LOWENSTEIN, SANDLER, KOHL, FISHER & BOYLAN
A PROFESSIONAL CORPORATION
COUNSELLORS AT LAW
65 LIVINGSTON AVENUE
ROSELAND, NEW JERSEY
07068-1791
TELEPHONE (201) 992-8700
FACSIMILE (201) 992-5820

SOMERVILLE OFFICE
TELEPHONE (201) 526-3300

ALAN V. LOWENSTEIN
RICHARD M. SANDLER
BENEDICT M. KOHL
ARNOLD FISHER
JOSEPH LEVOW STEINBERG
MATTHEW P. BOYLAN
BRUCE D. SHOULSON
JOHN R. MACKAY 2ND
MARTIN R. GOODMAN
JOHN D. SCHUPPER
STEPHEN N. DERMER
MICHAEL L. RODBURG
ALLEN B. LEVITHAN
R. BARRY STIGER
GREGORY B. REILLY
PETER H. EHRENBERG
HOWARD S. DENBURG
STEVEN B. FUERST
THEODORE V. WELLS, JR.

WILLIAM S. KATCHEN
MICHAEL DORE
GERALD KROVATIN
RICHARD D. WILKINSON
ALAN WOVSANIKER
KENNETH J. SLUTSKY
DAVID L. HARRIS
ZULIMA V. FARBER
WILLIAM P. MUNDAY
COLLEEN P. KELLY
DANIEL J. BARKIN
GEORGE J. MAZIN
JAMES STEWART
ROBERT L. KRAKOWER
KEITH H. ANSBACHER
LAURA R. KUNTZ
ROBERT D. CHESLER
RICHARD F. RICCI

RICHARD P. BOEHMER
NORMAN W. SPINDEL
OF COUNSEL

LEE HILLES WERTHEIM
STUART S. YUSEM
KEVIN KOVACS
JOHN L. BERGER
LEE ANNE GRAYBEAL
PHYLLIS F. PASTERNAK
RICHARD NIEMIEC
MARY-LYNNE RICIGLIANO
LUCINDA P. LONG
STEPHEN H. SKOLLER
DAVID W. FIELD
MARY JO REICH
ANN P. OSTERDALE
MARTHA L. LESTER
LINDA PICKERING
CAROL A. SURGENS
MICHAEL O'B. BOLDT
BETH ANN WILANSKY
BONNIE K. LEVITT
MICHAEL D. SCOTT
ROCHELLE B. GALIBER
SOLON L. KANDEL
PAUL C. PAWLOWSKI
DENNIS F. GLEASON
ANTHONY J. REITANO, JR.
HOWARD A. TEICHMAN
ROBERT G. MINION
KAREN GAYNOR KILLEEN
DEBBIE KRAMER GREGG
M. ANNE CONLEY-PITCHELL
JEFFREY J. WILD
LEON S. SEGEN
TERRY E. THORNTON
ALEXANDER J. KOVACS
CONSTANCE J. ALEXANDER

MARIA A. DANTAS
ARTHUR H. SAIEWITZ
DAVID S. WOLIN
DOLORES M. BLACKBURN
WALTER A. EFFROSS
GEORGIA A. McMILLEN
MARC B. KRAMER
JOHN F. DELANEY
SCOTT E. RATNER*
LYNNE S. SCHERTZ*
PATRICK J. CONLON
SAMUEL ROSENBERG
GARY M. WINGENS
CHRISTINE RANIERI SMITH
MARJORIE E. KLEIN
IVAN M. BARON
VIVIAN D. LAGER
SUNIL K. GARG
GAIL E. XIOUES
EILEEN M. CLARK
MONICA C. BARRETT
BRIAN M. ENGLISH
RICHARD P. SHAPIRO
JAYNE A. PRITCHARD
MIRIAM KAHAN BRODY
GWEN J. LOURIE
DARRYL E. GUGIG
SAMUEL B. SANTO, JR.
JONATHAN T. K. COHEN
CRAIG M. LESSNER
SUSAN L. YOUDOVIN
PAUL F. CARVELLI
JAY A. SOLED
SUSAN E. WAELBROECK**
ADAM L. GANS

*N.Y. BAR ONLY
**TEXAS BAR ONLY

March 23, 1990

Alexander M. Moskie, P.E.
Senior Sanitary Engineer
N.Y.S.D.E.C.
Bldg. 40 - SUNY
Stony Brook, NY 11794

Re: Cerro Conduit, Syosset, NY
Our File No. M2377-2

Dear Mr. Moskie:

On August 3, 1987, the Department of Environmental Conservation ("Department") and Cerro Conduit Company ("Cerro") entered into an Order on Consent ("Order") relating to the decommissioning of Cerro's manufacturing facility in Syosset, New York. In addition to structures and equipment decommissioning, a goal of the Order was the evaluation of "the impacts, if any, of any waste within the soil on the site"; and remediation of "any contaminated soil found at the site" having any potentially adverse impacts.

Through the cooperative efforts of the parties, the work necessary to meet the requirements of the Order with respect to structures and equipment has been completed. However, the soil issue remains open.

It appears that the lack of finality in this area may be the result of some misunderstanding between the parties as to how the investigation in this area was to proceed, although at least the open issue has been narrowed to the contaminants in soil within Basins 1, 2 and 3 and the area around sampling point B109. The purpose of this letter is to attempt to resolve this misunderstanding so that the parties can proceed in a manner that will finally resolve this matter.

It might be best to start with a brief review of the soil program so far. An initial report on soil sampling and analysis was submitted to the Department on July 28, 1987 ("Phase 1 Report"). The Department undertook a review of this Report and in a memorandum dated September 17, 1987, from Anthony Candela to Rocky Piaggione, the Department recommended that additional sampling take place and that "total metals" analysis be used. Cerro complied and on April 19, 1988 submitted a Phase 2 report that sought to satisfy the Department's recommendations.

On June 22, 1988, Mr. Candela informed Cerro that the Phase 2 Report was acceptable, further assessment of the results of the plant decommissioning and soil sampling program was necessary, and that "some remediation of the site. . .specifically to Basins 1, 2, 3 and the area around sampling point B109," would be necessary.

On July 21, 1988, Cerro's consultant, The Avendt Group, Inc. ("Avendt Group"), met with Mr. Candela to discuss how to proceed further. The results of that discussion are set forth in a letter from Avendt Group to Mr. Candela dated July 25, 1988. Cerro's understanding of that letter is that the parties agreed that instead of performing an impact assessment based on the Phase 2 Report, an additional round of sampling and analysis would take place according to the protocol set forth in the letter. The results of this round were to be submitted to the Department for comment and a subsequent impact assessment would be performed depending on the result. (See items A.2 and A.3 of the July 25, 1988, letter.)

The sampling and analysis set forth in the July 25 letter, and as slightly modified in a letter from Avendt Group to Mr. Candela dated November 8, 1988, were performed, and the results were submitted to the Department in a Phase 3 Report dated March 22, 1989. It was Cerro's expectation that thereafter the Department and Cerro's consultant would agree as to what substances were to be the subject of the impact assessment and that any decision as to the remediation of any soil would await the completion of the impact assessment.

Contrary to this understanding, on June 23, 1989, you wrote to Avendt Group, stating that the Department's staff had reviewed the Phase 3 Report. Without further comment on the Report, you stated that there had been a decision to use "three times average background concentration as a clean-up standard." You further set forth what are apparently the clean-up standards for selenium (>1.2 ppm), copper (>120 ppm) and cyanide (>12 ppm), and stated that soil exceeding these levels should be removed or remediated.

Cerro believes that the determination of background levels and any decision regarding removal or remediation is premature and inconsistent with the terms of the Order. The Order contemplates that Cerro would have the opportunity to submit an impact assessment relating to substances of concern prior to any determination as to the need for or methods of remediation. Although the Order speaks in paragraph VIII of a "Report" in the singular, it is clear that the parties decided to proceed with a "phased" approach. In our view, Cerro should submit the final phase - the impact assessment - before a final decision on remediation can be made.

In order to resolve this matter expeditiously and in the spirit of continuing cooperation between the parties, we are submitting with this letter the Impact Assessment and Recommendations prepared by Avendt Group, Inc. Cerro requests that the Department consider this impact assessment before making any determination pursuant to paragraph IX of the Order determining whether a remedial action program is necessary. It is hoped that the Department will adopt the recommendations Avendt Group has made. We suggest that any questions or comments about the Impact Assessment and Recommendations should be addressed at a meeting of Cerro representatives to be scheduled at your convenience.

Please do not hesitate to contact me or Mr. Thomas Wills at Avendt Group, Inc., to discuss this matter further.

Very truly yours,

John F. Delaney

John F. Delaney

JFD:SBF

CERRO CONDUIT SITE

SYOSSET, NASSAU COUNTY, NEW YORK

SOIL SAMPLING PROGRAM

DATA ASSESSMENT

Submitted to
The New York State Department of Environmental Conservation
Stony Brook, New York

by

The Avendt Group, Inc.
180 Admiral Cochrane Drive
Annapolis, MD 21401

March 23, 1990

CERRO CONDUIT SITE
SOIL SAMPLING PROGRAM
DATA ASSESSMENT

List of Tables

List of Figures

1.0 INTRODUCTION

This Data Assessment has been prepared to fulfill the terms of an Order on Consent (consent order) issued by the New York State Department of Environmental Conservation (NYSDEC) for the former Cerro Conduit Company (Cerro) site in Syosset, New York. Specifically, NYSDEC, through the consent order, stipulated that Cerro was to evaluate the impacts of any waste within the soil on the site. Cerro retained the Avendt Group, Inc. (AGI) to perform this evaluation. This Data Assessment begins with a description of the background and history of investigations at the site. Next, a summary of site characteristics and results from previous soil sampling programs is presented. Following this background information, assessments are made of the potential contaminants of concern with regard to their toxicity, environmental impacts, and potential exposure pathways. The Avendt Group concludes the Data Assessment with a discussion of potential areas of concern. This is followed by a recommendation for further and more focussed investigation.

1.1 Background

Cerro Conduit Company operated a copper wire drawing and electrical conduit plating facility at Robbins Lane and Miller Place in Syosset, Nassau County, New York. The facility was constructed in 1951 on former agricultural property and continued in operation until October 1986. Ownership of the property transferred in 1985 to Sy Associates of Queens County, New York. Sy Associates recently sold the property to the New York Daily News.

In October 1986, in order to comply with the State of New York's closure regulations, Cerro voluntarily commenced a decommissioning procedure. The aim of this procedure was to clean all structures and equipment and to dispose of any wastes remaining after Cerro's operations were terminated.

In 1987, Cerro initiated a soil sampling program to determine the nature and extent of any contaminants present in the soil and to evaluate the impact of any contamination. Phase 1 of the Soil Sampling Program was developed and carried out in March 1987. Phase 1 sampling consisted of collecting shallow soil samples according to a 100-foot grid across the property and deep soil samples near structures that processed wastewaters and sludges generated on site. Cerro reported the results of the analysis of these 90 soil samples to NYSDEC in July 1987.

1.2 **Order on Consent**

On August 3, 1987, Cerro and NYSDEC entered into a consent order. This consent order formalized the on-going joint efforts to properly decommission the manufacturing plant and to complete an investigation of the site soils. The consent order stated that Cerro agreed to:

a) continue to develop and carry out the decommissioning plan, and

b) continue to develop and carry out a soil sampling program.

Upon completion of the decommissioning plan and soil sampling program, Cerro agreed to provide an assessment of the results to determine the environmental impacts of wastes disposed of at the site. The decommissioning of the plant and a three-phase investigation of the soil were performed in accordance with the terms of the consent order and approved by NYSDEC. This Data Assessment is submitted to NYSDEC as specified by Part VIII, (b) of the consent order.

1.3 **Decommissioning Plan**

Decommissioning activities began on October 7, 1986 and ended on June 30, 1987. Equipment and structures associated with each of the processes used in manufacturing at the Cerro Conduit plant were decontaminated. Any salvageable materials were prepared for salvage. Waste materials were disposed of according to New York State and Federal regulations. NYSDEC maintained close communication with the Nassau County Department of Health (NCDH). NYSDEC approved the building decommissioning by a certified letter dated June 6, 1988 from Ms. Tanya Hermos, Assistant Sanitary Engineer, Hazardous Waste Department, Stony Brook, New York. The letter stated that the site had been inspected and met the requirements of 6NYCRR, Part 373-3.7, Closure and Post Closure. Mr. Anthony Candela, Senior Engineer, NYSDEC Hazardous Waste Remediation, in a letter dated June 30, 1988 stated that he agreed that the decommissioning of the plant had been satisfied and did not require any further assessment. Therefore, AGI has not included the decommissioning activities within the scope of this Data Assessment.

Approval of the decommissioning plan effectively removed the site from NYSDEC's list of active hazardous waste facilities. On January 23, 1986, by letter from Mr. Anthony Candela, NYSDEC acknowledged the downgrading of the Cerro site from a Level 2a, a site requiring further investigation and remediation, to a Level 4, a site which has been properly closed but requires continued management.

1.4 Soil Contamination

In September 1987, NYSDEC requested more soil sampling and additional analyses at sixteen locations previously sampled during Phase 1 and at five new locations in the three basins on site. These basins had been permitted by NYSDEC for the discharge of treated wastewater and non-contact cooling water to the groundwater beneath the site. AGI performed Phase 2 of the Soil Sampling Program in December 1987 and submitted a report to NYSDEC in April 1988.

In a letter dated June 22, 1988, Mr. Anthony Candela approved the Phase 2 sampling report and identified two issues still to be addressed. The first was the need for an assessment of the sampling program in accordance with Part VIII, (b) of the consent order. The second issue involved a perceived need for limited remediation of the site, particularly in the three basins and the area of high copper concentration in the vicinity of boring B109.

During November 1988, 32 samples were collected from the three basins for the Phase 3 sampling event. After receipt of the Phase 3 report, Mr. Alexander Moskie of NYSDEC responded in a letter dated June 23, 1989, suggesting a clean-up standard of three times background levels for selenium, copper and cyanide.

Based on the written record documenting the three phases of the soil sampling program conducted under the authority of the consent order, the scope of this Data Assessment addresses the impacts and potential need for remediation of the three basins and B109 area with respect to soil contamination by copper, cyanide and selenium.

The professionals who participated in the preparation of this Data Assessment are listed in the Appendix.

2.0. SITE CHARACTERIZATION

2.1 Location

The former Cerro Conduit plant is located in Syosset, in northeast Nassau County, on Long Island, New York. The 40-acre property is bounded on the south by Miller Road, on the west by Robbins Lane, on the north by the Long Island Railroad Line, and on the east by the Town of Oyster Bay Public Works facility.

2.2 Surrounding Land Use

The Cerro site and surrounding land are used primarily for industrial purposes. Residential land use occurs within one-half mile of the site. NYSDEC currently lists the Cerro site as Class 4 on its list of inactive waste disposal sites. A Class 4 site is defined as one that has been properly closed but requires continued management. The Cerro site has been commercially inactive since October 1986. Most structures remain; however, some are in poor condition. Vandalism and unauthorized use of the site appear to have occurred throughout the property.

The Syosset Landfill lies north of and adjacent to the Cerro site. The landfill is currently on the USEPA National Priority List as an uncontrolled hazardous waste disposal site. NYSDEC classifies the landfill as a Class 2 site on their list of inactive hazardous waste disposal sites. NYSDEC defines a Class 2 site as requiring action because it presents a significant threat to the public health or environment.

2.3 Surface Topography

The Syosset area is located on glacial outwash deposited during the most recent period of glaciation, in the Pleistocene Age. Except for man-made excavations, the land varies from relatively level to slightly sloping, dictated by glacial and glaciofluvial action. On site excavations have altered the elevation by as much as 50 feet in some areas. These excavations create site-specific conditions which dictate local surface runoff.

2.4 Geology

2.4.1 Site Stratigraphy

The geology of Nassau County consists of unconsolidated glacial and marine deposits dating to the late-Cretaceous, Pleistocene and Holocene Ages. These deposits overlie crystalline igneous and metamorphic bedrock. Depth to bedrock is approximately 1,000 feet, dipping southeasterly at an approximate slope of 80 feet per mile (Isister, 1966). The Lloyd Aquifer lies above the bedrock and is composed of 150 to 400 feet of quartzose sand and gravel in a clayey matrix. Sandy clay lenses are believed to be prevalent in this formation. A confining layer, the Raritan Clay, lies between the Lloyd and the overlying Magothy Aquifer. The Raritan Clay is composed of approximately 150 to 300 feet of clay, sandy clay and silt (Kilburn, 1979).

The saturated thickness of the Magothy Aquifer under the Syosset area is approximately 520 feet (McClymonds and Franke, 1972). The sediment grain size in the Magothy Aquifer ranges from silt (2um-62um) to gravel (2mm-256mm) with interbedded clay lenses. These unconsolidated deposits date to the Upper to Middle Pleistocene.

Glacial deposits define the upper stratigraphy from ground surface to a depth of 60 to 100 feet. This formation consists of fine to coarse sand, pebble- to boulder-sized gravel and sandy loam that was deposited by receding glaciers during the Late Pleistocene. The permeability of this formation is greater than that of the underlying Magothy Aquifer (Geraghty & Miller, 1989). Site stratigraphy is represented in Figure 2.1.

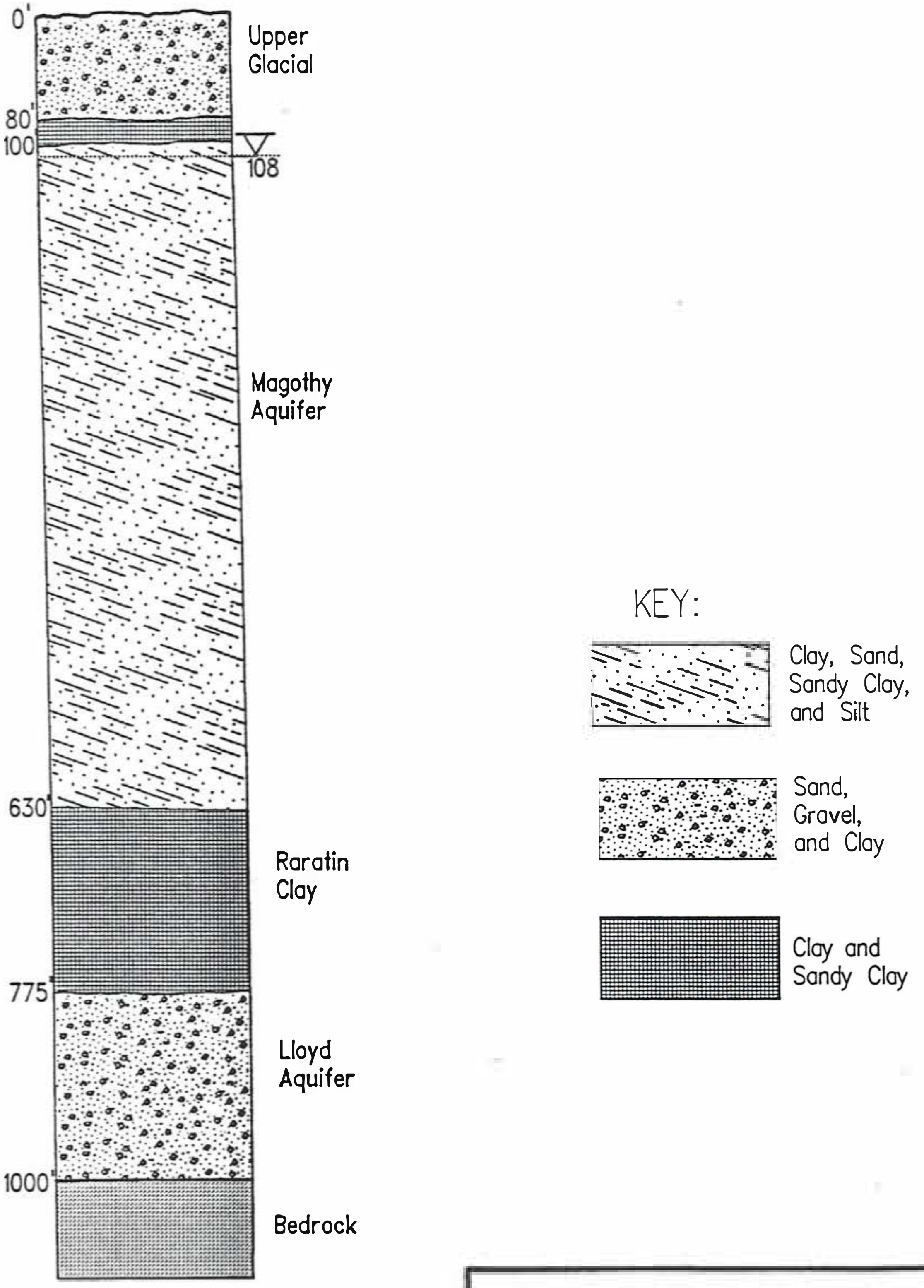


FIGURE 2.1

SITE STRATIGRAPHY

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: 1"=125'
DATE: MARCH 1990
PROJECT NO. 90016

3.0 SOIL SAMPLING PROGRAM

Soil samples were collected by AGI during three phases, summarized in the following sections. The soil sampling locations are shown on Figure 3.1 for Phases 1 and 2 and on Figure 3.2 for Phase 3.

3.1 Phase 1 Summary

Phase 1 soil sampling consisted of collecting 74 shallow soil samples (18 inches to 24 inches) throughout the property and 16 deep borings, as shown on Figure 3.1. Samples were analyzed for ten metals and cyanide, using the EP Toxicity method identified in 40 CFR 261. The ten metals selected were: arsenic, barium, cadmium, chromium (total), copper, iron, lead, selenium, silver and zinc.

Soil samples collected in the vicinity of process equipment were analyzed using the EP Toxicity procedure to determine if any pollutants had been released from the equipment and to evaluate the potential for migration of any pollutants found. In all instances, the metal concentrations measured in the extracts were less than EP Toxicity levels, indicating that the soils are not considered to be hazardous. The results of soil sampling around process equipment did not detect any leakage from this equipment.

The Phase 1 uniform grid soil sampling program detected low levels of various metals and cyanide in the EP extracts. No EP-Toxic concentrations of metals were found. The Phase 1 sampling results are summarized in Table 3.1.

3.2 Phase 2 Summary

Phase 2 soil sampling consisted of 13 soil samples collected at either three-foot or six-foot depths at locations previously sampled during Phase 1. These locations are indicated by an asterisk (*) in Figure 3.1. Three other samples were collected at the locations of the deep soil borings sampled during Phase 1: B101, B109, and B113. Additionally, five samples at six

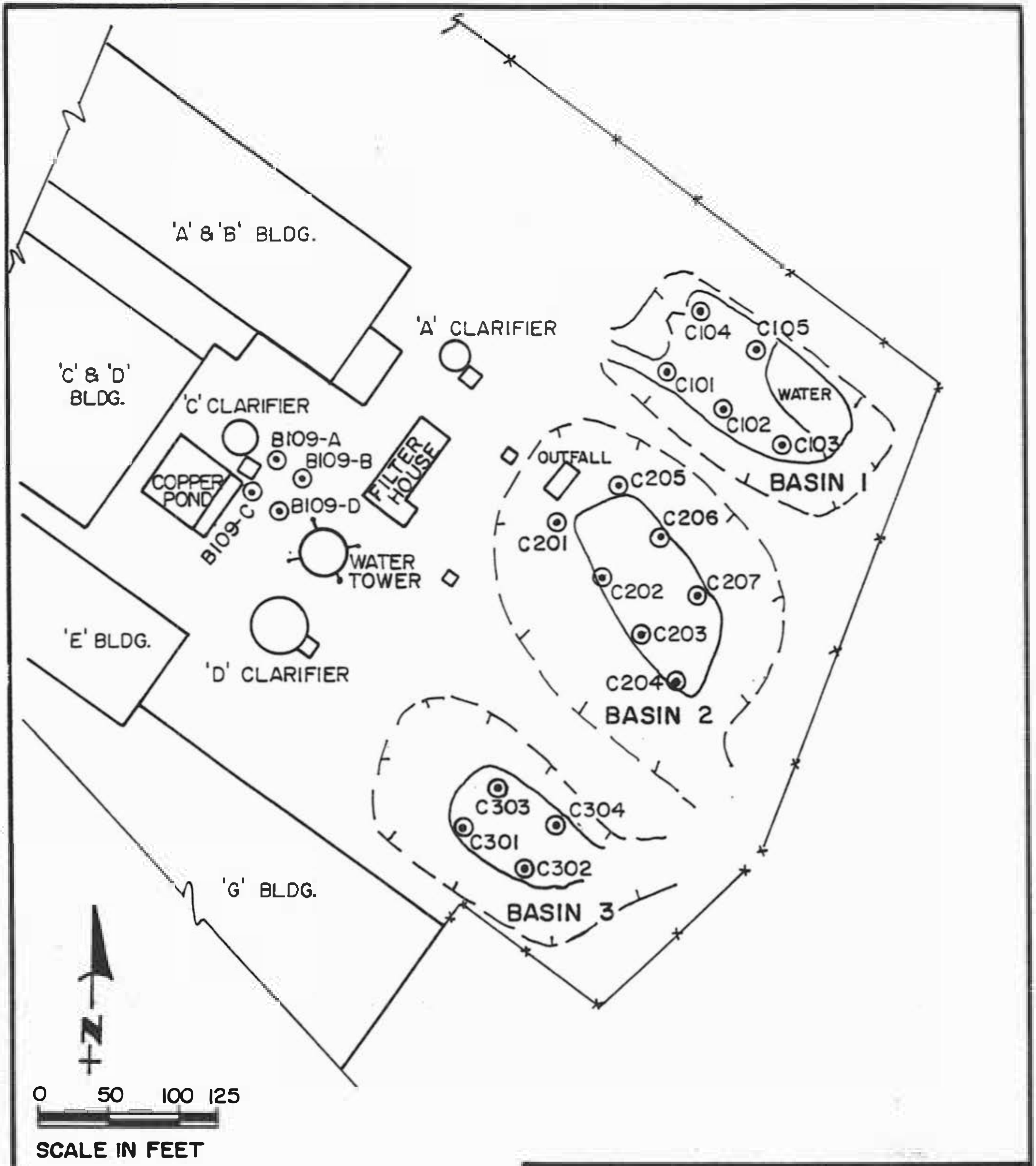


FIGURE 3.2
PHASE 3 SAMPLING LOCATIONS

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: 1" = 100'
DATE: MARCH 1990
PROJECT NO. 90016

Table 3.1, Phase 1 Analytical Results - EP Toxicity Testing

Metal	EP Tox Criteria (mg/l)	Median Extract Concentration (mg/l)	Maximum Extract Concentration (mg/l)
Uniform Grid Soil Samples			
Arsenic	5.0	<0.5	<0.5
Lead	5.0	0.15	4.6
Copper	100. *	5.8	88.7
Barium	100.	0.25	1.2
Silver	5.0	<0.10	0.4
Iron	30. *	0.10	0.3
Cadmium	1.0	0.02	0.3
Zinc	500. *	0.96	74.9**
Selenium	1.0	<0.20	0.3
Chromium	5.0	0.02	0.23
Tank Area Soil Samples			
Arsenic	5.0	<0.5	<0.5
Lead	5.0	<0.1	<0.1
Copper	100. *	0.06	1.20
Barium	100.	0.25	0.32
Silver	5.0	<0.01	<0.01
Iron	30. *	3.0	10.9
Cadmium	1.0	<0.005	0.01
Zinc	500. *	0.09	0.26
Selenium	1.0	<0.20	<0.20
Chromium	5.0	0.01	0.07

*Copper, iron and zinc are not target metals in the EP Toxicity procedure. The EP Tox criterion in these cases was established as 100 times the New York State Groundwater Standard.

**A duplicate analysis of sample number A057 gave a zinc concentration of 727 mg/l. The original sample concentration was 10.8 mg/l. The duplicate analysis value is ten times greater than the next highest, and it is assumed to be an analytical error.

foot depths were collected from the three basins. A total of 21 samples were collected during Phase 2. Sample locations and depths were approved by NYSDEC in their letter dated September 15, 1987. Samples were analyzed for the same ten metals as in Phase 1 using the EP Toxicity and total metals analytical procedures. All samples were also analyzed for total cyanide.

The results of the Phase 2 testing adjacent to process equipment confirmed the Phase 1 results. In all instances, the metal concentrations observed in the soil EP Toxicity extracts were less than EP Toxicity levels. The total metal concentrations indicate low levels of non-leachable copper and iron in the soils adjacent to the tanks.

The results of the basin soil sampling were compared to EP Toxicity standards. In all instances, the metal concentrations measured in the EP extracts were less than the EP Toxicity standards. Cyanide concentrations were all below the detection limit of 10 mg/kg. The Phase 2 test results are summarized in Table 3.2.

3.3 Phase 3 Summary

Phase 3 soil sampling consisted of the installation of four 25-foot deep borings at right angles surrounding Boring B109. In addition, an extensive sampling effort was made to fully characterize the contamination levels in the three basins. The locations of the Phase 3 borings in the basins were selected by setting up a 50-foot grid in the bottom of the basins and boring at the grid line intersections. Ponding of water in the basins restricted the number of boring locations to five in Basin 1, seven in Basin 2, and four in Basin 3. Two samples were collected from each soil boring location shown in Figure 3.2 at three-foot and six-foot depths for a total of 32. Samples were analyzed for total copper, total cyanide and leachable copper using the EP Toxicity method.

Table 3.2, Results of Analyses of Phase 2 Samples

Tank Area Soil Samples - Total Sample Analyses (mg/kg)

Parameter	Maximum Concentration	Minimum Concentration
Arsenic	2.00	<1.00
Lead	5.70	1.10
Copper	2200.	8.30
Barium	9.70	4.70
Silver	0.70	0.27
Iron	3500.	2100.
Cadmium	<1.00	<1.00
Zinc	120.	3.80
Selenium	1.60	<1.00
Chromium	4.20	<1.00
Cyanide	0.60	<0.10

Uniform Grid Soil Samples - Total Sample Analyses (mg/kg)

Parameter	Maximum Concentration	Minimum Concentration
Arsenic	8.6	<1.0
Lead	5.7	0.52
Copper	34.0	5.00
Barium	20.0	5.20
Silver	0.64	<1.00
Iron	20,000.	1500.
Cadmium	1.80	<1.00
Zinc	54.0	3.90
Selenium	4.3	<1.00
Chromium	16.0	2.70
Cyanide	1.40	<0.10

Basin Soil Samples

	Total Sample Analysis (mg/kg)		EP Extract Analysis (mg/l)	
Parameter	Max	Min	Max	Min
Arsenic	2.40	<1.00	<0.05	<0.05
Lead	8.30	1.40	<0.05	<0.05
Copper	290.	80.0	<0.05	<0.05
Barium	23.0	4.70	0.14	0.11
Silver	0.37	0.14	<0.50	<0.50
Iron	6400.	2200.	0.15	0.04
Cadmium	<1.00	<1.00	<0.10	<0.10
Zinc	220.	443.0	0.63	0.05
Selenium	1.30	<1.00	0.35	<0.30
Chromium	3.20	<1.00	<0.50	<0.50
Cyanide	17.0	0.97	<0.10	<0.10

3.3.1 **Basin Sampling Results**

Additional soil sampling in the three basins was requested by NYSDEC in their letter of September 15, 1987. Significant earthwork was necessary in Basin 1 before the drilling rig could access the bottom of the basin. Therefore, sampling depths were adjusted to correct for the grade changes within Basin 1.

Average concentrations of total copper, EP-Toxic copper and total cyanide were calculated for each of the three basins and are presented in Table 3.3. The data indicate that the contaminants decrease in concentration with depth. This situation is anticipated due to the insolubility of the contaminants of concern. In effect, the basins are acting as filters, removing particulate contaminants as water percolates through the soil. Comparisons of the Phase 3 sample results to proposed NYSDEC clean-up levels are presented for each basin and each contaminant of concern in Figures 3.3 through 3.8.

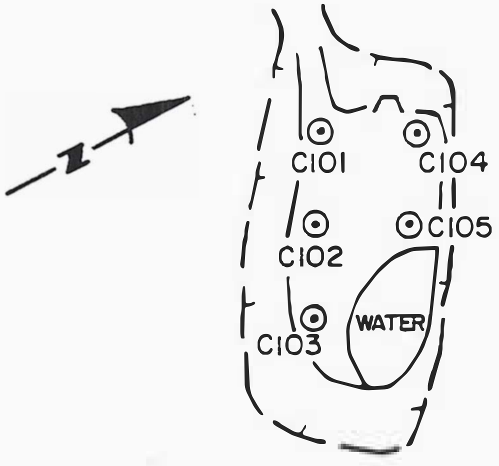
3.3.2 **Results of Sampling Near B109**

During Phase 1 soil sampling, deep soil samples were collected around the copper filter house and the three in-ground clarifiers. This was done to determine if contaminant releases from these structures had occurred. Phase 1 analytical results for copper using the EP Toxicity method showed 0.63 milligrams per liter (mg/l) in the extract. During Phase 2, at the direction of NYSDEC, another sample was collected in this location at the 17-foot depth and analyzed for total and EP-Toxic copper. The EP Toxicity method results indicated the leachable copper concentration was less than 0.50 mg/l. The total copper concentration was 2200 mg/kg. Due to the high copper concentration in this soil sample, NYSDEC requested additional sampling at B109 to determine the extent of copper contamination.

During Phase 3, four sample locations were selected at right angles from one another and approximately 12.5 feet from the original location of B109 at a depth of 25 feet. The

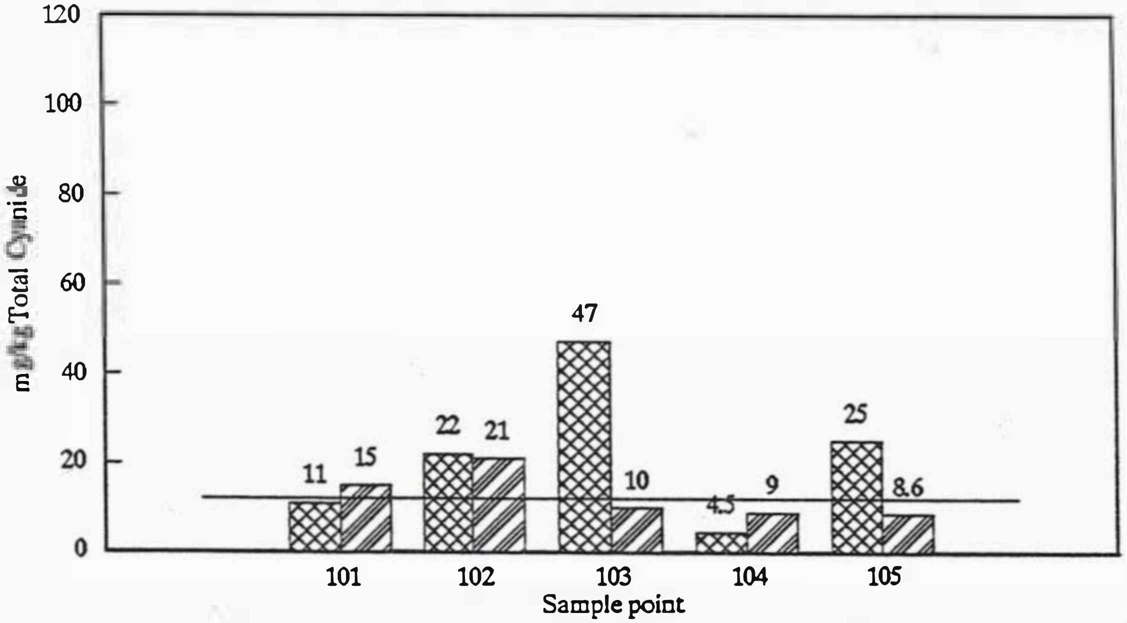
Table 3.3, Phase 3 Sampling: Average Concentrations of Total Copper, Extractable Copper and Cyanide

Location	Total Copper (mg/kg)		Extractable Copper (mg/l)		Cyanide (mg/kg)	
	Avg	Max	Avg	Max	Avg	Max
Basin 1						
-3-ft depth	506	1040	4.30	7.70	21.9	47.0
-6-ft depth	285	500	3.39	4.84	12.7	21.0
Basin 2						
-3-ft depth	538	2290	5.42	25.9	18.8	96.0
-6-ft depth	216	397	1.79	3.65	4.6	8.9
Basin 3						
-3-ft depth	834	2070	5.22	17.3	12.0	44.0
-6-ft depth	559	1900	3.74	10.5	4.5	15.0



BASIN I

Phase 3 Sampling
Basin 1 samples compared to proposed NYSDEC clean–up levels for cyanide



▩ –3ft below original grade
▨ –6 ft below original grade

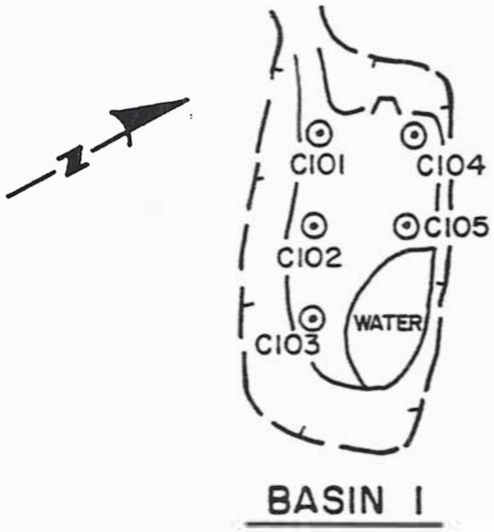
—— Proposed clean–up standard, 12ppm

Sampling Date: Nov. 15,16 1988
' Sidewall sample is not included

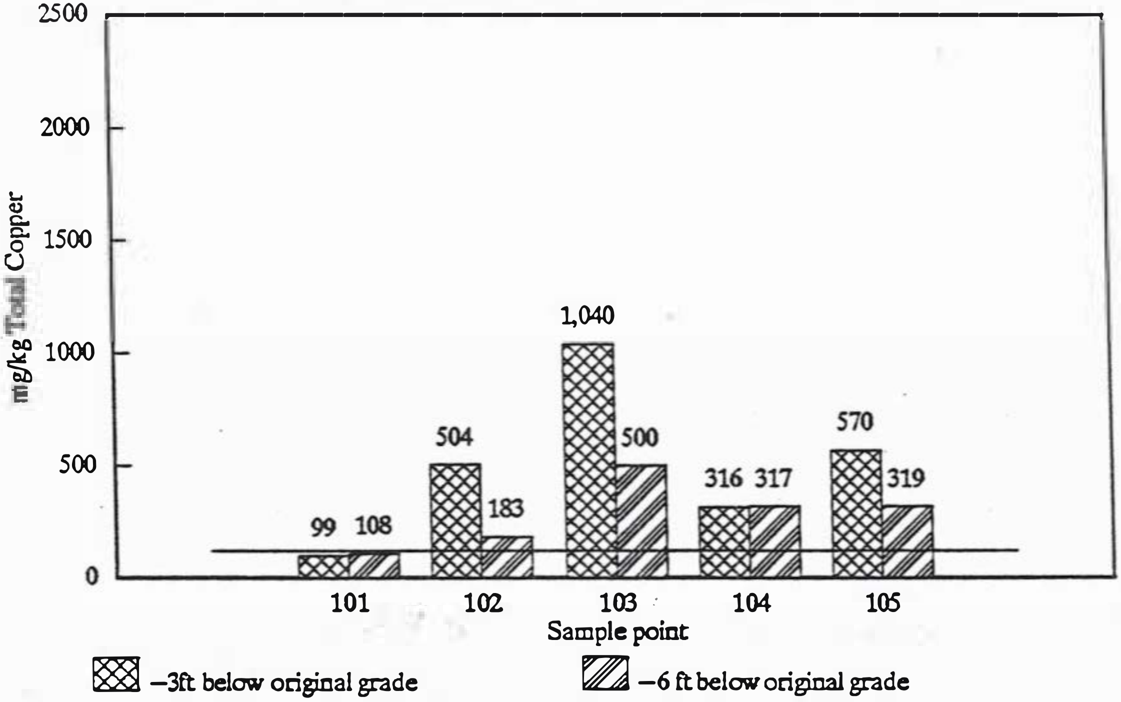
FIGURE 3.3
PHASE 3 SAMPLING: CYANIDE

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016



Phase 3 Sampling
Basin 1 samples compared to proposed NYSDEC clean-up levels for copper



—— Proposed clean-up standard, 120 ppm

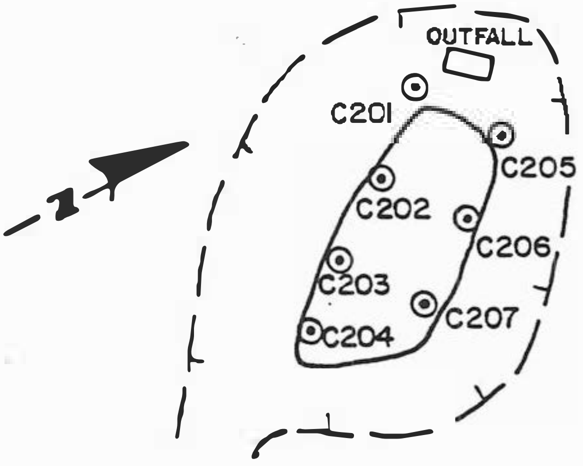
Sampling Date: Nov. 15,16 1988

FIGURE 3.4

PHASE 3 SAMPLING: COPPER

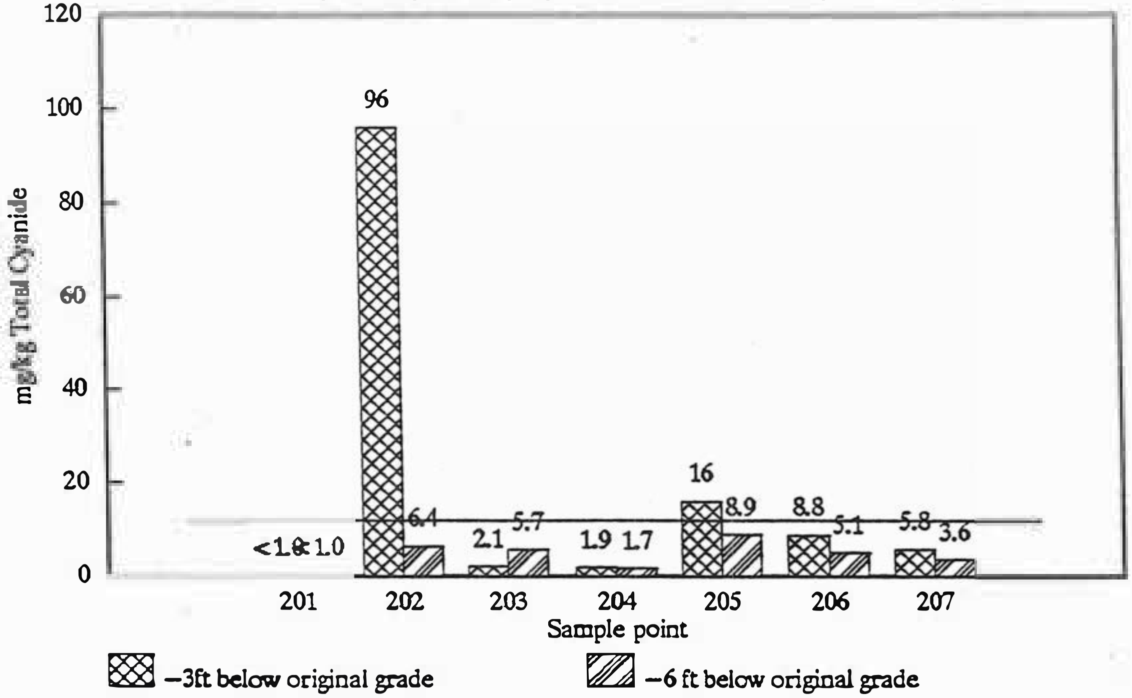
AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016



BASIN 2

Phase 3 Sampling
Basin 2 samples compared to proposed NYSDEC clean–up levels for cyanide

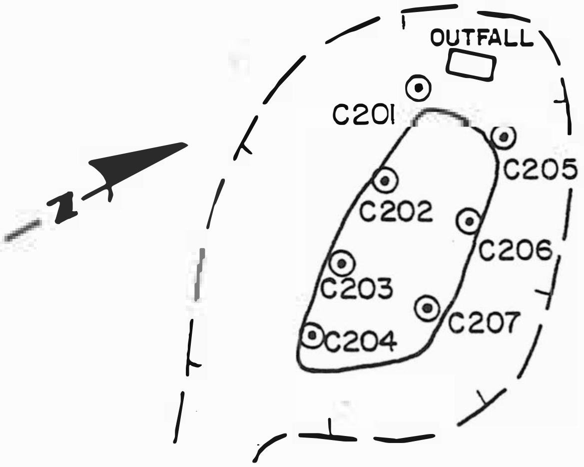


—— Proposed clean–up standard, 12 ppm
Sampling Date: Nov. 15,16 1988

FIGURE 3.5
PHASE 3 SAMPLING: CYANIDE

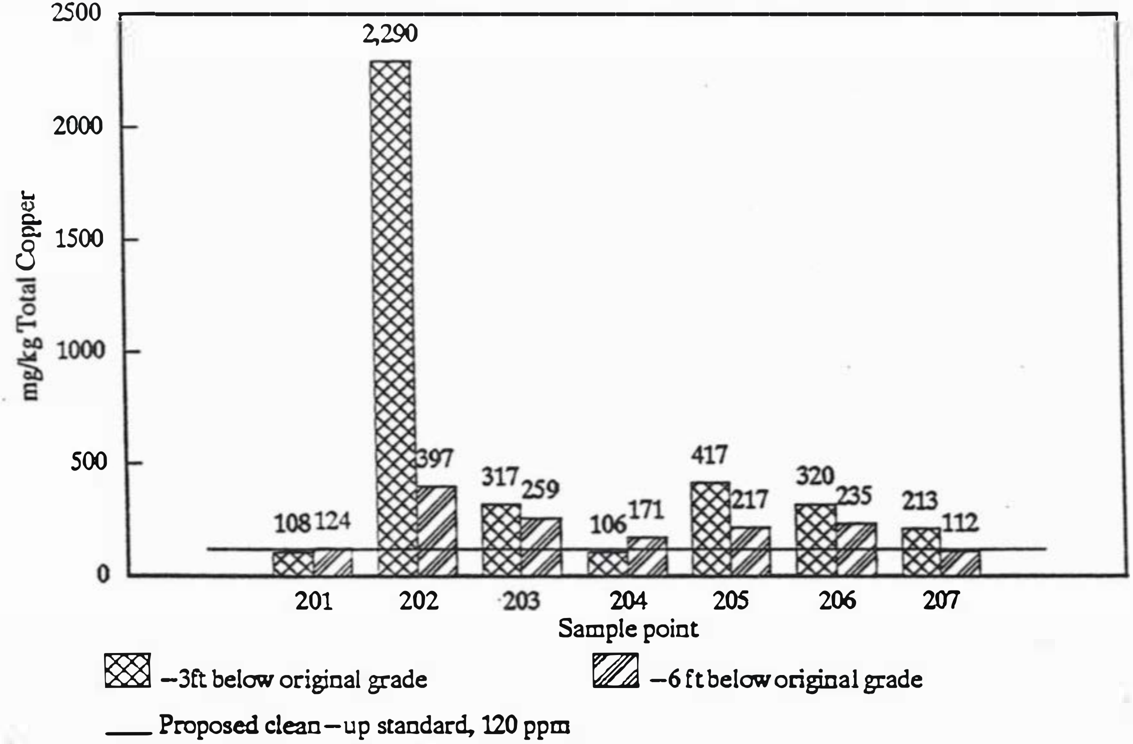
AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016



BASIN 2

Phase 3 Sampling
Basin 2 samples compared to proposed NYSDEC clean−up levels for copper

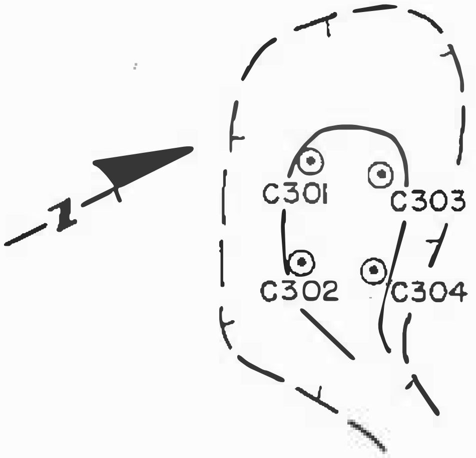


Sampling Date: Nov. 15,16 1988

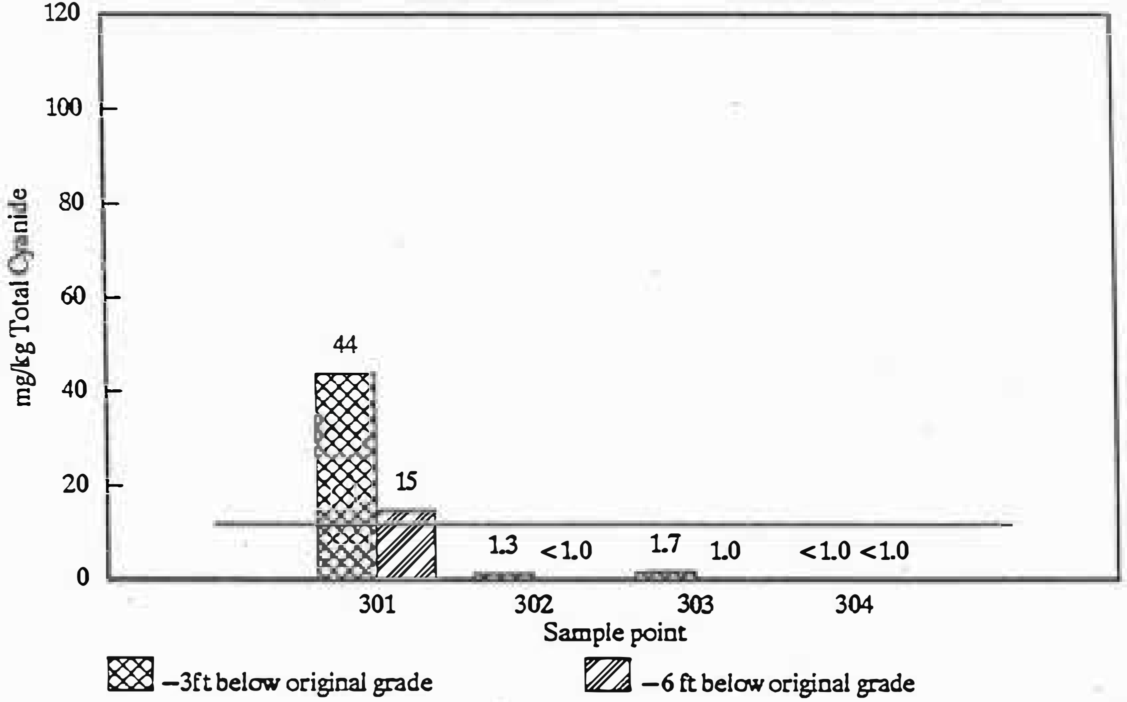
FIGURE 3.6
PHASE 3 SAMPLING: COPPER

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016



BASIN 3



Phase 3 Sampling
Basin 3 samples compared to proposed NYSDEC clean—up levels for cyanide

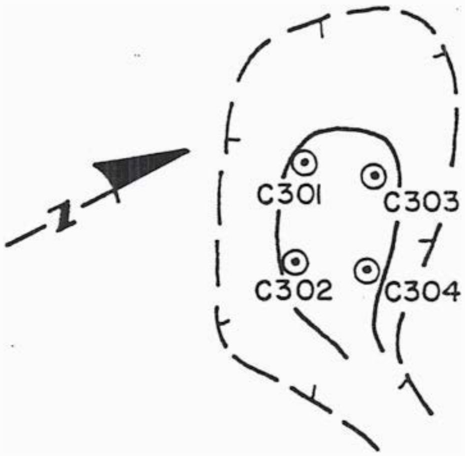
Sampling Date: Nov. 15,16 1988

FIGURE 3.7

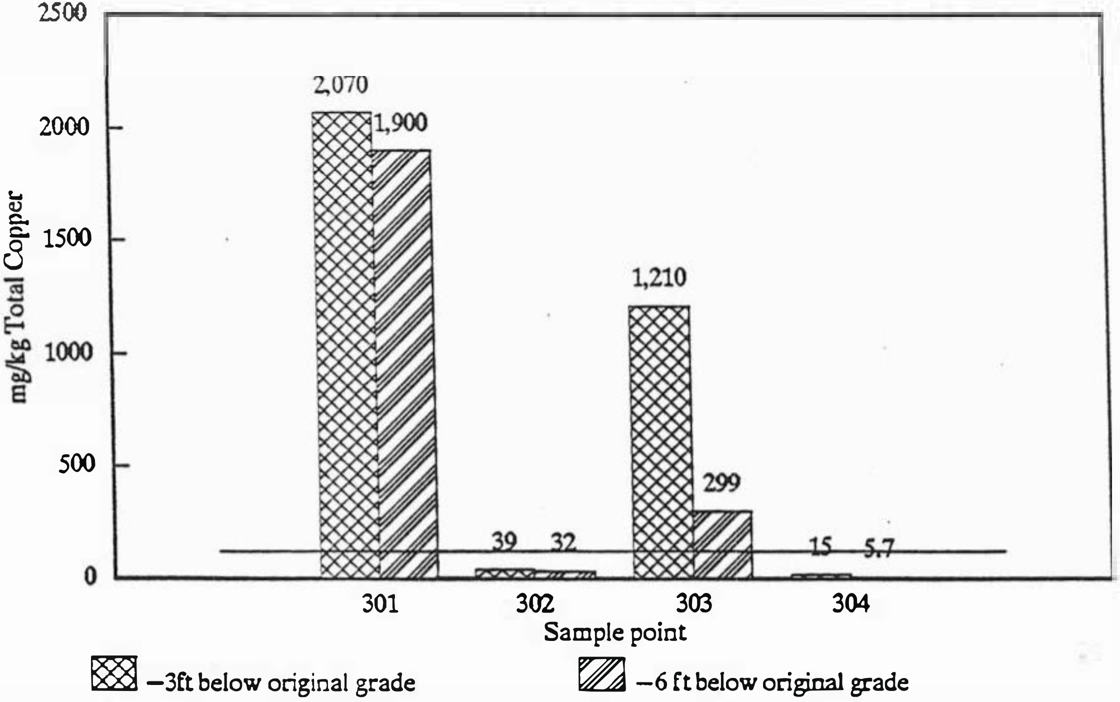
PHASE 3 SAMPLING: CYANIDE

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016



BASIN 3



Phase 3 Sampling
Basin 3 samples compared to proposed NYSDEC clean–up levels for copper

Sampling Date: Nov. 15,16 1988

FIGURE 3.8

PHASE 3 SAMPLING: COPPER

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016

locations were identified as follows:

Boring	Location
B109A	northeast of B109
B109B	southeast of B109
B109C	northwest of B109
B109D	southwest of B109

A three-dimensional representation of B109 is shown in Figure 3.9.

Total copper results ranged from 2.9 mg/kg (low) to 22 mg/kg (high). The low value of 2.9 mg/kg was identified at B109D while the highest value of 22 mg/kg was identified at B109B. None of the samples exhibited total copper values near to the Phase 2 total copper level at B109 of 2200 mg/kg. The Phase 3 sampling results failed to confirm the presence of copper contamination at boring location B109.

In an attempt to identify the source of copper contamination at the B109 location, a four-inch transit pipe exiting from the filterhouse was excavated. A crack in the pipe was found. Soil discoloration indicated that contamination was limited to a small volume of soil, one to two cubic feet, located directly under the crack. A sample of the discolored soil was collected. A total copper concentration of 4270 mg/kg was found.

The highest concentration of copper, 41,500 mg/kg, was found in B902, a shallow sample collected from a location adjacent to the filterhouse. This contamination may have resulted from minor spills of filtrate or sludge from the filterhouse.

Samples in all other excavated areas along the intact drainage pipe and copper basin were taken at six-foot depths. These samples indicated copper concentrations of less than 3.7 mg/kg. The samples were split with NYSDEC officials, who were on hand to observe back-filling operations.

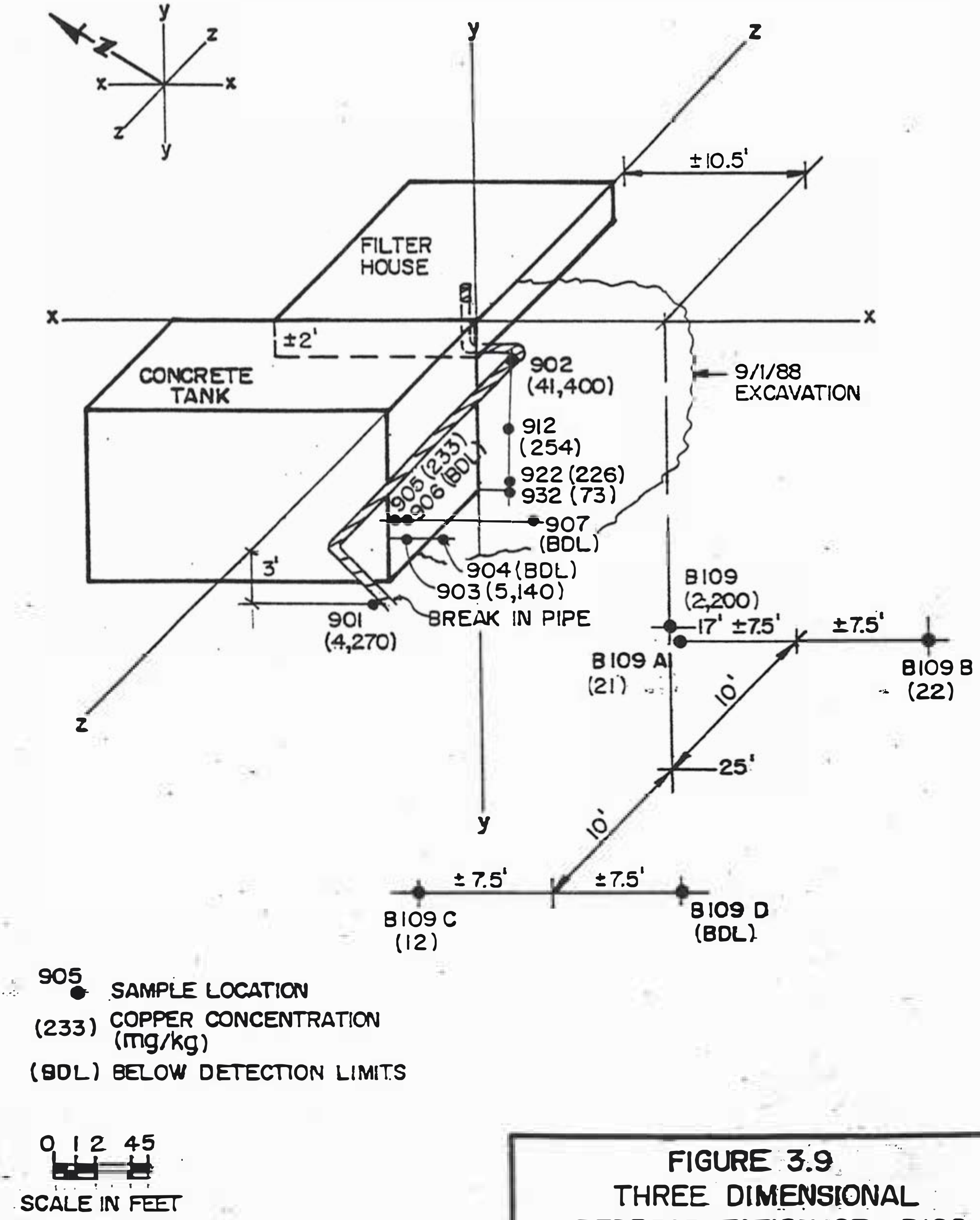


FIGURE 3.9
THREE DIMENSIONAL
REPRESENTATION OF B109

AVENDT GROUP, INC. ANNAPOLIS, MARYLAND	**SCALE:** 1/8" = 1'-0"
	DATE: MARCH 1990
	PROJECT NO. 90016

Cyanide concentrations from the four sampling points nearby B109 were all below detection limits (<1.0 mg/kg). Since this contaminant was not identified in significant quantities, AGI believes that further investigation of this contaminant around B109 is not warranted.

3.3.3 **Basin 1 North Side Wall**

During the Phase 3 sampling event, an additional sample was collected from the discolored soil found in a discrete area in the north face of the side wall in Basin 1. This sample was not included in the sampling plan agreed upon by NYSDEC and the Avendt Group. A total cyanide level of 269 mg/kg was found in this sample.

This result was not reported with the original Phase 3 Sampling Report due to an error in the original laboratory data report. The report showed the results as parts per billion (ug/l). When these data are viewed as parts per billion, the levels are not notable. Upon reviewing the data, AGI noted that data for a soil matrix should be reported as parts per million (mg/kg). Hittman-Ebasco confirmed that the results had indeed been reported incorrectly. The data were reevaluated and the analyses of this sample were reported to NYSDEC by the Avendt Group in a letter dated March 19, 1990.

4.0 DATA ASSESSMENT

4.1 Introduction

4.1.1 Cerro Manufacturing Processes

Cerro manufactured copper wire and cable; galvanized strip steel; and galvanized electrical tubing and conduit. Wastewater containing copper was generated by the copper rod pickling line, where copper rods were cleaned in a sulfuric acid bath to remove copper oxides. Cyanide plating baths were used in the manufacture of tubing and conduit. Two identical cyanide/zinc plating lines were employed to galvanize the steel tubing and conduit.

Rinsewater bearing cyanide was treated using chlorine in an alkaline solution to oxidize cyanide to cyanate. The treated cyanide wastes were combined with other waste streams, and combined flow was treated with lime (CaO) to precipitate soluble metals as metal hydroxides. A polyelectrolyte was employed to aid in the flocculation and settling of metal hydroxide sludge. Two clarifiers were used to separate the metal sludges from the water phase.

Before March of 1982, when discharge of wastewater to the Nassau County sewer system started, Cerro discharged wastewater to infiltration basins on site.

4.1.2 Treatment Process Chemistry

4.1.2.1 Precipitation of Copper

Copper is readily precipitated from acid solutions by increasing the pH through the addition of lime or caustic soda.

(1) $Cu^{++} + 2OH^{-} = Cu(OH)_{2(s)}$

The solubility relationships for $Cu(OH)_2$ are well known (Stumm and Morgan, 1970) and are presented in Section 4.1.3.1.

4.1.2.2 **Destruction of Cyanide**

Cyanide is oxidized to cyanogen, a highly toxic gas, by chlorine. At alkaline pHs, greater than 10, cyanogen is hydrolyzed to cyanate. The following reactions occur:

(2) $CN^- + OCL^- + H^+ = CNCl + OH^-$

(3) $CNCl + 2OH^- = CNO^- + Cl^- + H_2O$

Cyanate (CNO^-) can be further oxidized by chlorine to carbon dioxide and nitrogen as follows:

(4) $2CNO^- + 4OH^- + 3Cl_2 = 6Cl^- + 2CO_2 + N_2 + 2H_2O$

Cyanate can also be converted to ammonia by acidification:

(5) $CNO^- + 2H^+ + H_2O = NH_4^+ + CO_2$

Cyanide forms stable complexes with many metals (iron II, iron III, cadmium, copper, nickel, silver, zinc, and others) of the form $M(CN)_x^{-y}$, e.g., iron III forms ferricyanide $Fe(CN)_6^{-3}$. The iron cyanide complexes are extremely stable, resisting dissociation even in strong acid solutions.

4.1.2.3 **Analytical Considerations**

The analytical methodology used for the analysis of cyanide and its complexes involves the acid reflux of the sample in order to generate HCN gas which is scrubbed from solution and trapped in a solution of NaOH (APHA and AWWA, 1989). Free cyanides (HCN and CN^-), insoluble metal cyanides, and cyanide metal complexes can all be recovered by the acid reflux procedure. Other common forms of cyanide cyanate (CNO^-) and thiocyanate (CNS^-) are not converted to HCN by the digestion process.

4.1.3 **Copper and Cyanide Speciation and Behavior in Soils**

The factors affecting the solubility of various copper species present in soil are the stability of the particular copper species in the soil, pH and carbonate concentration. Solid phase copper may be present as copper hydroxide ($Cu(OH)_2$); copper hydroxy carbonate complexes, Malachite ($Cu_2(OH)_2CO_3$) and Azurite ($Cu_3(OH)_2(CO_3)_2$); exchangeable copper adsorbed onto clay minerals and organic matter; or it may be found as part of the soil matrix.

The treatment process used by Cerro removed copper from solution through the addition of lime to raise the pH to between 9 and 10, the point of minimal solubility for copper hydroxide. The solid hydroxide was removed by sedimentation. The overflow from the clarifiers was discharged to the basins. Small amounts of copper could have existed in the overflow as both soluble copper and solid phase hydroxide. The solid phase would have been effectively removed by filtration as the treated effluent percolated through the bed of the basins. The soluble copper would have been removed by absorption and precipitation as either copper hydroxide or malachite.

4.1.3.1 **Solubility of Copper Hydroxide**

The equilibrium concentration of copper in solution when in contact with solid phase copper hydroxide will be a function of pH only. Equilibrium constants were obtained from Stumm and Morgan (Stumm and Morgan, 1970). The following equations control the solubility of copper hydroxide:

(6) $CuO_{(s)} + 2H^+ = Cu^{++} + H_2O$ $\log K_{s0} = 7.65$

(7) $CuO_{(s)} + H^+ = CuOH^+$ $\log K_{s1} = -0.35$

(8) $2CuO_{(s)} + 2H^+ = Cu_2(OH)_2^{++}$ $\log K_{s22} = 4.30$

(9) $CuO_{(s)} + 2H_2O = Cu(OH)_3^- + H^2$ $\log K_{s3} = -19.15$

(10) $CuO_{(s)} + 3H_2O = Cu(OH)_4^{--} + 2H^+$ $\log K_{s4} = -32.25$

The solubility relationships expressed in the above equations have been plotted in Figure 4.1.

Copper (+2) Solubility
Copper Hydroxide Complexes

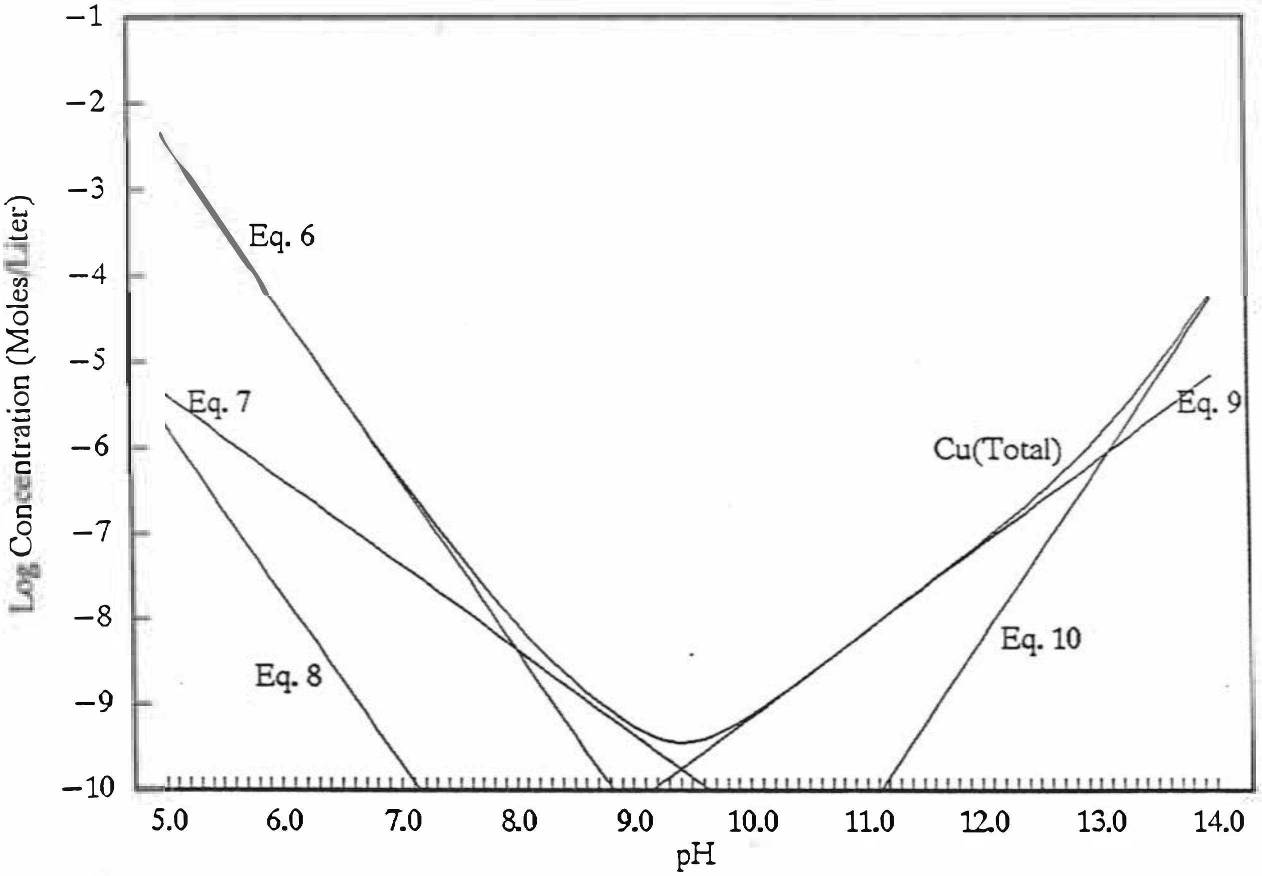


FIGURE 4.1

COPPER SOLUBILITY
COPPER HYDROXIDE COMPLEXES

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016

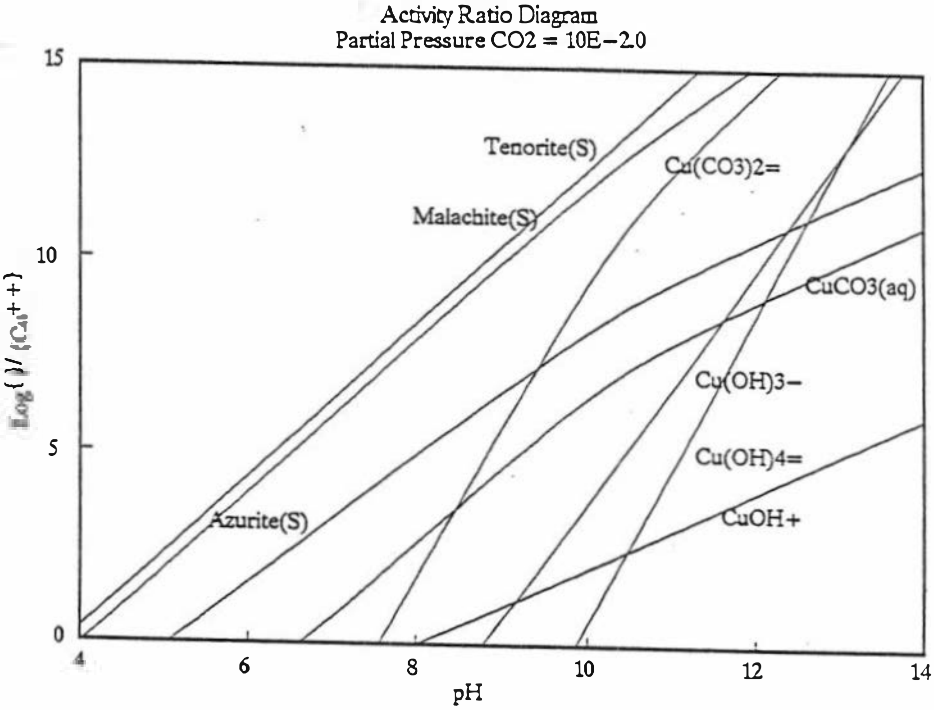
4.1.3.2 Solubility of Copper Hydroxy Carbonate Complexes

In the presence of free CO_2, copper is capable of forming other solid phases. The chemical reactions controlling copper solubility in the presence of carbonates are described by the following equations (Stumm and Morgan, 1970):

		Log K
(11)	$CuO_{(s)} + 2H^+ = Cu^{+2} + H_2O$	7.65
(12)	$Cu_2(OH)_2CO_{3(s)} + 4H^+ = Cu^{+2} + 4H_2O + CO_{2(g)}$	14.16
(13)	$Cu_3(OH)_2(CO_3)_{2(s)} + 6H^+ = 3Cu^{+2} + 4H_2O + 2CO_{2(g)}$	21.24
(14)	$Cu^{+2} + H_2O = CuOH^+ + H^+$	-8.0
(15)	$2Cu^{+2} + 2H_2O = Cu_2(OH)_2^{+2} + 2H^+$	-10.95
(16)	$Cu^{+2} + CO_3^{-2} = CuCO_{3(aq)}$	6.77
(17)	$Cu^{+2} + 2CO_3^{-2} = Cu(CO_3)_2^{-2}$	10.01
(18)	$CO_{2(g)} + H_2O = HCO_3^- + H^+$	-7.82
(19)	$Cu^{+2} + 3H_2O = Cu(OH)_3^- + 3H^+$	-26.3
(20)	$Cu^{+2} + 4H_2O = Cu(OH)_2^{-2} + 4H^+$	-39.4

These relationships have been plotted in two diagrams. Figure 4.2 is an activity ratio diagram, in which the concentration of each species is plotted relative to the concentration of Cu^{+2}. Figure 4.3 is a solubility diagram, in which the solubility of all copper species is plotted as a function of pH. It was assumed that the concentration of total carbonate species was in approximate equilibrium with CO_2 in the atmosphere. The graphs were generated for CO_2 partial pressures of $10^{-3.5}$ and 10^{-2}, representative of the concentration of CO_2 in the earth's atmosphere and in soil gas respectively.

The stability diagrams indicate that copper solubility is controlled by Tenorite at both levels of CO_2 for all pH levels above 4. The solubility diagrams were developed using



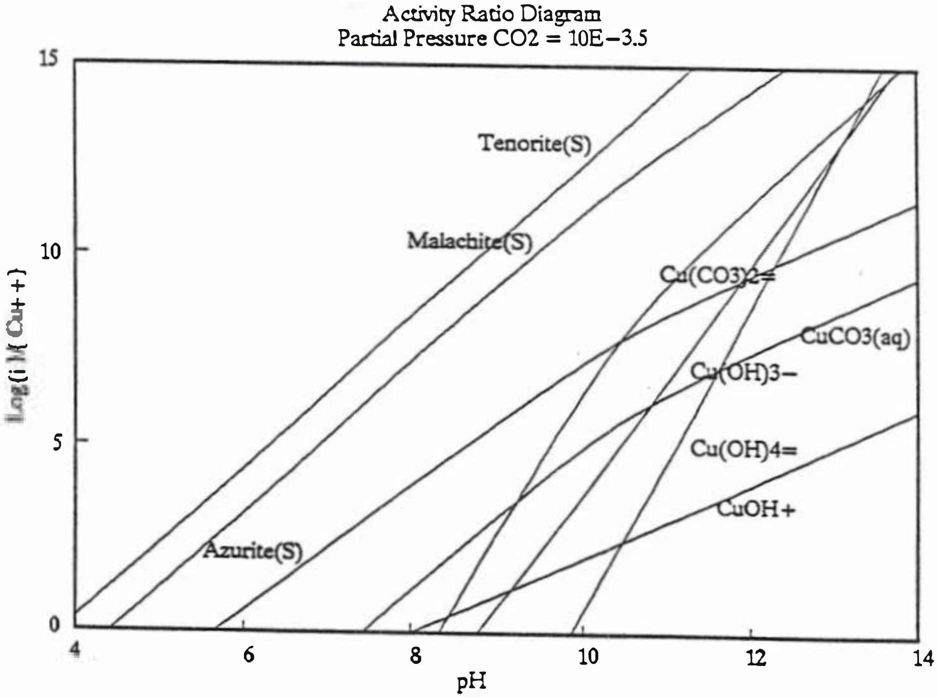
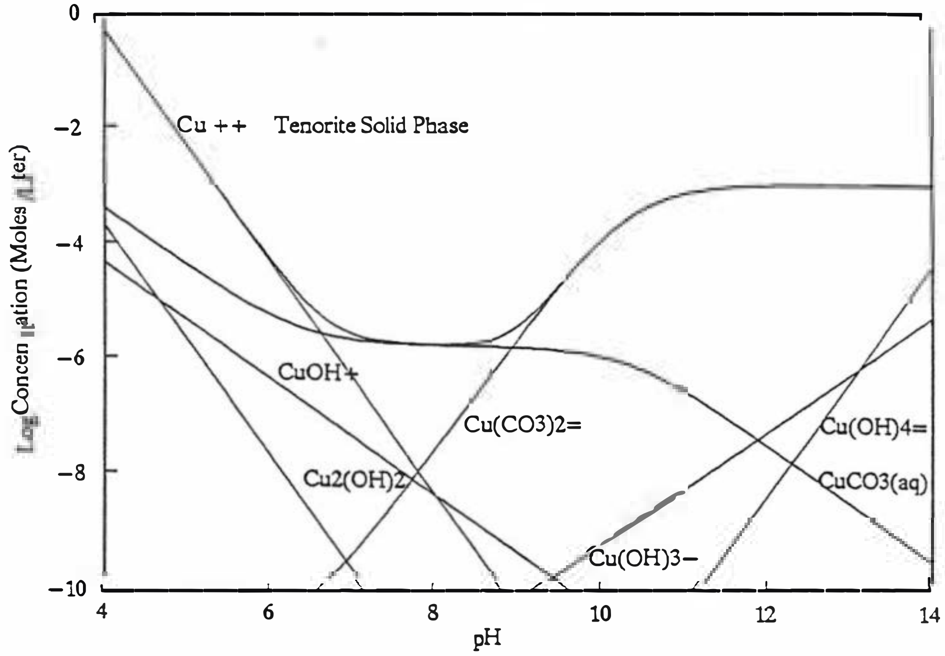


FIGURE 4.2

ACTIVITY RATIO DIAGRAMS

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016


Solubility Diagram
Partial Pressure CO2 = 10E–2.0

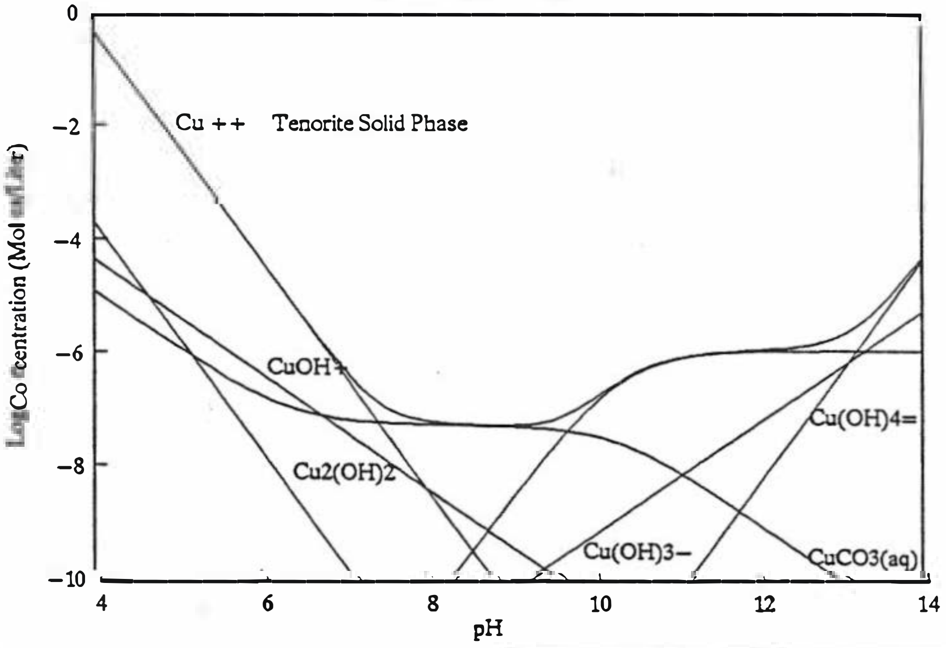

Solubility Diagram
Partial Pressure CO2 = 10E–3.5

FIGURE 4.3

COPPER SOLUBILITY DIAGRAM

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016

Tenorite as the solid phase. The solubility of total copper is greatly influenced by the presence of carbonate species in solutions because of the Cu-CO_3 complexes formed. Copper solubility in the pH range between 7 and 9 is essentially independent of pH and is determined by reaction described in equation 16 above.

Fuller (Fuller, 1977) provided a review of copper solubility from copper soil matrices. The copper soil reaction is represented as follows:

(21) Cu^{+2} + soil = Cu-soil + $2H^+$

The equilibrium constant for this reaction was determined to be $10^{-3.2}$. This relationship predicts a Cu^{+2} solubility that is approximately five orders of magnitude less than that for the common copper minerals, tenorite CuO, malachite $Cu_2(OH)_2CO_3$, and azurite $Cu_3(OH)_2(CO_3)_2$. The actual stability constant can be expected to vary with soil type. However, the magnitude of the stability constant means that the Cu^{+2} + soil reaction is likely to be the controlling factor in the solubility of copper in soils. The factors controlling the extremely low solubility of copper species in soils are hydrous oxides of iron and manganese (Fuller, 1977). The hydrous oxides provide the principal soil matrix onto which copper and other heavy metals are absorbed, coprecipitated, and occluded.

4.1.3.3 Cyanide Speciation

The detection of quantifiable amounts of cyanide in the basin soil suggests the presence of cyanide in the treated wastewater. Even if free cyanide (HCN or CN^-) was present in the treated cyanide rinsewater, the presence of iron II in rinsewater from the steel pickling operation could have produced stable iron cyanide complexes. Owing to the low toxicity and the high stability of ferrocyanides, this reaction has been used as a treatment method for cyanide in Europe.

Ferro and ferri cyanides are among the most stable metal cyanide complexes. Chemical degradation of these complexes is achieved only at extremely low pH; they decompose very slowly under the reflux conditions used to analyze for cyanides.

4.1.3.4 **Cyanide Degradation and Loss Pathways**

Free cyanides and metal cyanide complexes in soil and water are subject to a number of degradation and transportation pathways (Versar, 1979 and Oak Ridge, 1978). Photodecomposition, biodegradation, volatilization and absorption have all been shown to be important mechanisms for removal and stabilization of cyanide.

Ultra-violet light has been shown to decompose iron and other metal cyanide complexes in water (Oak Ridge, 1978 and Versar, 1979). The degradation product is free cyanide. Photodecomposition is not a viable mechanism in soils. Hydrogen cyanide is a very weak acid pKa = 9.32. A graph of the relative distribution of HCN and CN^- in solution as a function of pH is included as Figure 4.4. At pH values below 8, essentially all cyanide would be present as undissociated HCN. HCN is an extremely volatile gas, having a strong bitter almond odor, which would volatilize rapidly from water and the soil surface. It has been well established that cyanide is subject to rapid biodegradation when present in low concentrations (Oak Ridge, 1978). Fuller, 1978, reports that concentrations of up 200 mg/kg NaCN in soil are readily degraded. The ability to degrade cyanide is nearly universal in the microbial population (Versar, 1979).

Fuller, 1978, investigated the movement of cyanide in the soil. He concluded that free cyanide, HCN and CN^-, and $Fe(CN)_6^{-3}$ were very mobile in soils. Cyanide retention was the greatest when the soil contained high concentrations of iron oxides. The formation of insoluble Prussian blue ($Fe_2Fe(CN_6)$) was an effective removal mechanism when Fe^{+2} was present.

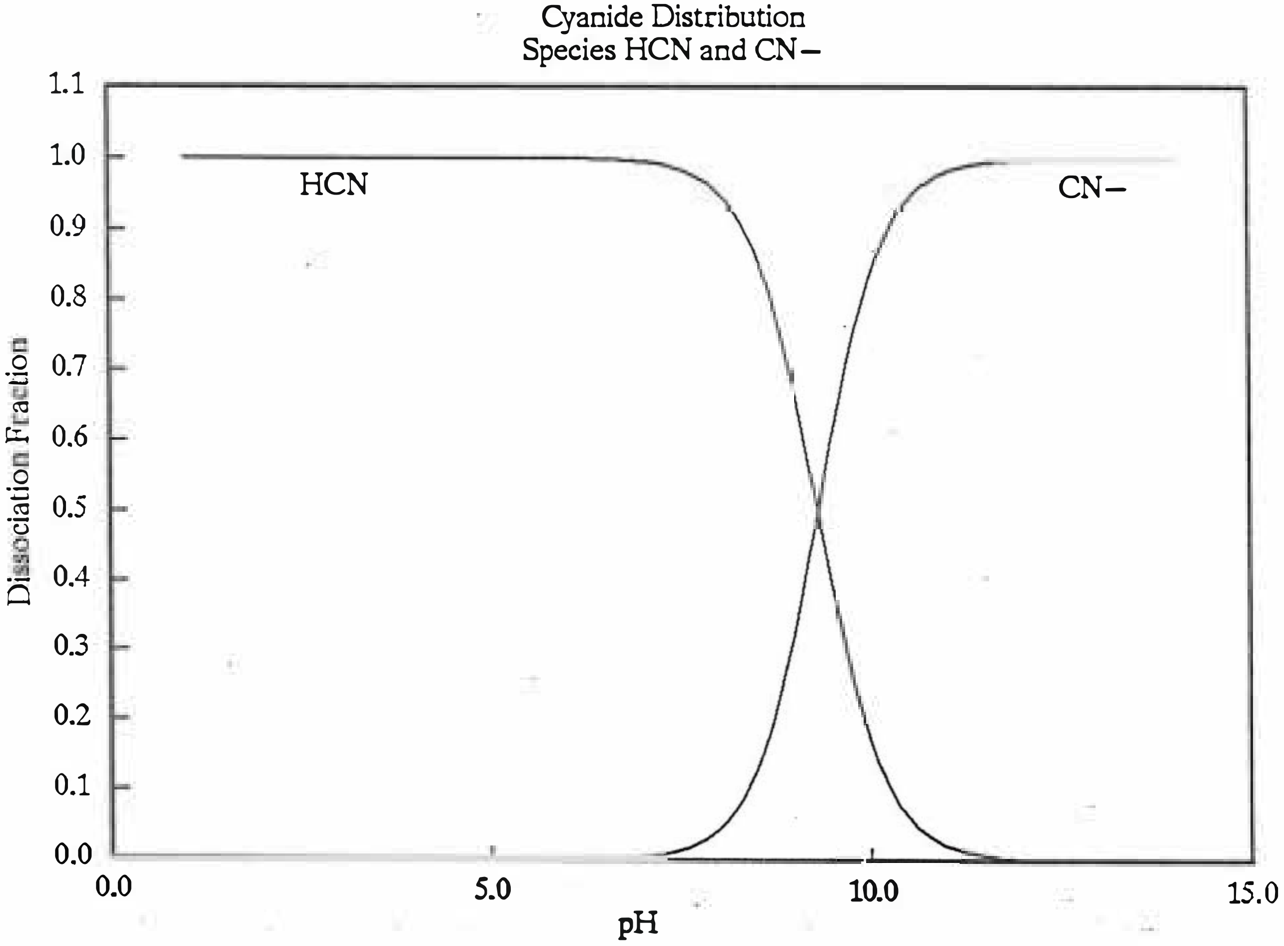


FIGURE 4.4
RELATIVE DISTRIBUTION OF HCN AND CN^- AS A FUNCTION OF pH

AVENDT GROUP, INC. ANNAPOLIS, MARYLAND	**SCALE:** NONE
	DATE: MARCH 1990
	PROJECT NO. 90016

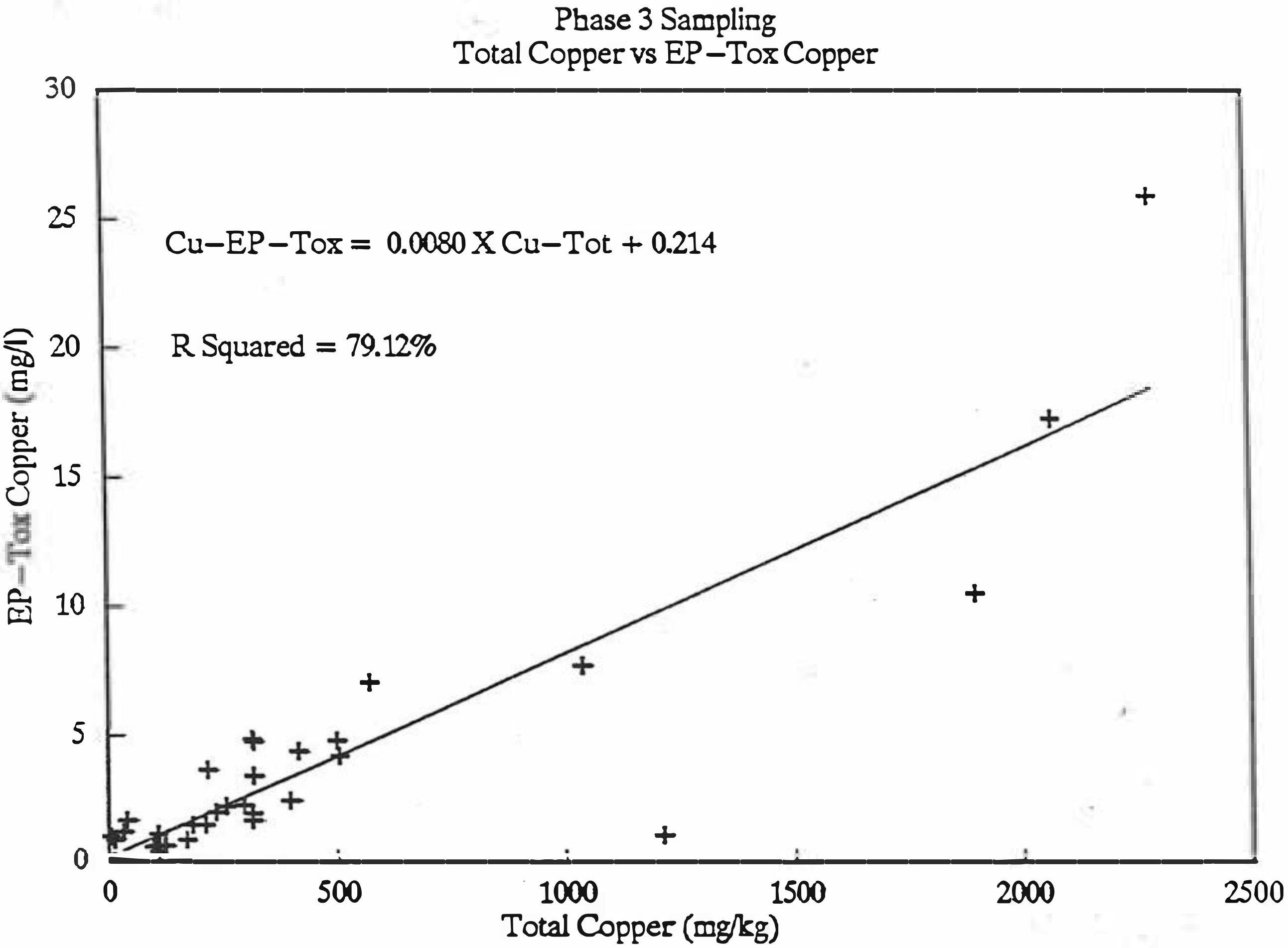
4.2 Potential Contaminants of Concern

4.2.1 Selenium

At the request of NYSDEC, the final or Phase 3 soil investigation focussed on Basins 1, 2, and 3, and around sampling point B109. The purpose of the investigation was to provide additional information on the areas and contaminants of concern (i.e., cyanide and copper) based on the results of the Phase 2 Soil Sampling Program. Selenium was not included as a parameter in the Phase 3 soil investigation. However, samples from the basins were analyzed for selenium during the Phase 2 soil investigation. All sample results were below 1.0 mg/kg, except one sample from Basin 1 that was 1.30 mg/kg. The selenium levels reported in the basins pose no environmental concern for three reasons. First, selenium is not a by-product of any of the operations conducted at the plant. Therefore, the probability is high that the levels reported are actually background. Second, NYSDEC chose selenium as a clean-up criterion for the basins and recommended removal or remediation of any soil with concentrations of selenium above 1.2 mg/kg. With one exception, all samples have levels of selenium well below the clean-up criterion. Third, the only sample location of concern was in Basin 1 and was within 0.1 mg/kg of the proposed clean-up criterion. This level of difference is not statistically significant given normal variation in laboratory data. Selenium is not present at levels that warrant further concern.

4.2.2 Copper

The concentrations of total copper found in basin soil samples during the Phase 3 investigation ranged between 6 and 2,300 mg/kg. Corresponding copper concentrations in the EP Toxicity leachates ranged between 0.43 and 25.9 mg/l. A correlation exists between the total copper concentration in the soil and the concentration in the leachate. These data are plotted in Figure 4.5. The slope of the line indicates that approximately 0.80% of the total copper is leachable at a pH of 5.0, the pH used for the EP Toxicity test.



Phase 3 Sampling
Total Copper vs EP–Tox Copper

FIGURE 4.5

TOTAL COPPER
VS
EP TOX COPPER

AVENDT GROUP, INC.
ANNAPOLIS, MARYLAND

SCALE: NONE
DATE: MARCH 1990
PROJECT NO. 90016

4.2.3 Cyanide

The analytical concentrations of cyanide found in the basin soil samples collected in November 1988 ranged between <1 mg/kg (the method detection limit) and 296 mg/kg of soil.

4.2.4 Soil Conditions

Soils at the Cerro site are predominantly coarse sands and gravels with extremely low quantities of colloidal material (i.e., clay and organics). Because of the lack of soil colloids, the soil is not likely to remove and retain significant quantities of copper by absorption, which is expressed by the cation exchange capacity of the soil. However, other removal mechanisms, discussed below, are effective in immobilizing copper in soils.

No soil pH data were obtained during any of the site investigations. However, initial soil pH from the laboratory extraction logs, kept during the performance of the EP Toxicity extraction procedure, can be used to provide an indication of soil pH. These data are presented in Table 4.1. The initial pH values from the EP Toxicity extraction logs varied between 6.4 and 9.7.

4.2.5 Groundwater Quality

In October of 1984, a test well was installed at the Cerro site. This well was completed in sand and gravel to a depth of 130 feet and screened from 120 to 130 feet. Samples were collected from the well on November 6, 1984 and analyzed for drinking water parameters. The concentrations of copper and cyanide were 0.02 and <0.1 mg/l, respectively.

Eight additional groundwater monitoring wells were installed in 1987 by the H2M Group for Sy Associates. H2M concludes that "groundwater at the Cerro Conduit site is generally not impacted at concentrations above the New York State or USEPA standards" (H2M, 1989).

Table 4.1, Soil pH Data from Laboratory EP Toxicity Extraction Logs

Lab ID	Sample	pH	mls HAC
6870	C101 3ft	7.9	2.00
6871	C101 6ft	7.5	2.00
6872	C102 3ft	8.5	2.50
6873	C102 6ft	8.1	2.50
6874	C103 3ft	6.9	2.50
6875	C103 6ft	7.0	2.75
6876	C104 3ft	7.0	2.50
6877	C104 6ft	6.9	2.50
6878	C105 3ft	7.3	3.50
6879	C105 6ft	7.6	3.00
6880	C201 3ft	9.7	11.50
6881	C201 6ft	8.6	2.00
6882	C201 3ft	7.5	100.75
6883	C201 6ft	9.2	18.50
6884	C203 3ft	8.4	6.00
6885	C203 6ft	8.2	5.00
6886	C204 3ft	8.8	21.50
6887	C204 6ft	7.7	23.00
6888	C205 3ft	6.1	5.00
6889	C205 6ft	6.1	9.70
6890	C206 3ft	7.8	4.00
6891	C206 6ft	7.2	5.00
6892	C207 3ft	9.4	22.50
6893	C207 6ft	9.4	12.00
6894	C301 3ft	6.6	5.00
6895	C301 6ft	6.6	3.00
6896	C302 3ft	6.9	2.00
6897	C302 6ft	7.3	2.00
6898	C303 3ft	6.4	7.00
6899	C303 6ft	5.7	1.00
6900	C304 3ft	7.1	2.50
6901	C304 6ft	7.3	1.50

4.3 Toxicity and Public Health Data

4.3.1 Drinking Water Quality Standards

Copper is currently regulated in drinking water as a secondary contaminant, one that is regulated for aesthetic reasons rather than public health concerns. Copper is found in drinking water primarily as a result of copper pipe corrosion. The SMCL (Secondary Maximum Contaminant Level) for copper is 1.0 mg/l. The proposed National Primary Drinking Water Standard (MCLG) for Copper is 1.3 mg/l. The MCLG is a health-based, non-enforceable goal.

The U.S. Public Health Service has established an advisory level for cyanide in water of 0.2 mg/l.

4.3.2 Other Regulated Levels

The copper and cyanide are regulated under the Clean Water Act for industrial point sources.

4.3.3 Toxicity and Public Health Data Summary for Copper

Copper is a naturally occurring metal found in rock, soil, water, sediment and air. The only reported health advisory information is from the National Academy of Sciences which recommends daily intake of no more than 2-3 mg Cu (0.0286 -0.0429 mg/kg/d) (Dowdle, 1989). For humans and other living organisms, copper is an essential nutrient. While a daily dosage is recommended for good health, large dosages have detrimental health effects.

Long-term exposure to copper dust has been proven to be an irritant and can cause headaches, dizziness, nausea, and diarrhea. Very young children can be sensitive to copper. Long-term exposure to high levels of copper in food or water may cause liver damage and death. However, specific studies of the short-term and long-term effects of human consumption of food with elevated levels of copper are not available. In addition, conclusive studies have not been reported concerning the toxicity of copper in soil (Dowdle, 1989).

4.3.4 Toxicity and Public Health Data Summary for Cyanide

As with copper, limited information exists concerning the levels of cyanide detected in air or soils. This lack of data limits the ability of toxicologists to assess the association of adverse health effects with exposure to environmental levels of cyanide. The physical properties of cyanides affect their route and extent of exposure to humans, as well as their subsequent absorption, distribution, and possible adverse health effects. Because of their higher mobility in water and soils, water-soluble cyanide salts and complexes may be ingested by drinking contaminated groundwater. Cyanide salts and complexes that release HCN under conditions below pH 9 may pose a potential for inhalation exposure, if these salts are present in waste sites and come into contact with acidic leachate (Mason, 1989).

Due to the treatment processes used by Cerro, the cyanide found in basin soils is expected to be present as relatively stable, insoluble, metallocyanide complexes of low toxicity. In this form, the cyanide will remain bound to the hydrous iron oxides which are abundant in the basin soils rather than leach into the subsurface soils or groundwater.

For cyanide, EPA health advisories exist for HCN, NaCN, and KCN. No advisories exist for the iron cyanide complexes predicted to be present at the Cerro site. Similarly, the EPA has not established oral RfDs for iron cyanide complexes. Oral RfDs have been established for free cyanide, hydrogen cyanide, sodium cyanide, potassium cyanide, calcium cyanide, barium cyanide, cyanogen, chlorine cyanide, copper cyanide, zinc cyanide, silver cyanide and potassium cyanide (Mason, 1989).

4.4 Specific Environmental Impacts Associated With the Cerro Site

4.4.1 Copper

The mobility of copper in soils, as described above, is controlled by solubility of the copper species present in the solid phase of the soil matrix. As demonstrated in the solubility diagrams, the copper solubility is highly pH dependent. At neutral pH levels, six to nine, copper solubility would be most likely controlled by the extremely stable copper-to-soil binding.

In general, when equilibrium phenomena are involved, the total quantity of solid phase, in this case copper hydroxide, present is not a factor in determining the equilibrium concentration. In a situation where water is percolating through a soil, equilibrium between the water and solid phases would not normally occur. This is the case because the rate at which copper dissolves is relatively slow compared to the residence time of water in the soil. Extended periods of time would be needed to establish true equilibrium conditions. This effectively reduces the potential for significant groundwater contamination.

Extraction procedure toxicity testing of the basin soils was conducted to estimate the leaching potential of copper. The EP Toxicity test was devised by EPA to simulate whether a given solid waste was likely to leach substantial amounts of specific constituents when disposed of in a sanitary landfill. The EP Toxicity test assumes that the solid waste in a typical sanitary landfill would be subject to leaching by weak organic acids. Therefore, acetic acid is used to adjust the pH of the extraction mixture to pH 5.0.

Action levels for the EP Toxicity procedure are set at 100 times the primary drinking standards for metals and pesticides. Copper is not included as a target metal in the procedure. Using the copper in drinking water standard of 1 mg/l, the EP Toxicity limitation for copper would be 100 mg/l. None of the EP Toxicity extracts from the basin soil samples leached copper at concentrations approaching this level.

The soil conditions at the site exhibit relatively high pH levels, probably as a result of discharge of excess lime from the treatment process. The significantly higher pH levels will minimize the potential for copper to leach from the basin. At pH values below 8, the solubility of copper increases by a factor of 100 for each unit decrease in pH. If the assumption is made that the copper concentration in the EP Toxicity leachate is approximately in equilibrium with copper in the soil, then at pH 6 the maximum copper concentration in the leachate would be expected to be 0.3 mg/l, rather than the 26 mg/l found at pH 5. The actual pH levels in the basins average 7.5. At this pH, the leaching potential for copper will not represent a threat to the groundwater. Should the pH of the soil decrease, a natural process in the region, the potential for leaching of copper will increase accordingly. Several samples exhibited a high buffer capacity as a result of excess lime from the treatment process. This is apparent from the quantity of acetic acid added to achieve a pH of 5.0 in the EP Toxicity test. These data are presented in Table 4.1.

4.4.2 **Cyanide**

The fact that cyanide is present in the soil six years after discharges to the basins ended attests to the fact that the cyanide is present in a highly stable form. The most likely cyanide compound is the ferro or ferri cyanide complex, possibly Prussian blue, which may have been formed during the treatment process. The cyanide iron complexes will remain bound to hydrous iron oxides, which are abundant in the basin soils.

The presence of Prussian blue, which is an extremely stable and insoluble compound, would be significant in retaining cyanide in the soil at the Cerro site. High concentrations of iron were known to be present in Cerro's wastewater and sludges as a result of the steel pickling operations. Fuller found that hydrous iron and manganese oxides were effective in immobilizing both cyanide and cyanide metal complexes.

The rate at which cyanide complexes would break down in the environment to form free cyanides is unknown, but it is likely to be extremely slow given the stability of the complexes. Should free cyanide be liberated, the small quantities produced would be rapidly biodegraded.

The cyanide complexes will not produce environmentally significant amounts of cyanide in water percolating through the basins.

4.5 Summary

The basin soils exhibited elevated levels of copper and cyanide. The potential for leaching either copper or cyanide from the soil is minimal due to soil conditions which act to stabilize and prevent leaching. The basins pose no significant environmental impact to the groundwater resources of the area as long as neutral to slightly alkaline soil pH levels are maintained.

5.0 EXPOSURE PATHWAY ASSESSMENT

This section evaluates the potential for contaminant releases to the environment through each of the media pathways: air, surface water, sediments, ground water, and soils.

5.1 Potential Exposure Pathways

5.1.1 Air

Fugitive dust releases to the air can occur through the wind erosion of contaminated soils or through vehicular traffic over unpaved areas with contaminated surface soils. EPA guidance (EPA, 1988) states that the cut-off point for suspendible soil particle size is less than 100 um aerodynamic equivalent diameter. At the Cerro site, dust releases are not anticipated because the surface soils are coarse sands. With particle sizes between .5mm and 1 mm, the site soils are above the range of those particles that are capable of being suspended and transported by the wind and those that can be inhaled.

The other air release pathway to be assessed at a contaminated site is the volatilization of contaminants from covered landfills, spills, leaks, landfarming and basins. This is not a viable contaminant release pathway at the Cerro site because the contaminants of concern, an iron cyanide complex and a copper compound, are not volatile.

5.1.2 Surface Water

The contaminated soils at the site are found at the base of surface impoundments with depths of 20 to 40 feet. Site runoff drains into the basins, not away from them. Therefore, any contamination would not be transported to local surface water bodies through contaminated runoff.

5.1.3 Sediments

Sediments are solid fragmental materials that are transported and deposited by wind, water, or ice, or that can be chemically precipitated from solutions that form loose, unconsolidated layers, such as sand, mud, or till. Such sediments do not exist at the Cerro site.

5.1.4 Groundwater

The fate of contaminants in groundwater and any intermedia transfer mechanisms from groundwater to other environmental media are being assessed in another study by agreement between the property owner and NYSDEC.

5.1.5 Soil

The elevated levels of cyanide found in the basin soils are most likely in the form of ferro and ferri cyanides, stable metal cyanide complexes. These metal cyanide complexes are the most probable compounds to form as a result of mixing the incompletely oxidated cyanide from the plant cyanide treatment process with the iron II in the rinsewater from the steel pickling operation. The most significant contaminant movement in soils is a function of liquid movement. The metal cyanide complexes are stable and insoluble. Therefore, intermedia transfer mechanisms to groundwater will not occur at the site.

Other transfer mechanisms that must be assessed for soil contaminants include volatilization to or resuspension in the atmosphere and bio-uptake by plants and soil organisms. These transfer mechanisms are not of concern at the site due to the fact that the contaminants are not volatile, the particles are too large to be resuspended, and the site has long been denuded.

5.2 Exposure Pathways - Current Land Use

The plant has been commercially inactive for four years. Security initially provided by fences has been allowed to deteriorate. Local adolescents appear to have used the unpaved back lots to race all-terrain vehicles (ATVs). Limited dermal exposure to any contamination present in the surface soils can occur if this type of activity continues in the bottom of the basins. This situation could easily be remedied by the property owner.

5.3 Exposure Pathways - Future Site Conditions

The site has recently been purchased from Sy Associates by the Daily News. We anticipate that the new owner will implement adequate site control and site improvements, including either backfilling the basins and paving over the area for a parking or equipment staging area, or constructing a building foundation over the area. With these site improvements, the only exposure pathway of concern, that of dermal exposure to contaminated soils, will be eliminated. The site will then pose no threat to human health or the environment due to any residual contamination from the treatment basins. Paving over the filled basins would also serve to prevent the migration of copper and cyanide by protecting the basin soils from leaching by percolating rainwater.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Based on an analysis of the data collected from previous site investigations and an assessment of the potential contaminants of concern with regard to their toxicity, environmental impacts, and potential exposure pathways, AGI concludes that the Cerro site poses no imminent or substantial threat to human health or the environment. The contaminants of concern, copper and cyanide, are present in forms that are not toxic and not mobile. The copper is present in an insoluble particulate form. The cyanide is complexed as either ferro or ferri cyanide, both of which are stable metal cyanide complexes. Selenium is not present at levels that warrant any further concern. No clear regulatory mandate or explicit requirement for remediation has been identified.

Two areas do exist at the site where elevated levels of either copper or cyanide have been detected. These areas are the soils surrounding sample point B109, and the north wall of Basin 1. However, the extent of contamination at these locations has not been as well delineated as at the other areas sampled at the site.

6.2 Recommendations

In the absence of a clear regulatory mandate and a mechanism for exposure, AGI believes that the levels of copper and non-reactive cyanide present in Basins 1, 2 and 3 and near B109 do not justify the expense of further remediation. We recommend that no further remediation be performed.

AGI recommends further investigation of the two areas cited in Section 6.1 to define the extent of contamination. We recommend collection of discrete soil samples at varying depths along a grid, the dimensions of which would be negotiated with NYSDEC. Samples from Basin 1 would be collected and analyzed for total cyanide and copper; EP-Toxic copper;

reactive cyanide; and soil pH. Samples surrounding B109 would be excavated and analyzed for total copper, EP-Toxic copper, and soil pH.

7.0 REFERENCES

APHA and AWWA, Standard Methods for the Examination of Water and Wastewater, 18th Edition. American Public Health Association and American Water Works Association, 1989.

Arizona University-Department of Soils, Investigation of Landfill Leachate Pollutant Alternative by Soils, NTIS PB-286 995. Springfield, VA: U.S. Department of Commerce, August 1978.

Cohen, P., Franke, O.L., and Foxworthy, B.L., "Atlas of Long Island's Water Resources", New York Water Resources Commission Bulletin #62. New York: State of New York Publisher, 1968.

Copenhaver, E.D., "Transport of Hazardous Substances Through Soil Processes", Oak Ridge National Laboratory Report, Part 1, Vol. I (ORNL-Eis-74-70), November 1974.

de Vera, E.R., et al., Samples & Sampling Procedures for Hazardous Waste Streams (EPA-600/2-80-018). Cincinnati: MERL, January 1980.

Dowdle, Walter R., Toxicological Profile for Copper (Agency for Toxic Substances & Disease Registry 88-0608-02). Springfield, VA: U.S. Dept. of Commerce, November, 1989.

EPA, A Compendium of Superfund Field Operations (EPA/540/P-87/001). Washington, D.C.: U.S. Government Printing Office, 1987.

EPA, Health Effects Assessment for Cyanide (NTIS PB 86-134228). Springfield, VA: U.S. Department of Commerce, September 1984.

EPA, Superfund Exposure Assessment Manual (EPA/540/1-88/001). Washington, DC: U.S. Government Printing Office, 1988.

Fetter, C.W., Applied Hydrogeology. Columbus, OH: Charles E. Merrill, 1980.

Fuller, W., Movement of Selected Metals, Asbestos, and Cyanide in Soil: Applications to Waste Disposal Problems (NTIS PB-266 905), April 1977.

Fuller, W. Investigation of Landfill Leachate Pollutant Attenuation by Soils (NTIS PB-286 995), August 1978.

Geraghty & Miller, Inc., Draft Interim Remedial Investigation of the Syosset Landfill, January 1989.

Gregg, D.O., and Kennedy, K.G., "Movement of Chemical Contaminants in Groundwater", Conference Proceedings from Environmental Aspects of Chemical Use in Well-Drilling Operations(TX-W+15 PB 246 947). Houston, TX: May 1975. .

H_2M Group, "Phase II Investigation Cerro Conduit Site". Prepared for Sy Associates, February 1989.

Hart, M.J., and Van der Geugten, R.P., Determination of Cyanide in Soil and Groundwater. Studies in Environmental Science, Vol. 17. Netherlands: Elsevier Scientific Publishing Company, March 1981.

Isister, J., Geology and Hydrology of Northeastern Nassau County, Long Island, New York (USGS Water Supply Paper 1825). Washington, DC: U. S. Government Printing Office, 1967.

Kilburn, C., "Hydrogeology of the Town of North Hamstead, Nassau County", New York Water Resources Bulletin #12. Long Island, NY: Nassau County Department of Public Works, 1979.

Mason, J.O., Toxicological Profile for Cyanide (Agency for Toxic Substance & Disease Report, 68-C8-0004). Springfield, VA: U.S. Department of Commerce, December, 1989.

McClymonds, N.E., and Franke, O.L., Summary of the Hydrologic Situation on Long Island, New York, as a Guide to Water-Management Alternatives (U.S.G.S. Professional Paper 627-F). Washington, D.C.: Government Printing Offices, 1972.

McClymonds, N.E. and Franke, O.L., Water-Transmitting Properties of Aquifers on Long Island, New York (U.S.G.S. Professional Paper 627-E). Washington, D.C.: U.S. Government Printing Office, 1972.

Oak Ridge National Lab, Reviews of the Environmental Effects of Pollutants: V. Cyanide (NTIS PB-289-920), October 1978.

Stumm, W., and Morgan, J.J., Aquatic Chemistry. New York: John Wiley and Sons, 1970.

Versar, Inc., Water Related Environmental Fate of 129 Priority Pollutants, Volume I (NTIS PB80-204373), December 1979.

Appendix : Professionals Engaged in the Preparation of the Data Assessment

Name	Title	Discipline
Thomas Wills, P.E.	Project Manager	Management
Lily Openshaw, P.E.	Sr. Environmental Engineer	Pathway Assessment
Jack Hewitt, Ph.D.	Sr. Chemist	Environmental Chemistry
Jens Islev-Petersen	Environmental Geologist	Hydrogeology
Craig Owen	Environmental Scientist	Data Interpretation
Celeste DiNucci	Technical Editor	Editing
Linda Holmberg	Drafter	Graphics