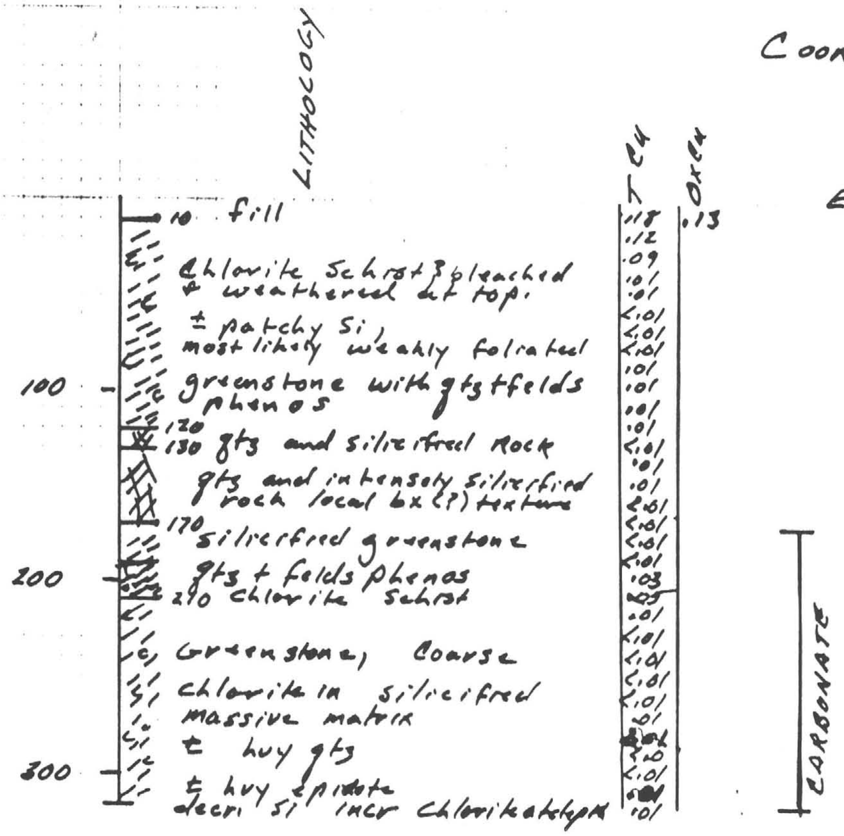
MONITOR WELL

ZONIA
HOLE - A - 14
Comp. 1/27/93

TD 315'
-90°

COORDS: ftN ftE

ELEV. =



1" = 100'

NOTE: LOST 2 Cones in Hole, Abandoned at 315'

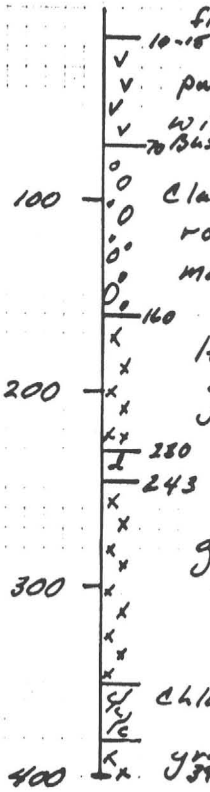
18' of 8" Casing Installed at Surface with 1' Stickup.

MONITOR WELL

ZONIA
HOLE A-16
Comp. 1/28/93
T.D = 400'
-90°

COORDS ft N ft E

ELEV. =



purple-gray aphanite
with ~10% pyroxene + felds phenos Tr qtz phenos
Basal 10' Vitric with oxidized biotite & phenos

Clasts of qtz, qtz-mica schist and qtz-felds rock (gr?) in a red silty (mica) clayey matrix Prob. Tert Conglomerate

Holocrystalline qtz + plag + Kspar
gr-qtz monzonite

diabase

granite or qtz monzonite
290-380 hvy qtz
mod to hvy calcite, minor chlorite

Chlorite schist

granite or qtz monzonite Chloritic
390-400 hvy qtz

CARBONATE

1" = 100'

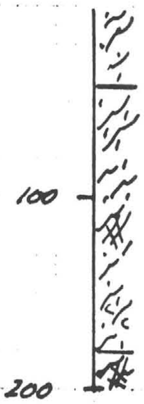
NOTE: DRILLED AS MONITOR WELL
NOT ASSAYED 0-230
230-400 <.01% Tcu
11 ft of 8" casing installed at surface
with 1' stickup

ZONIA
HOLE A-17
Comp: 8/28/93
TD = 200'
-90°

COORDS: ft N ft E

ELEV.' =

LITHOLOGY



qtz-mica Schist
bleached /leached appearance

qtz-mica schist
local patchy silicification

150-170
Weakly chloritic

Silicified mica schist

T Cu	Ox Cu
.04	
.03	
.09	
.07	
.16	.14
.74	.72
1.14	1.04
.23	.21
.29	.25
.14	(~.13)
.15	.11
.47	.43
.10	(~.09)
.17	.13
.27	.24
.05	
.18	
.17	
.11	
.13	

} 110' / .34 / ~.31 90% OXIDE

1" = 200'

NOTE: DRY HOLE