

FEASIBILITY STUDY OF EMERGENCY RESPONSE REMOVAL/TREATMENT
OPTIONS FOR CALIFORNIA CREATIVE DYNAMICS

by

Robert A. Evangelista
Enviresponse, Inc.
Livingston, NJ 08837

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Project Officer

Andre Zownir
Environmental Response Branch
Office of Emergency Response
U.S. Environmental Protection Agency
Edison, NJ 08837

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SECTION 1

SUMMARY AND RECOMMENDATIONS

California Creative Dynamics (CCD) is a former aluminum chemical milling company with a plant site in San Diego, CA. This site contains approximately 100,000 gallons of caustic, 20,000 gallons of acid solutions, and small amounts of caustic solids for disposal.

The objective of this evaluation was to explore various treatment options for these wastes and to recommend a technically sound, cost-effective method or methods of disposal.

Our findings for the evaluated treatment options are presented in the following summary:

<u>Treatment Option</u>	<u>Conclusions and Comments</u>
1. Recycling of Liquids	Viable for caustic liquids (See Notes 1 and 2)
2. Onsite Treatment	
A. Neutralization and precipitation	Viable for total waste products (Three vendors available)
B. Electrochemical removal of zinc	<u>Not</u> viable, does not selectively remove enough zinc
C. EDTA chelation/acid precipitation and neutralization/calcium carbonate precipitation	<u>Not</u> viable, does not selectively remove zinc
D. Centrifugation of caustic	<u>Not</u> viable, no significant removal of zinc
3. Offsite Treatment	Viable, economically unattractive

- NOTE: 1. Alcoa will accept one railcar load of filtered caustic on trial basis for recycling.
2. Acid and solids must be disposed in another way.

Our recommendation is to recycle the liquid caustic material for the following reasons:

- o The bulk of the hazardous wastes (caustic liquids) are removed from the site for introduction as feed stock to a process industry's production cycle.
- o Minimal pretreatment (in the form of filtration) is required.
- o Larger quantities of potentially toxic sludge are generated by the other options.
- o Costs are similar to on-site treatment costs.
- o The small quantities of acid waste and caustic solid/filter cake can easily be treated offsite and landfilled, respectively.

A second viable option is the on-site neutralization and precipitation process currently available from three potential sources: International Technology Corp., Rexnord, and Tetra Resources Systems. These companies offer on-site treatment at 50% of the cost of the offsite treatment. The large quantity of metal sludge produced by this option must be finally characterized for state requirements before disposal in a proper secure or unsecured landfill.

EVALUATION OVERVIEW

The evaluation was conducted in three phases: 1) waste characterization, 2) determination of potential treatment options, and 3) evaluation and selection of the optimum treatment for the site wastes.

Waste Characterization

Waste characteristics were determined by sample analysis of the acid solutions, caustic solutions, and caustic solids found at the site. Zinc and sulfides were the principal pollutants in the caustic samples and zinc, copper, and chromium were the principle pollutants in the acid samples. The solutions must be treated to remove these pollutants before on-site disposal to the municipal sewage authority could be accepted.

Determine Potential Treatment Options

The following options were selected as ways to reduce the wastes to forms for acceptable disposal to the municipal sewage authority.

Recycling --

Recycling is an attractive option to remove principal on-site waste and return it to the industrial market as a useable product.

On-site treatment --

Several mobile treatment methods were identified to detoxify wastes at the site so they can provide a quick solution:

- o Neutralization and precipitation - Process provides a liquid and a solid product that can be simply disposed in sewers and secured landfills, respectively.
- o Electrochemical removal - By removing the zinc selectively the waste would then be put to sewage with minimum solid waste disposal. Actual testing, which was confirmed by technical advice, showed the process did not remove enough of the zinc to make it worthwhile.
- o Chelation/precipitation - This technique was reviewed for its potential to remove zinc through selective precipitation. Actual testing showed that selectivity was inadequate.
- o Centrifugation - Manufacturer of the caustic and acid etchants thought the zinc was not dissolved but existed as suspended particles and could be selectively removed. Centrifugation tests were ineffective in removing any zinc precipitate.

Offsite treatment --

Treatment options are similar to on-site choices but in permanent offsite facilities. All approaches showed the combination of waste transportation cost plus treatment costs to increase overall costs significantly.

Evaluation and Selection

Recycling to Alcoa was selected as the most practical available option because the wastes could be reused in the industrial process cycle at costs comparable to costs for on-site treatment. On-site precipitation/neutralization was chosen as the second-best option because in-house and vendor treatability studies showed liquid effluent met sewer discharge requirements; however, large amounts of toxic sludge were generated.

SECTION 2
INTRODUCTION

California Creative Dynamics (CCD) is a former aluminum chemical milling company located in San Diego, California. At this site, CCD used concentrated caustic solutions (Turcoform Etchant 9H) to etch aluminum parts, and dilute acid (Turcoliquid Smut - GO T 5601) to rinse the etchant from the aluminum parts. Both liquids are made by Purex Industries. Seven tanks of caustic solution and four tanks of acid solution, totaling approximately 100,000 and 20,000 gallons, respectively, remain on-site. A small amount of caustic solids also remains. This site is in a mixed residential/industrial neighborhood and must be treated in a timely manner.

The objective of this feasibility study was to explore treatment options for these wastes and to suggest the most effective and economical waste treatment.

This effort was performed in three phases: 1) waste characterization, 2) determination of treatment options, and 3) selection of optimum treatment.

SECTION 3

WASTE CHARACTERIZATION

OBJECTIVE

The site-specific wastes were characterized by performing analytical tests on representative waste material samples. Waste characterization is necessary to select and design treatability schemes, and to provide a baseline against which all future results are compared.

METHODOLOGY

All tanks at the CCD site were sampled, with 31 discrete samples extracted from the top, middle, and bottom levels of these tanks. These discrete samples were composited under the direction of Andre Zownir, EPA Environmental Response Branch, and resulted in 11 samples: 2 acid, 6 caustic solution, and 6 caustic solid samples. Composite designations were assigned in the following manner: 1) The designation's numerical portion was taken from the last two numbers of the field data sheet and denotes that the sample was taken from one tank, and 2) The designation's letter portion was taken from the sample data series label (which corresponds to the field data sheet) and denotes the tank level at which the discrete sample was taken (A = top level, B = middle level, and C = bottom level of tank). For example, composite designation 63AB64AB65A is a horizontal composite of samples taken from the locations noted on field data sheets 63, 64, and 65. These data sheets correspond to tanks P6691, T1, and T2, respectively, and from tank depths top and middle (AB), top and middle (AB), and top (A), respectively (see Table 1 for details on compositing scheme).

Analysis on these samples was performed in accordance with SW846, EPA test method for solid wastes (1982), and Standard Methods 15th Edition. The following analyses were performed:

- o priority pollutant metals
- o aluminum
- o sulfide
- o fluoride (acid samples only)
- o acid or base normality
- o total acid or basic content

TABLE 1. DISCRETE SAMPLE COMPOSITING SCHEME OF WASTES FROM TANKS

Type of Sample	Composite Designation	Sample Location	
		CCD Tank #	Level Sampled
Acid solution	58B	P4071	bottom
Acid solution	58AB59ABC60 ABC61ABC	P4071	top, bottom
		P6604	top, middle & bottom
		P6620	top, middle & bottom
		P6539	top, middle & bottom
Basic solution	62ABC	P6613	top, middle & bottom
Basic solution	63AB64AB65A	P6691	top & middle
		T1	top & middle
		T2	top
Basic solution	63C64C65BC	P6691	bottom
		T1	bottom
		T2	middle & bottom
Basic solution	66ABC	T4	top, middle & bottom
Basic solution	67AB	IT	top & middle
Basic solution	68ABC	490N	top, middle & bottom
Basic solids	69A	T7	--
Basic solids	69B	47, 50	--
Basic solids	69C	47, 50	--

RESULTS

Acid solutions were relatively dilute (approximately 1.3 N) and contained:

Acid fluorides	1500-1600 ppm	Nickel	2 ppm
Aluminum	1800-1900 ppm	Beryllium	1.6 ppm
Zinc	750- 800 ppm	Lead	1 ppm
Copper	220- 240 ppm	Cadmium	0.9 ppm
Chromium	19 - 21 ppm	Arsenic	0.8-1 ppm
Thallium	1.9 ppm		

(See Table 2 for detailed results.)

Caustic solutions were highly basic concentrations (approximately 9-11 N) and contained:

Aluminum	30,000-170,000 ppm	Sulfides	3,700-20,000 ppm
Zinc	1,700- 4,200 ppm	Thallium	9.8-21 ppm

Sample 8 was an exception, containing a less concentrated caustic solution with proportionately lower quantities of metals. (See Table 3 for detailed results).

Caustic solids contained:

Aluminum	130,000-210,000 ppm	Thallium	32-45 ppm
Zinc	6,100- 6,500 ppm	Arsenic	16-38 ppm
Copper	1,000 - 1,100 ppm	Nickel	4-5.3 ppm
Chromium	130 - 140 ppm	Beryllium	0.5-0.9 ppm

(See Table 4 for detailed results.)

TABLE 2. ANALYSIS OF ACID SOLUTION SAMPLES

Parameter	Detection Limit (ppm)	Sample Number	
		58B (ppm)	58AB59ABC60ABC61ABC (ppm)
Aluminum (total)	0.20	1,800	1,900
Antimony (total)	0.06	ND	ND
Arsenic (total)	0.05	1	0.83
Beryllium (total)	0.005	1	1.6
Cadmium (total)	0.01	0.77	0.89
Chromium (total)	0.05	19	21
Copper (total)	0.025	220	240
Lead (total)	0.10	0.66	0.96
Mercury (total)	0.002	ND	ND
Nickel (total)	0.04	1.7	2
Selenium (total)	0.01	0.44	ND
Silver (total)	0.05	ND	ND
Thallium	0.10	1.8	1.9
Zinc (total)	0.02	750	800
Fluoride (total)	0.20	1,500	1,600
Sulfide (total)	1.0	ND	ND
Normality	-	1.156	1.352
% HNO ₃	-	7.3	8.5

* Levels of acid and base are accurate to within $\pm 10\%$ of the volume
 ND Not Detected.

TABLE 3. ANALYSIS OF BASIC SOLUTION SAMPLES*

Parameter	Detection Limit (ppm)	62 ABC (ppm)	63AB64AB65A (ppm)	Sample Designation 63C64C65BC (ppm)	66ABC (ppm)	67AB (ppm)	8 (ppm)
Aluminum (total)	2.0	130,000	150,000	130,000	110,000	170,000	30,000
Antimony (total)	0.60	ND	ND	ND	ND	ND	ND
Arsenic (total)	0.50	0.50	0.50	0.05	0.05	ND	ND
Beryllium (total)	0.05	0.32	0.41	0.40	0.34	ND	ND
Cadmium (total)	0.10	ND	ND	ND	ND	0.57	0.50
Chromium (total)	0.50	0.50	ND	ND	ND	ND	ND
Copper (total)	0.25	0.51	ND	0.25	ND	0.500	ND
Lead (total)	1.00	ND	ND	ND	0.85	ND	ND
Mercury (total)	0.004	ND	ND	ND	ND	ND	0.67
Nickel (total)	0.40	ND	ND	ND	ND	ND	ND
Sejenium (total)	0.10	ND	ND	ND	ND	ND	ND
Silver (total)	0.50	ND	ND	ND	ND	ND	ND
Thallium	1.00	17	19	14	15	21	ND
Zinc (total)	0.20	3,900	4,200	4,000	3,900	3,500	9.8
Fluoride (total)	0.20	NR	NR	NR	NR	NR	1,100
Sulfide (total)	1.00	17,000	14,000	19,000	20,000	13,000	3,700
Normality b	-	9.945	10.647	11.115	9.243	10.881	3.393
% NaOH	-	40	43	44	37	43	14

* Levels of acid and base are accurate to within $\pm 10\%$ of the volume
 ND Not Detected.
 NR Not Requested.

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TABLE 4. ANALYSIS OF BASIC SOLID SAMPLES

Parameter	Detection Limit (ppm)	Sample Designation		
		69A (ppm)	69B (ppm)	69C (ppm)
Aluminum (total)	20.0	210,000	130,000	130,000
Antimony (total)	6.0	ND	ND	ND
Arsenic (total)	5.0	ND	16	38
Beryllium (total)	0.50	0.85	0.50	0.75
Cadmium (total)	1.0	ND	ND	ND
Chromium (total)	5.0	130	130	140
Copper (total)	2.5	170	1,000	1,100
Lead (total)	10.0	ND	ND	ND
Mercury (total)	0.20	ND	ND	ND
Nickel (total)	4.0	4.0	4.6	5.3
Selenium (total)	1.0	ND	ND	ND
Silver (total)	5.0	ND	ND	ND
Thallium	10.0	45	32	35
Zinc (total)	4.0	6,400	6,100	6,500
Fluoride (total)	NR	NR	NR	NR
Sulfide (total)	1.0	ND	ND	ND

NR Not Requested.

ND Not Detected.

SECTION 4
DETERMINATION AND EVALUATION OF TREATMENT OPTIONS

RECYCLING

Objective

The objective of recycling is to find an industrial receptor for the CCD wastes, an organization that would use some or all of the waste contents. Recycling the acid and caustic wastes for any or all components, including the metals, may be economical, environmentally sound, and an attractive treatment procedure.

Description

Several organizations that could use these wastes as potential feed stocks were contacted. The most practical recycling options are discussed below.

Alcoa Aluminum --

Alcoa Aluminum expressed an interest in the caustic solution for their Pt. Comfort, Texas facility. Alcoa found value in the solution because of its caustic content. Based on a sample sent to Pt. Comfort for characterization, Alcoa decided to accept one rail car load (approximately 15,000-20,000 gallons) of the caustic solution, after it has been filtered to remove the grey-brown precipitate. The most effective method to remove these precipitates is to filter prior to shipment, preferably during loading. No decision of the deadline for accepting the remaining solution was given by Alcoa. Since only part of the caustic would be accepted immediately for recycling, we have the choice of mobilizing a filtration system to filter only one railcar load or to filter all caustics on site and place the filtrate into clean tanks. Bench scale application studies at vendors are necessary to locate an effective filtration unit that can be rented for on-site caustic filtration.

Alcoa expressed no interest in any of the acid solution, caustic solids, or any aluminum sludges generated by waste treatment. Recycling the caustic solution to Alcoa would require the acid solution and caustic solids/filtercake to be disposed off-site and securely landfilled, respectively.

The estimated costs for recycling of the caustic solution to Alcoa are:

Estimated rail shipment costs for 100,000 gal of caustic solution from San Diego to Pt. Comfort.	\$112,500
Rail car rental costs \$500 per car per month, seven cars required.	\$ 3,500/mo.
Filter 100,000 gal of caustic and transport to rail yard.	(ERCS Contract work)
Dispose of 20,000 gal of acid and caustic solid wastes	(To be determined)

Waste Exchanges --

An organization interested in these solutions can call EI through the waste exchanges to make the necessary arrangements. The CCD acid and caustic solutions are listed on the California Waste Exchange (916-324-1807) and Western Waste Exchange (602-965-1858).

Conclusion: Recycling

Recycling CCD wastes is an environmentally sound and attractive method of waste treatment because wastes are hauled off-site for introduction into an industrial process. Costs of this method are comparable to on-site treatment and no treatment sludges are generated.

ON-SITE TREATMENT

Objective

The objective of on-site treatment is to eliminate expensive packaging and transportation costs of sending the wastes to off-site treatment facilities and to provide a treatment that produces a liquid effluent that can be discharged on-site into the municipal sewer and a treatment-generated solid that can be easily removed to a landfill.

Description

On-site treatment options for CCD-type wastes have focused around two technologies: 1) physical/chemical treatment and 2) electrochemical treatment.

Physical/Chemical Treatment --

Physical/chemical treatment utilizes the low solubility of metal hydroxides or sulfides within a narrow pH range. The insoluble metals precipitate out as a sludge, which must be disposed of or recycled. The concentrations of the residual soluble metals in the treatment effluent vary from very low to extremely low for metal hydroxide and metal sulfide precipitation, respectively. Sulfides in the caustic waste require a simple oxidation step to convert them to sulfates. This technology provides a proven and reliable treatment method and can be provided by several organizations.

IT Corporation -- The Mobile Technology (MOTech) Division of IT (7461 Derian, Irvine, CA 92714), provides mobile on-site waste treatment equipment. Waste samples were sent to their Martinez Technical Development Laboratory (Martinez, CA 94553) for a bench scale application study to determine if their technologies can handle the wastes and meet San Diego discharge requirements. Based on this study, this system can reduce contaminant levels to meet discharge requirements. Details of this effort are in Appendix 1.

IT provided a written guarantee that their Mobile Inorganic Treatment System (MITS) meets discharge limits. Treatment will last 2-3 weeks on-site and the unit is currently available for use.

IT has submitted a Part B permit application for a Transportable Treatment Unit (TTU). Their current practice is to submit a site-specific operation plan to the State of California and obtain a variance. The approximate cost for this treatment procedure is \$1.00 per gallon. Cost breakdown is as follows:

ITEM	COST
Mobilization/demobilization	\$ 15,000
Sludge disposal, \$133/ton 300 tons @ 50% solids	39,900
Treatment \$0.55/gallon for 120,000 gallons	<u>66,000</u>
TOTAL COST ESTIMATE	\$120,900

Rexnord Technologies -- Rexnord Technologies (5103 West Beloit Rd., Milwaukee, WI 53214) has a Mobile Physical/Chemical Treatment Unit to treat caustic/acid wastes and dewater sludges on-site. This system utilizes the same acid precipitation/neutralization technology as the MITS. CCD samples have been sent for a bench scale applications test, which confirmed the feasibility of this system for CCD wastes. The Rexnord treatment costs are \$1.08/gallon not including disposal.

Tetra Resources -- Tetra Resources provides treatment capability similar to Rexnord and IT. Tetra Resources (9391 Grogans Mill Rd., Suite A-6B, Woodland TX 77380) has mobile acid precipitation/neutralization treatment and sludge dewatering units available. CCD samples were sent for a bench-scale applications study; the results confirmed the feasibility of this system. Tetra Resources treatment costs are \$0.462/gallon not including disposal (Appendix 1).

Permutit -- Permutit's mobile treatment process can polish discharge effluents from other treatment processes by significantly reducing heavy metal solubility. Permutit (P.O. Box 355, Paramus, NJ 07652) has a mobile Sulfex^R pilot unit which uses a patented iron sulfide precipitation process to polish heavy metals contained in wastewater. Permutit claims that wastewater effluent from their process will result in metal concentrations 30,000 to 1 billion times lower than concentrations obtained by the hydroxide precipitation process (IT Corp, Rexnord, and Tetra Resources). They are not interested in treating the CCD waste as is; however, they will polish effluents from other on-site treatment units. A bench scale application study is necessary before treatment. Permutit provided the following cost estimates:

ITEM	COST
Mobile Sulfex ^R unit rental	\$ 500/week
Operator	\$ 450/day & expenses
Additional costs: transportation, chemicals, sludge disposal	Not Available

Reidel Environmental -- Reidel, the Region 9 ERCS contractor, is exploring on-site and offsite treatment options through subcontractors for CCD wastes. EI has sent samples to Bird Environmental Systems, South Walpole, Mass (a subcontractor to S.O.S. International, South San Francisco, CA) and EI Dupont, Deepwater, NJ as requested by Reidel.

Electrochemical Treatment --

Electrochemical treatment introduces electricity into a solution, which causes the metals to migrate and results in either metal deposition on the electrode, a concentrated metal solution, or metal and metal complex precipitates. Examples of this type of treatment are electrowinning, electro dialysis, and electroprecipitation. Although these technologies hold great waste treatment potential, they are relatively new technologies. Reliability is affected by interfering substances in solution.

Andco Environmental Processes, Inc. -- Andco Environmental Processes, Inc. (595 Commercial Drive, Amherst, NY 14150) is interested in treating the wastes and has transportable pilot units for electrochemically removing metals from waste streams. Their process produces a metal hydroxide, iron hydroxide and metal-iron-hydroxide sludge which may be recycled by two of their contractors: 1) World Resources, McLean, VA and 2) Horsehead Resources, Palmerton, PA. A bench scale application study (cost approximately \$200) is necessary before commitment and firm cost estimates are supplied. Andco did provide, however, some general costs.

ITEM	COST
Pilot unit rental	\$ 300/day
Operator	\$ 450/day & expenses
Additional costs: transportation, chemicals, sludge disposal (if necessary)	Not Available

Hegyan Corporation -- The Hegyan system was not successful during bench scale treatment studies at CCD. Hegyan has utilized a pilot electrowinning RetekTM unit to cathodically deposit zinc from CCD caustic wastes. The RetekTM unit lowers the caustic solution's 4000 ppm zinc levels to 200-400 ppm. To lower zinc and sulfides further to meet discharge limitations, the caustic leaving the RetekTM unit was treated with sulfide oxidation and acid precipitation. The Retek unit standing alone does not reduce zinc concentration sufficiently for on-site treatment.

The Electrosynthesis Company -- The Electrosynthesis Company is interested in exploring electrochemical treatment; however, even if feasibility is proven a treatment unit is not currently available and must be constructed. The Electrosynthesis Company (P.O. Box 16, E. Amherst, NY 14051) claims they may be able to electrolytically remove zinc from the caustic solution. Bench scale and pilot scale studies costing approximately \$15,000 are necessary. If successful, equipment procurement would take 3 months minimum.

SCADA Systems -- SCADA Systems, with expertise in electrochemical engineering, does not believe electrochemical technology is feasible for treatment of CCD wastes. SCADA Systems, Inc. (44 Fasken Dr., Unit 14, Rexdale, Ontario) claims that electrolytic removal of metals from the caustic solution will be difficult or impossible. He claims that zinc's high cathode potential will cause H₂ gas to bubble at the cathode first. In addition, aluminum in aqueous solution is difficult to reduce, while thallium may form the hydride, a poisonous gas. The acid solution is also difficult to treat electrolytically. Nitric acid must first be reduced before zinc is cathodically deposited.

Conclusion: On-Site Treatment

There are a number of mobile or transportable treatment technologies that may effectively treat CCD wastes on-site within a 2-5 week period. All these technologies required prior bench scale application tests so that vendors can confirm the feasibility and provide cost estimates. These tests showed that the preferred on-site treatment technology applicable to CCD wastes is acid precipitation/neutralization with sludge dewatering. Electrochemical metals removal, because of its uncertain capability to remove sufficient zinc, is not a practical treatment option for the CCD wastes. This should not discount its use in future remediation projects, and should be reviewed on a case-by-case basis.

Physical/Chemical Treatment --

The IT MITS is presently the best available on-site treatment option for CCD wastes. IT has guaranteed to meet municipal discharge limitations; however, large amounts (approximately 50% by volume) of hydrated precipitates containing aluminum, zinc, copper, and chromium are produced. This sludge is a candidate for secure landfilling. The criteria for nonsecure landfilling are established by specific analyses to determine total threshold limit concentration (TTL) and soluble threshold limit concentration (STLC) values (Article 11, Title 22, California Administrative Code). The TTL and STLC for zinc are 5,000 ppm and 250 ppm, respectively.

In addition to IT's unit, two other acid precipitation/neutralization mobile units have been identified: Rexnord Environmental Systems, Milwaukee, WI and Tetra Resources, Woodland, TX. Bench scale applications studies have shown that these systems can successfully treat CCD wastes.

Electrochemical Treatment --

Electrochemical removal of zinc from the CCD caustic solution is not in itself a practical treatment option. The Retek™ unit's 90% reduction of the zinc content in the caustic solution was not sufficient to meet discharge limits. However, the Retek™ unit could be utilized before acid precipitation/neutralization to reduce zinc levels in the acid-treatment-generated solids. This zinc reduction in the solids may allow nonsecure landfilling by meeting TTLC and STLC criteria.

Andco, an electrochemical equipment vendor, believes their system will remove zinc as a precipitate. They work with two metal recyclers who may accept this sludge. A two-week, \$200 bench scale applications study is necessary. If their process proves feasible, they have a 20-gpm pilot unit for waste treatment.

The Electrosynthesis Company is interested in providing feasibility bench and pilot scale testing; however, a 3-month minimum leadtime is necessary to build a full scale unit.

The comments of SCADA Systems, a very knowledgeable vendor with expertise in electrochemical engineering, indicate that we should proceed cautiously with any electrolytic metals removal because of the complex nature of the CCD wastes.

Table 5 lists the organizations contacted.

IN-HOUSE TREATABILITY STUDIES

Objective

The objective of the in-house treatability studies was to explore the feasibility of various bench scale treatments to reduce the levels of heavy metals and to adjust the pH in CCD wastes. Treatments evaluated in the in-house treatability study were: 1) acid precipitation and neutralization; 2) EDTA/acid/calcium carbonate precipitation and neutralization; and 3) physical separation via centrifugation (Appendix 2 contains the experimental procedures). The definition of treatment success is compliance with the City of San Diego permit limitations for liquid effluents, and generating recycleable solids or reducing the amount of hazardous solids that must be disposed of in a secure landfill. Information obtained during the treatability study will be provided to Region 9 for use in site cleanup plans.

TABLE 5. LIST OF ORGANIZATIONS CONTACTED

Organization	Contact	Position	Phone Number
Alcoa	Ernest Cox	Chemical Buyer	(412) 553-4355
IT Corp	Bob Schirripa	MOTech Project Manager	(714) 261-6441
Rexnord Technologies	Dick Osantowski	Manager of Hazardous Waste Program	(414) 643-3050
Tetra Resources	Hank Reeves Fritz Zuhl		(713) 363-0664 (412) 941-2660
Permutit	James Connolly	Process Engineer	(201) 967-6000
E. I. Dupont Company	John Straub	-----	-----
Reidel Environmental	Rich Gariphi Mike McRae		(503) 286-4656 (415) 222-7810
Andco Environmental Processes	Dean Raccioppi	Regional Sales Manager	(201) 544-8730
Hegyan Corp.	Dan Hegyan		(213) 373-6755
California Creative Dynamics	Bob Gloede	Principal	(619) 562-9118
The Electro- synthesis Company	Dr. Norm Weinburg		(716) 684-0513
SCADA Systems	Dr. Colin Small		(416) 674-0726

Study I. Acid Precipitation/Neutralization Study

Objective --

Waste characterization showed heavy metals, acidity, and basicity levels above allowable discharge limits for The City of San Diego sewage plant. The objective of this study was to treat the liquid waste by lowering heavy metal levels and adjusting the pH to meet discharge limits. A liquid effluent from such a treatment scheme would be in permit compliance and could be discharged onsite into the municipal sewer system.

Methodology --

The effects of phosphoric and sulfuric acids and two polymeric anionic flocculants at several concentrations were explored. Table 6 summarizes the experimental scheme used to explore acid precipitation and neutralization of representative caustic samples. This table lists the type and concentration of acid added to precipitate the metal and neutralize the caustic, as well as the type and concentration of flocculant used to settle the precipitate.

In all experiments, 250 ml of caustic solution were treated in a stirred beaker sitting in an ice bath to cool the exothermic reaction to room temperature. A final pH of 9.0 for the highly caustic solution was chosen because zinc reaches the point of its lowest solubility and precipitates at this pH, as depicted in Figure 1. Vacuum filtration of the treated sludge was performed in a Buchner funnel using Whatman # 42 filter paper.

Results --

This treatment technique was successful in treating CCD wastes. The most effective treatment scheme for the caustic waste was the addition of dilute (1:9) sulfuric acid plus 50 ppm flocculant 1123L (Betz Labs). After precipitation, neutralization, settling, and vacuum filtration, the resulting filtrate was characterized. Results of this analysis (Table 7) indicate that remaining zinc levels are 400 times lower than the permit limit of 22 ppm Zn for 5000 gpd of effluent.

Quality Assurance/Quality Control data for all analytical results are in Appendix 3.

Large amounts of solids (approximately 50% v/v) were produced by this treatment method. These gelatinous solids may prove difficult to dewater. The heavy metal content in the solids requires secure landfilling if TTLC and STLC (TTLC) are not met.

TABLE 6. EXPERIMENTAL MATRIX FOR ACID PRECIPITATION/
NEUTRALIZATION STUDIES

Experiment #	Type Acid	Acid: water Dilution	Flocculant ^a	Conc. (ppm)	Final pH	Comments
1	H ₃ PO ₄	Concentrated	--	--	13	Mixture setup as hard solid
2	H ₂ SO ₄	Concentrated	--	--	13	Mixture had very high solids content, large evolution of heat of solution, and neutralization
3	H ₂ SO ₄	1:1	--	--	1.5	Mixture had high solids content
4	H ₂ SO ₄	1:9	1115L	1	9	Mixture had consistency of cream. Flocculant did not settle precipitate
	H ₂ SO ₄	1:9	1115L	10	9	
	H ₂ SO ₄	1:9	1115L	100	9	
5	H ₂ SO ₄	1:9	1123L	10	9	Mixture had consistency of cream. 50 and 100 ppm flocculant settled precipitate into a gelatinous mass. Solids comprised approximately 50% of total volume.
	H ₂ SO ₄	1:9	1123L	50	9	
	H ₂ SO ₄	1:9	1123L	100	9	

^a Flocculant 1115L is a low charge density anionic flocculant, 1123L is a high charge density anion flocculant - Betz Labs.

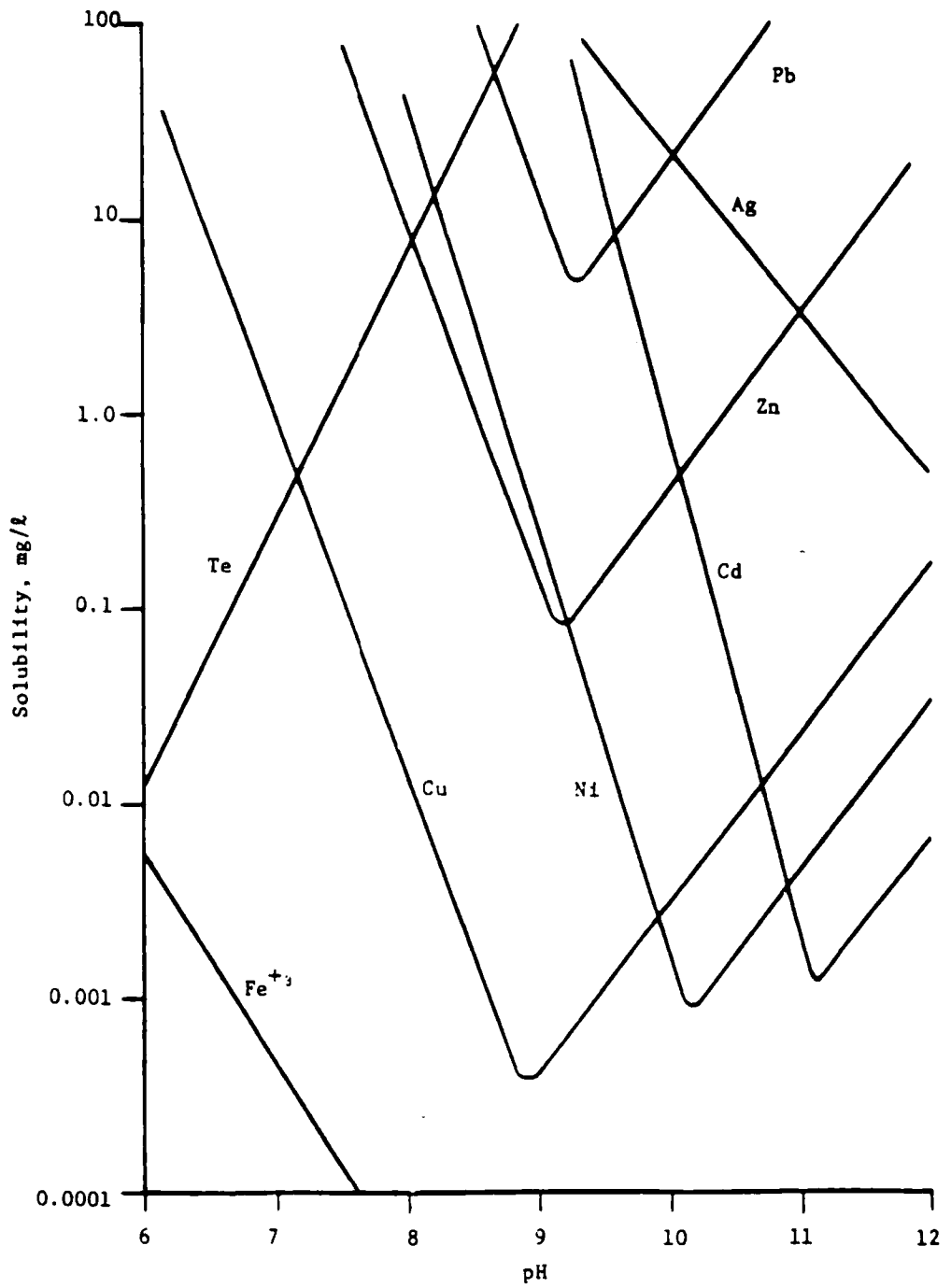


Figure 1 . Theoretical solubilities of metal hydroxides as a function of pH.

TABLE 7. CAUSTIC SOLUTION AFTER PRECIPITATION/NEUTRALIZATION

Parameter	Detection Limits (ppm)	Run 1 (ppm)	Run 2 (ppm)
Aluminum	0.40	3.1	3.2
Chromium	0.20	ND	ND
Copper	0.03	ND	ND
Nickel	0.06	ND	ND
Thallium	0.10	ND	ND
Zinc	0.005	0.049	0.049

ND not detected

These results demonstrate the feasibility of acid precipitation and neutralization for on-site treatment of the caustic waste. The waste acid solution onsite could provide some of the acid needed to treat the caustic waste, concurrently reducing the total acid purchase required and treating the acid waste.

Study II. EDTA Chelation, Acid Precipitation/Neutralization, and Calcium Carbonate Precipitation Study

Objective --

The liquid effluent resulting from acid precipitation/neutralization treatment of caustic wastes meets discharge limits; however, large quantities of toxic solids containing heavy metals are produced. Landfilling these solids is costly and may not be environmentally sound. If the amount of toxic solids can be reduced or eliminated, this chemical treatment scheme can be considered more desirable than acid precipitation/neutralization alone.

The objective of this study was to reduce the amount of toxic solids generated. This reduction can be accomplished by separating the toxic from the non-toxic precipitates in discrete steps.

Methodology --

The method proposes to "protect" zinc from acid precipitation by adding EDTA to form a stable zinc chelate; hence only aluminum will precipitate upon acid addition (Table 8).

Varied amounts of acid were added to precipitate the soluble aluminum exclusively, yielding final pH values of: 12.5, 11.0, 9.0, and no acid addition (control, approximately pH 13.0). After acid addition, the solutions were centrifuged for solid/liquid separation and the supernatant analyzed for aluminum, zinc, and sulfide.

To selectively precipitate the zinc, calcium carbonate was then added to break the zinc-EDTA chelate.

Samples of the filtrate were analyzed for aluminum, zinc, and sulfide.

The above experiments were performed in 1-liter stirred beakers (in an ice bath to maintain the solution at room temperature) containing 250 ml of caustic sample. Dilute (1:9) H_2SO_4 was added to each beaker. As directed in the Dow Chemical's "Keys to Chelation" (1985), 15.3 parts of EDTA (plus a 10% molar excess) per part of zinc were added. Calcium carbonate was added in a 10% molar excess and #42 Whatman paper was used for the final filtration.

TABLE 8. EDTA CHELATION, ACID PRECIPITATION/NEUTRALIZATION, AND CALCIUM CARBONATE PRECIPITATION STUDY SEQUENTIAL STEPS

-
- 1) Caustic Solution ($Al^{3+} + Zn^{2+} + S^{2-}$) + EDTA \longrightarrow
 $Al^{3+} + S^{2-} + Zn\ EDTA.$
- 2) $Al^{3+} + S^{2-} + Zn\ EDTA + H_2SO_4 + \text{flocculant}$ \longrightarrow
 $Al(OH)_3(s) + Al_2(SO_4)_3(s) + Zn\ EDTA + S^{2-}$
- 3) $Al(OH)_3(s) + Al_2(SO_4)_3(s) + Zn\ EDTA + S^{2-}$ Centrifuge \longrightarrow
 $Zn\ EDTA + S^{2-}$ (in contrate)
- 4) $Zn\ EDTA + S^{2-} + CaCO_3$ \longrightarrow $Zn\ S + Ca\ EDTA + S^{-}$ excess
- 5) $ZnS + Ca\ EDTA + S^{2-}$ filtration \longrightarrow $Ca\ EDTA + S^{2-}$
-

Results --

Initial experiments were not successful in treating CCD caustic solution. Zinc levels were expected to remain unchanged and the aluminum was expected to precipitate, leaving high levels of zinc and only trace amounts of aluminum in solution after EDTA and acid additions. After calcium carbonate addition, a zinc sulfide precipitate was anticipated, leaving only trace amounts of zinc concentration in solution.

However, after EDTA and acid addition, zinc levels in the solution were reduced (Table 9), probably as the result of coprecipitation with aluminum. After calcium carbonate addition, the zinc concentration in solution changed little, indicating that the calcium did not displace zinc in the chelate and the zinc did not precipitate out of solution as the sulfide.

TABLE 9. RESULTS OF THE EDTA/ACID/CALCIUM CARBONATE EXPERIMENTS

Parameter	Control	Supernatant after EDTA and acid addition		
		pH 9.0	pH 11.0	pH 12.5
Aluminum	106,200	1570	2350	480
Zinc	6,650	1040	1150	1100
Sulfide	73	2.0	1.0	1.0
Filtrate after calcium carbonate addition				
Aluminum		1590	2410	620
Zinc		1050	1130	1160
Sulfide		3.2	2.2	1.5
Solids after two water washings				
Zinc	4,190	8580	8070	7710

A striking difference between the results of the pH 9.0 sample in Study I and Study II (also at pH 9.0) was noted. After acid addition in Study I, aluminum and zinc concentrations in solution were 3.2 ppm and 0.049 ppm, respectively, while in Study II, after EDTA and acid addition, aluminum and zinc concentrations in solution were 1552 ppm and 1052 ppm respectively. The higher levels of aluminum and zinc in solution are probably due to the solubilizing effect of the chelation bond, which prevents these metals from precipitating. However, this effect on the zinc was not strong enough to keep it all in solution in the presence of acid. Another experiment using greater amounts of EDTA may keep the zinc in solution while the aluminum precipitates.

Study III. Caustic Centrifugation

Objective --

Turcoform^R Etchant 9 H, the caustic solution, is manufactured with 1.5%-2.0% sulfides to precipitate any heavy metals as metal sulfides during aluminum chemical milling. According to John Grainger of Turco Products, manufacturer of the caustic aluminum etchant at CCD, there should be little soluble zinc in the spent etchant solution. The equilibrium favors zinc sulfide rather than soluble zincate; therefore, any zinc that remains should be precipitated zinc sulfide suspended in the viscous solution. The objective of this study was to explore if centrifugation could settle the suspended zinc sulfide particulates, if they indeed exist.

Methodology --

A representative sample of caustic solution was centrifuged at 3500 RPM for 30 min in two 250-ml centrifuge tubes. After centrifugation, 30-ml aliquots were pipetted from the top and bottom of each tube. Both top samples were composited and the two bottom samples were composited for zinc analysis. Results were compared against an uncentrifuged (control) sample.

Results --

Centrifugation had no effect on the zinc concentrations of the top and bottom of the centrifugation tube. Any difference in zinc values was within the error of analysis. The results are listed below.

	Sample		
Zinc (mg/L)	Top	Bottom	Control
	6,270	6,230	6,090

CONCLUSION OF TREATABILITY STUDIES

Dilute sulfuric acid precipitation and neutralization were successful in precipitating the heavy metal and producing an effluent below discharge limits. The resulting precipitate was successfully settled using a high charge density anionic flocculant. An advantage of this remediation scheme is that the acid wastes on site can be used to treat the caustic wastes, thereby eliminating the two wastes simultaneously. A disadvantage of this treatment scheme is the large amount of hydrated aluminum hydroxide and heavy metal sludges produced (approximately 50% by volume). In addition, the sludge is very difficult to dewater due to its gelatinous nature. All the sludge generated by this scheme must be placed in a secure landfill.

To eliminate the need to place this toxic sludge in a secure landfilling of toxic sludge, the EDTA chelation/acid precipitation and neutralization/calcium carbonate precipitation method was explored. The expected separation of the zinc precipitate from the aluminum precipitate did not occur. Furthermore, final concentrations of zinc in the liquid greatly exceeded discharge limits. This technique is currently not applicable for treating CCD wastes.

Caustic centrifugation to settle out suspended zinc sulfide precipitants, as suggested by Turco Products, had no effect on zinc levels. Zinc levels detected in analysis are the result of soluble zinc, probably as zincate.

The most effective method explored during in-house studies is acid precipitation and neutralization. A waste reduction of approximately 50% is achieved and liquid effluent from the process readily meets on-site discharge limitations. A proposed treatment scheme for CCD wastes is presented in Figure 2.

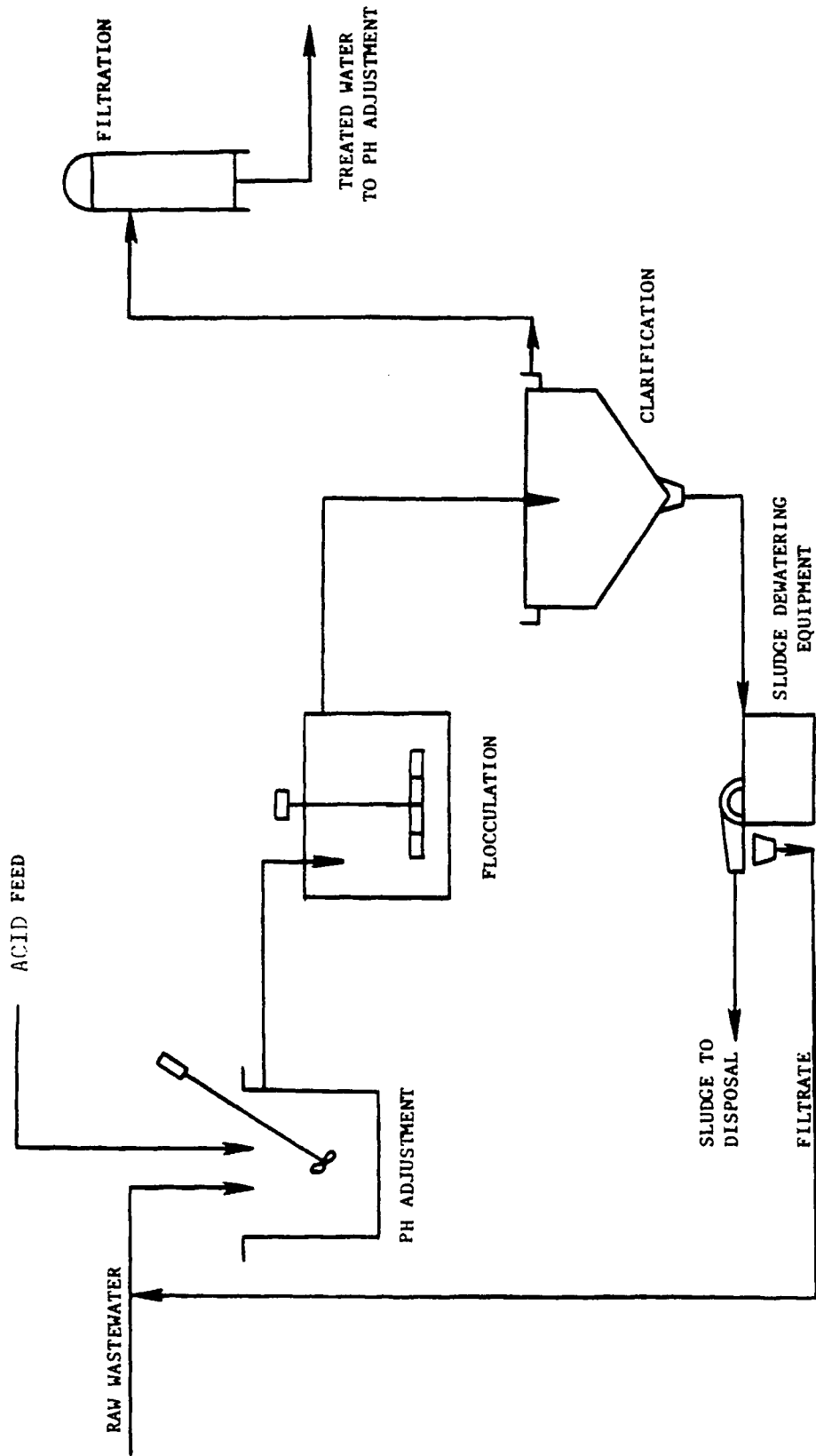


Figure 2. Typical continuous flow hydroxide precipitation treatment system.

SECTION 5
RECOMMENDATIONS

The best treatment presently available is recycling the caustic solution to Alcoa. The remaining dilute acid and caustic solids can be treated off-site and landfilled, respectively. Recycling has the following advantages:

- o The large quantities of highly concentrated caustic are hauled off-site for introduction into the process industry's cycle as a feed stock, not a hazardous waste;
- o Eliminates large quantities of toxic sludge generated by other options.
- o Minimal pretreatment (filtration) is required;
- o Costs are comparable to on-site treatment;
- o The small amounts of acid waste and caustic solid/filter cake are hauled off-site for treatment and landfilling respectively;

Another option is the utilization of the IT MITS or comparable Rexnord and Tetra Resources systems. It is also recommended to characterize the sludge generated from these systems for TTLV and STLV to determine whether to landfill the solids in a secure or a nonsecure landfill. These units are "ready to go" and cost 50% of off-site treatment at Casmalia Resources.

APPENDIX 1

RESULTS OF STUDIES BY IT CORP. AND TETRA RESOURCES

Report on Treatability
Studies for Waste Material from California Creative Dynamics in
San Diego, CA

Attached is the report on the treatability studies performed by IT Laboratory in Martinez, CA. As indicated in the report, the laboratory performed five treatability studies as follows:

- o One for each original sample
- o One for a composite of the caustic solutions
- o One for a composite of the caustic and acidic solutions according to their relative volumes in the field.

In all five studies, the treated wastewater met the public owned treatment works (POTW) criteria. As expected, high sludge volumes were produced due to the high aluminum concentrations in the original samples.

Treatability Studies
Enviresponse Inc.
Job Number 185004

Introduction

On February 9, 1987, Enviresponse, Inc. released IT to perform treatability studies on samples obtained from an EPA owned site in San Diego, CA. Samples were sent to the Martinez Technology Development Laboratory (MTDL) for the studies and were comprised of caustic and acidic metal finishing solutions. As we understand it, the material needed to be treated such that the resultant water could be discharged directly to a POTW. Furthermore, information provided by Enviresponse stated that the site contained approximately 100,000 gallons of caustic solution and 20,000 gallons of acidic solution.

Sample Descriptions, Treatability Studies, and Results

Five original samples were received in 1/2 gallon plastic containers and laboratory samples were prepared as in Table I below:

TABLE I
SAMPLE REFERENCE NUMBERS

<u>Enviresponse Sample #</u>	<u>No. Samples Received</u>	<u>Sample Description</u>	<u>MTDL Sample #</u>
62ABC	2	Basic Solution	4060-1
63C 64C 65BC	1	Basic Solution	4060-2
60ABC	2	Acid Solution	4060-3

MTDL Sample #4060-1 and 4060-3 were prepared by combining the contents of 2 separate 1/2 gallon containers, rendering 3 samples. These three samples were then used for treatability studies. The physical and chemical characteristics and results of the treatabilities for these samples are presented in Tables II, III, and IV. Treatabilities were successfully performed on all three samples to meet the local submitted POTW discharge requirements as indicated in each table.

In addition, treatabilities were performed on two composited samples. These composite samples were: (1) equal volumes of MTDL samples 4060-1 and 4060-2 (assigned MTDL #4060-4) and (2) a composite of 42% sample 4060-1 and 4060-2 each, plus 16% of sample 4060-3 (assigned MTDL #4060-5). This composite simulated a realistic composite of the waste on site based on

their relative volumes. Physical and chemical characteristics, as well as treatability results of the two composites are presented in Tables V and VI. In both cases, the bench treatabilities successfully met the discharge requirements specified by Enviresponse. The local POTW discharge limits presented in Tables II-VI are based on discharged volume of 1,000 gallons per day. Discharge volumes from the IT MITS unit will be about 10 times this volume (10,000 gallons/day). Discharge limitations to the local POTW, therefore, can be 10 times the values given in the tables.

Treatments for all five samples involved neutralization of the solutions and the removal of regulated heavy metals, by the use of various precipitating and neutralizing agents. All sample and composite site samples were diluted before bench treatabilities were performed.

During neutralization and precipitation of the caustic and composited samples, significant heating and thickening was observed, probably due to the high normalities and high aluminum concentrations contained in the samples. This was observed on treatability tests composed of one part sample to two parts water.

In samples diluted 1:1, the amount of precipitated solids after treatment was high, ranging from 43 percent to 53 percent by volume for samples 4060-1 and 4060-2, from 20 percent to 33 percent by volume for sample 4060-3, and from 49 percent to 53 percent by volume for the composited samples. To calculate the actual solids volume produced on-site relative to the original waste volume (keeping in mind a test dilution of 1:1) the percentages of solids presented above have to be doubled.

Belt press filtration tests were run on composite MTDL Sample #4060-5, that sample which most closely approximated a composite of all the samples on-site. The sample was first diluted 3:1 prior to neutralization and precipitation, then the precipitate was diluted 1:1 prior to the addition of polymer and belt press filtration. Volume reduction of the sample was about 12% compared to the original sample.

The cake produced by belt press filtration was very dry and easily passed the paint filter test. Belt filtration is a good choice for solids/liquid separation. The filtration produced in laboratory tests was clear, and the suspended particles produced in the belt overflow will settle easily.

An analysis for metals in the cake produced from MTDL Sample #4060-5 after precipitation, coagulation with polymer, and belt filtered, is given in Table VIII. Aluminum concentrations in the cake are what one would expect from the original sample (130,000 ppm, or 13% of the cake).

Conclusions and Recommendations From IT Corporation

The conclusions and recommendation given below are based on test results on the samples which were received by the MTDL and depend on the representativity of the samples. If the actual wastes to be processed on-site differ from the samples on which treatability tests were run, new samples must be taken to confirm treatability.

- o All samples submitted by Enviresponse, Inc. required neutralization and precipitation of regulated heavy metals, and filtration to meet the local POTW discharge requirements. All of the submitted individual samples were successfully treated by the MDTL.
- o Treatability studies were also performed on composites of the submitted samples. These composites were successfully treated by the MDTL to meet local POTW discharge requirements.
- o Solids products by volume for samples diluted 1:1 (as a percentage of the total treatability solution volume) were high, 43 percent to 53 percent for the caustic samples, 20 percent to 33 percent for the acidic samples and 49 percent to 53 percent for the composited samples. Due to dilution of the original feed, the percentages presented above have to be doubled to obtain actual solids volume in relation to feed volume.
- o Treatment of diluted precipitated samples with polymer, followed by belt filtration, resulted in a volume reduction of about 12% compared with the original sample volume. The cake produced by belt filtration passed the paint filter test. The suspended particles produced in the belt overflow will settle easily.
- o Concentration of metals in the cake for composited MTDL Sample #4060-5 were what one would expect from the original sample. Aluminum concentrations in the cake produced from composite MTDL Sample #4060-5 was 130,000 ppm (or 13% of the cake).

TABLE II

ENVIRESPONSE INC: MIDL SAMPLE #4060-1 DATA, TEST RESULTS, AND DISCHARGE STANDARD

Sample 4060-1 Sample Description	Caustic		Test Results Procedure: During testing, the amount of neutralizing and precipitating agents were varied. The pH given is the final test pH.	Discharge Limits Daily Maximum (mg/l)
	White Liquid			
Specific Gravity	1.29		Test 1 9.5	5-11
pH	>12.0		10.0	
Metals: (mg/l)	<10.0		<1.0	1.0
Sb	<10.0		<1.0	1.0
As	<10.0		<1.0	1.0
Be	<1.0		<1.0	1.0
Cd	<10.0		<1.0	0.6
Cr	<10.0		<1.0	3.5
Cu	<10.0		<1.0	2.3
Pb	<10.0		<1.0	0.3
Ni	<10.0		<1.0	2.1
Se	<10.0		<1.0	1.0
Ag	<10.0		<1.0	1.0
Tl	<10.0		<1.0	1.0
Zn	5700.0		<0.1	2.2
Al	150,000		N/A	N/A
Additional Sulfides Parameters: Cyanide	<0.1		N/A	0.1
	<1.0		N/A	1.0
(mg/l) % base (NaOH)	33.8%			

TABLE III

ENVIRESPONSE INC.: MTDL SAMPLE #4060-2 DATA, TEST RESULTS AND DISCHARGE STANDARDS

Sample 4060-2 Sample Description	Caustic		Test Results Procedure: During testing, the amount of neutralizing and precipitating agents were varied. The Ph given is the final test pH.	Discharge Limits Daily Maximum (mg/l)
	Opaque Black Liquid			
Specific Gravity	1.35		Test 1 9.0	5-11
pH	>12.0		Test 2 10.5	1.0
Metals:	<10.0		<1.0	1.0
Sb	<10.0		<1.0	1.0
As	<1.0		<1.0	1.0
Be	<10.0		<1.0	0.6
Cd	170.0		<0.1	3.5
Cr	950.0		<0.02	2.3
Cu	<10.0		<1.0	0.3
Pb	<10.0		<1.0	2.1
Ni	<10.0		<1.0	1.0
Se	<10.0		<1.0	1.0
Ag	<10.0		<1.0	1.0
Tl	6500.0		<0.1	1.0
Zn	190,000		N/A	2.2
Al			N/A	N/A
Additional Sulfides	<0.5		N/A	0.1
Parameters: Cyanide	<1.0		N/A	1.0
(mg/l) % Base (NaOH)	31.1			

TABLE IV

ENVIRESPONSE INC.: MTDL SAMPLE #4060-3 DATA, TEST RESULTS AND DISCHARGE STANDARDS

Sample 4060-3 Sample Description	Acid		Test Results		Discharge Limits Daily Maximum (mg/l)
	Clear Gold Liquid		Test 1	Test 2	
Specific Gravity	1.06		9.5	10.0	5-11
pH	0		N/A	N/A	1.0
Metals:	<1.0		N/A	N/A	1.0
(ug/l)	<1.0		N/A	N/A	1.0
Sb	<0.1		N/A	N/A	1.0
As	1.3		N/A	N/A	0.6
Be	25.0		<0.1	<0.1	3.5
Cd	260.0		<0.02	<0.02	2.3
Cr	<1.0		N/A	N/A	0.3
Cu	2.2		<0.1	<0.1	2.1
Pb	<1.0		N/A	N/A	1.0
Ni	1.0		N/A	N/A	1.0
Se	<1.0		N/A	N/A	1.0
Ag	<1.0		N/A	N/A	1.0
Tl	<1.0		N/A	N/A	1.0
Zn	930.0		<0.1	<0.1	2.2
Additional Sulfides	--		--	--	0.1
Parameters: Cyanide	--		--	--	1.0
(mg/l) % Acid (HCl)	4.8%				

ENVIRES-INC.: MTDL SAMPLE #4060-4 DATA, TEST RESULTS AND DISCHARGE STANDARDS

TABLE V

Sample #4060-4 Sample Description	Caustic Composite		Test Results	Discharge Limits Daily Maximum (mg/l)
	Clear Grey Liquid			
Specific Gravity	1.33		Test	5-11
pH	>12.0		10.0	1.0
Metals:	<10.0		<1.0	1.0
Sb	<10.0		<1.0	1.0
As	<1.0		<1.0	0.6
Be	<10.0		<0.1	3.5
Cd	80		<0.02	2.3
Cr	470		<1.0	0.3
Cu	<10.0		<0.1	2.1
Pb	<10.0		<1.0	1.0
Ni	<10.0		<1.0	1.0
Se	<10.0		<1.0	1.0
Ag	<10.0		<1.0	1.0
Tl	<10.0		<0.1	2.2
Zn	6150			
Additional Sulfides Parameters: Cyanide	<0.5		N/A	0.1
	<0.1		N/A	1.0

TABLE VI

ENVIRESPONSE INC.: MTDL SAMPLE #4060-5 DATA, TEST RESULTS AND DISCHARGE STANDARDS

Sample #4060-5	Caustic and Acid Composite		Test Results	Discharge Limits Daily Maximum (mg/l)
	Sample Description	Clear Grey Liquid		
Specific Gravity		1.25	Test 9.5	5-11
pH			<1.0	1.0
Metals:		<10.0	<1.0	1.0
(mg/l)		<1.0	<1.0	1.0
Sb		0.5	<1.0	0.6
As		74	<0.1	3.5
Be		440	<0.02	2.3
Cd		<10.0	<1.0	0.3
Cr		<1.0	<0.1	2.1
Cu		<10.0	<1.0	1.0
Pb		<1.0	<1.0	1.0
Ni		<10.0	<1.0	1.0
Se		<10.0	<1.0	1.0
Ag		<10.0	<1.0	1.0
Tl		5200	<0.1	2.2
Zn				
Additional Sulfides		<0.5	N/A	0.1
Parameters: Cyanide		<0.1	N/A	1.0

TABLE VII

ANALYSIS OF THE CAKE (PRECIPITATE) FROM
MTDL COMPOSITE SAMPLE #4060-5

<u>Metal</u>	<u>Concentration (ppm)</u>
Sb	<25
As	<25
Be	<2.5
Cd	<25
T Cr	94
Cu	580
Pb	<25
Ni	<25
Se	<25
Aq	<25
Zn	5300
Hg	<25
Co	<25
Ba	<25
V	<25
Mo	<25
Al	130,000

RESULTS OF TETRA RESOURCES APPLICATION STUDY

Tetra Resources
9391 Grogan Mill Rd.
Suite A-6B
Woodland, TX 77380
Contact: Hank Reeves (713-363-0664)

Sales Office:
Tetra Recovery Systems
1121 Boyce Rd.
Suite 1300
St. Clair Plaza
Pittsburgh, PA 15241
Contact: Fritz Zuhl (412-941-2660)

Final liquid effluent concentration (mg/l):

sulfide	2.0 less than	copper	0.05 less than
zinc	0.05 less than	chromium	0.05 less than
nickel	0.05 less than	aluminum	1,251 less than

Treatment cost: \$0.462/gallon not including disposal
(NOTE: IT disposal costs = \$39,900 or approximately \$0.333/gallon)

Treatment duration: 8.2 days per 24 hours day plus 2.8 day mobilization
and demobilization. Total = 11 days.

Waste volume reduction: 61.6% volume reduction

APPENDIX 2

EXPERIMENTAL PROCEDURES FOR EDTA CHELATION, ACID PRECIPITATION/NEUTRALIZATION AND CALCIUM CARBONATE PRECIPITATION STUDY

EDTA CHELATION

Four 1-liter beakers containing 250 ml caustic solution each were treated. The molar amount of EDTA added to the caustic solution was 15.3 times the molar amount of zinc in this solution (Keys to Chelation, Dow Chemical, 1985) plus a 10% excess. For the EDTA addition calculation, it was assumed that 1,600 ppm zinc were contained in the caustic solution (based on analytical characterization of the solution) or 0.01739 mole zinc per 250 ml of caustic. Then, 0.26915 mole EDTA/250 ml of caustic was added to each of four reaction beakers. The solution was mixed overnight so that the EDTA could thoroughly solubilize and react with the zinc.

ACID PRECIPITATION/NEUTRALIZATION

For the acid precipitation/neutralization experiment, four experimental groups were established: 1) control, no acid addition, 2) high pH (12.5), 3) mid pH (11.0), 4) low pH (9.0). Dilute (1:9) sulfuric acid was added to all beakers, except the control, to the defined pH endpoint.

High pH Solution

A total of 485 ml dilute acid was added in aliquots to the EDTA-caustic solution from the above chelation experiment. The pH endpoint of the solution was 12.5. At pH 12.7, the mixture turned milky; 24 ml of flocculant 1123L (Betz Labs) were added after acid addition to settle the precipitate.

Mid pH Solution

A total of 514 ml dilute acid was added in aliquots to the EDTA-caustic solution. The pH endpoint of the solution was 11.0, and 25 ml of flocculant 1123L were added to aid settling.

Low pH Solution

A total of 574 ml dilute acid was added in aliquots to the EDTA-caustic solution. The pH endpoint of the solution was 9.0, and 29 ml of flocculant 1123L were added to aid settling.

Each of the above solutions was mixed for 5 min after flocculant addition and allowed to settle for 1.5 hr. A precipitate was observed in all beakers.

The solutions were then centrifuged for 15 min at 3500 RPM. The supernatant was then analyzed for zinc, aluminum, and sulfide.

CALCIUM CARBONATE PRECIPITATION

Previous calculation showed 0.01759 mole zinc per 250 ml caustic solution; therefore, 0.01759 mole of calcium carbonate plus a 10% excess was added to each supernatant from the acid neutralization/precipitation step. The solutions were mixed overnight. No precipitate was observed. Each of these solutions was vacuum-filtered in a sidearm flask through #42 Whatman filter paper. The filtrate was analyzed for aluminum, zinc, and sulfide.

TABLE 2-1. ACID PRECIPITATION AND NEUTRALIZATION STUDY

Experiment #	Type Acid	Acid: water Dilution	Amount Acid Added (ml)	Amount Caustic Treated (ml)	Temp. Result of Reaction (°C)	Final pH	Flocculant a	Flocculant conc. (ppm)	Comments
1	H ₃ PO ₄	Conc.	50	300	40-50	13	-	-	Mixture setup as hard solid.
2	H ₂ SO ₄	Conc.	40	300	100+	13	-	-	Mixture had very high solid content, large evolution of heat of solution and neutralization.
3	H ₂ SO ₄	1:1	150	300	30-35	1.5	-	-	Mixture had high solids content. Less heat evolved than experiment #2 because prior acid dilution produced a separate heat of solution.
4A	H ₂ SO ₄	1:9	550	250	-	9.5	-	-	Caustic solution got progressively cloudier during acid addition.
4B	H ₂ SO ₄	1:9	555	250	22-47	9:0	1115L	1	Mixture had consistency of cream. Flocculant 1115L did not settle precipitate.
	H ₂ SO ₄	1:9	555	250	22-47	9:0	1115L	10	
	H ₂ SO ₄	1:9	555	250	22-47	9:0	1115L	100	
5	H ₂ SO ₄	1:9	555	250	22-47	9:0	1123L	10	Mixture had consistency of cream. 50 and 100 ppm flocculant 1123L settled precipitate. Solids comprised 50% of volume.
	H ₂ SO ₄	1:9	555	250	22-47	9:0	1123L	50	
	H ₂ SO ₄	1:9	555	250	22-47	9:0	1123L	100	

a flocculant 1115L is a low charge density anionic flocculant; 1123L is a high charge density anionic flocculant - Betz Labs.
 All above experiments were performed in a stirred 1 liter beaker sitting in an ice bath.

APPENDIX 3

QA/QC Results of In-House Treatability Studies

The QA/QC data and documentation for the in-house treatability studies are presented in this section.

ENVIRESOLVE, INC.

ENVIRONMENTAL EMERGENCY RESPONSE UNIT

GSA RARITAN DEPOT, WOODBRIDGE AVENUE, BUILDING 209, BAY F, EDISON, N.J. 08837
(201) 548-9660

DATE: March 9, 1987

TO: Robert Evangelista

FROM: Renee Tessler

THROUGH: Michael Miller
John Borris

Janis Giga
Mitchell Garber

SUBJECT: CALIFORNIA CREATIVE DYNAMICS

On February 2, 1987 Analytikem Inc. received eight (8) aqueous and three (3) non aqueous samples from the California Creative Dynamics site.

The samples were prepared and analyzed according to the following publications:

EPA Test Methods for Evaluating Solid Wastes - Physical/Chemical Methods - SW 846, 1982.

Standard Methods for the Examination of Water and Wastewater, 15th Edition.

The samples were analyzed for the following parameters:

Aluminum, total	Lead, total
Antimony, total	Mercury, total
Arsenic, total	Nickel, total
Beryllium, total	Selenium, total
Cadmium, total	Silver, total
Chromium, total	Thallium, total
Copper, total	Zinc, total

Total sulfide

Total fluoride

Percent nitric acid and percent sodium hydroxide based on the normalities of the sample.

This is an ongoing project, additional data will be released as separate memos.

RESULTS

The results of the metal analyses are found in sample Tables 1-6. The results of the fluoride and sulfide analyses in ug/L (ppb) are found in Tables 7-8. The detection limits for each of the parameters are included with each table due to the large variance of the detection limit from sample to sample. Tables 9 and 10 present the results of the titrations to determine the normality of each of the aqueous samples.
eh/7626D:0355D

Table 1. METAL SAMPLE RESULTS
 Concentrations reported in ug/L

Parameter	Detection Limit	Acid A-58B	Acid AC-58AB 59ABC60ABC 61ABC
Aluminum, total	200	1,800,000	1,900,000
Antimony, total	60	ND	ND
Arsenic, total	50	1,000	830
Beryllium, total	5	1,300	1,600
Cadmium, total	10	770	890
Chromium, total	50	19,000	21,000
Copper, total	25	220,000	240,000
Lead, total	100	660	960
Mercury, total	2.0	ND	ND
Nickel, total	40	1,700	2,000
Selenium, total	10	440	ND
Silver, total	50	ND	ND
Thallium, total	100	1,800	1,900
Zinc, total	20	750,000	800,000

ND denotes not detected

Table 2. METAL SAMPLE RESULTS

Concentrations reported in ug/L

Parameter	Detection Limit	Basic BC-62ABC	Basic BC-63 AB64AB65A
Aluminum, total	2000	130,000,000	150,000,000
Antimony, total	600	ND	ND
Arsenic, total	500	500	500
Beryllium, total	50	320	410
Cadmium, total	100	ND	ND
Chromium, total	500	500	ND
Copper, total	250	510	ND
Lead, total	1000	ND	ND
Mercury, total	4.0	ND	ND
Nickel, total	400	ND	ND
Selenium, total	500	ND	ND
Silver, total	500	ND	ND
Thallium, total	1000	17,000	19,000
Zinc, total	200	3,900,000	4,200,000

ND denotes not detected

Table 3. METAL SAMPLE RESULTS
 Concentrations reported in ug/L

Parameter	Detection Limit	Basic BC-66ABC	Basic BC-63C 64C65BC
Aluminum, total	2000	110,000,000	130,000,000
Antimony, total	600	ND	ND
Arsenic, total	500	500	500
Beryllium, total	50	340	400
Cadmium, total	100	ND	ND
Chromium, total	500	ND	ND
Copper, total	250	850	250
Lead, total	1000	ND	ND
Mercury, total	4.0	ND	ND
Nickel, total	400	ND	ND
Selenium, total	500	ND	ND
Silver, total	500	ND	ND
Thallium, total	1000	15,000	14,000
Zinc, total	200	3,900,000	4,000,000

ND denotes not detected

Table 4. METAL SAMPLE RESULTS

Concentrations reported in ug/L

Parameter	Detection Limit	Basic BC-67AB	Basic Sample # 8
Aluminum, total	2000	170,000,000	30,000,000
Antimony, total	600	ND	ND
Arsenic, total	500	ND	ND
Beryllium, total	50	570	50
Cadmium, total	100	ND	ND
Chromium, total	500	500	ND
Copper, total	250	ND	670
Lead, total	1000	ND	ND
Mercury, total	4.0	ND	ND
Nickel, total	400	ND	ND
Selenium, total	500	ND	ND
Silver, total	500	ND	ND
Thallium, total	1000	21,000	9,800
Zinc, total	200	3,500,000	1,100,000

ND denotes not detected

Table 5. METAL SAMPLE RESULTS

Concentrations reported in ug/kg

Parameter	Detection Limit	Basic-Filter Cake BS-69A	Basic-Filter Cake BS-69B
Aluminum, total	20,000	210,000,000	130,000,000
Antimony, total	6,000	ND	ND
Arsenic, total	5,000	ND	16,000
Beryllium, total	500	850	500
Cadmium, total	1,000	ND	ND
Chromium, total	5,000	130,000	130,000
Copper, total	2,500	170,000	1,000,000
Lead, total	10,000	ND	ND
Mercury, total	200	ND	ND
Nickel, total	4,000	4,000	4,600
Selenium, total	1,000	ND	ND
Silver, total	5,000	ND	ND
Thallium, total	10,000	45,000	32,000
Zinc, total	4,000	6,400,000	6,100,000

ND denotes not detected

Table 6. METAL SAMPLE RESULTS

Concentrations reported in ug/kg

Parameter	Detection Limit	Basic-Filter Cake BS-69C
Aluminum, total	20,000	130,000,000
Antimony, total	6,000	ND
Arsenic, total	5,000	38,000
Beryllium, total	500	750
Cadmium, total	1,000	ND
Chromium, total	5,000	140,000
Copper, total	2,500	1,100,000
Lead, total	10,000	ND
Mercury, total	200	ND
Nickel, total	4,000	5,300
Selenium, total	1,000	ND
Silver, total	5,000	ND
Thallium, total	10,000	35,000
Zinc, total	4,000	6,500,000

ND denotes not detected

Table 7. TOTAL SULFIDE

Sample	Detection Limit	Total Sulfide
Acid A-58B	1,000 ug/L	ND
Acid AC-58ABC59ABC 60ABC61ABC	1,000 ug/L	ND
Basic BC-62ABC	1,000 ug/L	17,000,000 ug/L
Basic BC-63ABC64ABC 65A	1,000 ug/L	14,000,000 ug/L
Basic BC-66ABC	1,000 ug/L	20,000,000 ug/L
Basic BC-63C64C65BC	1,000 ug/L	19,000,000 ug/L
Basic BC-67AB	1,000 ug/L	13,000,000 ug/L
Basic Sample-8	1,000 ug/L	3,700,000 ug/L
Basic-Filter Cake BS-69A	1,000,000 ug/kg	ND
Basic-Filter Cake BS-69B	1,000,000 ug/kg	ND
Basic-Filter Cake BS-69C	1,000,000 ug/kg	ND
Method Blank	1,000 ug/L	ND

ND denotes not detected

Table 8. TOTAL FLUORIDE
Concentrations reported in ug/L

Sample	Detection Limit	Total Fluoride
Acid A-58B	200	1,500,000
Acid AC-58ABC59ABC 60ABC61ABC	200	1,600,000
Method Blank	200	ND (200)

ND denotes not detected

Table 9. RESULTS OF PERCENT NITRIC ACID

Samples	Normality (by titration)	% Nitric Acid
Acid A-58	1.18	7.4
Acid AC-58AB59ABC 60ABC61ABC	1.21	7.6

Table 10. RESULTS OF PERCENT SODIUM HYDROXIDE

Samples	Normality (by titration)	% Sodium Hydroxide
Basic BC-62ABC	9.83	39.3
Basic BC-63ABC64ABC65A	10.76	43.0
Basic BC-66ABC	9.24	37.0
Basic BC-63C64C65BC	10.53	42.1
Basic BC-67AB	10.88	43.5
Basic Sample #8	3.28	13.12

QA/QC RESULTS

QA/QC results of the matrix spikes for metals are found in QA/QC Tables 11-15. The samples were spiked in duplicate with the various constituents and the percent recovery and the relative percent difference were calculated.

Results of sample, Acid A-58B, are found in QA/QC Table 11. Recoveries of all constituents are between 41% and 112% with the exception of silver, which had a spike recovery of 8% and 14%. The silver combined with the fluoride to form AgF which is insoluble in water. All the compounds, including silver, had RPD values within the control limits of the laboratory. Aluminum, copper and zinc spikes were performed on a deionized (DI) water sample due to the interferences of the sample matrices.

Results of sample, Basic BC-62ABC, are found in QA/QC Table 12. The sample was spiked with the constituents beryllium, cadmium, chromium, copper, nickel, silver and thallium. The spike recoveries ranged from 40%-94%. The relative percent difference (RPD) for all the metals was less than 5.4%. These RPD values were all within the laboratory control limits.

Sample, Basic BC-63C64C65BC, was spiked with the constituents aluminum, antimony, lead, and mercury. These results are presented in QA/QC Table 13. The spike recoveries for this sample ranged from 56%-180%. Mercury had spike recoveries of 0.34% and 0.44% due to the sample matrix. The ICP digestion was used for this sample because of the large amount of precipitate which formed when acid was added to the sample. QA/QC Table 14 presents the results of a DI water spike in this matrix. Mercury, aluminum, and zinc spikes were performed on a DI water due to the sample matrix interferences. The percent recovery of these spikes ranged from 84%-96%, with the exception of lead which had recoveries of 45%-57%. All of these compounds with the exception of mercury fell within the control limits of the laboratory.

Results of sample, Basic Filter Cake BS-69B, are found in QA/QC Table 15. The constituents had spike recoveries between 39%-95% for most of the constituents. All of the constituents had spike recoveries within the laboratories control limits. Silver had spike recoveries of 7% & 8%. A deionized (DI) water spike was performed for the constituent aluminum. The spike recovery was 74%.

QA/QC Table 16 presents the results of the sample spikes for total fluorides and total sulfides. Sample spikes were performed on the acid and basic matrices for total sulfides. In the acid matrix, there was no recovery of the spike. In the basic matrix, the spike recoveries of the duplicate runs averaged 49%. The relative percent difference (RPD) was 4.0. This value is within the acceptable limits of the laboratory. A spike was performed on deionized (DI) water to test the efficiency of the spiking process. The recovery of this spike was 91%. The low recovery for the spikes in the sample was due to matrix interferences.

A total fluoride spike was performed on sample, Acid AC-58AB59ABC60ABC61ABC, the recovery of this spike was 99% in each of the duplicate runs. The percent recovery and RPD were within the laboratory control limits.

QA/QC Table 11. Matrix Spike Duplicate Analysis

Sample: Acid A-58B

Parameter	Spike Conc. (ug/L)	% Recovery		RPD
		Run 1	Run 2	
Antimony	500	81	82	1.2
Arsenic	300	112	111	0.89
Beryllium	300	64	69	4.5
Cadmium	300	67	72	7.7
Chromium	300	63	72	13.2
Lead	300	56	56	0.0
Mercury	20	66	68	3.0
Nickel	300	82	41	7.5
Selenium	300	44	43	2.3
Silver	300	14	8	55.0
Thallium	300	62	66	6.3
Aluminum*	1000	80	--	--
Copper*	300	80	--	--
Zinc*	300	84	--	--

* Spike was performed on DI water
 RPD denotes Relative Percent Difference

QA/QC Table 12. Matrix Spike Duplicate Analysis

Sample: Basic BC-62ABC

Parameter	Spike Conc. (ug/L)	% Recovery		RPD
		Run 1	Run 2	
Beryllium	300	81	81	0.0
Cadmium	300	40	42	4.9
Chromium	300	54	57	5.4
Copper	300	59	60	1.7
Nickel	300	53	54	1.9
Silver	300	45	47	4.4
Thallium	300	90	94	4.3

RPD denotes Relative Percent Difference

QA/QC Table 13. Matrix Spike Duplicate Analysis

Sample: Basic BC-63C64C65BC

Parameter	Spike Conc. (ug/L)	% Recovery		RPD
		Run 1	Run 2	
Aluminum	1000	180	154	18.0
Antimony	500	68	64	6.1
Lead	300	56	56	0.0
Mercury	20	0.35	0.44	23.0

RPD denotes Relative Percent Difference

QA/QC Table 14. Matrix Spike Duplicate Analysis

Sample: DI Water

Parameter	Spike Conc. (ug/L)	% Recovery		RPD
		Run 1	Run 2	
Aluminum	300	86	96	11.0
Antimony	20	96	88	8.7
Lead	300	45	57	24.0
Mercury	300	84	--	--
Zinc	300	84	--	--

RPD denotes Relative Percent Difference

QA/QC Table 15. Matrix Spike Duplicate Analysis

Sample: Basic Filter Cake BS-69B

Parameter	Spike Conc. (ug/kg)	% Recovery		RPD
		Run 1	Run 2	
Antimony	500	50	40	67.0
Arsenic	500	80	95	17.0
Beryllium	500	77	79	2.6
Cadmium	500	71	74	4.1
Chromium	500	70	73	4.2
Copper	500	55	70	39.7
Lead	500	60	63	4.9
Mercury	20	63	57	10.0
Nickel	500	71	74	4.1
Selenium	500	39	56	35.0
Silver	500	7	8	13.0
Thallium	500	79	85	7.3
Zinc	500	21	91	125.0
Aluminum*	1000	74	--	--

* Spike was performed on DI water
 RPD denotes Relative Percent Difference

QA/QC Table 16. Matrix Spike Duplicate Analysis

Sample	Parameter	Amount of Spike (ug)	% Recovery		RPD
			Run 1	Run 2	
Acid AC-58AB 59ABC60ABC 61ABC	Total Sulfide	1000	-	-	-
Basic Filter Cake BS-69B	Total Sulfide	1000	50	48	4.0
DI Water	Total Sulfide	1000	91	-	-
Acid AC-58AB 59ABC60ABC 61ABC	Total Fluoride	100	99	99	0.0

RPD denotes Relative Percent Difference

DATE: March 10, 1986
TO: Robert Evangelista
FROM: Renee Tessler

THROUGH: Michael Miller ^{JMM} Janis Giga ^{JG}
John Borris ^{JB} Mitchell Barber ^{MB} MDR/DEM
SUBJECT: CALIFORNIA CREATIVE DYNAMICS

International Technology Corporation received one (1) liquid sample on February 26, 1987 for analysis of the following parameters:

Aluminum, total
Chromium, total
Copper, total
Nickel, total
Thallium, total
Zinc, total

The sample analysis was performed in accordance with EPA/NJDEP Approved Methodology.

This is an ongoing project, additional data will be released as separate memos.

RESULTS: Sample results are found in Table 1.

QA/QC RESULTS: Duplicate results of sample E702138-01 are found in QA/QC Table 2. The relative percent difference (RPD) for all the parameters analyzed was between 0.0-3.2. An RPD value of less than 10 is good. QA/QC Table 3 presents the results of the matrix spike analysis. The percent recovery of the spike for all the parameters tested was between 97%-131%. A spike recovery of 100 % \pm 10% is good. In the case of nickel, 131 percent of the spike was recovered. This recovery was within the control limits established by the laboratory.

TABLE 1. SAMPLE RESULTS
concentrations in ug/L (ppb)

Sample E702138-01
California Creative Dynamics

PARAMETERS	CONCENTRATION ug/L
Aluminum	3,150 *
Chromium	ND (200)
Copper	ND (30)
Nickel	ND (60)
Thallium	ND (100)
Zinc	49

ND denotes not detected

* denotes the average of duplicate runs

QA/QC TABLE 2. RESULTS OF DUPLICATE ANALYSIS
 concentrations reported in ug/L (ppb)

Sample E702138-01
 California Creative Dynamics

PARAMETERS	CONCENTRATION		RPD
	run 1	run2	
Aluminum	3100	3200	3.2
Chromium	ND(200)	ND(200)	--
Copper	ND(30)	ND(30)	--
Nickel	ND(60)	ND(60)	--
Thallium	ND(100)	ND(100)	--
Zinc	49	49	0.0

ND denotes not detected
 RPD denotes Relative Percent Difference

QA/QC TABLE 3. RESULTS OF MATRIX SPIKE ANALYSIS

concentrations reported in ug/L (ppb)

Sample E702138-01
California Creative Dynamics

PARAMETERS	SAMPLE CONC.	CONC. OF SPIKE	RECOVERED CONC.	PERCENT RECOVERY
Aluminum	3150 *	2000	5100	98
Chromium	ND(200)	1000	1070	107
Copper	ND(30)	250	249	100
Nickel	ND(60)	400	523	131
Thallium	ND(100)	500	483	97
Zinc	49	1000	1150	110

ND denotes not detected

* represent the average of duplicate runs

DATE: March 12, 1987
TO: Robert Evangelista
FROM: Renee Tessler
THROUGH: Michael Miller *MM* Janis Giga *JG*
John Borris *JB* Mitchell Garber *MDG/DEM*
SUBJECT: CALIFORNIA CREATIVE DYNAMICS

International Technology Corporation received three (3) liquid samples on March 5, 1987 for the analysis of zinc.

The sample analysis was performed according to EPA/NJDEP Approved Methodology.

This is an ongoing project, as additional data becomes available it will be released as separate memos.

RESULTS: Sample results are found in Table 1.

QA/QC RESULTS: The laboratory corrected for any spectral interferences caused by sample matrix. QA/QC Table 2 presents the results of the duplicate runs. The relative percent difference of the duplicate runs was 3.9. An RPD of less than 10 is good. QA/QC Table 3 presents the matrix spike results. The spike recovery of the sample was 102%. A spike recovery of 100 % 10% is good.

TABLE 1. SAMPLE RESULTS OF ZINC ANALYSIS
concentrations reported in mg/L (ppm)

Sample No.	Concentration
E703031-01 Top	6270
E703031-02 Bottom	6230
E703031-03 Composite	6090 *

* represents the average of duplicate runs

QA/QC TABLE 2. RESULTS OF ZINC DUPLICATE ANALYSIS

concentrations reported in mg/L (ppm)

SAMPLE NUMBER	CONCENTRATION		RPD
	run 1	run 2	
E703031-03 composite	6207	5968	3.9

RPD denotes Relative Percent Difference

QA/QC TABLE 3. RESULTS OF MATRIX SPIKE ZINC ANALYSIS
concentration reported in mg/L (ppm)

SAMPLE NO.	SAMPLE CONC.	CONC. OF SPIKE	RECOVERED CONC.	PERCENT RECOVERY
E703031-03 composite	6207	5000	11,290	102

INTER OFFICE CORRESPONDENCE

DATE: March 18, 1987
TO: Robert Evangelista
FROM: Renee Tessler
THRU: Michael Miller *mmiller*
Janis Giga *Janis Giga*
SUBJECT: CALIFORNIA CREATIVE DYNAMICS

International Technology Corporation received four (4) solid samples on March 10, 1987 for zinc analysis. On March 9, 1987 International Technology Corporation received seven (7) liquid samples for aluminum, sulfide, and zinc analysis. This is a compilation of these two sample sets.

The sample analysis was performed according to EPA/NJDEP Approved Methodology. The control sample was adjusted to pH 12.5, pH 11.0, and pH 9.0, respectively. The liquid phase was separated from the solid phase for each pH level. The liquids were analyzed for zinc, aluminum and sulfide to determine if there was any change in concentration as pH decreased. The solid phases were analyzed for zinc to determine if there was any change in the concentration of zinc as the pH decreased.

This is an ongoing project, as additional data becomes available it will be released as separate memos.

RESULTS: Sample results of these two reports and presented in Tables 1-2.

Table 1 presents the results of aluminum and zinc analysis. Aluminum was analyzed for only in the liquid samples. There was a decrease in the aluminum concentration as the pH was lowered. Zinc analysis was performed on all the samples. In the solid samples the zinc concentration increases as the pH is decreased. In the liquid samples the zinc concentration decreases as the pH is decreased from 14.0 to 12.5. The zinc concentration stayed constant between pH 12.5-pH 11.0. There was another decrease in zinc concentration as the pH was lowered from 11.0 to 9.0.

Table 2 presents the sulfide concentrations of the liquid samples. The liquid control sample was treated with 448.1 grams of EDTA for every liter of caustic solution. It is to be noted that the sulfide concentration has decreased from the original sulfide concentrations reported by Analytichem in the memo dated March 9, 1987.

QA/QC RESULTS: QA/QC Table 3 presents the results of duplicate analyses of both the liquid and solid samples. The relative percent difference (RPD) of the zinc in the solid control sample is 17.9. This RPD is within the acceptability limits of the laboratory. The liquid portion of the sample was run in duplicate for zinc, aluminum, and sulfide concentration. QA/QC Table 4 presents these results.

Sample, Step 1 pH 9.0, was run in duplicate for zinc and aluminum, the relative percent difference (RPD) for both constituents is less than 3.0. Sample, Step 2 pH 11.0 was run in duplicate for sulfides. The RPD was 18.2. All the above values are within the control limits of the laboratory. QA/QC Table 5 presents the matrix spike results of a 1000 mg/L spike of aluminum. The recoveries ranged from 94%-126%. The control sample spike recovery was 100%. QA/QC Table 6 present the matrix spike analysis of a 1000 mg/L spike of zinc. The spike recoveries ranged from 99%-122%. The spike recoveries are within the control limits of the laboratory.

cc: John Borris
Mitchell Garber

TABLE 1. SAMPLE RESULTS

concentrations reported in mg/L (ppm)

Sample Identification	Aluminum Conc.	Zinc Conc.
Step 1 pH 9.0	1570*	1040*
Step 2 pH 9.0	1590	1050
Step 1 pH 11.0	2350	1150
Step 2 pH 11.0	2410	1130
Step 1 pH 12.5	480	1100
Step 2 pH 12.5	620	1160
Control pH 14.0	106,200	6650
Solids pH 9.0	NR	8580 #
Solids pH 12.5	NR	7710 #
Solids pH 11.0	NR	8070 #
Solids Control pH 14.0	NR	4190*#

* denotes the average of duplicate runs.

NR not requested.

denotes concentrations reported in mg/Kg (ppm)

TABLE 2. SAMPLE RESULTS OF SULFIDE DETERMINATION
concentrations reported in mg/L (ppm)

Sample Identification	Sulfide
Step 1 pH 9.0	2.0
Step 2 pH 9.0	3.2
Step 1 pH 11.0	1.0
Step 2 pH 11.0	2.2*
Step 1 pH 12.5	1.0
Step 2 pH 12.5	1.5
Control	73.0

* denotes the average of duplicate runs.

QA/QC TABLE 3. RESULTS OF DUPLICATE ANALYSIS
concentrations reported in mg/Kg (ppm)

SAMPLE IDENTIFICATION

SOLIDS CONTROL

Parameter	CONCENTRATION		RPD
	Run 1	Run 2	
Zinc	3810	4560	17.9

QA/QC TABLE 4. RESULTS OF DUPLICATE ANALYSIS

concentrations reported in mg/L (ppm)

SAMPLE IDENTIFICATION

PARAMETER	<u>STEP 1 pH 9.0</u>			<u>STEP 2 pH 11.0</u>		
	CONCENTRATION		RPD	CONCENTRATION		RPD
	run 1	run 2		run 1	run2	
ZINC	1050	1020	2.9	NR	NR	--
ALUMINUM	1550	1580	1.9	NR	NR	--
SULFIDE	NR	NR	--	2.4	2.0	18.2

RPD denotes Relative Percent Difference

NR denotes not detected

QA/QC TABLE 5. RESULTS OF MATRIX SPIKE ANALYSIS

concentrations reported in mg/L (ppm)
all samples spiked with 1000 mg/L aluminum

SAMPLE IDENTIFICATION	SAMPLE CONCENTRATION	SPIKED SAMPLE CONCENTRATION	PERCENT RECOVERY
STEP 1 pH 9.0	1570*	2750	118
STEP 2 pH 9.0	1590	2850	126
STEP 1 pH 11.0	2350	3330	98
STEP 2 pH 11.0	2410	3660	125
STEP 1 pH 12.5	480	1420	94
STEP 2 pH 12.5	620	1740	112
CONTROL	106,200	107,200	100

* denotes the average of duplicate runs.

QA/QC TABLE 6. RESULTS OF MATRIX SPIKE ANALYSIS

concentrations reported in mg/L (ppm)
all samples spiked with 1000 mg/L zinc

SAMPLE IDENTIFICATION	SAMPLE CONCENTRATION	SPIKED SAMPLE CONCENTRATION	PERCENT RECOVERY
SOLIDS CONTROL	4190*#	5270 #	108
STEP 1 pH 9.0	1040*	2200	116
STEP 2 pH 9.0	1050	2040	99
STEP 1 pH 11.0	1150	2220	107
STEP 2 pH 11.0	1130	2300	117
STEP 1 pH 12.5	1100	2260	116
STEP 2 pH 12.5	1160	2380	122
CONTROL	6650	7710	106

* denotes the average of duplicate runs.

denotes concentrations reported in mg/Kg (ppm)