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TEMPORARY AQUIFIER PROTECTION PERMIT APPLICATION
ZONIA MINE
YAVAPAI COUNTY, ARIZONA

Arimetco, Inc.
6245 E. Broadway, Suite 350
Tucson, Arizona 85711

Temporary Aquifer Protection Permit Application

Facility Data

Name: Zonia Mine

Date Facility Began: 1966

Expected Life of Facility: undetermined

Mailing Address of Facility: Box 649, Yarnell, Arizona 85362

Phone Number: (602) 427-3564

County: Yavapai

Facility Location: Section 12 (all), Section 14 (all), NW 1/4 Section 13, SE 1/4 Section 11, T11N, R4W, G&SRB&M

Latitude: N 34 19'00" to N 34 17'20"

Longitude: W 112 37'10" to W 112 38'50"

Facility Contact Person:
Harrison Matson
Chief Geologist
Arimetco, Inc.
(602) 745-8882

Applicant Information

Arimetco, Inc.
6245 E. Broadway, Suite 350
Tucson, Arizona 85711
Phone: (602) 745-8882
Fax: (602) 745-0315

Owner information

The Zonia Company
212 S. Marina Street
Prescott, Arizona 86303
Phone: (602) 778-2101

Operator Information

Same as applicant

Existing Permits

U.S. Corps of Engineers, Section 404
Nationwide Permit, dated March 23, 1993

Preface to Application

In order to alleviate allegedly chronic water pollution problems at a mining and processing site which was operated prior to enactment of The Clean Water Act, construction of a containment system for potential discharges is necessary. It is requested that a temporary Aquifier Protection Permit be issued for the Zonia Mine facility as an interim measure while a complete Individual Aquifier Protection Permit application is being prepared for a new zero discharge facility. This temporary permit would expedite implementation of an EPA approved remediation plan.

Nature of Facility

The Zonia mine is a previously closed oxide copper mine with heap leach, in-situ leach and cement copper recovery components. The facility was in operation from 1966 to 1975 after which only recirculation of leach solutions for containment reasons was practiced. Containment of leach solution has, in the past, been allegedly inadequate. The proposed activities at the Zonia mine, once complete, are intended to fully contain all discharges.

Arimetco, Inc., which is not a principally responsible party, has obtained a lease/option on the property from the Zonia Company. It is Arimetco's intention to re-open the mine and build a new solvent extraction/electrowinning copper production facility. Concurrent with the design and construction of such a new facility, a remediation program will be conducted to assure that a zero discharge operation can be maintained both during and after mining operations have ceased. A copy of the proposed remediation plan is included with the application.

Characterization of Discharge

Existing Facility Components

1) There are three principal oxide copper heap leach pads existing at the Zonia mine: The original numbering system was obscure so the heaps were reassigned numbers 1-3 with #1 the farthest north, #2 next in line to the south, and #3, the largest one to the south. These heaps are called leach basins at Zonia because they were built to fill canyon basin areas and unlike most leach heaps in use today, they were built with internal dams to store solution. The common practice now is to build free draining heaps which report to an external pond. The leach basins have piping which drains the internal solution storage to the toe. Piping which protrudes from the toe of the leach basins has been the source of much of the uncontrolled discharges from the mine in the past. Valves were installed but are ineffective because the solution simply builds up in the heap after precipitation events and eventually overtops the internal dams. External storage to allow an attenuation of solution volume through evaporation is needed for a reliable, low maintenance solution control system. This external storage will be described under the proposed facility design.

A representative analysis of solution discharge from leach basin #1 and #3 is attached. The sample from LB #1 is identified as such while the sample from LB #3 is marked Basin 3 #13.

Several photographs are included with this application showing construction of leach basin #1 and leach basin #3. The leach basins were reported to have been built by clearing of the canyons

and compacting the native soil subbase to 90-95% standard proctor. A spray coating of MC 250 liquid asphalt was then applied as a hot finish seal. In some cases, a three-inch mixed in place soil asphalt layer was also installed as a compacted liner component. Unfortunately only sketchy data is available to verify liner installation. Photographs taken during construction clearly show the asphalt liner being installed at LB #3 and to a lesser extent LB #1. No data are available for LB #2, the smallest of the leach basins.

Liner integrity can only be proven by the use of groundwater monitoring stations strategically located down gradient from the leach basins. Testing to date confirms liner integrity of LB #1 and LB #3. These data will be further discussed under another section of the application.

2) Two areas on the north end of the existing open pit mine were fractured by explosives and used as in-situ leach basins by McAllester Fuels, the former operator. These in-situ areas are apparently the source of some degraded quality water discharges at springs in Zonia Gulch. A representative sample was collected on March 17, 1993, results of analysis are attached.

In order to alleviate these discharges which eventually report to French Gulch, a pump back well field is required. Two existing extraction wells, each capable of pumping 200 gpm were reestablished and piping installed in an attempt to evaporate the solution by sprays at the uppermost in-situ area. This method has been ineffective during the spring precipitation and an alternate method of pumping to storage at the SW holding pond will be

practiced during wet weather or when the solution level in the wells is high. The solution will be transferred via a surface pipeline.

3) There are four existing containment ponds presently in use at the Zonia mine. The largest is known as the southwest holding pond. This pond was created by construction of a wide earthen dam across a canyon near the head of French Gulch. It was built by the former operator to hold excess process solution and solution which contained more dissolved iron than was desirable for leaching. Capacity is in excess of 100 million gallons. Details of the liner system are not available, but it appears that the area was cleared of brush and the in place soil compacted. Evaluation of groundwater in the vicinity is ongoing.

Long term future use of the SW holding pond area is, at this writing, uncertain, but will be resolved before the individual permit application. Solution temporarily stored at this location will be used as the initial wetting or make up water for the heaps prior to new operations. Given a potential consumption of approximately 300 to 500 gpm for make up water once heap leaching resumes, it would be easily possible to completely drain the SW holding pond within a year. The pond will also be needed to store affected groundwater pumped from the in-situ leach basins as part of the remediation plan. Discharge to this pond may reach a maximum of 400 gpm, 24 hrs./day for several weeks. The SW holding pond dam is located at N 34 17'48" latitude W 112 38'00" longitude.

East of the SW holding pond about 1000 feet is another existing containment pond, which catches surface runoff from the

southern portion of the Zonia open pit. This area is simply an excavated depression in bedrock which holds water. This south pit runoff containment pond is unlined except for the low permeability bedrock at the site. No discharges other than natural unaffected runoff will report to this area in the future. The location is at N 34 17'45" latitude W 112 38'07" longitude.

A third existing pond was utilized by the McAllester Fuels Co. as a raffinate pond or barren solution pond. The pond is east of and uphill from the plantsite. It is reported to be on bedrock schist with a compacted clay liner. The clay liner has apparently been eroded from the uppermost portion of the pond. The pond has most recently been used to store solutions discharging from the #1 leach basin. These solutions are presently pumped uphill to the pond intermittently at a maximum rate of 200 gpm. New design rate will be a maximum of 4500 gal/min. Capacity is approximately 4 million gallons. A new composite liner system will be installed using 12" of low permeability clay under a 60 mil VLDPE liner. The raffinate pond is located at N 34 18'28" latitude W 112 37'55" longitude.

In the past, use of the barren pond for storage depended on the availability of storage in the fourth existing pond on site. A small clay lined pond just below the plant site was built to help control discharge from LB #1. The small size of this pond, a few hundred thousand gallons, limits its usefulness so it will be replaced with a new doubly lined pond as discussed under proposed components.

4) The existing plantsite presently is in use to provide a pump

station for solutions from LB #1. The site was formerly used to produce an impure grade of copper by the iron replacement/cementation process. The proposed new solvent extraction electrowinning facility is planned to be built at this location: N 34 18'30" latitude W 112 38'00" longitude.

Characterization of Discharge

Proposed Facility Components

1) In order to control discharges from leach basins #2 and #3, two containment ponds will be constructed in series in the drainage below the basins. These ponds will catch the discharge and allow it to evaporate. See design plan ZEE 006. The primary containment pond will have a capacity of approximately 1.3 million gallons and will have a composite liner. The liner system will consist of one 12" thick layer of compacted native clay with a coefficient of permeability of 1 x 10 e-7 cm/sec. or better in place and one overlying 60 mil VLDPE synthetic liner. Construction details are shown on design plan ZEE 001. A pump system will be installed with a pipeline capable of transporting discharged solution to either an evaporative spray field, the southwest holding pond, or the plantsite.

The LB #3 secondary containment pond will have a capacity of approximately 3.8 million gallons and will consist of a single liner system of low permeability clay and 1/4 to 1/2 inch polyacrylamide over low permeability bedrock. The steep walls of the canyon prevent usage of any other type of lining system at this specific site. Construction details are shown on design plan ZEE 002.

These new containment ponds, in conjunction with internal storage, will be capable of holding runoff from the watershed of the leach basins generated during the 100 year/24 hour event. The rate and duration of discharge depends on weather conditions as their principal function is to halt discharges associated with precipitation events. One pond will also be utilized, however, as a PLS collection pond upon renewal of leaching activity. The primary containment pond which is doubly lined will serve as a plant feed pond while the secondary pond will continue to provide backup containment only.

The LB #3 primary pond is located at N 34 18'08" latitude W 112 38' 21" longitude. The LB #3 secondary pond is located at N 34 18'12" latitude W 112 38'22" longitude.

2) In order to control discharges from the #1 leach basin, two containment ponds will be constructed below that basin while a third existing pond will be relined. The primary containment pond immediately below LB #1 will have a double or composite liner consisting of a 12" minimum thickness of compacted clay with an in-place coefficient of permeability of 1 x 10 e-7 cm/sec. or better, over which will be placed a 60 mil VLDPE synthetic liner. The capacity of the primary containment pond will be at least 1.3 million gallons. Site conditions related to rock weakness on the east abutment limit the size of the containment structure.

Below the primary containment pond and the plantsite, will be built a secondary pond with a capacity of 1.3 million gallons. The secondary pond will have a double synthetic liner on compacted subbase. A leach recovery system will separate the two liners.The

uppermost liner will be 60 mil VLDPE while the lower liner be 40 mil VLDPE or better. This pond will also serve as a raffinate staging pond for the new SX/EW plant and will be fitted with pumps to transfer solution to the existing raffinate or barren solution pond. The barren solution pond will have a new composite liner system installed as previously discussed.

Like the ponds below LB #3, the LB #1 system will also be capable of containing runoff resulting from the 100 year/24 hour precipitation event. The secondary containment pond and plantsite will be protected from French Gulch flooding by a concrete 7 x 12' culvert and concrete channel wall scour protection.

The location of LB #1 primary pond is N 34 18'27" latitude W 112 38'00" longitude.

The location of LB #1 secondary pond is N 34 18'34" latitude W 112 38'00" longitude.

The design plans for all these proposed structures are included in the application as plans ZEE #3 through #5.

3) Transfer of solution from the in-situ area and from the various ponds will be accomplished through the use of a newly installed piping and pumping system. The pipe will be installed on surface, but when conditions require that routing be underground for some short distance, such as to go under an access road, the line will be installed pipe-in-pipe. This will allow any leakage to be observed and the condition repaired rapidly. The pipeline will be HDPE type, properly sized according to flow rates. Proposed routing is shown on the design plans. In no case will routing be within a channel or plain subject to flooding.

4) The new SX/EW plant under production conditions, would discharge at the in-flow rate from the leach basins to the LB #1 secondary pond. This would form a closed circuit with no external discharges. The solution would be reacidified to about 20 grams/liter H2SO4 at the secondary pond and then would be pumped to the barren solution pond. The chemical characteristics of a typical leach solution are shown under table 4 (from K. Schmitt 1989) under the heading heap leach.

From the barren pond the solution would be redistributed to leach basins #1 and #3. Leach basin #2 would not be used as the existence of a sound liner has not as yet been confirmed. Distribution on the heaps would be at a .003-.005 gallon/minute sq. ft. rate.

The proposed plant would have full secondary, backup containment for all plant components including tanks, mixer settlers, and electrowinning cells. The relevant, complete containment design plans will be submitted with the individual aquifier protection permit application.

Proposed contained discharges are summarized below:

A. In-situ basins #5 and #6, 400 gpm to either evaporative spray at #5 and #6 or SW holding pond or raffinate pond.

B. #1 leach basin, at approximately 500,000 sq. ft. of drainage area, 1500 gpm maximum to LB #1 primary containment pond then to either new SX/EW plant or LB #1 secondary containment pond or old barren solution pond. The 5.5 inch, 100 year design storm containment for LB #1 was calculated for the remediation plan to be 3,198,995 gallons of which 949,042

gallons may be accommodated by in-heap storage. An additional 460,000 gallons of storage would be required if the two year/one hour event is to be simultaneously contained.

C. #2 and #3 leach basins, approximately 1,000,000 sq. ft. surface area, 3000 gpm maximum to #3 LB primary containment pond then either to secondary containment pond during prolonged precipitation events or to new SX/EW plant or to old barren solution pond. The SW holding pond may also be used for temporary storage in emergency situations. The 100 year design storm containment for LB #2 and #3 was calculated for the remediation plan to be 7,214,340 gallons of which up to 6,684,692 may be accommodated by in-heap storage. An additional 1,040,000 gallons would be required if the two year/one hour rainfall of .8 inch were to be stored simultaneously. Both events would be contained under the proposed plan.

D. Barren Pond, under maximum production conditions, 1500 gpm to LB #1, 3000 gpm to LB #3.

Demonstration of Compliance with Standards

The proposed remediation plan is designed to bring the Zonia Mine property into immediate compliance as a zero discharge facility. Continued full remediation of discharges can only be assured over the long run however, after the comprehensive plan for renewal of operations at Zonia has been approved. Besides providing funding through production, the renewal of mining would allow the rubblized rock at the in-situ areas to be removed to the lined heaps for containment. The open pit wall rock thus exposed

would not be as fractured, nor would have been affected by acid leaching. Runoff containment would be simplified.

One method by which compliance with water pollution control standards may be demonstrated is through the use of groundwater monitoring wells. A series of monitoring stations is proposed for the Zonia operation as shown on the included site plan ZEE 005. Generalized groundwater flow is toward the northeast from the area of operations. A set of downgradient monitor wells just outside of the pollution management area is proposed as the principal points of compliance.

These wells are currently in existence and are labelled on the plan as Z601, Z602, and cabin wells. A fourth well is also proposed as a point of compliance due to its critical placement to verify containment of solutions and liner integrity of LB #3. The A16 well was drilled by Arimetco in January 1993. The hole was placed to test surface mapping which showed that LB #3 was partially underlain by a Tertiary stream channel. The channel was proved to dip toward the west, cross-cutting under the leach basin. This presented itself as a perfect collection point, almost like a leak recovery sump, for migrant solutions from the leach basin if the liner were not intact. Water quality sampling of A16 indicates that no migration has occurred and that the liner is intact.

Sampling of groundwater from other wells adjacent to the #1 Leach Basin also shows a lack of increased metal values. Samples from the cuprite, Z603 and A-8 drill holes all contain low metal and low sulfate values. This is indicative of liner soundness at the #1 Leach Basin.

A typical monitor well design is appended which shows proposed construction details of any new monitor wells such as A16.

Details on some of the existing wells are obscure but will be provided under separate cover. A hydrogeologic report on the property is currently under preparation and is expected to be issued by late May 1993. This report will detail groundwater sampling results at Zonia and further clarify methods to demonstrate compliance.

Demonstration of BADCT

All new primary containment ponds will meet BADCT requirements with a dual liner system. This system is a composite type with compacted low permeability clay as the base liner and synthetic 60 mil VLDPE as the top liner. The synthetic liner rests directly atop the clay so that a plugging action might be effected by the clay if a small puncture occurs in the VLDPE.

The existing barren pond which is planned for use will also be relined using this same composite system. Compliance will be tracked by a nearby proposed monitor well, A14.

The LB #1 secondary containment (and raffinate staging) pond will be double lined using two synthetic membranes separated by highly transmissive geonet. A leak recovery line will be installed for hydraulic relief between the liners. This method is used here as site conditions lend themselves to the technique.

Two ponds which are planned for limited use do not have double liners. The LB #3 secondary containment pond cannot be equipped thusly due to the extremely steep rock walls of the narrow canyon where the containment had to be located. Instead the site

conditions in conjunction with a novel sealing method are proposed as BADCT. The pond floor is to be sealed with low permeability clay over jointed granite bedrock. The jointed granite and clay are planned to be sealed with a coating of acid resistant crosslinked polymer. Use of this pond would be limited to receiving overflow from the primary pond under adverse conditions.

The SW storage pond is not slated for lining due in part to the extremely large capacity, which at this writing is about 80% full. The pond is planned to be used only for temporary emergency storage or for a fresh water impoundment.

The SX/EW plant is to be built at the existing plantsite using a full secondary containment design. The mixer settler units and piping will be entirely within a walled containment area to confine possible spills or leaks. The settlers will themselves be concrete with stainless steel internal liners and will have leak detection ports every three feet. Storage tanks will be contained in a concrete lined tank farm area capable of holding 110% of the tank capacity or will be set in individual containment sumps with similar capacities. The EW cells will set on pedestals above a floor sump which will drain to the SX sumps for full secondary containment.

The bulk of the BADCT demonstration will be contained in the individual aquifier protection permit and is only presented as a partial summary here.

Enforcement Actions

The current owner of the Zonia Mine, The Zonia Company of Prescott, Arizona, was cited in November 1992 by the U.S. EPA for

violation of the Clean Water Act and ordered to perform certain measures to contain discharges. Arimetco had not taken possession of the property at that time and is an innocent third party in regards to past discharge practices. Arimetco, Inc. agreed to enter and conduct remediation related activities at the minesite on behalf of The Zonia Company. This was done in January 1993 on the expectation of receiving permits to reactivate the facility as a zero discharge operation.

As of this writing, only one enforcement action has ever been taken against Arimetco, Inc. and this singular event was of a minor nature. Arimetco, Inc. operates the Yerington mine and SX-EW plant in Nevada. During the month of November 1990, a finding of alleged violation and order was issued by the Nevada Division of Environmental Protection requiring corrective measures at the Yerington operation. The finding alleged that synthetic liner material was not adequately anchored around a leach pad and that certain berms were not built the required height. In addition to this, it was stated that a report required within thirty days of completion of construction was not timely filed with NDPE. Arimetco, Inc., agreed to pay a fine of $10,000 and correct the problem. No leach solutions were lost because of the problem and the local groundwater was never compromised.

Certification

I certify that under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that based on my inquiry of those persons immediately responsible for obtaining the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

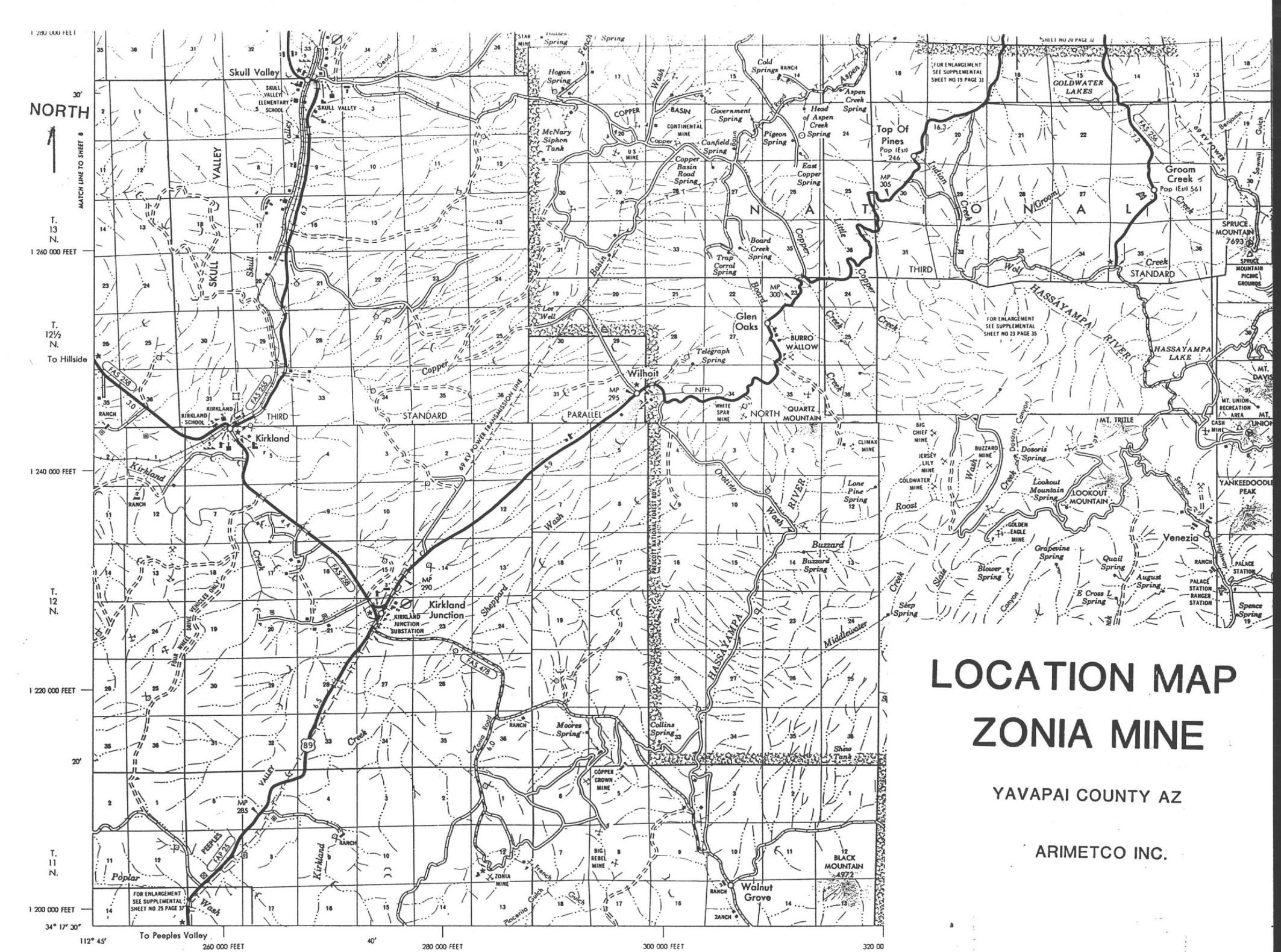
Harrison Matson, Chief Geologist

Statement of Financial Officer

All financial information available to me at this time suggests that Arimetco, Inc. is and will be capable of meeting closure plans at the Zonia Mine which are commensurate with closure costs and plans associated with other open pit heap leach facilities of a similar size. Monitoring of water quality conditions near the mine will be regularly scheduled after closure for a minimum of five years and a zero discharge status will be assured. A sum of $150,000 will be allocated from the net production profits of the mine to guarantee payment of these reclamation related expenses.

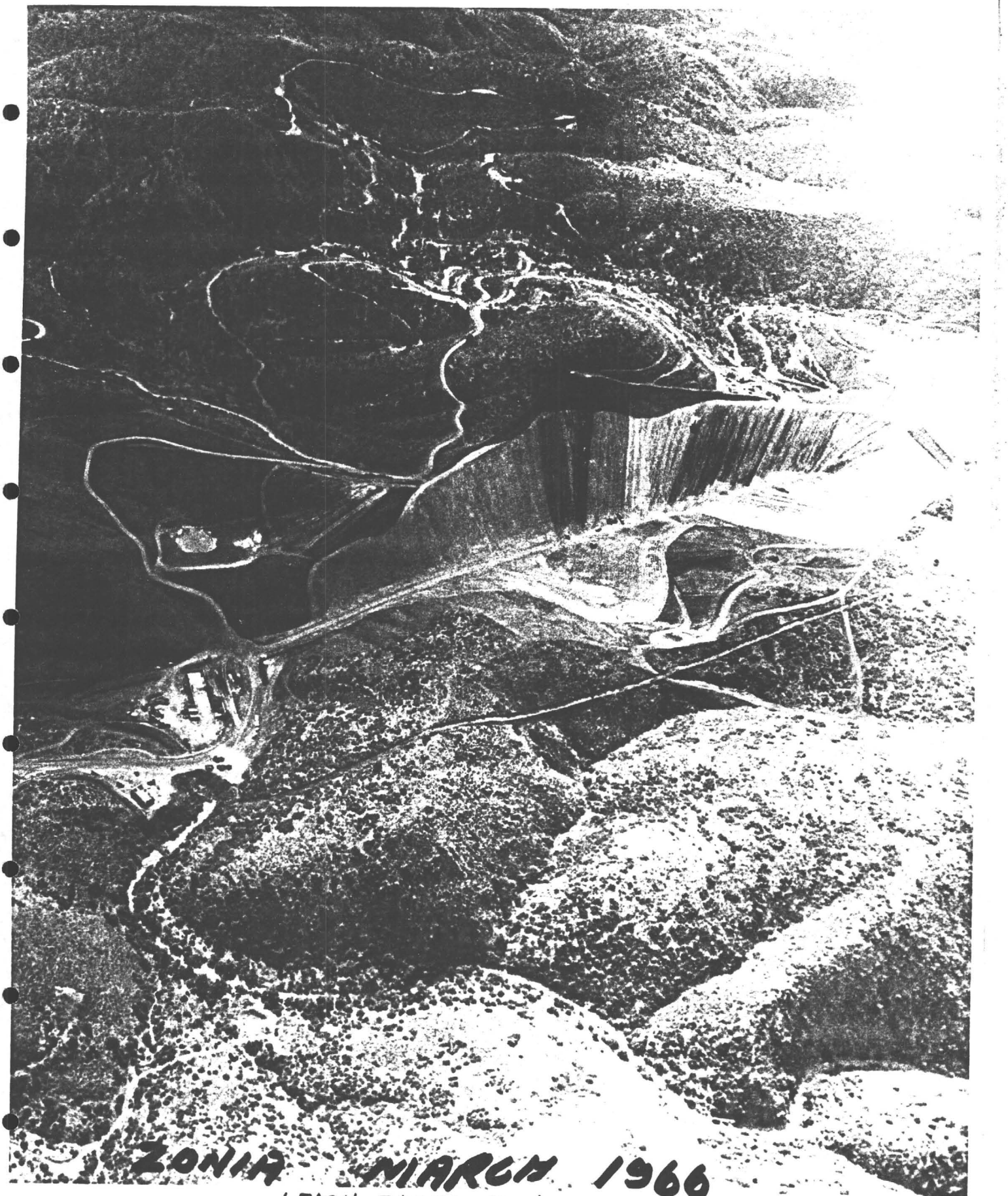
Signed:

John A. McKinney
V.P. of Corp. Affairs


LOCATION MAP
ZONIA MINE
YAVAPAI COUNTY AZ
ARIMETCO INC.
NORTH
MATCH LINE TO SHEET 8
Skull Valley
Kirkland
Kirkland Junction
Wilhoit
Glen Oaks
Top Of Pines
Pop (Est) 246
Groom Creek
Pop (Est) 561
Venezia
Walnut Grove
To Hillside
To Peeples Valley
T. 13 N.
T. 12½ N.
T. 12 N.
T. 11 N.
1 260 000 FEET
1 240 000 FEET
1 220 000 FEET
1 200 000 FEET
34° 17' 30"
112° 45'
260 000 FEET
280 000 FEET
300 000 FEET
320 00
R. 5 W.
R. 4 W.
R. 3 W.
BLACK MOUNTAIN 4972
SPRUCE MOUNTAIN 7693
QUARTZ MOUNTAIN
LOOKOUT MOUNTAIN
YANKEEDOODLE PEAK
MT. TRITLE
MT. DAVIS
HASSAYAMPA RIVER
HASSAYAMPA LAKE
PRESCOTT NATIONAL FOREST BDY
69 KV POWER TRANSMISSION LINE
FOR ENLARGEMENT SEE SUPPLEMENTAL SHEET NO 25 PAGE 37
FOR ENLARGEMENT SEE SUPPLEMENTAL SHEET NO 23 PAGE 35
FOR ENLARGEMENT SEE SUPPLEMENTAL SHEET NO 19 PAGE 31
SHEET NO 20 PAGE 32

1966 ZONIA MINE LEACH BASIN NO. 1

ZONIA MINE 1983



ZONIA MARCH 1966

LEACH BASIN NO. 1

SHB AGRA, INC.
Engineering & Environmental Services

1870 West Prince Road
Suite 66
Tucson, Arizona
U.S.A. 85705
Phone: 602-792-2779
Fax: 602-888-0014

April 2, 1993

Arimetco International Inc.
6245 East Broadway, Suite 350
Tucson, Arizona 85711

SHB Job No. C93-6522

Attention: Mr. Harrison Matson

Re: **Misc. Testing**
Tucson, Arizona
SHB Lab No. 2054

Gentlemen:

Transmitted herewith are copies of laboratory test results performed on a sample recovered from the referenced project.

Should you have any questions, regarding these results, we would be pleased to discuss them with you.

Respectfully submitted,
SHB AGRA, Inc.

By Tom L. Romero
Tom L. Romero
Manager Construction Services

Copies: Addressee (2)

at 95% standard proctor exceeds spec

SHB AGRA INC.
ENGINEERING & ENVIRONMENTAL SERVICES

PROJECT:	ARIMETCO INTERNATIONAL	**JOB NO.**	C93-6522
SAMPLE:	CLAY FOR DAM CORE	**W.O. NO.**	1
		LAB NO.	2054
		DATE	3/25/93

PERMEABILITY TEST (EM1110-2-1906/SW846-9100-1986)
FLEXIBLE WALL PERMEABILITY (ASTM D5084-90)

WET DENSITY	129.7 pcf
DRY DENSITY	112.2 pcf
VOLUME	329.094 cc
INITAL MOISTURE	17.9%
MOISTURE @ SATURATION	15.6%

HEAD inches	PSI	Q cc	TIME sec.	K cm/sec	K ft/yr
19.76	32	10	109800	1.55E-08	1.60E-02
19.76	32	10	139500	1.22E-08	1.26E-02
19.86	32	6	85500	1.19E-08	1.23E-02
19.90	32	4	30600	2.22E-08	2.30E-02

SHB AGRA, INC.
Engineering & Environmental Services

3232 West Virginia Avenue
Phoenix, Arizona 85009
Phone: 602-272-6848
Fax: 602-272-7239

April 6, 1993

Arimetco International, Inc.
6245 East Broadway Suite 350
Tucson, Arizona 85711

SHB Job FT93-3975

Attention: Mr. Harrison Matson

Re: **Zonia Mine - Compaction Testing**
Kirkland Junction, Arizona
P.O. #ZON00390

Gentlemen,

Transmitted herewith are results of field density testing performed at the above referenced project on March 25, 1993.

These tests are spot tests only. The values are indicative of conditions at the time and specific location of the test. This report does not certify to the overall quality of the workmanship or materials.

Should any questions arise concerning this report, please do not hesitate to call.

Respectfully submitted,
SHB AGRA, Inc.

By _____
Dale S. Parker
Field Services Coordinator

Copies: Addressee (1)

skn/J1-93/4-6-93

SERGENT, HAUSKINS & BECKWITH
CONSULTING GEOTECHNICAL ENGINEERS
MATERIALS TESTING ENGINEERS

ENGINEERING ANALYSIS • PHYSICAL TESTING • QUALITY CONTROL • FIELD EXPLORATION

FIELD DENSITY TEST DATA

DATE _____

PROJECT Zonia Mine JOB NO. FT93-3975

LOCATION Near Kirkland Junction, Arizona

CLIENT Arimetco International, Inc. ADDRESS 6245 East Broadway Suite 350 Tucson, AZ 85711

ARCHITECT/ENGINEER _____ CONTRACTOR _____

REQUESTED BY Mr. Harrison Matson PERFORMED BY SHB/EB

MATERIAL Black Silty Clay

DATE OF TEST	TEST NO.	DEPTH OF TEST	LOCATION	MOISTURE CONTENT % DRY WT.	DRY DENSITY LBS/CU.FT.	% MAX DRY DENSITY	CURVE NO.
3-25-93	1	Elev.	Exposed Section of Clay Core of Dam				
		4210	Top Center at Present Elev.	19.1	113.1	95.9	2054
	2	Elev.	Exposed Section of Clay Core of Dam				
		4210	30' NE of Test No. 1	17.9	118.7	100+	2054

PHOENIX, ARIZONA 3232 W. VIRGINIA 85009 (602) 272-6848
TUCSON, ARIZONA 1687 W. GRANT RD. SUITE 1048 85745 (602) 792-2729
ALBUQUERQUE, NEW MEXICO 4700 LINCOLN RD., N.E. 87109 (505) 884-0950
SANTA FE, NEW MEXICO 2811 SOUTH CERRILLOS ROAD 87501 (505) 982-3811
SALT LAKE CITY, UTAH 7117 SOUTH 400 WEST - SUITE 4 84047 (801) 566-5411
EL PASO, TEXAS 2810 CHICO 79903 (915) 564-1017

Western Mud Services, Inc.
P. O. Box 1898
Silver City, New Mexico 88062

27 April 1993

Prepared for: Harrison Matson
ARIMETCO

Prepared by: Clint C. Johnson
Western Mud Services, Inc.

PERMEABILITY TEST RESULTS

On March 12, 1993, samples were collected from the area of dam construction on the Zonia property. Soil samples estimated to be representative of the native inplace soils were collected, as were site typical PLS samples. By utilizing actual site typical materials, permeability tests performed in the lab more accurately duplicate field conditions.

TEST METHOD:

1. A 3000 cc, loose measure, sample of soil material was placed in a 6 foot tall, 4 inch diameter PVC chamber. The soil was tested as received, without attempting to adjust to optimum moisture content. The soil was compacted by 20 blows of a 3.75 lb. weight. Fluid head column was measured at 59 inches.

2. Several samples were run to determine initial permeability as well as the most cost effective level and blend of polymer treatments.

TEST DATA

Sample #1
Blank (to establish baseline permeability of native soil utilizing site typical PLS)

3/20/93

12:58	Filled cylinder with PLS
13:03	Dropped 17 cm Permeability 5.666 X 10^-2 cm/sec
13:05	Refilled cylinder
14:15	Dropped 122 cm Permeability 2.904 X 10^-2 cm/sec

3/22/93

14:34	All fluid had drained out of cylinder Refilled cylinder
14:39	Dropped 17 cm Permeability 5.666 X 10^-2 cm/sec

Sample #2
1/2 inch layer of 1/2% SW-1200L slurry with 2 #/bbl ground paper added as a matting agent, followed by 1/4 inch 4% blended CAT 3 and SW-540 polymer slurry.

3/20/93
14:00 Applied SH-1200L slurry to soil pack
3/21/93
14:10 Applied blended CAT 3 and DW-640 slurry to soil pack
3/22/93
13:16 Filled cylinder with PLS
16:06 Dropped 104.5 cm Permeability 1.024 X 10^-2 cm/sec.
Refilled cylinder
17:02 Dropped 40 cm Permeability 1.190 X 10^-2 cm/sec
3/23/93
09:30 Refilled cylinder
10:40 Dropped 48 cm Permeability 1.142 X 10^-2 cm/sec
4/05/93
The soil packs were removed from the cylinders and visually inspected. The visual examination revealed polymer infiltration to a depth of 3.5 inches in some areas of the soil pack. Coverage and infiltration was not uniform. This probably occurred due to the necessity of pouring the slurry from a height of 59 inches. This non-uniform coverage would alo explain the higher than anticipated permeability of the treated soil pack. It should be noted that field conditions during applicaton procedures are much more conducive to achieving a uniform application.
4/06/93
After drying by exposure to atmosphere, a piece of polymer infiltrated soil pack was rehydrated by immersion in PLS.
4/19/93
The sample was observed to still be maintaining it's physical integrity. When tested by applying pressure with a pencil, the sample felt very firm.

Sample 1A:
A 1/2 inch layer of 2% blended CAT 3 and DW-640 polymer slurry cross-linked with aluminum citrate. Slurry contains 2 #/bbl of ground paper for a matting agent.

4/06/93
15:40 Applied cross-linked polymer slurry to soil pack
4/07/93
09:42 Filled cylinder with PLS
09:47 Dropped 13 cm Permeability 4.333 X 10^-2 cm/sec
09:52 Dropped 20 cm Permeability 3.333 X 10^-2 cm/sec
Refilled cylinder with PLS
12:05 Dropped 74 cm Permeability 9.343 X 10^-3 cm/sec
Refilled cylinder
15:53 Dropped 87.5 cm Permeability 6.396 X 10^-3 cm/sec
4/08/93
10:16 Dropped 147 cm Permeability 1.840 X 10^-3 cm/sec
4/23/93
Soil pack was removed from cylinder. The soil pack mushed out into a pile. This pile was dried by atmospheric exposure.
4/25/93
The soil pile was very hard and well cemented, indicating polymer infiltration to a depth of approximately 1.5 inches.

Sample #2A
1 inch layer of 2% blended CAT 3 and DW-640 polymer slurry cross-linked with aluminum citrate. Slurry contains 2 #/bbl ground paper for a matting agent.

4/06/93
15:40 Applied cross-linked polymer slurry to soil pack
4/07/93
09:45 Filled cylinder with FLS
09:50 No measurable drop observed
4/08/93
10:18 Dropped 1 cm Permeability 1.131 X 10^-5 cm/sec
4/09/93
12:15 Dropped 1.75 cm Permeability 9.625 X 10^-6 cm/sec
4/12/93
12:00 Dropped 6 cm Permeability 1.363 X 10^-5 cm/sec
4/19/93
15:15 Dropped 10 cm Permeability 9.464 X 10^-6 cm/sec
4/23/93
Soil pack was removed from cylinder. The soil pack retained the physical shape of the cylinder for approximately 2/3 of it's cross section. Polymer infiltration appeared to be to a depth of approximately 3.5 inches. The soil pack was dried by atmospheric exposure.
4/25/93
The soil pack was very well cemented.

Sample #3A
1.5 inch layer of 2% blended CAT 3 and DW-640 polymer slurry cross-linked with aluminum citrate. Slurry contains 2 #/bbl ground paper for a matting agent.

4/06/93
15:40 Applied cross-linked polymer to soil pack
4/07/93
10:00 Filled cylinder with FLS
10:10 No meaurable drop observed
4/08/93
10:24 Dropped 2.5 cm Permeability 2.846 X 10^-5 cm/sec
4/09/93
12:15 Dropped 3 cm Permeability 1.658 X 10^-5 cm/sec
4/12/93
12:00 Dropped 5 cm Permeability 1.138 X 10^-5 cm/sec
4/19/93
15:15 Dropped 9.3 cm Permeability 8.998 X 10^-6 cm/sec
4/23/93
Soil pack was removed from cylinder. The soil pack retained the physical shape of the cylinder for it's circumference. Polymer infiltration appeared to be to a depth of 4.5 inches.
4/25/93
The soil pack was very well cemented.

Sample #4A
2 inch layer of 2% blended CAT 3 and DW-640 polymer slurry cross-linked with aluminum citrate. Slurry contains 2 #/bbl ground paper for a matting agent.

4/06/93

15:40 Applied cross-linked polymer to soil pack

4/07/93

10:10 Filled cylinder with PLS

10:20 No measurable drop observed

4/08/93

10:30 Dropped 1 cm Permeability 1.141 X 10^-5 cm/sec

4/09/93

12:15 Dropped 2 cm Permeability 1.109 X 10^-5 cm/sec

4/12/93

12:00 Dropped 4 cm Permeability 9.119 X 10^-6 cm/sec

4/19/93

15:15 Dropped 6.5 cm Permeability 6.160 X 10^-6 cm/sec

4/23/93

Soil pack was removed from cylinder. The soil pack retained the physical shape of the cylinder for it's entire circumference. Polymer infiltration appeared to be to a depth of approximately 5 inches.

4/25/93

The soil pack was very well cemented

NOTE: All test were conducted in open top cylinders, and no allowance has been made for evaporative losses. Therefore actual permeabilities would be slightly lower.

GENERAL CONCLUSIONS:

1. Polymer slurry concentrations need to be maintained at at least 2%.
2. Coverages should be at least 1/2 inch.
3. Coverages greater than 1 inch tend not to be cost effective. Permeabilities are not reduced at rate paralleling cost increases.

ALUMINUM CITRATE PROCESS

The aluminum citrate process has proven effective for the reduction of water mobility in subterranean formations. The process relies on the in situ gelation of partially hydrolyzed polyacrylamide with aluminum citrate. A great deal of laboratory work has been undertakento develop the technology and the ultimate refinement of the system.

The aqueous chemistry of aluminum has been the subject of extensive investigation both in and out of the petroleum industry. The prediction of hydrolysis-precipitation of aluminum solutions by various investigators has lead to an understanding of the behavior of aluminum salt solution and their reactions in water. The data i important for the total understandng of aluminum crosslinking mechanisms but only of minor importance in understanding the basics. For that reason, this paper will deal with reacions hat occur with partially hydrolyzed polyacrylamides.

EFFECT OF CITRIC ACID ON THE HYDROLYTIC REACTIONS OF ALUMINUM

Citric acid is a tribasic acid with pK values at 25xC of 3.128, 4.761, and 6.396 for pK1, pK2, and pK3 respectively. Nearly all metals that form divalent or polyvalent ions can be chelated with citric acid. Citric acid's strong chelating properties disrupt the hydroxyl bridging mechanism required for the formation of crystalline aluminum hydroxide. It has been demonstrated that citric acid hampers the crystallizatin of aluminum hydroxide at a high concentration.

Citric acid blocks the coordination sites of the terminal aliminum through complexation, and thus hampers the hydroxyl bridging mechanism in the hydrolysis and polymerization of aluminum. As a consequence of the hampering effects, the amount of solid phase aluminum is reduced by the presence of citric acid. X-ray diffraction indicates the noncrystalline solid phase is formed in the presence of citric acid. Crystallinity becomes visible upon aging and is attributed to the displacement of citrate from the coordination sites of the aluminum by the stronger hydroxyl ligand.

Hydrol tic reactions of aluminum may be pictured as involving deprotonation and dehydration of H2O molecules in the coordination sphere of aluminum ions and double bridging of the aluminum.

In the abscence of organic acids, the positively charged edges of the hydroxyl-aluminum polymers undergo hydrolysis.

The hydrolysis of these positive edges in the abscence of organic acids upon aging is accompanied by a drop in pH. The presrence of an organic acid, such as citric acid, in the aqueous solution of aluminum provides for the formation on an aluminum citrate complexes which imposes restraint on the hydrolysis of the aluminum polymer.

The more organic acid added to the system, the greater the replacement of H2O molecules and blocking of the coordination sites of aluminum. This leads to a greater restraint of the subsequent hydrolysis of the hydroxyl aluminum-polymer.

INTERACTION OF ALUMINUM CITRATE WITH POLYACRYLAMIDE

The addition of aluminum citrate solution to a solution of partially hydrolyzed polyacrylamide under the proper conditions produces a gel. The formation of the gel and it's strength are dependant on the pH of both the aluminum citrate solution and the polymer solution, the ratio of aluminum to polymer, and the ratio of aluminum citrate in the aluminum citrate solution. Research has shown that gelation is sensitive to pH with the optimum range being 4-7. At pH<4 there is no formation of gel because most of the carboxyl groups on the polymer chain are in the acid form and not available as a bond for aluminum. At pH>7 aluminum hydroxide is formed leaving no aluminum available for complexation with carboxyl groups. In the pH range of 4-7 the carboxyl groups of the polymer are ionized and concurrently some of the coordination sites on the aluminum hydroxyl complexes are occupied by water which can easily be displaced by the stronger carboxyl ligand forming a gel.

The citrate ion is believed to form a weak complex with aluminum in the gelation process such that it prevents the precipitation of aluminum hydroxide at the gelation pH. At the same time this complex does not prevent the aluminum-copolymer bonding that precedes gelation. If the aluminum citrate molar ratio is 1 or less there is no gel formation because there is no available aluminum for bonding. If the ratio is greater than 2 the citrate cannot prevent the precipitation of aluminum hydroxide at pH values higher than 5.

Sequential injection of polymer and aluminum citrate result in reduction of permeability. Early flow experiments with polymer and aluminum citrate were conducted in glass capillaries of variousdiameters. From these experiments, it was concluded that a layer of polymer is adsorbed flat on the surface of the porous medium from the first polymer slug. Aluminum citrate is then adsorbed on this layer and polymer molecules from the second polymer slug are adsorbed on the aluminum citrate. It was assumed that this layering effect is the dominant mechanism in the reduction of permeability. Careful examination of the data from these early experiments does not support the layering theory. Indications are that polymer entrapment plays a major role in permeability reduction, especially in very small capillaries.

Although polymer adsorption takes place from the flow of solution in porous media, its contribution to permeability modification is small compared to the othermodes of polymer retention. Polymer molecules can be retained in porous media by mechanical entrapment, hydrodynamic entrapment, and interaction of polymer molecules with other polymer molecules. These three

gels play a major role in permeability reduction when a polymer solution is injected in a porous medium.

The effects of pH and the degree of hydrolysis of the partially hydrolyzed polyacrylamide on the water diversion capabilities of the process have been studied in depth by a number of persons and organizations. The effect of pH on the hydrolytic reactions of Aluminum and on the interaction of aluminum with citrate have also been carefully studied. The role of the citrate anion is only to sequester the aluminum and plays no other role in the crosslinking process.

The other important variables which affect the performance of the process are salinity, presence of divalent ions in the injection stream and temperature. When studying the effects of these variables it is normally done in a beaker test for the formation of gels. These gels are normally weak and difficult to study with the naked eye. Ordinary gels which are semi-solid are made from concentrated solution are too thick to pump and are difficult to evaluate in a quantitative manner. A variety of methods have been suggested and they fall into one of two categories. One involves elaborate studies such as light scattering, birefringence of gels and viscoelastic measuring set ups. The other category involves rapid evaluation of the gels in a manner such as tipping the container and observing tongue length and shape. These are only qualitative and are impossible to convey the results to another person besides the observer.

GENERAL EFFECTS OF SALTS

The effects on gelation by sodium, magnesium, and calcium cations on this process are complex. If the ratios of aluminum to divalent cations is kept at one to one, there is an extension of gelation. If the ratio is higher than one to one, there is a decline in the gelation extent attributable to a decrease in the amount of aluminum available for crosslinking. This decrease is due to the shift in equilibrium of the hydrolytic reaction of aluminum towards the formation of aluminum hydroxide caused by the increased ionic strength and the presence of the divalent cations.

The enhancement of gelation extent in the presence of salts of mono and divalent cations can be explained in terms of polyelectrolyte theory. According to studies: for a given macroion with many anionic groups, the binding of counter ions increases as the valency of the counter ions increases: i.e., trivalent will bind more than divalent, which in turn will bind more than monovalent counter ions. Two types of binding are possible. One is site binding in which the counter ion is localized, for example to the carboxylate groups of partially hydrolyzed polyacrylamide. In the other type, territorial, the counter ion is not localized but free to move in the volume of influence of the macroion without leaving that volume. Monovalent ions tend to bind territorially, whereas divalent

ions will bind territorially at low macro ion charge and will site bind at high macroion charge density. On the other hand, trivalent counter ions will site bind totally.

If we have a solution of macroion with monovalent counter ions to neutralize the charge and we add a trivalent cation, the trivalent cations will replace the monovalent and bind to the macroion. The monovalent cations are released from the volume of influence of the macroion. By monitoring the amount of monovalent ion release we can determine the capacity of the macromolecule to bind trivalent ions.

EFFECTS OF TEMPERATURE

It is well known that as the temperature increases, polyacrylamide solutions show increased degradation and hydrolysis. This degradation is more rapid in the presence of dissolved oxygen, and even more rapid in the presence of air. For these reasons laboratory studies at temperatures above room temperature are normally conducted with solutions prepared anaerobically and kept in sealed ampules. Since most rheological studies are made at room temperature, samples must be cooled and removed from ampules for measurement.

Gel stability should never be a consideration in these [illegible]. Chemical structures that may affect the polymer or gel can diffuse freely in large containers, since concentrations are low and the samples are kept in a static condition. Any attempt to evaluate gel stability in this manner will not reflect the stability of the gel in a porous media. In porous media there is a physical barrier which minimizes diffusion, since individual pores do not communicate in all directions with other pores. Secondly, in porous media, when the polymer or gel is flowing, chemicals such as unpolymerized monomer, surfactants, or carbonates would be segregated from polymer slug either by adsorption or other mechanisms.

As with all other studies made with aluminum citrate, gelation [illegible] is controlled by the ration of aluminum to citrate. Up to 75 degrees C gelation shortens with increasing temperature for ratios of aluminum to citrate of 1.75, 1.5, and 1.25 to 1. In nearly all cases it will be observed that an aluminum to citrate ratio of 1 to 1 appears to give no gel. This does not preclude the formation of a gel over substantial periods of time. At the lower ratios the gels degrade very rapidly at [illegible].

[illegible] with temperature, it is wise to consider lower aluminum to citrate ratios. This will help [illegible] higher temperature reservoirs, [illegible]. This is even more [illegible] used for the [illegible]

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REMEDIATION PLAN
ZONIA MINE
YAVAPAI CO., AZ.
NOVEMBER 25, 1992

INTRODUCTION

This Rememdiation plan is provided to the United States Environmental Protection Agency and the Arizona Department of Environmental Quality in compliance with the November 13, 1992 Finding of Violation and Order, Docket No IX-FY93-09 concerning the Zonia mine property in Yavaipai, County Arizona. Item number eleven of the order requires that a remediation plan with a timetable for action be submitted by December 1, 1992. Approval by the EPA is necessary before implementation of this plan can begin.

LOCATION

The Zonia mine is located in the Walnut Grove mining district, Sections 10,11,13 and 14 T11N R4W GRB&M in southwestern Yavapai County Arizona. It is approximately 70 miles NNW of Phoenix, about halfway between Wickenburg and Prescott. A topographic map showing the Zonia mine area is attached.

BACKGROUND

The Zonia mine property was operated as an open pit oxide copper mine and metallurgical recovery facility using a heap leach followed by iron cementation process. This mine and plant facility was last actively operated by MacAllester fuels corporation in 1974.

MacAllester built three principal leach dumps which they called leach basins. They were called leach basins, because unlike a typical leach dump or pad, the valleys which they filled were dammed at the broad end and the ore filled out to the edge of the dam. Perforated collection piping was placed along the bottoms prior to filling and the pipes extended through the dam to report to the cementation plant. The bottom of the leach basins are reported to be lined with an asphalt based soil cement to prevent

leakage. In conjunction with the heap leaching, in the later years of operation an insitu method of leaching was employed. An area near the head of Zonia Gulch was fractured in-place by blasting and a series of injection and recovery wells installed. The groundwater table below the insitu area was depressed locally by pumping which was believed adequate for solution containment. Complete records concerning pumping activity after mine closure are presently not available.

The mine property was sold by MacAllester several years after closure and eventually in 1988 came to be owned by the Zonia company and Zonia Landfill Inc, the current owners.

The mine is presently under evaluation by Arimetco Inc. to determine the feasibility of mining and processing the remaining reserves of low grade copper oxide ore using modern technologies.

As part of the feasibility work, a hydrogeologic study of the property was scheduled and a remediation plan was being formulated well before the EPA order of November 13, 1992 was issued.

COMPLIANCE AND REMEDIATION-GENERAL

All leach basins are located in dammed canyons adjacent to French Gulch. French Gulch is an intermittent tributary to the Hassayampa River and has been classified as a water of the United States under the Clean Water Act. As such, any construction activity in the Gulch would need to be approved with a 404 permit from the US Army Corps of Engineers. A meeting has been scheduled with the corps on December 2, 1992 to discuss the application process and to obtain a determination as to whether a permit will be required for activity in the adjacent canyons. Remediation activities ascertained to require the 404 permit cannot by law be initiated until the permit is received. Any schedules or deadlines promulgated will therefore be contingent upon permit acquisition.

In addition to the Corp of Engineers permit, the Arizona Department of Environmental Quality may require that remediation activities be covered by an Aquifer Protection Permit.

A meeting was held with ADEQ on November 18, 1992 to discuss remediation plans at Zonia. It is believed that a temporary Aquifer Protection Permit could be issued pending review of the written remediation plan. This temporary permit is requested.

REMEDIATION-LEACH BASINS

The first principal concern of the reclamation plan is that all discharges of degraded waters into French Gulch cease. Site inspections indicate that the highest probability of discharge relates to solution flow from the Leach Basins. Increased flow is directly correlated to precipitation events.

In order to assure that runoff from the leach basin areas is fully contained, provision must be made to increase storage capacity within or below the leach basins. Ideal storage would be more than sufficient to hold the 100 year 24 hour precipitation event. In the Zonia area this event is projected to be 5.5 inches. Leach basin No.1 (AKA Dump 1 through 4) has a surface area of 982800 square feet and therefore requires storage of 3,199,000 gallons, calculated from United States Soil Conservation Service curve .95.

Leach basin No. 2 (AKA Dump 5-6) and Leach Basin #3 (AKA dump 7-9) have a combined surface area of 2,216,400 square feet requiring storage of 7,214,000 gallons for the design event. These runoff volumes would be correct only in the case where existing diversion trenches surrounding the basins perform effectively. The diversion trenches will be renovated during implementation of the remediation plan to assure good performance.

As mentioned earlier, the leach basins were built with a design not often used today. This design incorporated internal storage capacity into the dumps rather than provide storage in external ponds. Internal storage is plainly demonstrated by the reading of pressure guages located on closed collection pipes which protrude through the basin dam faces. Leach Basin #3 (AKA 7-9) recently recorded values of 20lb/ square inch or the equivalent of about 40 feet of head.

MacAllester construction plans and topographic data were used to recalculate total storage volume within leach basins #1 and #3 up to the dam heights. Data for leach basin #2 is presently unavailable so no storage value was tabulated.

An examination trench was cut to a depth of ten feet across LB#2 to evaluate the material in the basins. Inspection of the sides of this trench show the ore to have partly decomposed to a sandy matrix with coarse cobbles similar to a poorly graded fine sand and gravel mixture. The average porosity was then estimated on this basis as 20%. This value was then applied to the volume calculations.

The following table compares the runoff volumes in gallons required for design storm containment vs present calculated storage.

	Design	Present	Additional Needed
LB#1	3,198,995	949,042	2,249,953
LB#2&3	7,214,340	6,684,692	529,648

The short fall in storage capacity is proposed to be remedied by construction of low permeability retention ponds immediately below the leach basins. A single pond in the ravine down slope from Leach basins #2 and #3 will provide containment for both these areas while an additional pond will be required near the toe of

Leach basin #1. The containment ponds will be lined with UV resistant polyethylene type sheeting across the dam face and into the retention areas. 40 mil VLDPE or better is proposed. The ponds will be sized so that the additional volumes as tabulated will be fully accommodated plus solution storage which could be residual from a normal event. Final pond configurations are not yet designed due to the time constraints set by the order.

Another design factor to be considered is that the previous storage figures are based on a zero initial volume of water in the basins. Solution management would then be necessary to ensure that the internal storage is kept at a minimum. Pumping of solution to an evaporation field atop each leach basin is the proposed method of solution management at this time. Evaporation rates in central Arizona greatly exceed precipitation which would permit this method of solution management. Approximately 5 to 10 percent of the total quantity of solution pumped through a sprinkler type system should be evaporated each cycle, depending of course on many variables. Using the two year/one hour rainfall as the base case of .8 inch, an additional 460,000 gallons of runoff would be generated from the #1 basin and 1,040,000 gallons would be stored in #3. In order to evaporate this amount of solution, 6.9 weeks of pumping would be required at 200 gpm from the #3. While this amount of pumping could evaporate solution within a reasonable recurrence internal, management costs are far from optimum. The ideal system would, of course be maintenance free. In part this could be accomplished through the use of shallow retention ponds with maximum surface area to promote evaporation. The leach basins should drain naturally to the ponds without pumping. This latter design will be incorporated for the leach basins although site constraints will limit pond design, particularly for the #1 basin.

The first containment pond to be constructed will service the #2 and 3 basins. This pond is immediately needed to contain pipe and pump leakage observed during the September inspection. This pond is to be constructed within 60 days of regulatory approval.

The expected completion date is March 1, 1993.

The next containment structure would be below the #1 leach basin. This basin was not listed as an immediate threat in the inspection report. The expected completion date is ninety days after regulatory approval and is projected to be April 1, 1993.

REMEDIATION-FRENCH GULCH

Clean up activities in French Gulch will be initially centered on removal of any and all pipelines which formerly transported leach solutions. Other mine related debris will also be removed. This will require no permit and should be completed by February 1, 1993.

Removal of precipitates caused by migrant leach solution along the gulch channel will be scheduled as soon as permits are secured. Completion should be within thirty days of work initiation. Anticipated completion is by February 1, 1993. The affected gravels will be transported to a lined area such as one of the leach basins. The work will be accomplished using a front end loader and single dump truck. Professional supervision will assure cleanup.

V notch weirs will be installed to measure flows, if any, in French and Zonia Gulches. The weirs will be located as they were for previous studies, reports of which are on file at ADEQ and EPA offices. Completion date for installation is January 1, 1993.

REMEDIATION-INSITU AREA

As stated in the compliance order, operational pumps will be installed in the two recovery wells at the insitu area by January 1, 1993. Water level measurements will be taken before pumping begins. Pumping is planned at a rate of approximately 150 gpm from each well for a period of eight hours each day. Water level

measurements will be taken as part of the hydrologic investigation at the mine property which will be used to determine optimum pumping rates and durations. Until completion of the hydrologic study it would not be prudent to establish a set schedule for this pumping except to state that a cone of depression in the water table will be maintained.

The best long term solution to prevent groundwater outflow from the insitu area can only be implemented if the broken ore still contains enough value to support a mining operation. Mining and removal of the ore to lined leach pads would alleviate much of the current difficulties as the pit walls remaining after that operation would have much lower permeabilities than the blast fractured rock now at the site.

HYDROGEOLOGIC REPORT

The purpose of the hydrogeologic study is to determine the physical and chemical characteristics of the groundwater regime at the Zonia mine in order to properly engineer containment and control features for the prevention of groundwater contamination. Further to this end the following program is proposed.

1. All existing wells on the mine property will be sampled and water measurements collected.

2. Geologic mapping directed toward the definition of lithologic or structural controls on groundwater flow will be initiated.

3. Permeability measurements will be collected by various generally accepted technical methods on inplace materials such as different rock units or existing man-made impoundment liners.

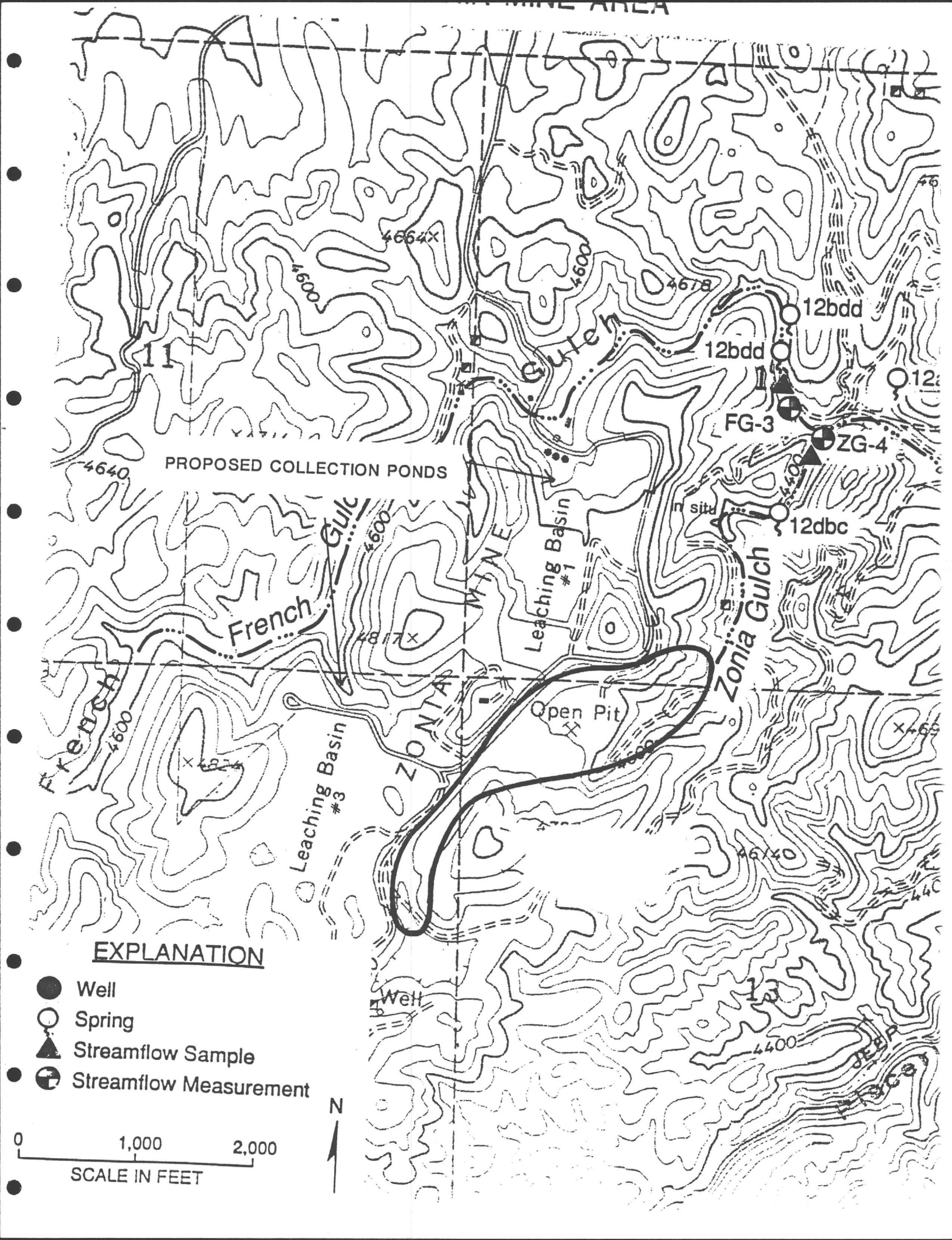
4. Runoff contamination potential will be evaluated by

conducting simulated rainwater leaching tests on waste material and ore from the mine site.

5. Flow will be measured in French and Zonia Gulches and samples will be periodically collected from the Zonia and French Gulch springs to ascertain possible correlations with insitu basin pumping.

6. Pending the results of the previously listed test work, monitor wells may be drilled to verify or disprove hypotheses. The number, depth, or location of these test wells cannot be stated at this time.

This study will be initiated upon approval and will work toward the goal of meeting completion by April 1, 1993. However due to the uncertainties related to conducting any scientific study no guarantee can be granted regarding a completion date. A more realistic timeframe with a June 15, 1993 completion is proposed.


MINE AREA
11
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FG-3
ZG-4
PROPOSED COLLECTION PONDS
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Leaching Basin #3
ZONIA MINE
Zonia Gulch
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CERTIFICATION

This document was prepared by H. Matson, Chief Geologist. Arimetco Inc. and others under my direction on behalf of the Zonia Company. I certify that the information submitted is to the best of my knowledge and belief, true, accurate and complete.

Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, I certify that the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

W. Ray Hill
The Zonia Company

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ARIZONA ECOLOGICAL SERVICES FIELD OFFICE
3616 West Thomas Road, Suite 6
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Telephone: (602) 379-4720 FAX: (602) 379-6629

2-21-93-I-013

January 22, 1993

Harrison Matson
Arimetco International Inc.
6245 E. Broadway
Suite 350
Tucson Arizona 85711

Dear Mr. Joe:

This letter is in response to your December 8, 1992, request for lists of endangered, threatened, or other species of special concern in the vicinity of Zonia mine, Yavapai County, in Arizona.

Federal proposed and candidate species which may be found in the vicinity of the mine include:

Proposed Species

Mexican spotted owl (Strix occidentalis lucida)

Category 2 Species

Lowland leopard frog (Rana yavapaiensis)
Chuckwalla (Sauromalus obesus)
Sonoran Desert tortoise (Gopherus agassizii)
Arizona southwestern toad (Bufo microscaphus microscaphus)
Spotted bat (Euderma maculatum)
Yavapai Arizona pocket mouse (Perognathus amplus amplus)

Proposed species must be considered in the development of projects. Candidate species are those which may in the future be considered for listing as endangered or threatened species. Category 2 candidates are those species for which sufficient information to propose listing is not available and for which we are seeking conclusive data on biological vulnerability and threats. Although candidate species have no legal protection, we would appreciate your consideration of them in the development of the projects.

Please note that the Arizona Game and Fish Department may know of species in the area that are State-listed or that are of management concern.

In future communications on this project, please refer to consultation number 2-21-93-I-013. If we may be of further assistance, please contact Lorena Wada or me.

Sincerely,

Sam F. Spiller
Field Supervisor

cc: Director, Arizona Game and Fish Department, Phoenix, Arizona

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, Ca. 94105-3901

December 14, 1992

Mr. W. Ray Hill
President
The Zonia Company
212 S. Marina St.
Prescott, AZ 86303

Subject: Zonia Mine Remediation Plan.

Dear Mr. Hill;

We thank you for your timely submission of a remediation plan for Zonia Mine as required by our November 13, 1992, Order for Compliance. With the following modifications, we approve the content of your November 25, 1992 remediation plan and look forward to its implementation.

The plan's specific measures have been discussed with Mr. Harrison Matson of Arimetco International, Inc. We understand that Arimetco will be doing much of the planning, design, and construction for the remedial measures at the Zonia Mine. We have the following comments, which have been discussed with Arimetco, regarding the remediation plan.

1) Design plans and specifications for the retention ponds must be submitted to us prior to beginning construction. We must also be notified of any deviations from the plans and specifications made during construction.

2) Solutions pumped out of in-situ Leach Basins (LB) 5-6 will be discharged into the evaporation pond on top of LB 6 at this time. If Arimetco resumes mining activity, the status of LB 5-6 may change.

3) The hydrogeologic report due on April 1, 1993, must include details such as hydraulic gradients, hydraulic conductivity, monitoring well locations and depths, and groundwater sampling results.

4) Remediation work in French Gulch can proceed unless the U.S. Fish and Wildlife Service (USFWS) has objections. If the USFWS has objections, they will be addressed in modifications to the remediation plan before work begins. It is our understanding that Arimetco has already contacted the USFWS regarding endangered species concerns.

If you have any questions, please contact Enio Sebastiani of my staff at (415) 744-1876.

Sincerely,

Ken Greenberg

Ken Greenberg, Chief
NPDES Compliance Section

cc: Mr. Harrison Matson
of Arimetco

ARIMETCO
INTERNATIONAL INC.

November 5, 1992

Mr. Enio Sabastiani
Environmental Engineer
NPDES Compliance Section
United States Environmental Protection Agency
Region IX
75 Hawthorne St.
San Francisco, Ca. 94105-3901

Sir,

The purpose of this letter is to summarize and provide written documentation of the November 3, 1992 conference call concerning environmental issues at the Zonia Mine in Yavaipai County Arizona. Participants in the discussion were Arimetco staff members Dan Gulley, Joe Smith and Harrison Matson, while the U.S. EPA Region IX office was represented by Chris Sfroul and Enio Sabastiani.

Initial contact with the EPA was made on October 29 by H. Matson through E. Sabastiani in order to gain approval for a proposed water quality remediation program at the Zonia mine. A conference call was requested by Mr. Sabastiani in order to have additional EPA personnel present for input and to gain a more through knowledge of Arimetco and the voluntary remediation proposal for Zonia. The salient facts and issues which were subsequently discussed on November 3 are as follows:

The current owner and operator of the inactive mining property, the Zonia Company, is alleged to have violated the clean water act by not exercising proper control of degraded quality water and allowing storm water runoff of possibly affected quality to discharge from the property.

Arimetco entered into a lease agreement with the Zonia Company on August 21, 1992 for the purpose of conducting a feasibility study with a final goal of resumption of copper mining activity on the property. Heap leaching followed by solvent extraction and electrowinning would be the expected case technology. The mining lease has a term of ten years or as long as minerals are produced or development activity progresses. Arimetco is under no obligation to maintain the lease if for any reason it is believed that the economic return on the project would be unacceptable.

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Not until October 28, 1992 was Arimetco informed by the Zonia Company of the outstanding administrative order issued by the EPA against the Zonia Company nor until that time was Arimetco appraised of the various inspection reports on the property generated by the Arizona Department of Environmental Quality and the U.S. EPA. This failure to disclose prior and continuing possible violations of the clean water act could be considered grounds for cancellation of the contract between Arimetco and the Zonia Co.

Arimetco to date has conducted no operations on the Zonia mine property and thus is not responsible for any existing environmental problems at the site.

Arimetco is however, willing to assume possession of the property and to initiate a voluntary remediation plan to prevent future substandard water discharges, if the regulatory authorities will hold Arimetco free and harmless from action relating to the present conditions at the site.

It is understood that exemptions from regulation are not allowable by law nor are they expected, but Arimetco as an innocent third party does request sufficient time to conduct the remediation efforts at Zonia without fear of punitive citations or administrative orders by the regulatory authorities. It is expected that a zero discharge condition could be achieved with the proper efforts within six months of initial implementation.

The remediation plan that is presently being developed by the Arimetco Engineering and Geology Department staff should address all water quality issues to the mutual satisfaction of the EPA, ADEQ and Arimetco Inc,. For the plan to be effective three areas of concern were outlined for attention.

The first concern is to assure that containment would be provided for the existing leach heaps to prevent storm water runoff and other degraded flows from entering French Gulch below the heaps. The plan calls for construction of synthetically lined catchment basins immediately below the leach pad areas. These catchments will be fitted with pumps which will be built within the lined area to catch all leaks and will allow the solution to be pumped back to an evaporation field on top of the leach heap. This system will

be properly sized to accommodate the expected flows by generally accepted engineering design principles. It is recognized that no such catchments currently exist and that the evaporation system now under deployment by the Zonia Company is not of adequate size.

The second issue is to remove and contain any chemical precipitates which exist along the normally dry channel of French Gulch to prevent further down gradient migration during runoff events. Reclamation would include excavation of any significantly contaminated gravels and removal of these deposits to a contained area on the property. In the process, a general clean up of the area such as removal of old piping etc. will be conducted.

The third concern is to evaluate potential groundwater contamination from the McAlester in situ site and prevent migration if contamination is identified. As part of both the remediation plan and the economic evaluation of the property a hydrogeologic site analysis will be initiated. The results of the study cannot be predicted beforehand but immediate problem resolution will be affected by rehabilitation of the existing extraction wells. Pumping these wells will depress the water table and reverse groundwater flow paths creating a contained system. Water pumped will be transferred to the evaporation field or possibly a storage impoundment.

Additional details of the proposed remediation plan will be provided to the EPA at such time as the comprehensive plan is developed.

If the Arimetco feasibility study/economic evaluation is positive and a decision is made to build a mine with an SX/EW plant at Zonia, the design will incorporate best available control technology for full secondary containment. The project will be a model for zero discharge design.

If the economic evaluation is negative, the property will be returned to the sole control of the Zonia Company but with the previously discussed containment structures and systems in place. The Zonia Company should then be capable of solution management at a level which would prevent future discharges.

The mission of the U.S. EPA is, in part, to secure full compliance with the clean water act and the agency may, at its discretion, use any enforcement measures necessary to that end. Although such measures maybe levied against the Zonia Company, the EPA officials agree that the environment would best be served by cooperation with Arimetco to allow unimpaired implementation of the remediation plan.

I trust this has been a reasonable representation of our interaction and look forward to working with you and your agency in full cooperation.

Sincerely,

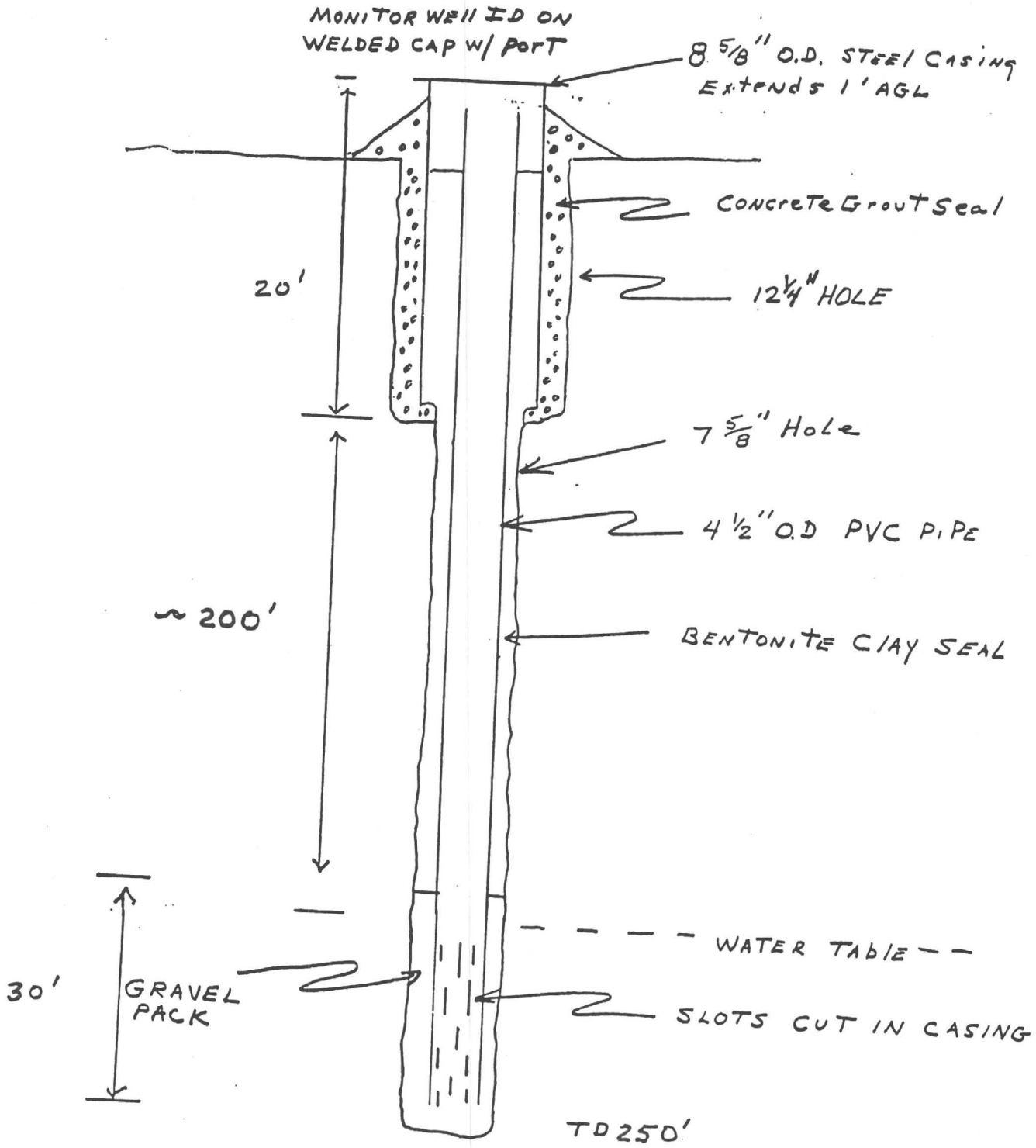
Harrison Matson
Chief Geologist

HM:yl

cc: Chris Sfroul-EPA
ED Pond-ADEQ
Wynn Winkyaw-ADEQ
Peter Hyde-ADEQ

ARIMETCO INC.

MONITOR WELL DESIGN 2605
ZONIA MINE



FROM: K. Schmidt

TABLE 1 - CHEMICAL ANALYSES OF GROUNDWATER

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

Analyses by BC Laboratories, Inc. of Bakersfield, California.

TABLE 3 - CHEMICAL ANALYSES OF GROUNDWATER

Constituent (mg/l)	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	26	20	64	2,250	700	6
Chloride	3	5	10	40	14	32
Nitrate	<1	<1	10	<1	3	<1
Ammonia-Nitrogen	-	0.2	-	-	-	-
Kjeldahl Nitrogen	-	0.4	-	-	-	-
Fluoride	0.4	<0.1	0.3	0.2	0.3	0.2
Boron	-	<0.1	-	-	-	-
Iron	8.2	<0.05	-	-	-	-
Manganese	0.07	0.02	-	-	-	-
pH	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)	343	375	287	3,537	1,220	560
Arsenic	<0.01	<0.01	-	-	-	-
Barium	<1.0	0.1	-	-	-	-
Cadmium	0.02	<0.005	-	-	-	-
Chromium	0.02	<0.01	-	-	-	-
Lead	0.01	<0.01	-	-	-	-
Mercury	<0.0002	<0.0002	-	-	-	-
Selenium	<0.01	<0.005	-	-	-	-
Silver	<0.01	<0.01	-	-	-	-
Copper	0.03	0.08	0.34	7.1	0.55	0.03
Zinc	-	<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).

TABLE 3 - CHEMICAL ANALYSES OF LEACH BASIN WATER

Constituent (mg/l)	1989 5-2	1980 5/6 Composite	1989 6-1	1989 6-7
Calcium	520	500	456	496
Magnesium	290	275	170	142
Sodium	40	33	29	22
Potassium	2	2	4	4
Carbonate	0	0	0	0
Bicarbonate	0	0	0	0
Sulfate	3,900	4,000	3,300	2,700
Chloride	25	10	14	8
Nitrate	131	63	58	38
Ammonia-Nitrogen	5.0	-	6.8	5.6
Kjeldahl Nitrogen	5.0	-	7.5	6.5
Fluoride	28.0	0.5	0.8	8.0
Boron	<0.1	-	<0.1	<0.1
Iron	2.8	17	<0.05	0.09
Manganese	298	345	204	145
pH	3.2	3.4	3.5	4.1
Electrical Conductivity (micromhos/cm @ 25°C)	5,600	4,800	4,500	3,800
Total Dissolved Solids (@ 180°C)	7,155	7,007	5,790	4,610
Arsenic	<0.01	<0.01	0.01	<0.01
Barium	<0.1	<1.0	<0.1	<0.1
Cadmium	0.912	0.87	0.895	0.47
Chromium	0.05	0.10	0.03	<0.01
Lead	<0.01	0.19	0.06	0.01
Mercury	0.0036	<0.0002	<0.0002	<0.0002
Selenium	<0.005	<0.01	<0.005	<0.005
Silver	0.04	<0.01	0.03	0.02
Copper	278	500	498	370
Zinc	120	100	104	57
Cobalt	4.5	-	3.6	2.3
Nickel	3.0	-	2.4	1.6
Date	2/1/89	11/30/80	2/1/89	2/1/89

Analyses by BC Laboratories, Inc. of Bakersfield, California.

TABLE 4 - CHEMICAL ANALYSES OF WASTEWATERS

Constituent (mg/l)	Main Collection	Discard Soln	Mill Pond	Heap Leach
Calcium	390	374	466	500
Magnesium	818	390	636	740
Sodium	15	25	17	7
Potassium	<1	2	<1	<1
Carbonate	0	0	0	0
Bicarbonate	0	0	0	0
Sulfate	13,400	6,200	11,500	19,250
Chloride	43	22	35	<2
Nitrate	14	<1	11	20
Ammonia-Nitrogen	5.2	2.0	4.2	-
Kjeldahl Nitrogen	7.1	2.5	15.5	-
Fluoride	120	40	96	<0.1
Boron	<0.1	<0.1	<0.1	-
Iron	40	159	28	460
Manganese	1,115	478	840	1,250
pH	3.0	2.8	3.0	2.6
Electrical Conductivity (micromhos/cm @ 25°C)	12,800	7,200	10,600	13,400
Total Dissolved Solids (@ 180°C)	24,060	11,285	19,840	30,090
Arsenic	<0.01	0.01	<0.01	-
Barium	<0.1	<0.1	<0.1	-
Cadmium	1.64	0.714	1.27	-
Chromium	0.49	0.27	0.37	-
Hexavalent Chromium	<0.05	<0.05	<0.05	-
Lead	<0.01	<0.01	<0.01	<0.01
Mercury	0.0004	<0.0002	<0.0002	-
Selenium	<0.005	<0.005	<0.005	-
Silver	0.12	0.01	0.09	-
Copper	1,750	620	1,430	1,840
Zinc	231	101	179	260
Cobalt	16.9	7.1	12.8	-
Nickel	9.6	4.0	7.5	-
Date	1/31/89	1/31/89	2/1/89	4/31/81

Analyses by BC Laboratories, Inc. of Bakersfield, California.

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0078

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D. A. SHAH
DIRECTOR
AZ REG #8888
IN BUSINESS SINCE 1966

ARIMETCO, Inc.
Harrison Matson
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 02-24-93
Date Sampled : 02-15-93
Time Sampled : 09:00
Date Reported: 03-05-93
CSAL ID No.:93-02-52990
C O C No.. : 08503

Project No.: Zonia
Client ID #: Basin 3 #13
Sample Type: Water
Sampled By : Archie Joe Smith

Laboratory Report

Constituents	Dissolved Metals Mg/L	Date & Time Analyzed
TDS	3510	03-03-93 á 14:40
Calcium	368	02-25-93 á 11:15
Magnesium	74.2	02-25-93 á 11:50
Sodium	12.4	02-25-93 á 12:50
Potassium	1.0	02-25-93 á 13:25
Bicarbonate	ND(1.0)	02-25-93 á 09:30
Sulfate	1500	03-03-93 á 11:30
Nitrate	1.2	03-02-93 á 13:00
Chloride	69.6	02-25-93 á 10:45
Iron	2.8	03-01-93 á 13:20
Manganese	67.5	03-02-93 á 09:25
Copper	265	02-25-93 á 14:40
Cadmium	0.16	03-01-93 á 11:25
Nickel	1.1	03-01-93 á 09:40
Zinc	20.1	03-02-93 á 13:10
Chromium	<0.1	03-01-93 á 15:50
pH	3.24	02-25-93 á 08:30

END REPORT

Cation/Anion Balance = 1.08%

Reviewed By D. A. Shah

TURNER/CAS
LABORATORIES INC.

ARIMETCO, INTERNATIONAL
6245 E. BROADWAY BLVD, SUITE 350
TUCSON, AZ 85711

REPORT NUMBER: T-92-25167
DATE RECEIVED: 9/16/92
DATE REPORTED: 10/6/92

PROJECT MANAGER: D. LYNN BRUMBAUGH
PROJECT: ARIMETCO-ZONIA

WASTEWATER ANALYSIS
mg/L (ppm)

MATRIX: WATER

SAMPLE NAME: LEACH BASIN 1 9/9/92.

PARAMETER	RESULTS	METHOD	DETECTION LIMIT
ALUMINUM	880	200.7	2
ANTIMONY	< 0.2	200.7	0.2
BARIUM	< 1	208.1	1
BERYLLIUM	< 0.1	200.7	0.1
BORON	0.14	200.7	0.1
CADMIUM	< 0.003	213.2	0.003
CALCIUM	470	200.7	0.2
CHROMIUM	< 0.03	218.1	0.03
COBALT	13.5	200.7	0.1
COPPER	1330	200.7	0.02
IRON	37.2	200.7	0.1
LEAD	< 0.005	239.2	0.005
MAGNESIUM	489	200.7	0.001
MANGANESE	751	200.7	0.02
MOLYBDENUM	0.04	200.7	0.001
NICKEL	9	249.1	0.1
SILVER	0.09	200.7	0.01
SODIUM	24.6	200.7	0.1
STRONTIUM	0.140	200.7	0.001
THALLIUM	0.022	279.1	0.1
TIN	< 1	200.7	1
VANADIUM	< 1	200.7	1
ZINC	148	200.7	0.04
PHOSPHORUS, TOTAL	< 0.5	365.2	0.5

W. W. TURNER
LABORATORY DIRECTOR

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0078

710 E. EVANS • TUCSON, AZ 85713

PH. (602) 884-5811 PH. (602) 797-0788 FAX# (602) 884-5812

D. A. SHAH
DIRECTOR
AZ REG #8888
IN BUSINESS SINCE 1966

ARIMETCO, Inc.
A.J. Smith
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 03-18-93
Date Sampled : 03-16-93
Time Sampled : 17:00
Date Reported: 03-31-93
CSAL ID No.:93-02-53934

Project No.: Zonia
Client ID #: A-16
Sample Type: Water
Sampled By : H. Matson

Laboratory Report

Constituents	Dissolved Metals Mg/L	Date / Time Analyzed
Arsenic	<0.01	03-22-93 @ 19:00
Calcium	62.1	03-22-93 @ 13:00
Magnesium	17.4	03-22-93 @ 13:30
Sodium	28.3	03-22-93 @ 14:20
Potassium	2.4	03-22-93 @ 15:10
Iron	2.9	03-25-93 @ 11:30
Manganese	0.6	03-25-93 @ 10:45
Copper	<0.1	03-24-93 @ 15:10
Cadmium	<0.01	03-24-93 @ 10:25
Nickel	<0.1	03-24-93 @ 11:50
Zinc	<0.1	03-24-93 @ 14:15
Chromium	<0.1	03-23-93 @ 13:10
Bicarbonate	230	03-19-93 @ 15:30
Sulfate	71.8	03-22-93 @ 11:00
Fluoride	2.42	03-26-93 @ 17:00
Chloride	11.9	03-19-93 @ 16:00
TDS	332	03-25-93 @ 13:00

END REPORT

Reviewed By D A Shah KH

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0078

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D. A. SHAH
DIRECTOR
AZ REG #6658
IN BUSINESS SINCE 1966

ARIMETCO, Inc.
A.J. Smith
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 03-18-93
Date Sampled : 03-17-93
Time Sampled : 11:05
Date Reported: 03-31-93
CSAL ID No.:93-02-53933

Project No.: Zonia
Client ID #: Z-607
Sample Type: Water
Sampled By : H. Matson

Laboratory Report

Constituents	Dissolved Metals Mg/L	Date / Time Analyzed
Arsenic	0.01	03-22-93 @ 19:00
Calcium	26.6	03-22-93 @ 13:00
Magnesium	5.4	03-22-93 @ 13:30
Sodium	31.7	03-22-93 @ 14:20
Potassium	3.4	03-22-93 @ 15:10
Iron	34.4	03-25-93 @ 11:30
Manganese	3.0	03-25-93 @ 10:45
Copper	0.1	03-24-93 @ 15:10
Cadmium	<0.01	03-24-93 @ 10:25
Nickel	<0.1	03-24-93 @ 11:50
Zinc	0.2	03-24-93 @ 14:15
Chromium	<0.1	03-23-93 @ 13:10
Bicarbonate	156	03-19-93 @ 15:30
Sulfate	<5	03-22-93 @ 11:00
Fluoride	2.58	03-26-93 @ 17:00
Chloride	19.9	03-19-93 @ 16:00
TDS	207	03-25-93 @ 13:00

END REPORT

Reviewed By D A Shah KH

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0078

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PH. (602) 884-5811 PH. (602) 797-0788 FAX# (602) 884-5812

D. A. SHAH
DIRECTOR
AZ REG #5888
IN BUSINESS SINCE 1966

ARIMETCO, Inc.
A.J. Smith
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 03-18-93
Date Sampled : 03-17-93
Time Sampled : 09:30
Date Reported: 03-31-93
CSAL ID No.:93-02-53932

Project No.: Zonia
Client ID #: Old Mill Well
Sample Type: Water
Sampled By : H. Matson

Laboratory Report

Constituents	Dissolved Metals Mg/L	Date / Time Analyzed
Arsenic	0.08	03-22-93 @ 19:00
Calcium	455	03-22-93 @ 13:00
Magnesium	159	03-22-93 @ 13:30
Sodium	72.0	03-22-93 @ 14:20
Potassium	3.4	03-22-93 @ 15:10
Iron	5.6	03-25-93 @ 11:30
Manganese	4.9	03-25-93 @ 10:45
Copper	4.6	03-24-93 @ 15:10
Cadmium	<0.01	03-24-93 @ 10:25
Nickel	<0.1	03-24-93 @ 11:50
Zinc	0.5	03-24-93 @ 14:15
Chromium	<0.1	03-23-93 @ 13:10
Bicarbonate	212	03-19-93 @ 15:30
Sulfate	1935	03-22-93 @ 11:00
Fluoride	0.53	03-26-93 @ 17:00
Chloride	21.9	03-19-93 @ 16:00
TDS	2847	03-25-93 @ 13:00

END REPORT

Reviewed By D. A. Shah KH

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0078

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D. A. SHAH
DIRECTOR
AZ REG #8888
IN BUSINESS SINCE 1966

ARIMETCO, Inc.
A.J. Smith
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 03-11-93
Date Sampled : 03-10-93
Time Sampled : 13:30
Date Reported: 03-29-93
CSAL ID No.:93-02-53633

Project No.: Zonia
Client ID #: Instrument Shack
Sample Type: Water
Sampled By : Archie Joe Smith

Laboratory Report

Constituents	Dissolved Metals Mg/L	Date / Time Analyzed
TDS	1300	03-22-93 @ 14:00
Arsenic	<0.01	03-17-93 @ 04:00
Calcium	147	03-12-93 @ 12:30
Magnesium	68.8	03-12-93 @ 14:00
Sodium	58.5	03-12-93 @ 15:30
Potassium	16.9	03-12-93 @ 16:25
Bicarbonate	673	03-12-93 @ 10:00
Sulfate	273	03-15-93 @ 15:00
Chloride	17.9	03-12-93 @ 11:00
Iron	13.1	03-18-93 @ 12:45
Manganese	2.1	03-18-93 @ 09:45
Copper	0.4	03-17-93 @ 13:30
Cadmium	0.01	03-18-93 @ 11:40
Nickel	<0.1	03-18-93 @ 14:10
Zinc	0.1	03-18-93 @ 10:25
Chromium	<0.01	03-17-93 @ 20:00

END REPORT

Anion/Cation Balance = 0.93

Reviewed By D A Shah KH

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0078

710 E. EVANS • TUCSON, AZ 85713

PH. (602) 884-5811 PH. (602) 797-0788 FAX# (602) 884-5812

D. A. SHAH
DIRECTOR
AZ REG #6888
IN BUSINESS SINCE 1966

ARIMETCO, Inc.
A.J. Smith
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 03-11-93
Date Sampled : 03-10-93
Time Sampled : 08:00
Date Reported: 03-29-93
CSAL ID No.:93-02-53631

Project No.: Zonia
Client ID #: Z601
Sample Type: Water
Sampled By : Archie Joe Smith

Laboratory Report

Constituents	Dissolved Metals Mg/L	Date / Time Analyzed
TDS	440	03-22-93 @ 14:00
Arsenic	0.01	03-17-93 @ 04:00
Calcium	26.7	03-12-93 @ 12:30
Magnesium	16.9	03-12-93 @ 14:00
Sodium	67.3	03-12-93 @ 15:30
Potassium	4.4	03-12-93 @ 16:25
Bicarbonate	277	03-12-93 @ 10:00
Sulfate	20.6	03-15-93 @ 15:00
Chloride	7.0	03-12-93 @ 11:00
Iron	6.2	03-18-93 @ 12:45
Manganese	<0.1	03-18-93 @ 09:45
Copper	<0.1	03-17-93 @ 13:30
Cadmium	<0.01	03-18-93 @ 11:40
Nickel	<0.1	03-18-93 @ 14:10
Zinc	<0.1	03-18-93 @ 10:25
Chromium	<0.01	03-17-93 @ 20:00

END REPORT

Anion/Cation Balance = 1.14

Reviewed By D A Shah KH

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0076

710 E. EVANS • TUCSON, AZ 85713

PH. (602) 884-5811 PH. (602) 797-0788 FAX# (602) 884-5812

D. A. SHAH
DIRECTOR
AZ REG #8688

IN BUSINESS SINCE 1966

ARIMETCO, Inc.
A.J. Smith
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 03-11-93
Date Sampled : 03-09-93
Time Sampled : 16:30
Date Reported: 03-29-93
CSAL ID No.:93-02-53629

Project No.: Zonia
Client ID #: Z603
Sample Type: Water
Sampled By : Archie Joe Smith

Laboratory Report

Constituents	Dissolved Metals Mg/L	Date / Time Analyzed
TDS	423	03-22-93 @ 14:00
Arsenic	<0.01	03-17-93 @ 04:00
Calcium	30.6	03-12-93 @ 12:30
Magnesium	11.1	03-12-93 @ 14:00
Sodium	9.0	03-12-93 @ 15:30
Potassium	2.6	03-12-93 @ 16:25
Bicarbonate	27.7	03-12-93 @ 10:00
Sulfate	220	03-15-93 @ 15:00
Chloride	15.9	03-12-93 @ 11:00
Iron	39.0	03-18-93 @ 12:45
Manganese	12.9	03-18-93 @ 09:45
Copper	9.9	03-17-93 @ 13:30
Cadmium	0.01	03-18-93 @ 11:40
Nickel	<0.1	03-18-93 @ 14:10
Zinc	0.7	03-18-93 @ 10:25
Chromium	<0.01	03-17-93 @ 20:00

END REPORT

Anion/Cation Balance = 0.91

Reviewed By D A Shah KH

COPPER STATE ANALYTICAL LAB, INC.

ARIZONA STATE CERTIFIED LAB NO. 0078

710 E. EVANS • TUCSON, AZ 85713

PH. (602) 884-5811 PH. (602) 797-0788 FAX# (602) 884-5812

D. A. SHAH
DIRECTOR
AZ REG #6686
IN BUSINESS SINCE 1956

ARIMETCO, Inc.
A.J. Smith
6245 East Broadway Blvd., #350
Tucson, AZ 85711

Date Received: 03-18-93
Date Sampled : 03-17-93
Time Sampled : 14:00
Date Reported: 03-31-93
CSAL ID No.:93-02-53931

Project No.: Zonia
Client ID #: Zonia #1 LB
Sample Type: Water
Sampled By : H. Matson

Laboratory Report

Constituents Dissolved Metals	Dissolved Metals Mg/L	Date / Time Analyzed
Arsenic	0.03	03-22-93 @ 19:00
Calcium	50.5	03-22-93 @ 13:00
Magnesium	550	03-22-93 @ 13:30
Sodium	21.1	03-22-93 @ 14:20
Potassium	0.4	03-22-93 @ 15:10
Iron	20.0	03-25-93 @ 11:30
Manganese	696	03-25-93 @ 10:45
Copper	1171	03-24-93 @ 15:10
Cadmium	1.25	03-24-93 @ 10:25
Nickel	8.2	03-24-93 @ 11:50
Zinc	16.2	03-24-93 @ 14:15
Chromium	0.1	03-23-93 @ 13:10
Bicarbonate	<1.0	03-19-93 @ 15:30
Sulfate	10600	03-22-93 @ 11:00
Fluoride	191	03-26-93 @ 17:00
Chloride	39.8	03-19-93 @ 16:00
TDS	15620	03-25-93 @ 13:00

END REPORT

Reviewed By D. A. Shah KH