

Blackwell
Technical Report 93-09

**RESULTS OF SOIL SCREENING ACTIVITIES
BLACKWELL, OKLAHOMA**

Final Draft Report Submitted : 12/16/93

Final ODEQ Approval: _____

Prepared by:

Mintech, Inc.
1525 North 105th East Ave.
Tulsa, Oklahoma 74116

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LIST OF PREVIOUS REPORTS

Blackwell Technical Report 91-01	Proposed Phase I Groundwater Investigation at Blackwell, Oklahoma
Blackwell Technical Report 92-02	Results of Phase I Groundwater Investigation at Blackwell, Oklahoma
Blackwell Technical Report 92-03	Proposed Phase II Activities at Blackwell, Oklahoma
Blackwell Technical Report 93-04	Phase II Report and Expanded Work Plan at Blackwell, Oklahoma
Blackwell Technical Report 93-05	Soil Consolidation Plan, Washington School and Beatty-Rodgers Park
Blackwell Technical Report 93-06	Blackwell Industrial Authority, Site Maintenance Plan
Blackwell Technical Report 93-07	Expanded Groundwater Investigation at Blackwell, Oklahoma, Preliminary Draft
Blackwell Technical Report 93-08	Results of Phase II Expanded Groundwater Investigation - Blackwell, Oklahoma

AGENCY AND PROJECT CONTACTS

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Project Manager: Mr. James E. Kerrigan

**ENVIRONMENTAL STEERING COMMITTEE
BLACKWELL, OKLAHOMA**

Members

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Jack Whaylen

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Bernie Petrie

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Jim Willis
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Tom Trebonik
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ODEQ

Monty Elder
ODEQ

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I. **Soil Screening Survey**

Introduction

As a result of the United States Environmental Protection Agency (EPA) report of findings from an Expanded Site Inspection conducted in October 1992 and released on May 24, 1993, additional soil sampling and analysis was conducted on select sites within the City of Blackwell. A plan for the soil screening activities was forwarded to the Oklahoma Department of Environmental Quality (ODEQ) on September 3, 1993 (Appendix A) and was approved by ODEQ on September 13, 1993 (Appendix B). The primary objective of the plan was to further define through soil sampling and analysis the potential occurrence of elevated metal levels in the soil in specific residential sub-areas around the Blackwell Industrial Authority Site (the former location of the Blackwell Zinc Smelter) and to provide guidance in developing a detailed soil testing plan if warranted.

Purpose

The purpose of this report is to present the results of the soil screening efforts conducted to date; to delineate non-residential sub-areas to be screened through soil sampling and analysis; and to outline a detailed sampling and analysis program for specific residential sub-areas in the vicinity of the BIA site.

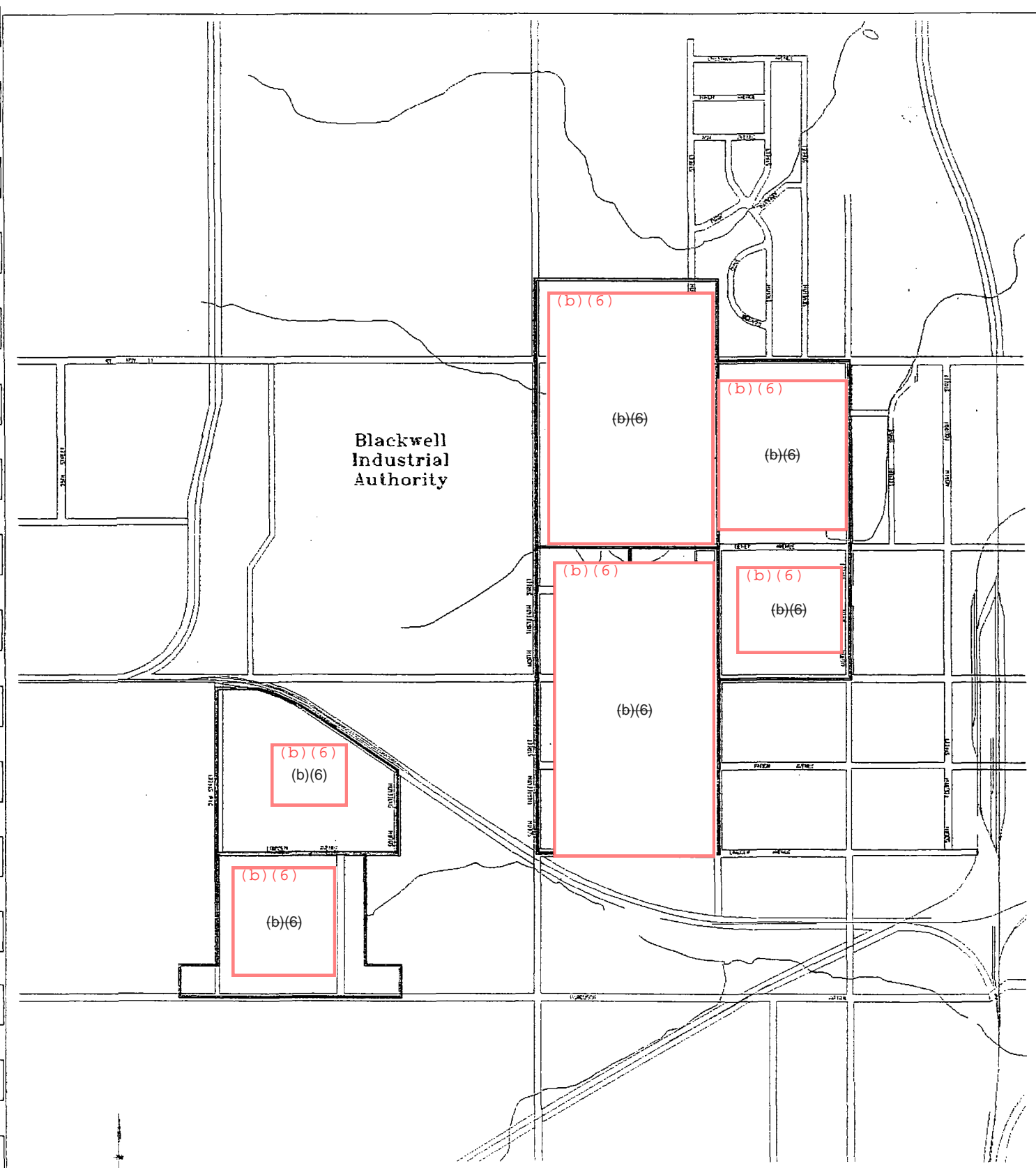
II. Sample Collection

Throughout the period of September 13, 1993 through September 23, 1993, a total of 39 soil samples were collected from the residential areas generally bordering the east and south sides of the BIA site. The target areas were assigned a temporary alphabetic or alphanumeric designation to identify the general locations for the sampling effort (Figure 1).

As outlined in the soil screening plan (Appendix A), samples were collected on a grid size varying from about 500 to 1,000 feet. The closer grid size allowed for a more detailed examination of soil metal concentrations in the residential areas than occurred in the original EPA sampling program. All samples were collected in accordance with the approved screening plan and followed the approved Field Sampling Plan and Quality Assurance Plan as outlined in Blackwell Technical Report 93-04, pages 41 through 43. Figure 2 presents the general locations of the 39 soil samples collected during the screening program and shows the relationship of the locations of the screening samples to the previous sampling activity conducted by EPA.

All samples were collected in accordance with the approved soil screening plan, and were identified with a residential sub-area designation and sample number. For example, sample tS-203 represents sample number 03 collected from residential sub-area tS-2. Sample tE-027 represents sample number 27 collected from sub-area tE. The locations of all sampling points are presented on Figure 2, and a descriptive location for each of the samples is provided in Appendix C.

All samples were analyzed in accordance with EPA approved methods and were analyzed for total arsenic, total cadmium, total lead and total zinc concentrations. Appendix D presents the laboratory report forms and chain of custody documentation for all of the samples.



Δ^{DT} - Soil Sampling Point

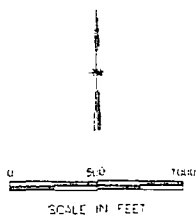


Figure 2
Soil Sampling Locations

III. Results of Analysis

The results of analyses of soil from within the residential areas generally indicate concentrations of lead and cadmium below the established action level for lead of 500 mg/Kg and for cadmium of 30 mg/Kg. Of the 39 samples collected, 3 samples, or 8 percent, contained a lead concentration above 500 mg/Kg, while five samples, or 13 percent, had cadmium levels in excess of the 30 mg/Kg action level.

Residential Sub-area tS-1

Residential sub-area tS-1 located immediately south of the BIA site was not sampled as part of this soil screening activity. Previous sampling conducted by EPA resulted in a total of eight samples having been collected from this small sub-area. The concentration of lead within the soil ranged from a low of 314 mg/Kg to a high of 1,850 mg/Kg. Cadmium was reported to range from 37 mg/Kg to 180 mg/Kg. Additional investigation and/or remediation of this area will be necessary.

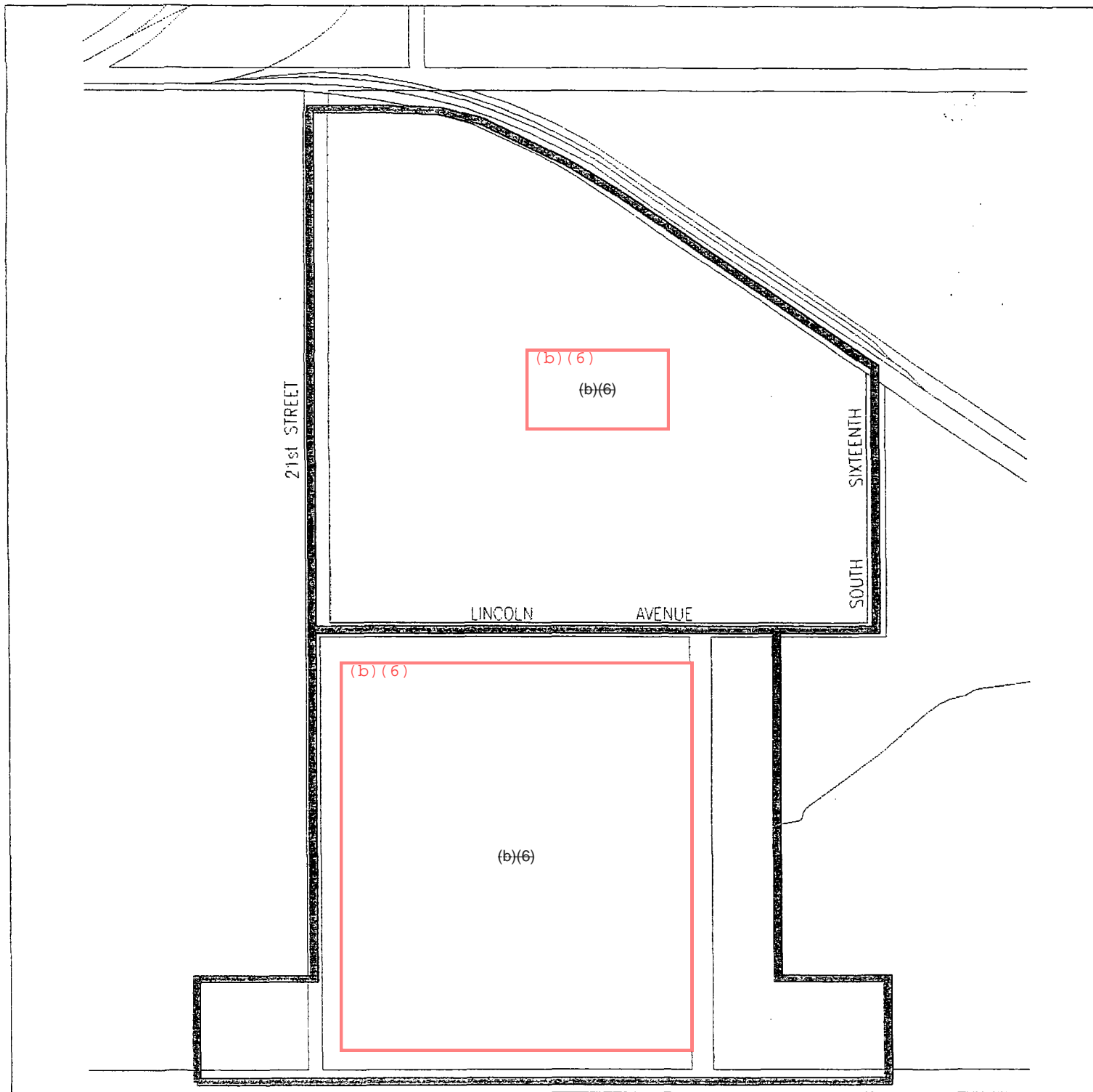
Residential Sub-area tS-2

Residential sub-area tS-2 is located directly south of the existing BIA site. Five soil samples were collected in this area and analyzed. The lead concentration in these samples varied from a low of 17.8 mg/Kg to a high of 130 mg/kg. Cadmium levels ranged from 3.33 mg/Kg to 20.2 mg/Kg. All values from this sub-area are well below the established action levels. Figure 3 presents the sampling locations and results of analysis for lead and cadmium within sub-area tS-2.

Residential Sub-area tSE-1

Eight soil samples were collected from this sub-area located southeast of the BIA site. Only one sample (tSE-108) had a lead concentration slightly above the action level and was reported at 535 mg/Kg.

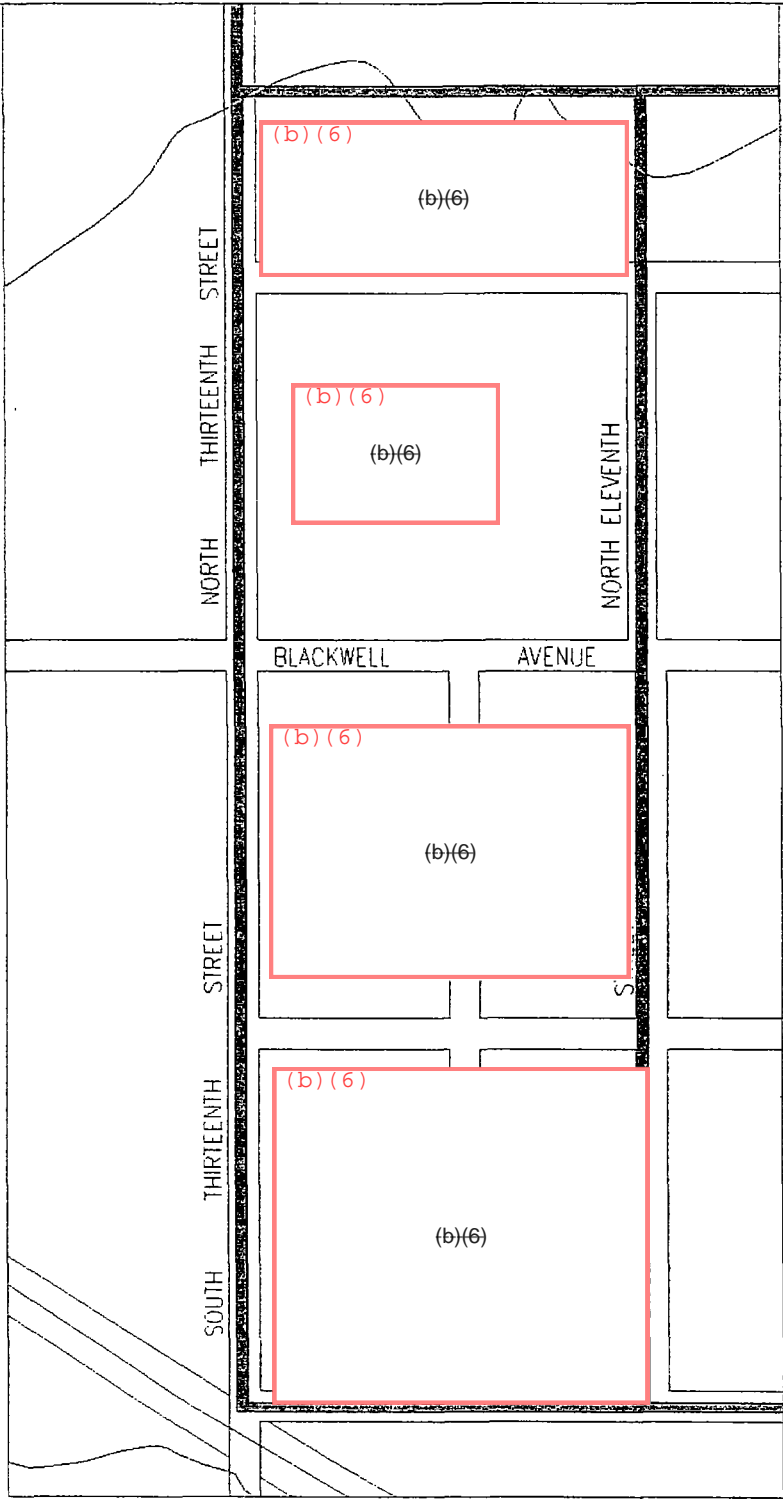
Three of the six soil samples from this sub-area, however, had cadmium concentrations in excess of the 30 mg/Kg established action level. Samples tSE-107,08 and 011 had cadmium concentrations of 43.5 mg/Kg, 38.5 mg/Kg and 32.7 mg/Kg respectively (see Figure 4).



- ▲⁰¹ - Soil Sampling Point
- 82.1 - - Lead (mg/kg)
- 9.42 - Cadmium (mg/kg)



Figure 3
Residential Sub-Area tS-2



▲⁰¹ - Soil Sampling Point
 82.1 - - Lead (mg/kg)
 - 9.42 - Cadmium (mg/kg)

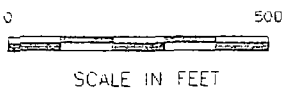


Figure 4
Residential Sub-Area tSE-1

Residential Sub-area tSE-2

Eight soil samples were also collected from sub-area tSE-2. One sample (tSE-2015) had a lead concentration of 528 mg/Kg, slightly above the established action level, and two samples (tSE-2012 and tSE-2017) had elevated cadmium concentrations. Sample 012 had a cadmium concentration of 37.7 mg/Kg while sample 017 had a concentration of 65 mg/Kg, the highest cadmium level reported in the survey. Figure 5 presents the locations and concentrations of the samples collected from sub-area tSE-2.

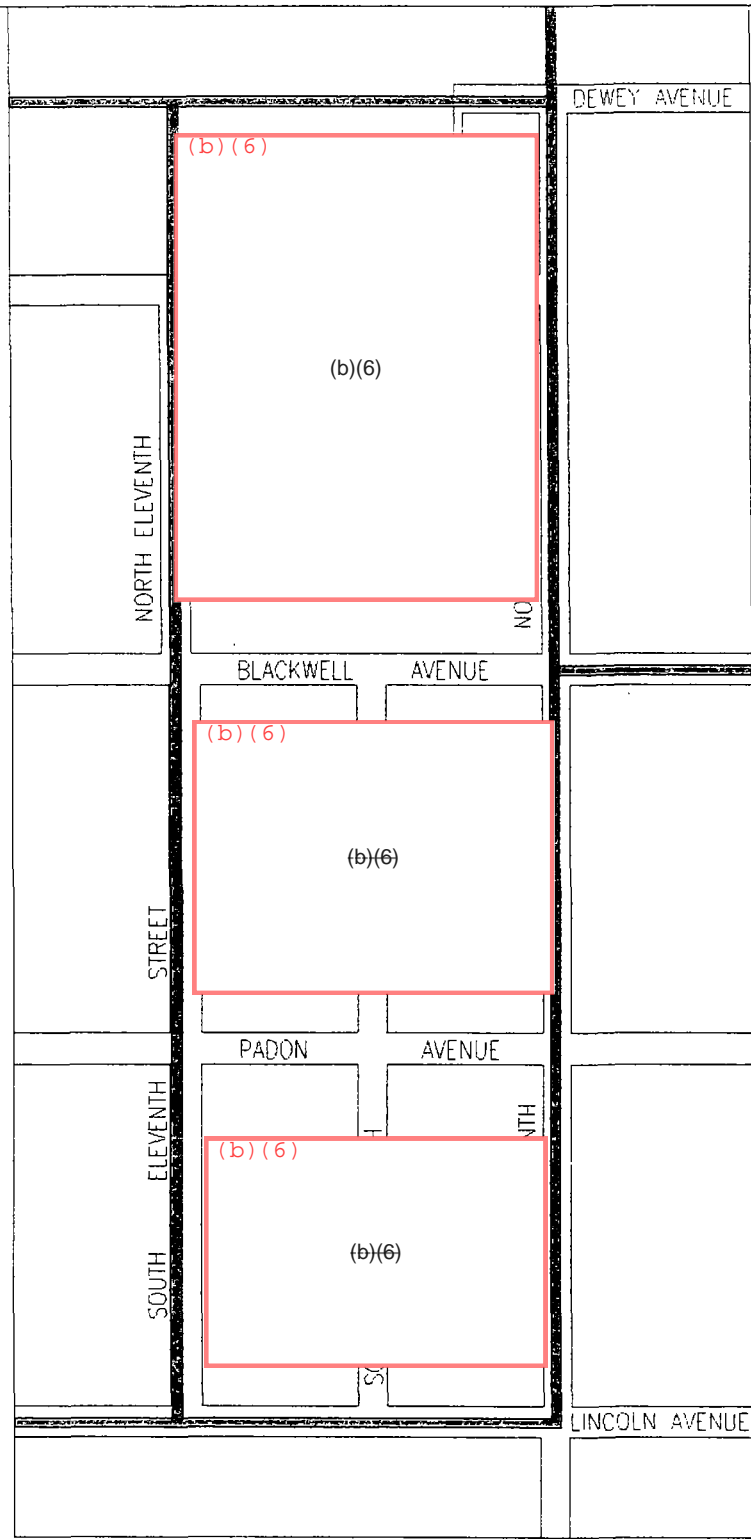
Residential Sub-area tNE

Residential sub-area tNE is located northeast of the BIA site and is predominantly composed of undeveloped land with some commercial development. All eight samples collected from within this sub-area were well below the action levels for both lead and cadmium (Figure 6).

Residential Sub-area tE

Residential sub-area tE is the farthest east residential area examined under this soil screening effort. A total of ten samples were collected from this sub-area. Only one sample (sample tE-023) had a lead concentration in excess of 500 mg/Kg. This sample, with 1,306 mg/Kg of lead, represents the highest reported lead value for all 39 samples collected during the screening study and likely represents a "hot spot" condition resulting from placement and use of smelter residue as fill material. Additional investigation into the conditions at this site will be necessary.

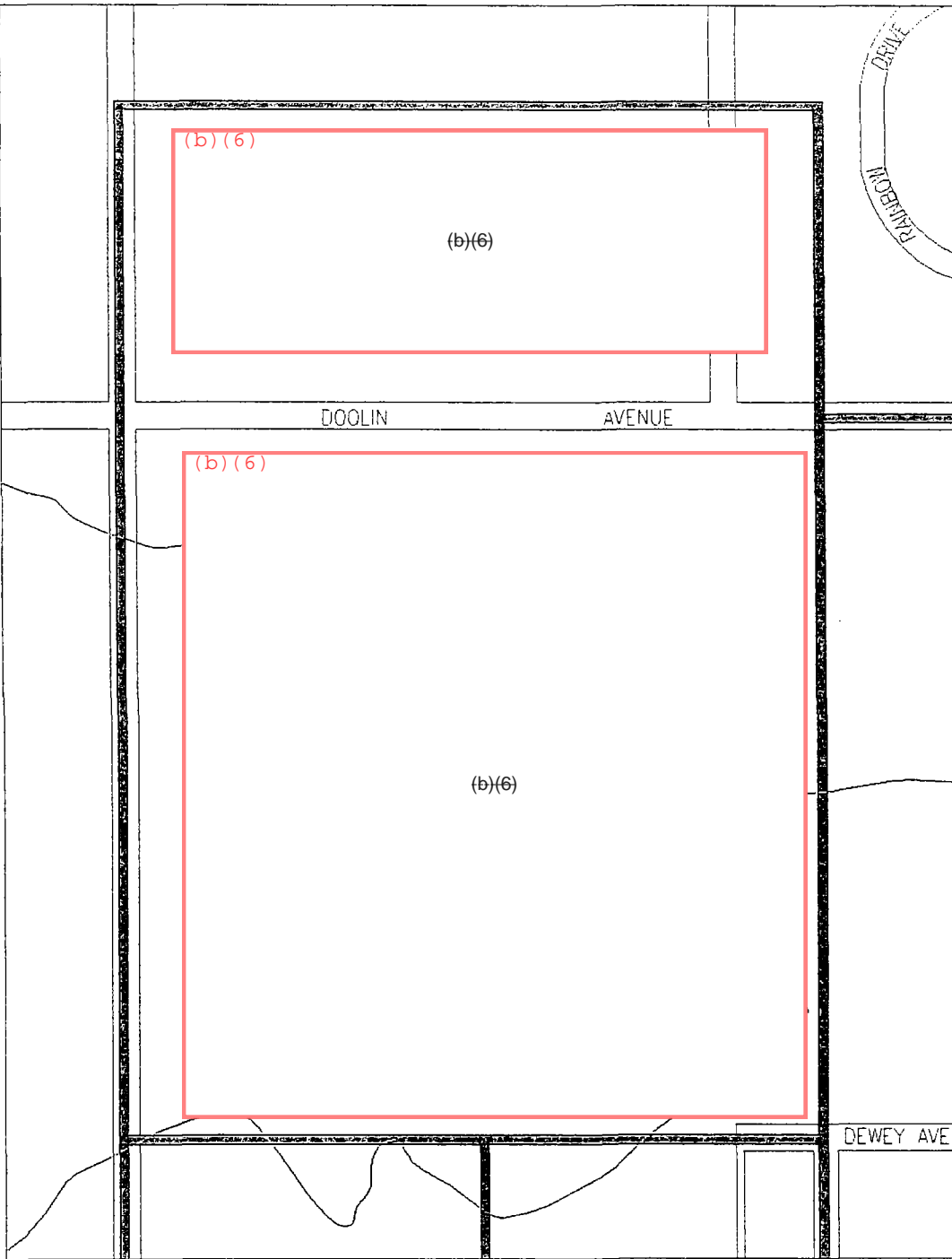
All cadmium levels within residential sub-area tE were well below the established action level for cadmium in soil. The level of cadmium measured in sample tE-023 was 20.7 mg/Kg. Figure 7 presents the results of lead and cadmium analysis for sub-area tE.



- ▲⁰¹ - Soil Sampling Point
- 82.1 - - Lead (mg/kg)
- 9.42 - Cadmium (mg/kg)



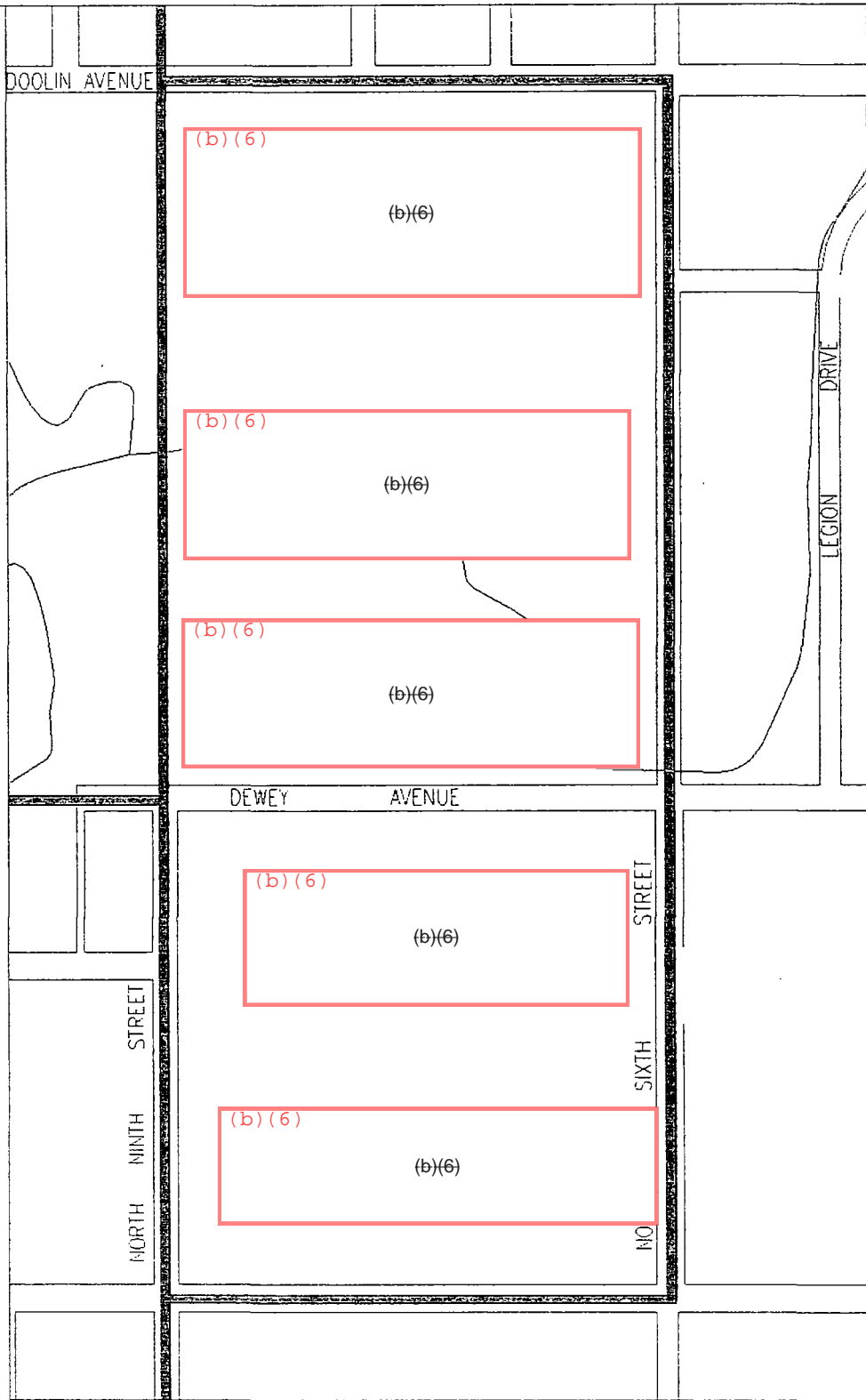
Figure 5
Residential Sub-Area tSE-2



- ▲⁰¹ - Soil Sampling Point
- 82.1 - - Lead (mg/kg)
- 9.42 - Cadmium (mg/kg)



Figure 6
Residential Sub-Area tNE



▲ - Soil Sampling Point
 82.1 - Lead (mg/kg)
 - 9.42 - Cadmium (mg/kg)

0 500
 SCALE IN FEET

Figure 7
Residential Sub-Area tE

IV. Observations

Some general observations on the heavy metals concentration in soil within the Blackwell area can be made based upon the results of the recent soil sampling and chemical analyses conducted. The overall concentrations of metals in the soil appear to decrease rapidly away from the former smelter site and to be well below EPA established action levels within one-half mile of the site.

Isolated "hot spots" likely exist within the residential areas. The hot spots are areas where high values of lead or cadmium are found in the soil, but are surrounded by areas of relatively low metal concentrations in the soil. These hot spots could represent areas where smelter residue has been hauled to the area and used for fill.

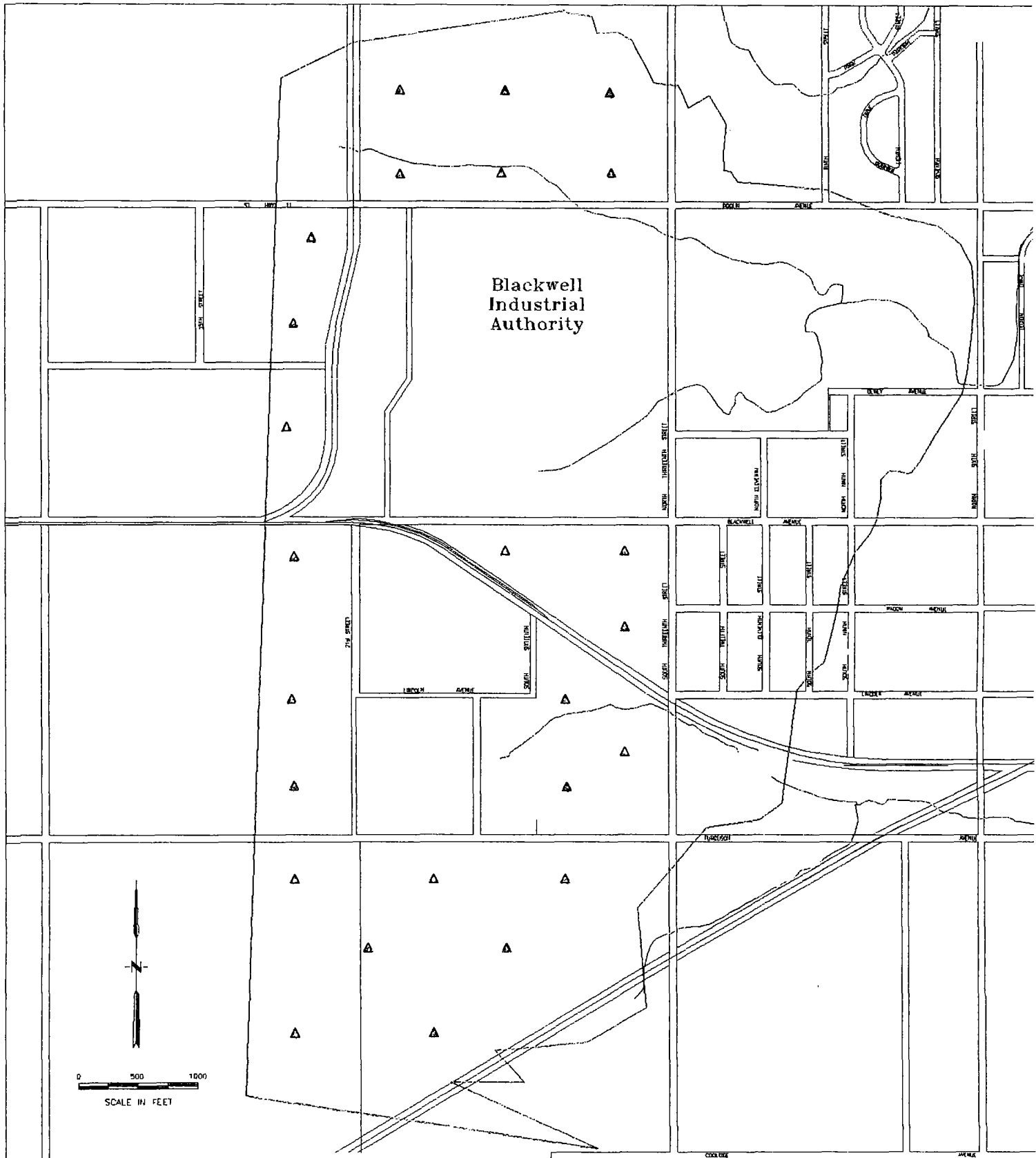
V. Expanded Soil Screening Activities

Sampling Undeveloped Areas

In order to fully characterize the area identified by EPA as potentially containing elevated soil metal concentrations (EPA Expanded Site Inspection Report) additional soil sampling activity will be conducted. The first phase of soil screening targeted predominantly the residential areas adjacent to the former smelter site. Undeveloped areas to the north and south of the former smelter site were not considered for sampling in the reported screening survey. In the expanded screening phase, these areas will be sampled on a wide grid basis (500 to 1,000 foot grid) to determine if additional characterization is necessary. Sample collection and Quality Assurance procedures will follow the approved Field Sampling Plan and Quality Assurance Plan as outlined in Blackwell Technical Report 93-04, pages 41 through 43. According to the procedure, soil samples will be collected from the surface after first removing vegetative cover and litter. The soil samples will be collected from 0 to 3 inches in depth and placed in pre-cleaned glass jars equipped with Teflon® lid liners. Samples will be preserved by chilling and will be transmitted to Metlab Testing Services, Inc., Tulsa, Oklahoma, for analysis.

Sampling equipment will be cleaned between samples to avoid cross contamination. Rinsate samples from the equipment cleaning procedures will not be collected or analyzed. Chain-of-custody documentation will be completed and maintained for all soil samples collected. The soil samples will be analyzed for total arsenic, total lead, total cadmium and total zinc concentrations.

Figure 8 presents the location of the samples to be collected from the undeveloped areas surrounding the site. Modification to the sampling or analysis program during the expanded screening effort will be coordinated and pre-approved by ODEQ prior to implementing those changes.



- ▲ - Soil Sampling Point
- ▭ - Soil Screening Area

Figure 8
Proposed Soil Sampling Locations

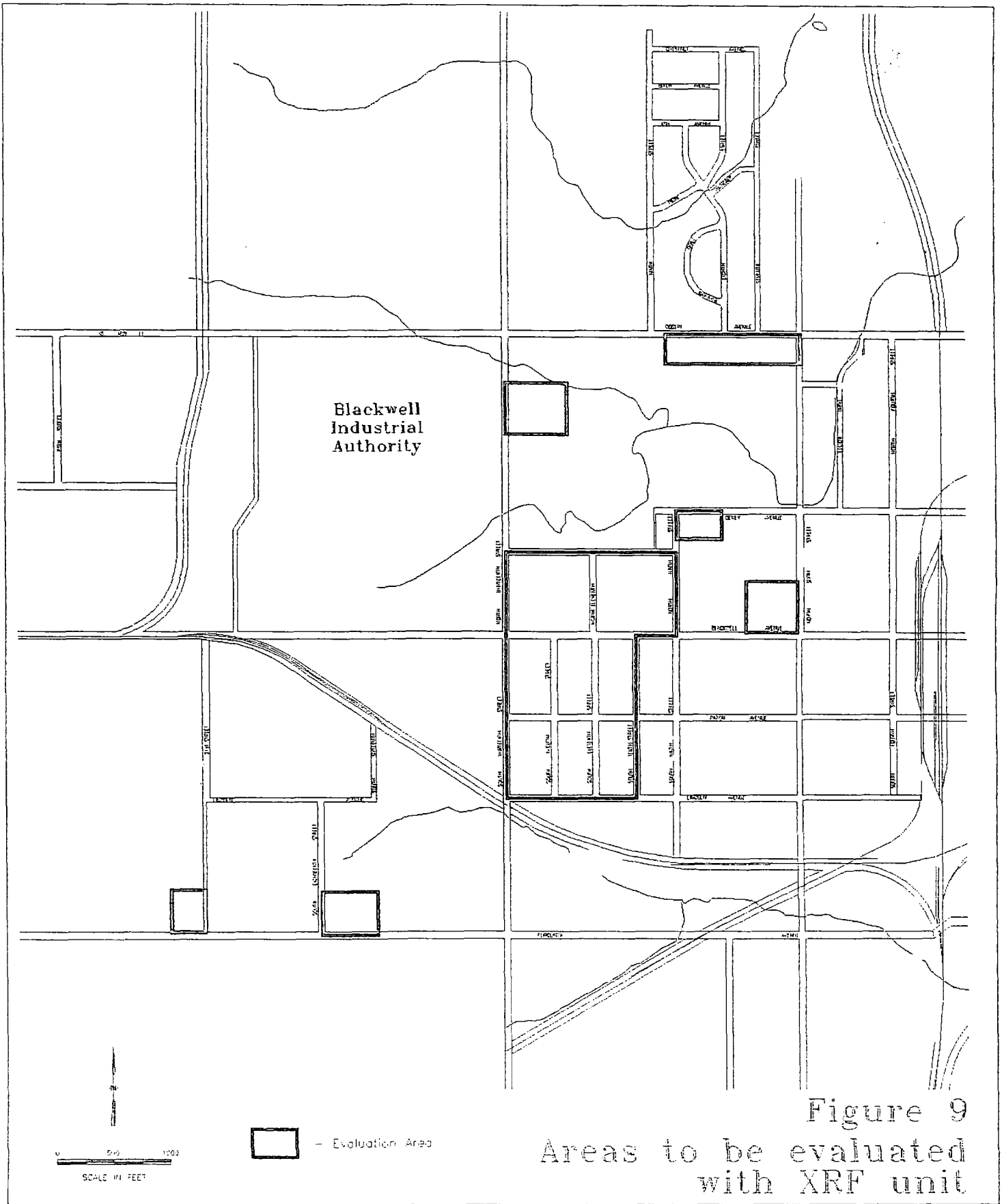
Soil Testing of Residential Areas

Based on the results of the soil screening program and previous EPA soil testing activities, the residential areas targeted for further soils evaluation were defined. In general, the sub-areas to be tested were established in cooperation with the Department of Environmental Quality based on existing soils information and are shown on Figure 9. Soils testing to be used to evaluate the occurrence of metal will be by a combination of portable field testing equipment and confirmatory laboratory chemical analysis.

The selection of sampling locations will be approximately a 200 ft. by 200 ft. grid pattern within the target residential areas (Figure 10). A grid intersect may fall on a site that is void of soil, near a street or structure, and it will be necessary to offset the sampling location to the nearest practical location where a proper soil measurement can be taken. Each soil sampling location will be at least 15 feet from the edge of a city street gutter and at least 10 feet from a residential or service structure. When grid intersects fall on alley ways, the sampling locations will be off set from the traffic areas to the edges of the alley, where the soil has not been disturbed by vehicles.

A field testing instrument will be used at each soil sample location to determine the concentration of metal contained at the surface, and a second instrument will be used to establish the location of the sample point. Metal concentration will be determined using a portable X-ray Fluorescence (XRF) unit, equivalent to a TN Technology, Spectrace 9000 unit. The portable XRF unit allows the field personnel to rapidly assess the field conditions, and allows them to make field decisions to expand the investigation in areas indicating elevated metal concentration. A limited number of soil samples, 5 to 10 percent, will be tested by conventional laboratory analysis methods to confirm the field measurements. Metals data measured by the XRF unit will include total arsenic, cadmium, lead and zinc concentrations. A general XRF Screen Plan to be followed for the Blackwell project is included in Appendix E.

A standard testing procedure will be used at each selected sampling location located on the approximate 200 ft. by 200 ft. grid. One XRF reading will be taken at the surface in each of four directions (north, east, south, and west) from the established sampling point at a distance of five feet (Figure 11). The XRF will be calibrated according to established procedures prior to use.



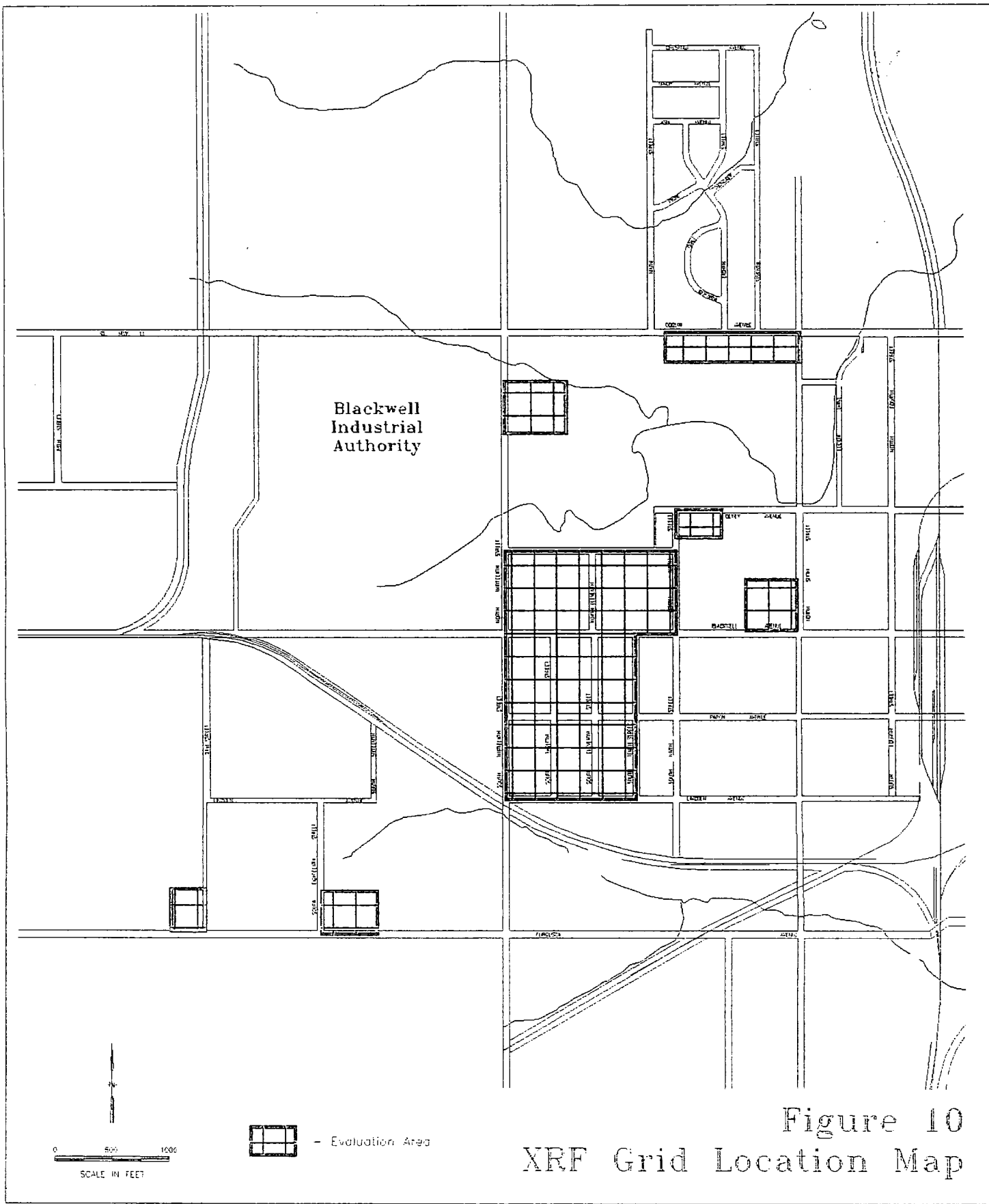


Figure 10
XRF Grid Location Map

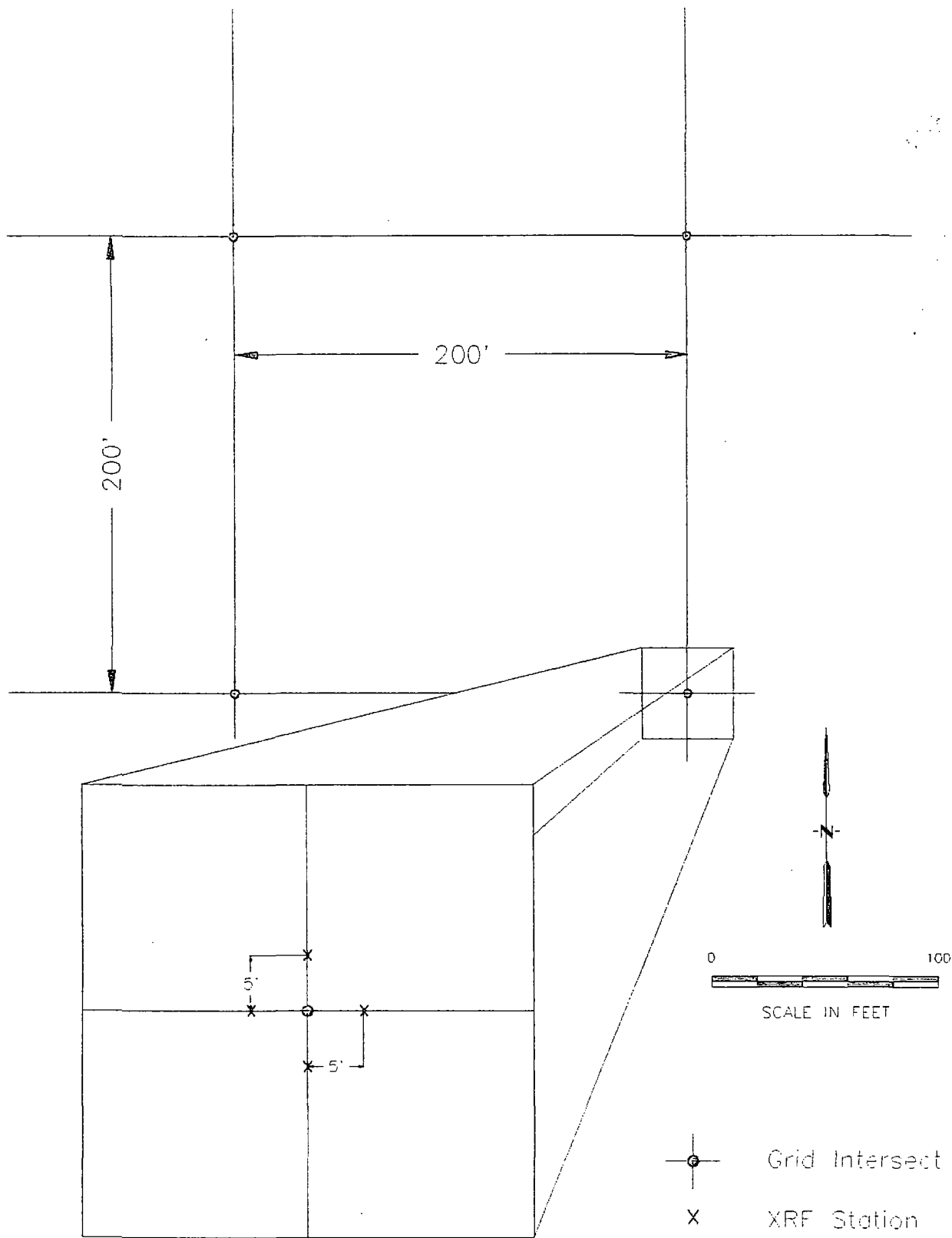


Figure 11
 Example of XRF
 Screening Procedure

In addition, a series of reference soil samples, representing local soil condition, will be pre-analyzed and tested with the XRF unit on a daily schedule to provide additional calibration of the XRF unit.

For the evaluation of the sample point, the four readings for each of the individual target metals will be averaged to represent the mean concentration of that metal for the selected sampling point.

Additional XRF measurements will be made, if field conditions indicate the presence of elevated metal levels such as the occurrence of smelter residual material.

A field location meter, called a global positioning system (GPS) unit, will be used to determine the longitude and latitude for each selected and special sample location. The center of the XRF measurement pattern will identify the location of the sample point within an accuracy of three feet. The GPS locations will be coordinated with individual property base maps to assist with the evaluation. The use of GPS will minimize overall field data collection time and provide an accurate method to determine the location where soils were evaluated.

VI. Schedule of Implementation

Completion of the Expanded Soil Screening effort will require approximately 10 weeks. This time frame considers delays due to inclement weather and laboratory response time required for verification/comparison samples and soil screening samples from undeveloped areas.

Final report time is anticipated to require approximately three weeks after completion of all tasks and receipt of laboratory data. A Gantt chart for the Expanded Soil Screening effort is included for review. The Gantt assumes project initiation on February 1, 1994 and completion of identified activities by April 8, 1994. Submittal of the report of findings to ODEQ is anticipated to be no later than April 11, 1994.

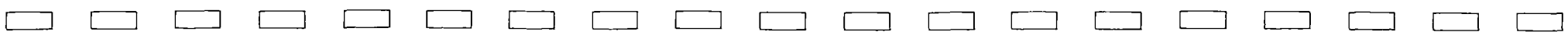
EXPANDED SOIL SCREENING SURVEY

ID	Name	Duration	December				January				February				March				Ap	
			12/5	12/12	12/19	12/26	1/2	1/9	1/16	1/23	1/30	2/6	2/13	2/20	2/27	3/6	3/13	3/20	3/27	4/3
1																				
2																				
3	SAMPLING OF UNDEVELOPED AREAS:	23d									█	█	█	█	█	█	█	█		
4	1. Field sampling efforts	2w									█	█								
5	2. Laboratory Analysis of Samples	3w										█	█	█						
6	3. Quality Assurance of Data	8d											█	█						
7																				
8																				
9	XRF FIELD SCREENING:	25d													█	█	█	█	█	█
10	1. Field Screening Efforts	3w													█	█	█			
11	2. Data Reduction and Evaluation	3w															█	█		
12																				
13																				
14	REPORT OF FINDINGS:	27d																	█	█
15	1. Data Compilation	2.4w															█	█		
16	2. Report Preparation	3.4w																█	█	█
17																				
18																				
19	SUBMITTAL OF REPORT TO ODEQ:	1d																		◆

21

Project: Blackwell, OK
Date: 1/25/94

Critical █ Progress █ Summary █
 Noncritical █ Milestone ◆ Rolled Up ◇



VII. Report of Findings

Upon completion of all task items for the Expanded Soil Screening Activities, a report of findings will be prepared and submitted to ODEQ. The report of findings will include all data results and interpretations from the expanded investigation outlined and will incorporate all relevant information derived from the soil screening activities.

APPENDIX A

Soil Screening Plan



September 3, 1993

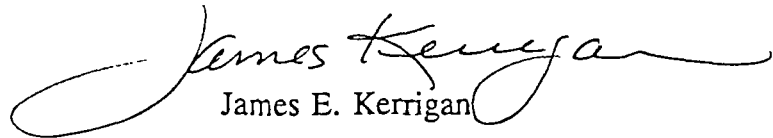
Scott Thompson
Oklahoma Department of Environmental Quality
Solid Waste Management
1000 N.E. 10th Street
Oklahoma City, Oklahoma 73117-1299

Dear Mr. Thompson:

To assist us in developing a site-specific plan for determining remedial actions, we would like some additional soils information at Blackwell. We would like to collect 40 to 50 soil samples from neighborhoods around the Blackwell Industrial Authority property.

If there are no objections we could start this screening soil survey by the middle of this month. If you have any questions, please call me at (303) 231-0204 or Tom Trebonik at (918) 836-0700 and we'll try to respond promptly.

Sincerely,


James E. Kerrigan

JEK/jb

c: Tom Trebonik

I. Introduction

General

In October of 1992, the United States Environmental Protection Agency (EPA) released a report of the findings of an Expanded Site Inspection for the closed Blackwell Zinc facility. The report contained the results of chemical analysis of one hundred soil samples collected from throughout the Blackwell, Oklahoma area. Upon further evaluation of the data, EPA released a document entitled "Geostatistical Analysis of Blackwell Zinc Superfund Site Data" which contained computer generated maps using soil chemical data collected during the Expanded Site Investigation. The geostatistical report, dated February 26, 1993, was released by EPA on May 24, 1993.

The latest report identifies areas within Blackwell indicating a likelihood of elevated soil metal concentrations. Four metals (arsenic, cadmium, lead and zinc) were mapped by EPA.

The area reported to contain elevated metal concentrations was limited to about a one square mile area surrounding and including the Blackwell Industrial Authority (BIA) property. The former Blackwell Zinc Smelter occupied the BIA site. The study area to be further investigated is generally bounded on the north by Doolin Avenue, on the east by Sixth Street, on the south by Ferguson Avenue, and on the west by 23rd Street. Figure 1 presents the location of the area identified by EPA as potentially containing elevated soil metal concentrations.

Objective

The primary objective of the investigation is to further define, through further soil sampling and analysis from selected locations in areas delineated by EPA's geostatistical modeling efforts, the potential occurrence of elevated metal levels in soil in specific sub-areas around the Blackwell Industrial Authority property. The result of investigation will provide guidance in developing detailed soil testing and, if advised, remedial action.

II. IDENTIFICATION OF AREAS TO BE EVALUATED

The areas identified for immediate evaluation include the residential areas surrounding the BIA property. For ease of identification, the area has been separated into six individual sampling areas and have each been assigned an alphabetic or alphanumeric designation (Figure 2). The designations include NE for an area located northeast of the BIA property; SE-1 and SE-2 for areas located southeast of the site; E for an area due east of the site; and S-1 and S-2 for residential areas located immediately south of the site. The boundaries are temporary and will be modified, based on the results of the screening tests. The BIA property and undeveloped land surrounding the site will not be evaluated during this Phase of the project. Activities in these areas will occur at a later time, if warranted.

III. SAMPLING METHODS

Soil samples will be collected on a grid basis, with the size of grid varying from about 500 feet to 1,000 feet, depending upon the area sampled (Figure 3). Approximately 39 samples are anticipated to be collected from the area. Where possible, samples will be collected from City of Blackwell right-of-way zones. When a sampling node falls within private property, the land owner will be contacted and permission to sample obtained prior to collecting the soil sample. Minor variations to the grid may be necessary (as a result of concrete drives, sidewalks, etc.) and will be noted in the records kept for this effort. A detailed location description of each sampling point will also be recorded.

Sample collection techniques and Quality Assurance procedures will follow the approved Field Sampling Plan and Quality Assurance Plan as outlined in Blackwell Technical Report 93-04, pages 41 through 43. In general, all samples will be collected from the surface after first removing vegetative cover and litter. The soil samples will be collected from 0 to 3 inches in depth and placed in pre-cleaned glass jars equipped with Teflon lid liners. Samples will be preserved by chilling and will be transmitted to Metlab Testing Services, Inc., Tulsa, Oklahoma for analysis.

Sampling equipment will be cleaned between samples to insure that cross contamination does not occur. Rinsate samples from the equipment cleaning procedure will not be collected or analyzed. Chain-of-Custody documentation will be completed and maintained for all soil samples collected.

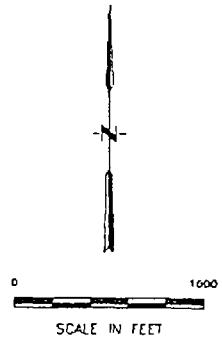
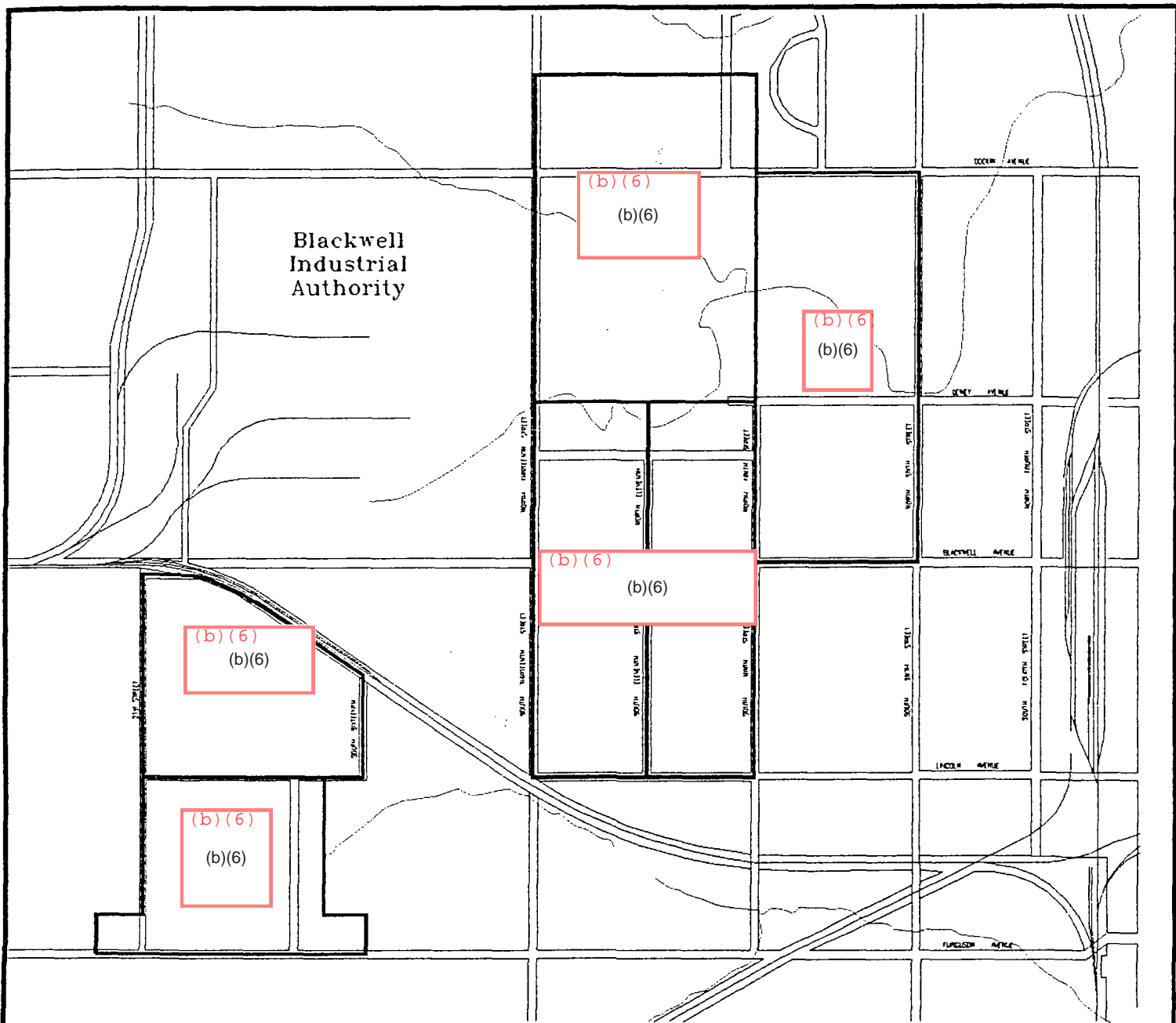


Figure 2
Areas for Soil Sampling

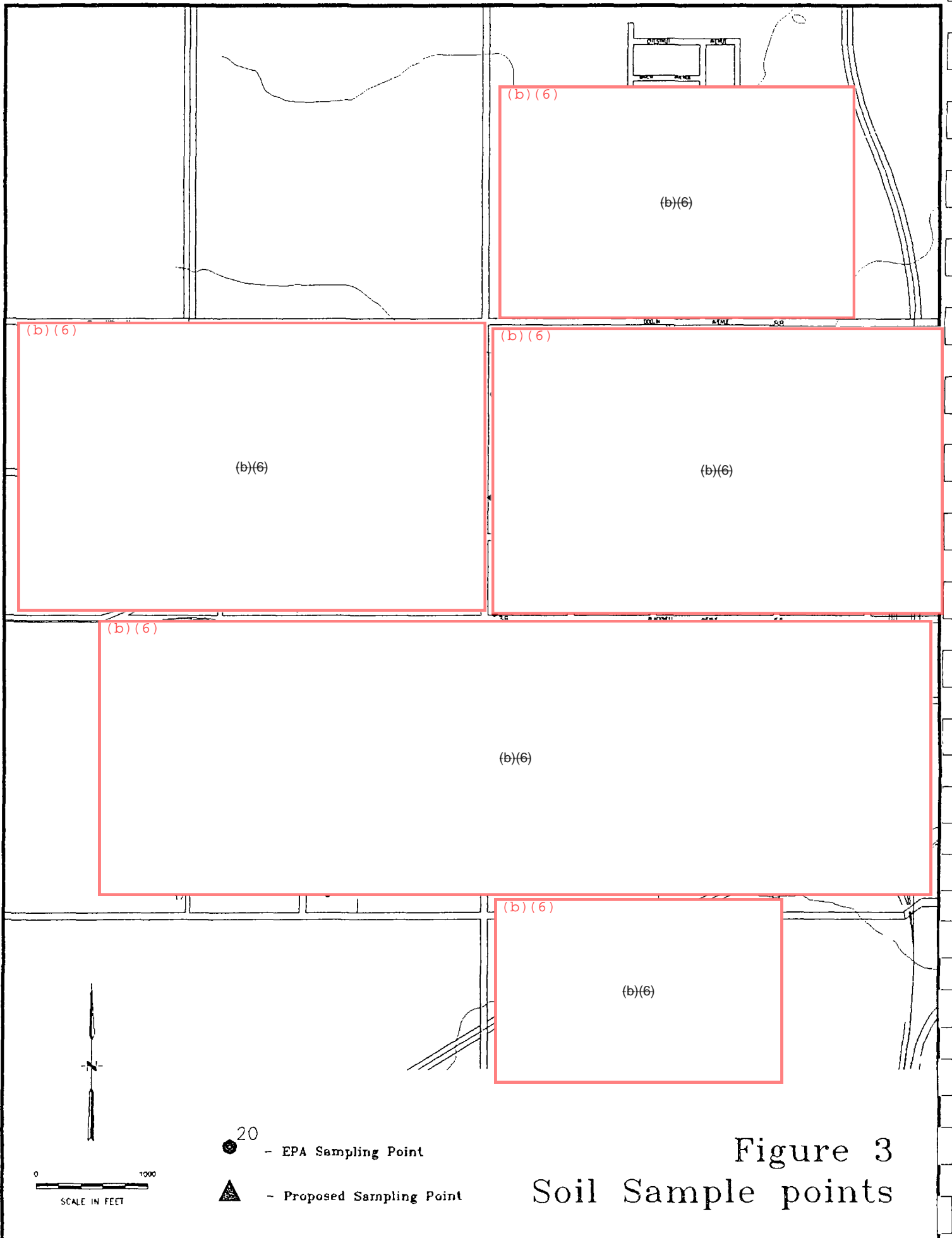


Figure 3
Soil Sample points

The soil samples will be analyzed for total arsenic, total lead, total cadmium, and total zinc concentrations. Any decisions to enlarge the sampling or analysis program during this screening effort will be coordinated through the Oklahoma Department of Environmental Quality (DEQ) prior to implementing those changes.

IV. REPORT OF FINDINGS

Upon completion of the task items within the designated areas, a report of findings will be prepared and submitted to the DEQ. The report of findings will include all data results and interpretations resulting from the investigation. The report will incorporate all relevant information of the area and will address whether the area will require additional detailed sampling (on a close grid spacing). The results of this screen testing will be used to develop detailed soil sampling activities and design corrective actions.

V. SCHEDULE OF IMPLEMENTATION

Sample collection activities have tentatively been scheduled for the second week in September and are anticipated to continue into the third week. As analysis results are obtained, information will be forwarded to the DEQ and appropriate actions taken for each area.

APPENDIX B

ODEQ Approval of Soil Screening Plan

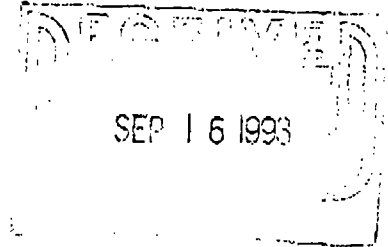


MARK S. COLEMAN
Executive Director

DAVID WALTERS
Governor

State of Oklahoma
DEPARTMENT OF ENVIRONMENTAL QUALITY

September 13, 1993



Mr. James E. Kerrigan
Project Manager
Amax Resource Conservation Company
1626 Cole Boulevard
Golden, Colorado 80401-3293

Dear Mr. Kerrigan:

The Oklahoma Department of Environmental Quality (DEQ) has no comments on the sampling plan attached to your letter of September 3, 1993. It is my understanding from our recent telephone conversation that the sampling event depicted by this plan is to be used to develop more detailed soil sampling plans. Please keep me informed of your progress.

If you have any questions, please give me a call at (405)271-7213.

Sincerely,

Scott A. Thompson
Environmental Specialist Supervisor
Superfund Division

cc: Robert Annis, City of Blackwell
Robert Long, Blackwell Industrial Authority
John Cullin, Kay County Health Department
Robert Sullivan, USEPA

Post-It [®] brand fax transmittal memo 7671		# of pages ▶ /
To <i>TOM TREBONIK</i>	From <i>JIM KERRIGAN</i>	
Co.	Co.	
Dept.	Phone #	
Fax #	Fax #	

APPENDIX C

Sample Log and Description

Sample I.D.	Residential Sub-Area	Location Description
(b)(6)	(b)(6)	Vacant property west of (b)(6) (b)(6) 10' south of (b)(6) (b)(6) and 15' east of mailbox.
		Alley behind (b)(6) (b)(6) 10' west and 2' south of southeast corner of fence.
		Alley behind (b)(6) (b)(6) 10' east and 2' north of northwest corner of fence.
		Alley behind (b)(6) (b)(6) 10' west and 2' south of southeast corner of fence.
		Vacant lot east of (b)(6) (b)(6) 10' south of (b)(6) (b)(6) and 15' east of mailbox.
		(b)(6) (b)(6) 10' east and 10' south of northeast corner of (b)(6) (b)(6) and (b)(6) (b)(6)
(b)(6)	(b)(6)	(b)(6) (b)(6) 10' east and 5' south of southeast corner of driveway and sidewalk.
		(b)(6) (b)(6) 10' west and 5' south of corner of driveway and Bridge.
		(b)(6) (b)(6) 10' west and 5' south of driveway and Bridge.
		(b)(6) (b)(6) 10' west and 10' south of driveway and (b)(6) (b)(6)
		(b)(6) (b)(6) 15' south of southwest corner of house.
		(b)(6) (b)(6) 10' east of driveway and 25' south of (b)(6) (b)(6)
		(b)(6) (b)(6) 15' south of southeast corner of (b)(6) (b)(6)
		(b)(6) (b)(6) 10' south of southwest corner of porch.

Sample I.D.	Residential Sub-Area	Location Description
(b)(6)	(b)(6)	(b)(6) (b)(6) 10' south of southeast corner of house.
		(b)(6) (b)(6) 10' south of southwest corner of front porch.
		(b)(6) (b)(6) 10' south of southwest corner of front porch.
		East side of alley behind (b)(6) (b)(6) 10' north of north phone pole and 37' north of (b)(6) (b)(6)
		Across (b)(6) (b)(6) vacant (b)(6) (b)(6) 20' north of north side of (b)(6) (b)(6) and 150' east of east side of (b)(6) (b)(6)
		(b)(6) (b)(6) 8' south of gas meter and 225' west of west side of (b)(6) (b)(6)
		(b)(6) (b)(6) 290' east of 13th and 20' north of (b)(6) (b)(6)
		(b)(6) (b)(6) 15' east and 5' south of east side of driveway and (b)(6) (b)(6)
		(b)(6) (b)(6) 20' east of east side of driveway and 5' south of (b)(6) (b)(6)
		(b)(6) (b)(6) 30' east of 8th and 5' south of (b)(6) (b)(6)
		(b)(6) (b)(6) 25' north of northwest corner of house.
		(b)(6) (b)(6) Alley behind (b)(6) (b)(6) 2' west and 10' south of northwest corner of fence.
		(b)(6) (b)(6) Corner of (b)(6) (b)(6) 35' south and 15' west of street sign pole.

Sample I.D.	Residential Sub-Area	Location Description
(b)(6)	(b)(6)	Alley behind 615 North 16th. 25' south and 3' west of northwest corner of (b)(6)
		Alley beside (b)(6) 20' north and 8' west of northwest corner of garage.
		Alley beside (b)(6) (b)(6) 10' east and 4' north of northeast corner of house.
		Alley behind 815 North 6th. 10' north of phone pole at northwest corner of property.
		Behind (b)(6) (b)(6) 25' south and 50' west of northeast corner of fence.
		(b)(6) (behind building). 10' south and 10' east of northwest corner of fence.
(b)(6)	(b)(6)	(b)(6) (b)(6) 50' south and 20' west of light pole inside property (northeast corner).
		(b)(6) (b)(6) 50' west and 50' north of light pole, southeast corner of property.
		South end of (b)(6) (b)(6) 20' east and 20' south of southwest corner of building.
		(b)(6) (b)(6) 75' south of southeast corner of building.
		(b)(6) East of house, 20' east and 20' south of north fence and northeast of sheep pen.
		(b)(6) (b)(6) 300' east and 70' north of southwest corner of property fence.

APPENDIX D

Laboratory Report Forms

METLAB Testing Services, Inc.

10835 E. Independence, Suite 102 • Tulsa, Oklahoma 74116-5673
918-234-7111 • 800-324-5757 • Fax 918-234-7152



METLAB TESTING REPORT

MINTECH, INC. MLTS# 93-5823 SAM# 93-09-266
ATTN: TOM TREBONIK DATE RECEIVED: 09/15/93 CONTACT GEORGE
COLLECTED BY: H. ROY GRIFFITH DATE COLLECTED: 9/13-14/93 PO# 1590-2

In accordance with your instructions, chemical analysis was performed on samples submitted from your company on the above date. The results of the analysis are listed below.

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL ARSENIC	10.4	mg/kg	KEA	09/21/93	SW846-7060
(b)(6)	TOTAL CADMIUM	9.42	mg/kg	KEA	09/20/93	SW846-6010
.	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
.	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
.	TOTAL LEAD	82.1	mg/kg	DBJ	09/21/93	SW846-6010
.	TOTAL ZINC	1470	mg/kg	DBJ	09/20/93	SW846-6010
(b)(6)	TOTAL ARSENIC	7.89	mg/kg	KEA	09/21/93	SW846-7060
(b)(6)	TOTAL CADMIUM	5.52	mg/kg	KEA	09/20/93	SW846-6010
.	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
.	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
.	TOTAL LEAD	41.1	mg/kg	DBJ	09/21/93	SW846-6010
.	TOTAL ZINC	995	mg/kg	DBJ	09/20/93	SW846-6010
(b)(6)	TOTAL ARSENIC	7.86	mg/kg	KEA	09/21/93	SW846-7060
(b)(6)	TOTAL CADMIUM	6.53	mg/kg	KEA	09/20/93	SW846-6010
.	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
.	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
.	TOTAL LEAD	47.3	mg/kg	DBJ	09/21/93	SW846-6010
.	TOTAL ZINC	1150	mg/kg	DBJ	09/20/93	SW846-6010

See the next page for more test results.

Approved by: George A. Dust
George A. Dust
Vice President

Dated: 12/10/93



METLAB TESTING REPORT
MLTS# 93-5823

MINTECH, INC. _____

SAM# 93-09-266

ATTN: TOM TREBONIK

DATE RECEIVED: 09/15/93

CONTACT GEORGE

COLLECTED BY: H. ROY GRIFFITH

DATE COLLECTED: 9/13-14/93

PO# 1590-2

RESULTS CONTINUED FROM THE PREVIOUS PAGE.

(PAGE 2)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL ARSENIC	4.94	mg/kg	KEA	09/21/93	SW846-7060
	TOTAL CADMIUM	3.33	mg/kg	KEA	09/20/93	SW846-6010
	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
	TOTAL LEAD	17.8	mg/kg	DBJ	09/21/93	SW846-6010
	TOTAL ZINC	437	mg/kg	DBJ	09/20/93	SW846-6010
	(b)(6)	TOTAL ARSENIC	20.5	mg/kg	DBJ	09/17/93
TOTAL CADMIUM		20.2	mg/kg	KEA	09/20/93	SW846-6010
FURNACE METALS PREPARATION		N/A	N/A	DM	09/16/93	UNSPECIFIED
ICP METALS PREPARATION		N/A	N/A	DM	09/16/93	EPA 3050
TOTAL LEAD		130	mg/kg	DBJ	09/21/93	SW846-6010
TOTAL ZINC		2940	mg/kg	DBJ	09/20/93	SW846-6010
(b)(6)		TOTAL ARSENIC	5.43	mg/kg	KEA	09/21/93
	TOTAL CADMIUM	8.73	mg/kg	KEA	09/20/93	SW846-6010
	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
	TOTAL LEAD	70.3	mg/kg	DBJ	09/21/93	SW846-6010

See the next page for more test results.

Approved by: George A. Dust
George A. Dust
Vice President

Dated: 12/10/93



METLAB Testing Services, Inc.

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 918-234-7111 • 800-324-5757 • Fax 918-234-7152



METLAB TESTING REPORT

MINTECH, INC. MLTS# 93-5823 SAM# 93-09-266
ATTN: TOM TREBONIK DATE RECEIVED: 09/15/93 CONTACT GEORGE
COLLECTED BY: H. ROY GRIFFITH DATE COLLECTED: 9/13-14/93 PO# 1590-2

TSE-106 CONTINUED FROM THE PREVIOUS PAGE. (PAGE 3)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL ZINC	1550	mg/kg	DBJ	09/20/93	SW846-6010
	TOTAL ARSENIC	22.7	mg/kg	DBJ	09/17/93	SW846-6010
	TOTAL CADMIUM	43.5	mg/kg	KEA	09/20/93	SW846-6010
	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
	TOTAL LEAD	383	mg/kg	DBJ	09/21/93	SW846-6010
	TOTAL ZINC	7390	mg/kg	DBJ	09/20/93	SW846-6010
(b)(6)	TOTAL ARSENIC	28.0	mg/kg	DBJ	09/17/93	SW846-6010
	TOTAL CADMIUM	38.5	mg/kg	KEA	09/20/93	SW846-6010
	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
	TOTAL LEAD	535	mg/kg	DBJ	09/21/93	SW846-6010
	TOTAL ZINC	7550	mg/kg	DBJ	09/20/93	SW846-6010
	(b)(6)	TOTAL ARSENIC	21.3	mg/kg	DBJ	09/17/93
TOTAL CADMIUM		18.2	mg/kg	KEA	09/20/93	SW846-6010
FURNACE METALS PREPARATION		N/A	N/A	DM	09/16/93	UNSPECIFIED
ICP METALS PREPARATION		N/A	N/A	DM	09/16/93	EPA 3050

See the next page for more test results.

Approved by: George A. Dust
 George A. Dust
 Vice President

Dated: 12/10/93



METLAB TESTING REPORT
 MLTS# 93-5823

MINTECH, INC. _____ SAM# 93-09-266
 ATTN: TOM TREBONIK _____ DATE RECEIVED: 09/15/93 CONTACT GEORGE _____
 COLLECTED BY: H. ROY GRIFFITH _____ DATE COLLECTED: 9/13-14/93 PO# 1590-2 _____

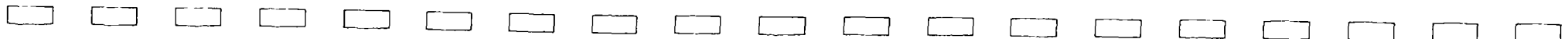
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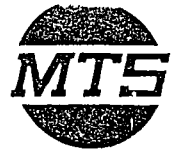
SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL LEAD	106	mq/kg	DBJ	09/21/93	SW846-6010
	TOTAL ZINC	3250	mq/kg	DBJ	09/20/93	SW846-6010
(b)(6)	TOTAL ARSENIC	24.0	mq/kg	DBJ	09/17/93	SW846-6010
	TOTAL CADMIUM	18.8	mq/kg	KEA	09/20/93	SW846-6010
	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
	TOTAL LEAD	248	mq/kg	DBJ	09/21/93	SW846-6010
	TOTAL ZINC	4120	mq/kg	DBJ	09/20/93	SW846-6010
	TOTAL ARSENIC	24.8	mq/kg	DBJ	09/17/93	SW846-6010
(b)(6)	TOTAL CADMIUM	32.7	mq/kg	KEA	09/20/93	SW846-6010
	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED
	ICP METALS PREPARATION	N/A	N/A	DM	09/16/93	EPA 3050
	TOTAL LEAD	469	mq/kg	DBJ	09/21/93	SW846-6010
	TOTAL ZINC	2880	mq/kg	DBJ	09/20/93	SW846-6010
	TOTAL ARSENIC	21.9	mq/kg	DBJ	09/17/93	SW846-6010
	TOTAL CADMIUM	37.7	mq/kg	KEA	09/20/93	SW846-6010
(b)(6)	FURNACE METALS PREPARATION	N/A	N/A	DM	09/16/93	UNSPECIFIED

See the next page for more test results.

Approved by: George A. Dust
 George A. Dust
 Vice President

Dated: 12/10/93





METLAB TESTING REPORT
 MLTS# 93-5920

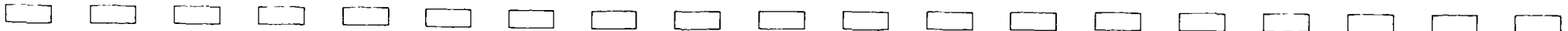
MINTECH, INC. SAM# 93-09-414
 ATTN: TOM TREBONIK DATE RECEIVED: 09/23/93 CONTACT GEORGE
 COLLECTED BY: H. ROY GRIFFITH DATE COLLECTED: 09/20-21/93 PO# 1590-2

In accordance with your instructions, chemical analysis was performed on samples submitted from your company on the above date. The results of the analysis are listed below.

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b) (6) (b)(6)	TOTAL ARSENIC	16.7	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	24.1	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	528	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL ZINC	4460	mg/kg	KEA	09/30/93	SW846-6010
(b) (6) (b)(6)	TOTAL ARSENIC	15.6	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	22.9	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	211	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	3220	mg/kg	KEA	09/30/93	SW846-6010
(b) (6) (b)(6)	TOTAL ARSENIC	14.4	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	65.0	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	164	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	3070	mg/kg	KEA	09/30/93	SW846-6010
(b) (6) (b)(6)	TOTAL ARSENIC	15.3	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	6.66	mg/kg	KEA	09/30/93	SW846-6010

See the next page for more test results.

Approved by: George A. Dust Dated: 10/11/93
 Vice President



METLAB Testing Services, Inc.

10835 E. Independence, Suite 102 • Tulsa, Oklahoma 74116-5673
 918-234-7111 • 800-324-5757 • Fax 918-234-7152



METLAB TESTING REPORT
 MLTS# 93-5920

MINTECH, INC. SAM# 93-09-414

ATTN: TOM TREBONIK DATE RECEIVED: 09/23/93 CONTACT GEORGE

COLLECTED BY: H. ROY GRIFFITH DATE COLLECTED: 09/20-21/93 PO# 1590-2

TSE-2018 CONTINUED FROM THE PREVIOUS PAGE. (PAGE 2)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
.	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	30.5	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	1260	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	14.5	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	3.00	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
.	TOTAL LEAD	49.2	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	629	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ARSENIC	12.4	mg/kg	KEA	09/29/93	SW846-6010
(b)(6)	TOTAL CADMIUM	2.33	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	42.0	mg/kg	KEA	09/30/93	SW846-6010
.	TOTAL ZINC	420	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ARSENIC	<11.0	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	3.15	mg/kg	KEA	09/30/93	SW846-6010
.	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	21.3	mg/kg	KEA	09/30/93	SW846-6010

See the next page for more test results.

Approved by: George A. Dust Dated: 10/11/93
 Vice President



METLAB TESTING REPORT

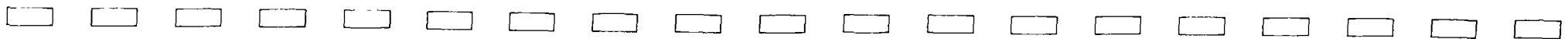
MINTECH, INC. _____ MLTS# 93-5920 _____ SAM# 93-09-414
 ATTN: TOM TREBONIK _____ DATE RECEIVED: 09/23/93 _____ CONTACT GEORGE _____
 COLLECTED BY: H. ROY GRIFFITH _____ DATE COLLECTED: 09/20-21/93 _____ PO# 1590-2 _____

TSE-1021 CONTINUED FROM THE PREVIOUS PAGE. (PAGE 3)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL ZINC	567	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ARSENIC	<11.9	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	22.4	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	176	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	3560	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ARSENIC	35.5	mg/kg	KEA	10/11/93	EPA 206.2
	TOTAL CADMIUM	20.7	mg/kg	KEA	09/30/93	SW846-6010
	FURNACE METALS PREPARATION	N/A	N/A	VS	10/07/93	UNSPECIFIED
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
(b)(6)	TOTAL LEAD	1306	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	4713	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ARSENIC	17.2	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	18.8	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
(b)(6)	TOTAL LEAD	179	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	4190	mg/kg	KEA	09/30/93	SW846-6010

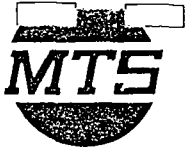
See the next page for more test results.

Approved by: George A. Dust Dated: 10/11/93
 George A. Dust
 Vice President



METLAB Testing Services, Inc.

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 918-234-7111 • 800-324-5757 • Fax 918-234-7152



METLAB TESTING REPORT MLTS# 93-5920

MINTECH, INC.

SAM# 93-09-414

ATTN: TOM TREBONIK

DATE RECEIVED: 09/23/93

CONTACT GEORGE

COLLECTED BY: H. ROY GRIFFITH

DATE COLLECTED: 09/20-21/93

PO# 1590-2

RESULTS CONTINUED FROM THE PREVIOUS PAGE.

(PAGE 4)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL ARSENIC	<12.0	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	4.59	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	62.5	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	681	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	<12.4	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL CADMIUM	15.8	mg/kg	KEA	10/04/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	156	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL ZINC	1640	mg/kg	KEA	10/04/93	SW846-6010
(b)(6)	TOTAL ARSENIC	<10.9	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	5.02	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	60.2	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	886	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	13.7	mg/kg	KEA	10/04/93	SW846-6010

See the next page for more test results.

Approved by: George A. Dust
 George A. Dust
 Vice President

Dated: 10/11/93



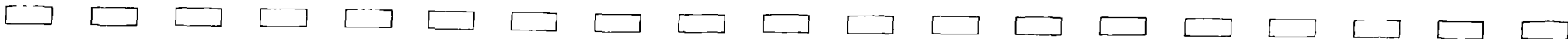
METLAB TESTING REPORT
 MINTECH, INC. MLTS# 93-5920 SAM# 93-09-414
 ATTN: TOM TREBONIK DATE RECEIVED: 09/23/93 CONTACT GEORGE
 COLLECTED BY: H. ROY GRIFFITH DATE COLLECTED: 09/20-21/93 PO# 1590-2

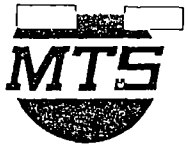
TE-028 CONTINUED FROM THE PREVIOUS PAGE. (PAGE 5)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL CADMIUM	17.3	mg/kg	KEA	10/04/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	322	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL ZINC	4330	mg/kg	KEA	10/04/93	SW846-6010
(b)(6)	TOTAL ARSENIC	<11.6	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	5.93	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	199	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	1162	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	12.2	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	6.56	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	121	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	977	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	<11.3	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	2.96	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050

See the next page for more test results.

Approved by: George A. Dust Dated: 10/11/93
 Vice President





METLAB TESTING REPORT
 MLTS# 93-5920

MINTECH, INC.

SAM# 93-09-414

ATTN: TOM TREBONIK

DATE RECEIVED: 09/23/93

CONTACT GEORGE

COLLECTED BY: H. ROY GRIFFITH

DATE COLLECTED: 09/20-21/93

PO# 1590-2

TE-031 CONTINUED FROM THE PREVIOUS PAGE.

(PAGE 6)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL LEAD	69.6	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	853	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	<11.5	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	4.03	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	38.4	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	459	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ARSENIC	<12.5	mg/kg	KEA	10/04/93	SW846-6010
(b)(6)	TOTAL CADMIUM	5.25	mg/kg	KEA	10/04/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	69.8	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL ZINC	1320	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL ARSENIC	14.1	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL CADMIUM	10.2	mg/kg	KEA	10/04/93	SW846-6010
(b)(6)	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	74.3	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL ZINC	1230	mg/kg	KEA	10/04/93	SW846-6010

See the next page for more test results.

Approved by: George A. Dust Dated: 10/11/93
 Vice President



METLAB TESTING REPORT

MINTECH, INC. _____ MLTS# 93-5920 _____ SAM# 93-09-414
 ATTN: TOM TREBONIK _____ DATE RECEIVED: 09/23/93 _____ CONTACT GEORGE
 COLLECTED BY: H. ROY GRIFFITH _____ DATE COLLECTED: 09/20-21/93 _____ PO# 1590-2

RESULTS CONTINUED FROM THE PREVIOUS PAGE. (PAGE 7)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
(b)(6)	TOTAL ARSENIC	13.7	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL CADMIUM	9.05	mg/kg	KEA	10/04/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	92.0	mg/kg	KEA	10/04/93	SW846-6010
	TOTAL ZINC	1280	mg/kg	KEA	10/04/93	SW846-6010
(b)(6)	TOTAL ARSENIC	13.5	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	19.7	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	115	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	2287	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	14.0	mg/kg	KEA	09/29/93	SW846-6010
	TOTAL CADMIUM	26.8	mg/kg	KEA	09/30/93	SW846-6010
	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
	TOTAL LEAD	200	mg/kg	KEA	09/30/93	SW846-6010
	TOTAL ZINC	3530	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	13.0	mg/kg	KEA	09/29/93	SW846-6010

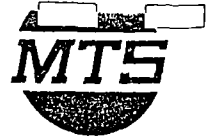
See the next page for more test results.

Approved by: George A. Dust Dated: 10/11/93
 George A. Dust
 Vice President



METLAB Testing Services, Inc.

10835 E. Independence, Suite 102 • Tulsa, Oklahoma 74116-5673
918-234-7111 • 800-324-5757 • Fax 918-234-7152



METLAB TESTING REPORT

MINTECH, INC. _____ MLTS# 93-5920 SAM# 93-09-414
ATTN: TOM TREBONIK DATE RECEIVED: 09/23/93 CONTACT GEORGE
COLLECTED BY: H. ROY GRIFFITH DATE COLLECTED: 09/20-21/93 PO# 1590-2

TNE-038 CONTINUED FROM THE PREVIOUS PAGE.

(PAGE 8)

SAMPLE ID	PARAMETER	RESULTS	UNITS	ANALYST	ANALYZED	METHOD
.	TOTAL CADMIUM	17.4	mg/kg	KEA	09/30/93	SW846-6010
.	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
.	TOTAL LEAD	113	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ZINC	2022	mg/kg	KEA	09/30/93	SW846-6010
(b)(6)	TOTAL ARSENIC	14.2	mg/kg	KEA	10/04/93	SW846-6010
.	TOTAL CADMIUM	22.2	mg/kg	KEA	10/04/93	SW846-6010
.	ICP METALS PREPARATION	N/A	N/A	DM	09/27/93	EPA 3050
.	TOTAL LEAD	114	mg/kg	KEA	10/04/93	SW846-6010
.	TOTAL ZINC	2230	mg/kg	KEA	10/04/93	SW846-6010

Should you have any questions, please feel free to call.

Approved by: George A. Dust Dated: 10/11/93
George A. Dust
Vice President

CHAIN OF CUSTODY
RECORD - SAMPLE
ANALYSIS REQUEST

CLIENT Mintech Inc.
CONTACT NAME Tom Trebonik
ADDRESS 1525 N 105 E Ave
Tulsa, Ok. 74016
PHONE # 836-0700

LAB # 93-5920 93-09-44
P.O. # 1590-2
BILLING ADDRESS _____
FAX # _____



ANALYSES REQUESTED
P.L.S. SIGNATURE: H. Roy Griffith

SAMPLE IDENTIFICATION	DATE	TIME	SAMPLE TYPE	NUMBER OF CONTAINERS	ANALYSES REQUESTED	REMARKS
(b)(6)	9-20-93	1045	Soil	1	X	
(b)(6)	9-20-93	1105		1	X	
	9-20-93	1127		1	X	
	9-20-93	1205		1	X	
	9-20-93	1230		1	X	
	9-20-93	1245		1	X	
	9-20-93	1310		1	X	
	9-20-93	1400		1	X	
	9-20-93	1432		1	X	
	9-20-93	1455		1	X	
	9-20-93	1520		1	X	
	9-20-93	1600	00	1	X	

Inquished by: H. Roy Griffith Date 9-23-93 Time 8:30 Received by: _____ Date _____ Time _____ Comments: _____
 Inquished by: _____ Received by: _____
 Inquished by: _____ Received by: _____
 Inquished by: _____ Received by: Sharon Lawrence 09/23/93 0830

10035 East Independence Suite 102, Tulsa, Oklahoma 74116-5673

CHAIN OF CUSTODY
RECORD - SAMPLE
ANALYSIS REQUEST

CLIENT Mintech Inc.
CONTACT NAME Tom Trebonik
ADDRESS _____
PHONE # _____

LAB # _____
P.O. # 1590-2
BILLING ADDRESS _____
FAX # _____



ANALYSES REQUESTED
P.L.S. SIGNATURE: H. Roy Griffith

SAMPLE IDENTIFICATION	DATE	TIME	SAMPLE TYPE	NUMBER OF CONTAINERS	ANALYSES REQUESTED	REMARKS
(b)(6)	9-20-93	1635	Soil	1	X	
(b)(6)	9-20-93	1700		1	X	
	9-20-93	1725		1	X	
	9-20-93	1755		1	X	
	9-20-93	1825		1	X	
	9-21-93	835		1	X	
	9-21-93	910		1	X	
	9-21-93	950		1	X	
	9-21-93	1035		1	X	
	9-21-93	1110		1	X	
	9-21-93	1150	00	1	X	

Inquished by: H. Roy Griffith Date 9-23-93 Time 8:30 Received by: _____ Date _____ Time _____ Comments: _____
 Inquished by: _____ Received by: _____
 Inquished by: _____ Received by: _____
 Inquished by: _____ Received by: Sharon Lawrence 09/23/93 0830

METLAB Testing Services, Inc.

(918)234-7111 Fax (918)234-7152

CHAIN OF CUSTODY
 RECORD - SAMPLE
 ANALYSIS REQUEST

CLIENT Winter 6 sluc
 CONTACT NAME Tom Treborik
 ADDRESS _____
 PHONE # _____

LAB # _____
 P.O. # 1590-2
 BILLING ADDRESS _____
 FAX # _____



ANALYSTS SIGNATURE: A. Roy Griffith

NO.	DATE	TIME	SAMPLE TYPE	NUMBER OF CONTAINERS	ANALYSES REQUESTED										REMARKS		
					TOX	MR	PT	CH	Zn								
(b)(6)	9-21-93	230	Soil	1	X												
(b)(6)	9-21-93	230	"	1	X												

Inquired by: <u>A. Roy Griffith</u>	Date: <u>9/22/93</u>	Time: <u>8:20</u>	Received by:	Date:	Time:	Comments:
Inquired by:			Received by:			
Inquired by:			Received by:			
Inquired by:			Received by: <u>Charles Lawrence</u>	<u>08/27/93</u>	<u>08:30</u>	

TYPE OF SUBMITTER (check one): _____

APPENDIX E

Standard XRF Soil Screening Procedures

Standard XRF Soil Screening Procedures

The development of energy dispersive X-ray fluorescence (XRF) technology and corresponding development of field portable equipment now allows for rapid assessment of sites potential impacted with elemental metal constituents. When applicable, XRF equipment in combination with laboratory chemical analysis will be used to screen potentially impacted areas. A TN Technologies, Spectrace 9000 portable X-ray fluorescence unit (or equivalent) will be used for the screening process.

Metal concentration data to be collected with the XRF will generally be site specific, but in most cases will be limited to a determination of the arsenic, cadmium, lead and zinc concentrations in the soil. Detection limits for each element vary, but are generally within an adequate range for screening purposes. Manufacturer representative information on the Spectrace 9000 XRF unit is included for review.

Evaluation will consist of field gridding the individual sites or lots and taking surface readings with the XRF unit. All XRF readings will be recorded and plotted on individual base maps constructed for the site or lot being evaluated. Prior to its use, the XRF will be calibrated in accordance with accepted procedures. The XRF will be used to evaluate the entire site and the readings will ultimately be used to determine areas for future investigation and/or remediation.

Verification/comparison sampling will be conducted to insure accuracy of the XRF unit. The verification sampling frequency is anticipated to be 5% to 10% of the sites evaluated. At a minimum, one out of each ten sites will be subjected to both XRF and laboratory chemical analysis for the chosen screening parameters. It is anticipated that one sample, randomly chosen from the verification site, will be collected and analyzed. The results will then be compared to the XRF readings obtained, as a check on the accuracy of the instrument the readings. At a minimum, one soil sample per day will be collected and used for verification/comparison purposes. The XRF check sample will be collected and mixed in the field before the XRF reading is made and the mixed soil sample sent to the laboratory for confirmatory analysis.

All soil samples to be used for comparison purposes will be collected from known XRF stations after first removing the vegetative cover. The samples for laboratory analysis will be collected from 0" to 3" in depth and will be analyzed for total concentration of the screening parameter element(s) using atomic absorption (AA) or inductively coupled plasma atomic

emission spectrophotometry (ICP) techniques. All sampling and laboratory procedures will be in accordance with standard EPA protocol as outlined in Technical Report 93-04.

The grid size to be used on an individual site will be dependent upon the size and shape of the site, but in no case will be greater than 50' on centers assuming a square grid pattern. Alternate spatial sampling grids (hexagonal) may be used when appropriate for property size and shape. Both square and hexagonal patterns produce a low average and low maximum standard error for spatial sampling projects.

Alternate grid sizes may be used in screening large areas. Approval for any enlargement of the grid size will be obtained from ODEQ prior to its use. Grid sizes smaller than 50' on centers may be used when appropriate or deemed necessary.



Tom Trebonik
Mintech Inc.
1525 N. 105th E. Ave.
Tulsa, OK 74116
(918) 836-0700

10/13/93

Dear Mr. Trebonik,

Thank you for your interest in the Spectrace 6000 and 9000 for your field analysis of contaminated soils. I have enclosed a brochure describing each instrument along with some technical papers that compare their results with laboratory AA/ICP results. Dennis Richards is the regional sales manager for your area and can be contacted for sales or rental pricing. If any other questions come up give us a call.

Sincerely,

A handwritten signature in black ink that reads "Todd A. Rhea". The signature is written in a cursive style.

Todd A. Rhea
Applications Specialist
Spectrace Instruments, Inc.
2401 Research Blvd. #206
Fort Collins, Colorado 80526
Ph. (303) 493-2219
Fax (303) 493-2520

RECEIVED OCT 18 1993

INTRODUCTION

In the realm of characterization and remediation of contaminated soil sites, a need exists for quick and reliable in-situ assays of coarse soils. As a field instrument, energy dispersive X-ray fluorescence (EDXRF) analyzers make very efficient use of time and resources as they are able to simultaneously detect most inorganic pollutants present in a sample. Integrating the ability of the in-situ analysis to provide guidance toward areas of significant contamination with Contract Laboratory Program sampling assays provides a cost-effective site remediation.

Inconveniences of field portable EDXRF analyzers in the past have been either poor resolution as a result of gas proportional detection (around 800 eV for Mn K-alpha) or extra size and weight of instruments using a cryogenically cooled detector. The development of the solid state mercuric iodide (HgI_2) detector allows high resolution X-ray detection (around 270 eV for Mn K-alpha) at near ambient temperature.

This report will describe the Spectrace 9000 and discuss its capabilities with respect to in-situ soil analysis. The results of experimental precision and crossover data will be tabulated along with lower limits of detection for various inorganic contaminants in silica based samples.

INSTRUMENTATION

The Spectrace 9000 combines radioactive source excitation with solid state mercuric iodide detection to provide high resolution field portable EDXRF analysis. The Spectrace 9000 consists of two main components: an analysis probe and supporting electronics unit.

The probe unit is a sealed aluminum enclosure containing a high resolution mercuric iodide detector and three radioisotope X-ray excitation sources. The radioisotope sources, Fe-55, Cd-109, and Am-241 are separately shielded in a motorized turret and are rotated into position for measurement of independent source spectra. Each source emits a different energy of radiation which provides efficient excitation of specific ranges of elements as listed in Table 1.

TABLE 1

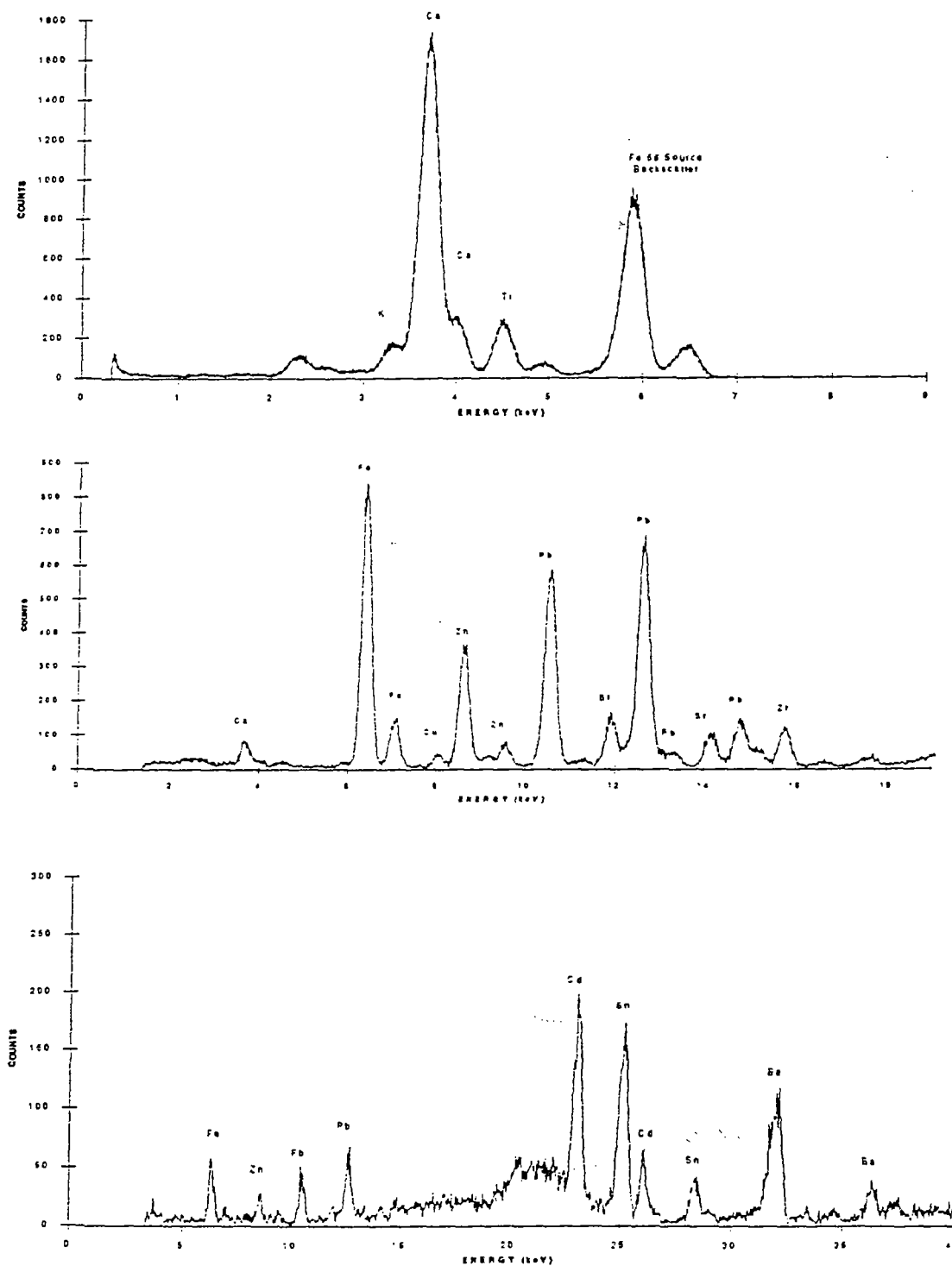
Source	Element Range
Fe-55	S to Cr (K X-rays)
	Mo to Ba (L X-rays)
Cd-109	Ca to Rh (K X-rays)
	Ta to Pb (K X-rays)
	Ba to U (L X-rays)
Am-241	Cu to Tm (K X-rays)
	W to U (L X-rays)

The analytical range of the Spectrace 9000 is sulfur to uranium with detection limits around 50-100 ppm for most analytes. The probe weighs 4.2 lb (1.9 kg).

The electronics unit provides data acquisition, processing, and display capabilities. The unit contains sufficient memory to store up to 300 sets of analysis results and up to 120 spectra. Its computer includes a math coprocessor for fast calculation of results. After the data has been stored, an RS-232 port can download results and spectra to another computer. The electronics subsystem operates off either AC-power or rechargeable NiCd batteries and weighs 14.75 lb (6.7 kg).

For qualitative identification of elements, the on-board 2048 channel MCA spectrum display allows the user to view any of the three spectra that comprise a complete analysis. Once a spectrum is on the screen, a number of operations can be performed. A few of these are: element lines, spectrum cursor, display keV of cursor, horizontal or vertical magnification of the spectrum, and coarse/fine cursor movement. The RS-232 port allows the three spectra of an analysis to be sent to and simultaneously viewed on a personal computer. An example of this is shown below in Figure 1.

Figure 1



SAMPLE MEASUREMENTS

All of the sample measurements taken by the Spectrace 9000 were 200 seconds for each of the three sources. The samples ranged from finely ground soils to relatively large particle soils. For convenience, the soils were placed in 32 mm sample cups, sealed with a 6.3 μm polypropylene X-ray film window and analyzed with the Spectrace 9000 probe in the lab stand base.

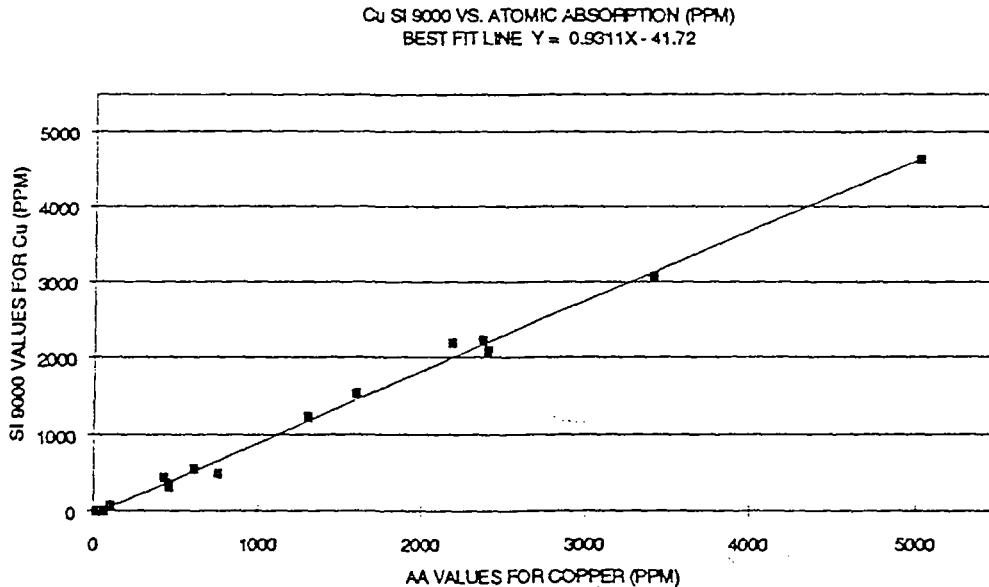
STANDARDIZATION

The Spectrace 9000 uses a fundamental parameters method of standardization derived from theoretical considerations to calculate the element concentrations. The three main factors of the calculation are: 1. The measured analyte X-ray intensity relative to the pure element intensity of that analyte. 2. The fluorescent yield of the analyte. 3. The sum of many terms that characterize the X-ray absorbing nature of the matrix the analyte is within.

The instrument has two methods of energy calibration. One is the automatic energy calibration that is performed every time a sample measurement is taken. This method makes use of Compton scattered X-ray from one of the three sources and reliably maintains accurate calibration of the instrument. A second more infrequent energy calibration is done by placing the probe's safety cover over the window aperture and running a 600 sec. energy calibration.

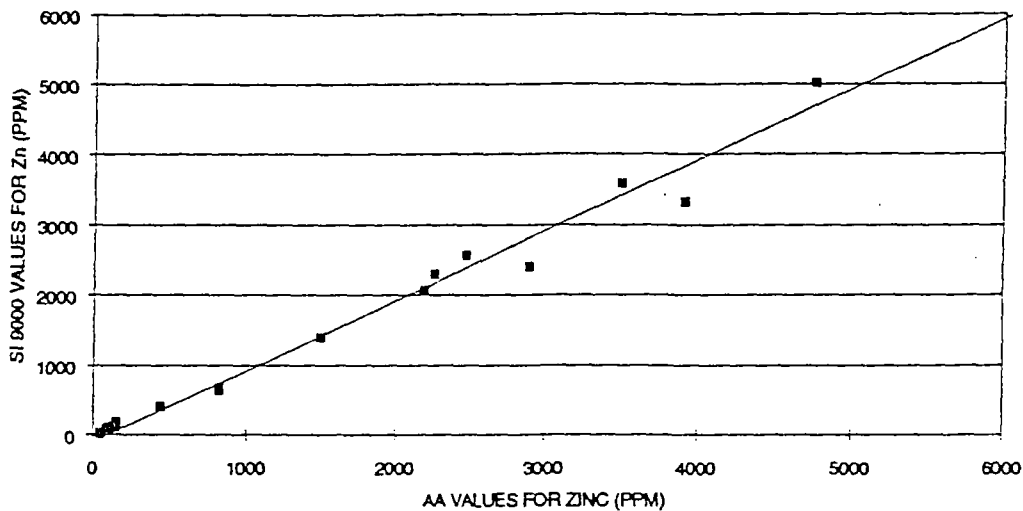
RESULTS

Crossover Study: Results of measured values from the Spectrace 9000 vs. Atomic Absorption values for Cu, Zn, Pb, Cr, and As.

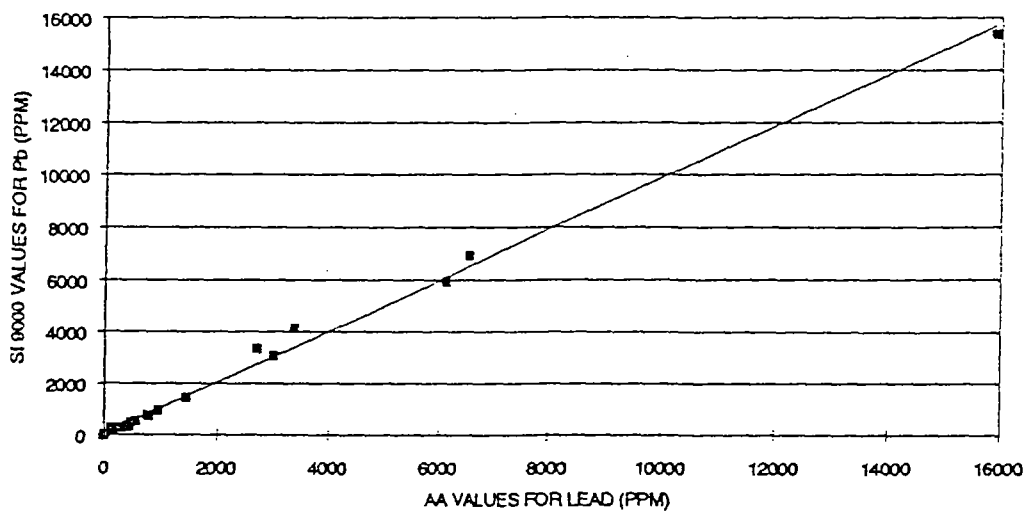


Crossover Results continued

Zn SI 9000 VS. ATOMIC ABSORPTION (PPM)
BEST FIT LINE $Y = 1.004X - 90.921$

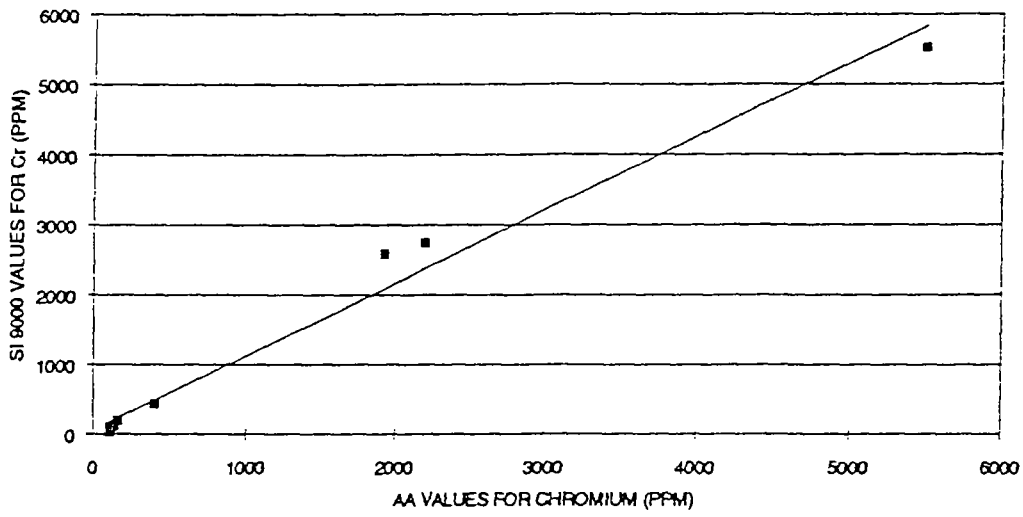


Pb SI 9000 VS. ATOMIC ABSORPTION (PPM)
BEST FIT LINE $Y = 0.9836X + 65.55$

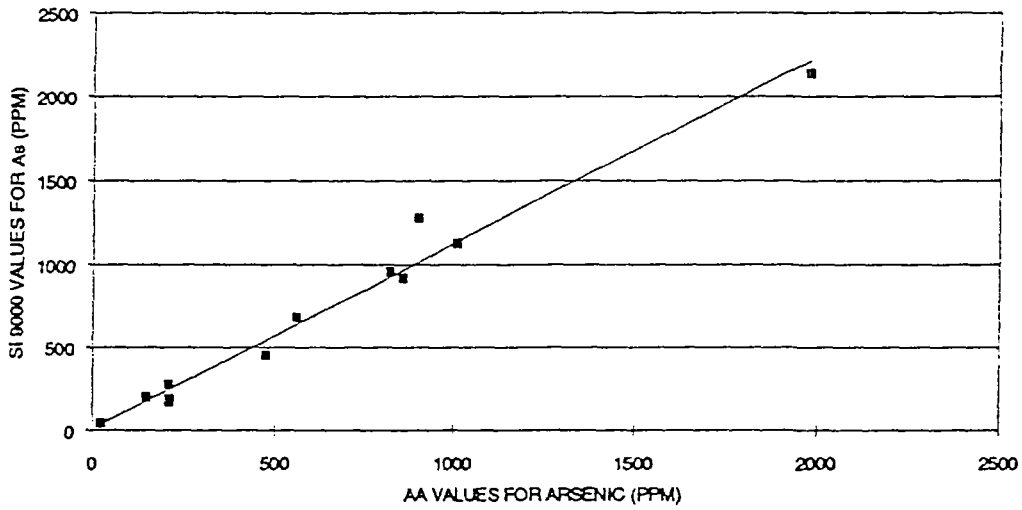


Crossover Results continued

Cr SI 9000 vs. ATOMIC ABSORPTION (PPM)
BEST FIT LINE $Y = 1.047X + 73.222$



As SI 9000 vs. ATOMIC ABSORPTION (PPM)
BEST FIT LINE $Y = 1.110X + 15.541$



Minimum detection limits for twenty two elements in quartz are listed below.

Lower Limits of Detection for the Spectrace 9000 [3 SD (bkg)]

Source	Element	MDL (ppm)
Fe-55	K	117
	Ca	53
	Ti	45
Cd-109	Cr	78
	Mn	174
	Fe	105
	Co	97
	Ni	60
	Cu	41
	Zn	34
	As	27
	Se	17
	Sr	4
	Zr	3
	Mo	4
	Hg	30
	Pb	15
Am-241	Rb	5
	Cd	90
	Sn	56
	Sb	33
	Ba	10

Precision data was obtained from three soil samples. The following table lists the mean, standard deviation and relative standard deviation data for 10 replicate analyses of three soil samples.

Element	Sample 1	Sample 2	Sample 3
Pb	5826 ± 35; 0.6%	286 ± 7.4; 2.4%	286 ± 7.4; 2.4%
Cu	576 ± 22; 3.8%	494 ± 23; 4.6%	128 ± 18; 14%
As	N D	434 ± 19; 3.8%	187 ± 16; 8.5%
Cr	364 ± 37; 10%	141 ± 38; 27%	232 ± 66; 28%

N D = not detected.

CONCLUSION

The Spectrace 9000 is a field portable , high performance EDXRF analyzer for contaminated soil site investigation or remediation. The lightweight handheld probe and electronics subsystem archive up to 300 separate in situ soil sample measurements. Excellent correlation between the portable EDXRF and independent analysis is realized and illustrated in correlation plots of results by the two techniques. Precision and accuracy provided by portable EDXRF indicates that the Spectrace 9000 is ideal for on-site in situ contaminated soil analysis.



Soil Analysis Detection Limits for the Spectrace 9000

Lower Limits of Detection for the Spectrace 9000 [3 SD (bkg)]

Source	Element	MDL (ppm)
Fe-55	K	161
	Ca	70
	Ti	55
	Cr	90
Cd-109	Mn	203
	Fe	111
	Co	101
	Ni	63
	Pb Cu	44
	Zn	35
	As	25
	Se	17
	Sr	4
	Zr	3
	Mo	4
	Hg	29
	Pb	14
	Rb	5
Am-241	Cd	86
	Sn	47
	Sb	32
	Ba	9

LLD Calculation Equation

$$LLD = \frac{3\sqrt{I_B}}{I_P} \times \frac{1}{\sqrt{T}} \times conc$$

$I_B = background(cps)$

$I_P = peak(cps)$

$T = time$

The Spectrace 9000 is capable of analyzing any element heavier than phosphorus. Right now the soil application on board the analyzer will quantitate all of the elements above including U, Th, and Ag.

Soil Analysis Detection Limits for the Spectrace 6000

The detection limits of Cr, Ni, Cu, As, Pb, Ag and Cd were calculated using the raw peak and background data generated on the Spectrace 6000. The equation used gives a ppm value representing a concentration that yields a net signal equal to three times the standard deviation of the background counts. This provides 99% probability that the net number of counts are truly greater than the background counts of a sample at the quoted detection limit. The excitation conditions and primary filter used for each element are shown below. A 200 second count time was used. The standards used for calculation of these detection limits were: NBS 1648, NBS 2704, PACS-1, NBS 8407, NBS 8408.

Element	LLD (ppm)	Filter	Voltage (kV)	Current (mA)
Cr	10	Aluminum	11	0.35
Ni	5	Pd Thin	20	0.23
Cu	4	Pd Thin	20	0.23
As	3	Pd Thin	20	0.23
Pb	4	Pd Thick	25	0.30
Zn	4	Pd Thick	25	0.30
Ag	2	Copper	50	0.35
Cd	2	Copper	50	0.35

LLD Calculation Equation

$$LLD = \frac{3\sqrt{I_B}}{I_P} \times \frac{1}{\sqrt{T}} \times conc$$

$I_B = \text{background}(cps)$

$I_P = \text{peak}(cps)$

$T = \text{time}$