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**HYDROGEOLOGICAL INVESTIGATION REPORT  
OF THE  
FORMER NATIONAL ZINC SITE  
CHERRYVALE, MONTGOMERY COUNTY, KANSAS**

December 2003

for:

Salomon Smith Barney Holdings, Inc.  
United States Steel Corporation

BER SCANNED  
FEB 07 2013

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## INTRODUCTION

Respondents, Salomon Smith Barney Holdings, Inc. (Salomon) and U.S. Steel Corporation (U.S. Steel), directed A & M Engineering and Environmental Services, Inc. (A & M Engineering) to conduct a hydrogeological investigation at the National Zinc Site located in Cherryvale, Kansas. The investigation was conducted in accordance with Hydrological Investigation Work Plan ("Work Plan") dated 8/27/02, as amended and approved by Kansas Department of Health and Environment ("KDHE") Consent Order 3-E-002 signed between Respondents and KDHE.

The Work Plan required the drilling and installing of four new monitor wells at the site and procedures for testing, sampling and analysis of the new and existing wells. The investigation followed those requirements and the details and results are included in this Report.

## SITE CHARACTERIZATION

### Location:

The National Zinc Site ("Site") is located on the northwestern city limits of the City of Cherryvale, Montgomery County, Kansas. The legal description of the Site is the NE/4, Section 8, Township 32 South, Range 17 East in Montgomery County. The geographic coordinates of the site are 39° 42' 30" North Latitude and 96° 25' 00" West Longitude.

Figure 1 shows the topographic map of the Site and the surrounding areas.

## Climate:

The climate of Montgomery County is characterized as a continental climate that is typically warm to hot in the summer and cold in the winter with the majority of precipitation events occurring in the spring and early summer. The average annual precipitation is 37 inches per year. The average winter temperature is 36.8°F and the average summer temperature is 78.4°F. The maximum 24-hour precipitation event recorded for Montgomery County is 6.38 inches.

## Site Description

The Site is the former location of the National Zinc smelter facility and currently is unoccupied grassland with minor remnants of the former facility. The Site covers approximately 160 acres. The Site is bounded by Martin Street on the south, County Road 5200 on the north, County Road 5400 on the east, and a tree line to the west.

The South Kansas and Oklahoma Railroad transects the site from southeast to northwest and a gas pipeline (Williams Pipeline Company) runs parallel to the railroad.

An unnamed creek starts in the middle portion of the Site and runs northwestward to the west edge of the Site and turns southward toward the southeast corner of the Site. It then turns west and joins Drum Creek approximately one-mile west. Another stream runs east to west along the southern edge of the Site and joins the unnamed creek at the western property line. These streams are intermittent type streams.

The Site slopes gently westward with approximately 20 feet of relief across the Site. The Site is generally grassland with the exception of a few buildings and structures in the

southeast part of the Site, which are remnants of the former smelter. The Site is bordered with residential areas to the south and with agriculture properties to the north, east, and west. Figure 2 is a detailed topographic map of the Site.

#### SITE BACKGROUND

The Site was the location of the former National Zinc smelter facility. The facility was constructed in 1898 and expanded over time.

During its operational history, the facility had large settling ponds covering approximately 23 acres. The major lagoon was located at the west central part of the Site in-between the two unnamed creeks (see Figure 1).

The smelter structures were mostly demolished with exception of the two buildings located in the southeastern part of the Site.

Recently (2000-2002), U.S. EPA conducted yard soil remediation in residential areas to the south of the Site and all the excavated soil was brought to the Site and deposited in the southeastern portion of the Site, adjacent to the existing buildings.

#### PREVIOUS SITE INVESTIGATIONS

The National Zinc smelter facility operated until 1976. KDHE conducted several investigations of the Surface Lagoon which was closed in 1979. The major investigations are described below:

The 1978 Investigation:

The first investigation was conducted in April-June 1978 by Wichita Testing Laboratories on behalf of National Zinc Company. The study was directed to investigate the lagoon embankment and its stability. A copy of this report is included in Appendix 1.

During the 1978 investigation, nine (9) borings were drilled and logged. Soil samples were collected and tested for geotechnical evaluation. Also, the existing five monitoring wells along the embankment (MW-1, MW-2S, MW-2D, MW-3, and MW-4) were completed during this study.

This study concluded that the lagoon embankment was safe.

1999-2000 Site Investigation:

KDHE conducted Phase I and Phase II investigations and a Brownfields Targeted Assessment (BTA) at the Site. These included file review of all available data, Site topographic survey, Site geophysical surveys, soil sampling using X-ray fluorescence (XRF) unit for surface and subsurface samples, surface water and sediment sampling, test boring for waste characterization, test boring for groundwater characterization, groundwater sampling and data integration evaluation and reporting.

The 1999-2000 Site investigation report reached the following conclusions and recommendations:

1. Surficial soils at the Site's southeast, south and central portions are impacted mainly with lead and cadmium and to a lesser extent, with arsenic, above non-residential Kansas RSK (NRRSK) levels.
2. Surface water and sediments in the on-Site stream and ditches are impacted, mainly with cadmium.
3. The previously closed lagoon area contained some treated waste.
4. Groundwater samples from the monitor wells located in the former lagoon area and on the west embankment had elevated cadmium levels.
5. These reports expressed concern about the groundwater-surface water interface at the west edge of the former lagoon area.
6. These studies concluded that off-Site groundwater was not impacted.
7. The reports recommended further investigations of off-Site areas for soil, surface water and groundwater.

## FIELD ACTIVITIES

The Work Plan specified the following tasks:

1. Drilling and completion of four monitor wells in the uppermost aquifer, one upgradient in the northeast quadrant of the Site for background purposes, and three downgradient wells to the west of the Site on adjacent properties.
2. Develop and sample the new four wells for three consecutive months for groundwater quality and measure water levels in all wells during these sampling events.
3. Address the potential for groundwater-surface water interface.

4. Evaluate all existing and new data and prepare this Report of the findings.

#### Monitor Well Drilling and Completion:

Drilling equipment and personnel were mobilized on July 21<sup>st</sup>, 2003 to the Site and drilling was started on July 22, 2003. The drilling subcontractor was Mohawk Drilling, Inc. of Tulsa, Oklahoma. The drilling method was air rotary with a 6 ¼" diameter air hammer. Drilling and well installation were completed on July 24, 2003.

Four monitor wells were completed, one upgradient (MW-5) in the northeast part of the Site and three downgradient wells (MW-6, MW-7, MW-8) west of the Site on the adjacent properties. Appendix 2 includes the lithologic and completion logs for the new wells and Appendix 3 includes the logs of the previously drilled and completed wells.

Figure 2 shows the location of all the wells.

#### Monitor Well Survey:

The new monitor wells (MW-5, MW-6, MW-7 and MW-8) were surveyed utilizing the existing wells vertical and horizontal data. The survey established control points from MW-2 and MW-3. The survey data with other well information are shown on Table 1 for all the new and existing wells.

#### Monitor Well Hydraulic Testing:

The new monitor wells were purged and developed after completion. On August 4, 2003 upgradient MW-5 and downgradient MW-8 were chosen for hydraulic conductivity

testing. The slug testing data were collected using a data logger that was later downloaded to a computer for analysis.

The Hvorslev Graphs for the two wells are included in Appendix 4. The hydraulic testing results show that the uppermost aquifer has a hydraulic conductivity of  $2.25 \times 10^{-5}$  cm/sec in MW-5 and  $1.21 \times 10^{-5}$  cm/sec in MW-8.

During the 1978 Site investigation, undisturbed samples were collected from MW-1 (8-9.5 ft.), MW-3 (5-6.5 and 12-13.5 ft.) and MW-4 (7-8.5 ft.). These samples were tested by falling head for permeability and the results were  $3.4 \times 10^{-5}$ ,  $4.6 \times 10^{-8}$ ,  $2.1 \times 10^{-4}$ , and  $5.3 \times 10^{-8}$  cm/sec, respectively.

#### Water Level Measurements:

The water levels in the new and existing monitor wells were measured monthly beginning August 2003. The water levels and calculated groundwater elevations in each well are shown in Table 2.

The water levels in MW-2D and MW-2S were unreliable and in these two wells the screens are suspected to be plugged. Thus the water levels or groundwater elevations of these two wells were not utilized in the potentiometric maps or evaluation.

#### Groundwater Sampling and Analysis:

In accordance with the Work Plan, the groundwater in the new monitor wells (MW-5, MW-6, MW-7, and MW-8) was sampled and analyzed for three consecutive months (August, September, and October 2003). The groundwater samples were analyzed for pH, Specific Conductance, Mercury, Arsenic, Cadmium, Chromium, Lead and Silver. The field data sheets and laboratory analytical reports for these three sampling events are included in Appendix 5. The analytical data for these sampling events are tabulated in Table 3.

#### SITE GEOLOGY

The Site is located within the Osage Cuestas part of the Osage Plains physiographic province, which is characterized by rolling hills, and steep-sided hills that are dissected by intermittent streams with flat alluvial valleys.

#### Soils/Unconsolidated Materials:

Undisturbed areas of the Site, especially the northeast part, are underlain by the Kenoma Series soils. The Kenoma Soils are generally deep, moderately well drained, very slow permeable soils on uplands, of 0 to 2 percent slopes. The surface layer typically consists of dark grayish brown silt loam about 6 to 12 inches thick. The lower part consists of dark brown, grayish brown, yellowish brown, light gray to reddish brown silty clay with 4 to 6 feet thickness. This undisturbed soil section is encountered in MW-5, MW-6, MW-7 MW-8, TW-9, TW-2 and TW-1.

Fill clay generally grayish brown to dark brown with varying thickness is encountered in MW-1, MW-2, MW-3, MW-4, BH-5, and BH-6.

Bedrock:

The underlying bedrock is Pennsylvanian age Dennis Limestone of the Kansas City Group. Figure 3 shows the stratigraphic column of Montgomery County.

Dennis Limestone underlies the soil and unconsolidated materials at the Site and consists of light gray to bluish gray limestone, sandy, oolitic and fossiliferous in the upper portion. Gray shale and black fissile shale are present in the lower part of the formation and locally contains 1 to 4 feet thick limestone at the base. The thickness of Dennis Limestone ranges from 10 to 70 feet. The Dennis Limestone is underlain by the Coffeyville Formation which is mainly shale with coal and sandstone interbeds.

The above-described typical Dennis Limestone section was penetrated in the new MW-6 well. The limestone is also exposed at the bottom of the unnamed creek adjacent to MW-8. The exposed limestone at the bottom of the creek is fractured. To depict the vertical and horizontal changes several geologic cross sections are constructed. Figure 4 shows the cross-section locations and Figures 5, 6, 7, 8, and 9 show the geologic cross-sections.

The cross-sections show the soil section and the underlying limestone. The limestone gently slopes westward. The cross-sections also show the treated waste material

encapsulated in the former lagoon area. (Cross-section E, Figure 9 and Cross-section D, Figure 8 respectively)

## SITE HYDROGEOLOGY

The Site is located in the Osage Plains physiographic province which is characterized by rolling, steep-sided hills that are dissected by intermittent streams with alluvial valleys. The Site is on a drainage tributary of Drum Creek, which is in turn a tributary of the Verdigris River. Drum Creek is about 0.75 mile west of the Site and the Verdigris River is about 7 miles south of the Site.

The Site is drained by an intermittent stream which runs from the center of the Site westward to the western edge of the Site and turns south behind the dike and then westward to Drum Creek. Another intermittent stream runs along the southern boundary of the Site and merges with the other intermittent stream near MW-2. These two intermittent streams are collectively called Unnamed Creek.

The uppermost aquifer underneath of the Site is the fractured Dennis Limestone/Shale and the unconsolidated silty clay overlying the bedrock. During drilling in August 2003, moisture zones were encountered in the fractured Dennis Limestone and the underlying shale section at a depth of 5 to 25 feet. During previous drillings (1978 and 1999) saturated zones were reported just above the Limestone bedrock in the unconsolidated section.

Groundwater is encountered in all the monitor wells. Some of the wells were completed in unconsolidated sediments, others in the bedrock section (limestone/shale).

Groundwater levels in the monitor wells were measured monthly beginning August 2003 and are shown on Table 2. The groundwater levels in the monitor wells fluctuated 1 to 7 feet in the last four monthly measurements and these water level fluctuations are expected to be greater in the spring season.

#### Groundwater Flow:

Groundwater Potentiometric Maps are constructed using the monthly water levels (August, September, October and November 2003). Figures 10, 11, 12, and 13 show the potentiometric maps.

Groundwater flows from east to west. The contours show the intermittent stream effect on Site. Also the contours show a mounding at the location of the former lagoon in the vicinity of TW-3 and TW-4.

The August 2003 data plotted on Figure 10 show the intermittent stream was a gaining stream during low water levels. However, as some precipitation occurred during September and October 2003, the stream became a losing stream (see Figures 11 and 12).

The potentiometric maps also show the effect of the western dike of the former lagoon. The groundwater contours gradient increases at the location of the dike due to hydraulic

conductivity changes. The dike was constructed over the native soil with compacted clay. The sampling and testing during 1978 showed the hydraulic conductivity difference between the native material with  $8 \times 10^{-5}$  cm/sec conductivity and the compacted clay material with a  $5 \times 10^{-8}$  cm/sec conductivity. Thus during heavy precipitation events the groundwater builds up east of the dike and rises to the surface (See Figure 5 Cross-section A-A').

#### Groundwater Velocity:

The groundwater velocity can be calculated using the following formula:

$$v = \frac{Kxi}{n}$$

where

- v = groundwater velocity
- K = hydraulic conductivity
- i = hydraulic gradient
- n = porosity

Groundwater in the uppermost aquifer flows from east to west. Using groundwater measurements from October 2003, the groundwater flow gradient was calculated between MW-5 and TW-3 and it is 0.0038 ft/ft.

For rate calculation, the hydraulic conductivity value is  $2.252 \times 10^{-5}$  cm/sec. The effective porosity is estimated to be 0.2 (20 percent). The groundwater velocity between the two wells is:

$$v = \frac{Kxi}{n} = \frac{2.252 \times 10^{-5} \times 0.0038}{0.2} = 4.78 \times 10^{-7} \text{ cm/sec}$$

*or 0.04 cm/day*

The groundwater flow gradient was also calculated between TW-3 (at 803.45' MSL) and MW-8 (at 793.74' MSL) to be 0.011 ft/ft.

For velocity calculation, the hydraulic conductivity value for MW-8 was used and is  $1.212 \times 10^{-5}$  cm/sec. The effective porosity is estimated to be 0.2 (20 percent). The groundwater velocity between these two wells is:

$$v = \frac{Kxi}{n} = \frac{1.212 \times 10^{-5} \times 0.011}{0.2} = 6.66 \times 10^{-7} \text{ cm/sec}$$

*or 0.057 cm/day*

#### GROUNDWATER QUALITY / SUPPLY

In Montgomery County groundwater is present in unconsolidated sediments and Pennsylvanian bedrock formations (weathered and/or fractured shale limestone, sandstone). The groundwater in these units of the county is limited in yield and poor in quality. The well water in the Cherryvale area is reportedly marginal due to sulfates and excessive hardness. Also, oil field intrusion of brines from oil production dating back to the early 1900's has impacted shallow groundwater quality regionally in this portion of Southeast Kansas.

The City of Cherryvale and Montgomery County Rural Water District #12 supply water to private residences in this area. The City of Cherryvale receives water from Big Hill Lake located approximately five (5) miles east of Cherryvale. Montgomery County Rural Water District #12 receives water from the Verdigris River near Neodesha, approximately 20-25 miles northwest of Cherryvale. Both of these surface water intake locations are upgradient from the National Zinc facility. Thus there is no concern for water supply in relation to the Site.

KDHE Brownfields Targeted Assessment reviewed all available water well records within four (4) miles of the National Zinc facility and located seventeen (17) wells serving forty-one (41) persons. However, none of these wells are down gradient of the Site, specifically between the Site and Drum Creek. Therefore there is no concern for impact to any water well with regard to the subject site.

#### SITE SPECIFIC GROUNDWATER QUALITY

Groundwater at the Site was sampled by KDHE prior to 2002. The analytical results indicated that the groundwater in the wells inside the previously closed lagoon area and on the western dike had elevated concentrations of cadmium, chromium, lead and silver.

The new monitor wells were installed specifically to sample and analyze groundwater downgradient of the Site. The new monitor wells (MW-5 upgradient and MW-6, MW-7, MW-8 downgradient) were sampled and analyzed for three consecutive months (August,

September, and October 2003). The analytical reports are included in Appendix 5 and the data is tabulated on Table 3.

The groundwater samples of the downgradient wells did not detect any of the metals of concern above laboratory detection levels. The pH of upgradient groundwater samples is comparable to the downgradient groundwater samples, all in the range of 6.5 to 7.8 S.U. The specific conductance shows difference between the upgradient and downgradient groundwater samples. Specific conductance of upgradient water samples range from 640 to 1085 umhos/cm, and the specific conductance of downgradient well water samples range from 2175 to 4695 umhos/cm. The increase in specific conductivity across the Site indicates some soluble material (e.g. chloride, sulfate, carbonate) is impacting the groundwater. However, no metals of concern have been detected in the off-Site groundwater.

#### GROUND AND SURFACE WATER INTERACTIONS

The two intermittent streams and Unnamed Creek drain the surface water at the Site. The streams receive water from groundwater during low precipitation, however during higher precipitation the streams lose water to the uppermost groundwater aquifer.

Although KDHE previously expressed concerns regarding shallow seeps along the western dike of the former lagoon, several inspections have been made by A & M Engineering, some jointly with KDHE, and no seeps detected. During a joint field inspection, a KDHE representative stated that there was only one location for suspected

seepage concern along the western dike and showed the location. However, the suspected seepage was discovered to be coming from a discharge pipe draining surface runoff from the top of the former lagoon. The location of the pipe is adjacent to MW-3. The most recent inspections were conducted by A & M Engineering on December 12, 2003 during high groundwater elevations, and again no seepage was observed along the western dike.

The uppermost groundwater aquifer water levels fluctuate several feet. During September and October moderate precipitation caused groundwater levels to rise up to 6-7 feet and this fluctuation will definitely increase more during the spring season. The groundwater levels in MW-3 and TW-3 were almost at the surface elevation during the October and November 2003 measurements. This observation correlates with the swampy surface condition previously observed in the vicinity of TW-3. This observation indicates that the swampy area on top of the closed lagoon is primarily caused by the high groundwater fluctuations. Additionally, the surface berm on top of the dike along the western edge restricts surface runoff and, together with the flat topography of the lagoon cap, also contributes to the swampy conditions.

## CONCLUSIONS

The following conclusions are drawn from this hydrogeologic investigation:

1. The uppermost groundwater aquifer at the site is the unconsolidated sediment / fractured limestone and shale of the Dennis Formation at a depth of 5 to 20 feet.
2. The Site groundwater flows westward.
3. The groundwater fluctuates as much as 6-7 feet at the Site.
4. The swampy area on top of the closed lagoon is caused by the condition of poor surface drainage and groundwater fluctuation. This is caused by the compacted dike along the western edge of the Site which impedes groundwater flow, and the surface berm on top of the dike along the western edge that contributes to this condition by preventing surface water runoff.
5. Groundwater quality is impacted by metals (cadmium, lead, and chromium) inside the closed lagoon area, but the metal impact is not detected downgradient of the Site. This confirms KDHE's previous conclusion, and undoubtedly is related to the presence of limestone across the site.
6. Groundwater quality and yield is limited in this entire area and there is no water supply source impacted by the Site past or present activities.

## RECOMMENDATIONS

The following recommendations are made considering groundwater quality and the conditions observed on the Site:

1. Based on the KDHE data from the Former National Zinc Site BTA (February, 2000), the groundwater in the previously closed lagoon area is contaminated with metals of concern (cadmium, lead, and chromium). Therefore, the clay cap elevation in the vicinity of TW-3 and MW-3 should be raised to prevent groundwater and surface water interaction. The entire surface of the previously closed lagoon area should be raised a minimum of at least three (3) feet (the thickness of the proposed cap) in order to prevent interfacing between the groundwater and surface water.
2. Provide good storm water run-off systems around and over the closed lagoon site to provide good drainage and control erosion.
3. No additional sampling of monitor wells for quality is required.
4. Continue monthly water level measurements to obtain more data to utilize in the design phase.
5. No other corrective measures for groundwater are recommended.

**Tables**

Table 1

MONITORING WELL INFORMATION

Well No.	Date of Completion	Ground Elevation	T.O.C. Elevation	Total Depth	Screen Interval (From Ground Level)	Casing	Stick Up
MW-1	1978	802.85'	805.52'	*12.2'	9-17' **	0-9'	2.67'
MW-2S	1978	803.10'	806.20'	*4.56	7-12' **	0-7'	3.10'
MW-2D	1978	803.16'	806.08'	*11.0	16-19' **	0-16'	2.92'
MW-3	1978	802.22'	805.15'	*8.7'	8-14.0' **	0-8'	2.93'
MW-4	1978	803.02'	804.47'	*8.6'	8.5-16' **	0-8.5	1.45'
MW-5	7/22/03	813.06'	815.85'	16.50'	6.5-16.5'	0-6.5'	2.79'
MW-6	7/22/03	798.43'	802.15'	30.00'	10-30'	0-10'	3.72'
MW-7	7/22/03	796.09'	799.81'	22.50'	7.5-22.5'	0-7.5'	3.72'
MW-8	7/22/03	793.90'	797.07'	22.50'	7.5-22.5'	0-7.5'	3.17'
TW-1	8/16/99	806.76'	810.08'	14.00'	9-14'	0-9'	3.32'
TW-2	8/16/99	805.82'	809.48'	11.10'	6.1-11.1'	0-6.1	3.66'
TW-3	8/17/99	805.24'	808.80'	10.20'	5.2-10.2'	0-5.2'	3.56'
TW-4	8/17/99	805.75'	808.96'	7.50'	2.5-7.5'	0-2.5'	3.21'
TW-5	8/17/99	813.24'	815.36'	13.00'	8.0-13'	0-8.0'	2.12'
TW-9	8/19/99	818.03'	821.67'	9.00'	4-9'	0-4'	3.64'

\* Total Depth measured in the field on October 20, 2003, completion logs (1978) showed deeper wells.

\*\* Total Depth from the log records.

**Table 2**

**MONITOR WELLS WATER LEVEL MEASUREMENTS**  
**National Zinc Site**  
**Cherryvale, Kansas**

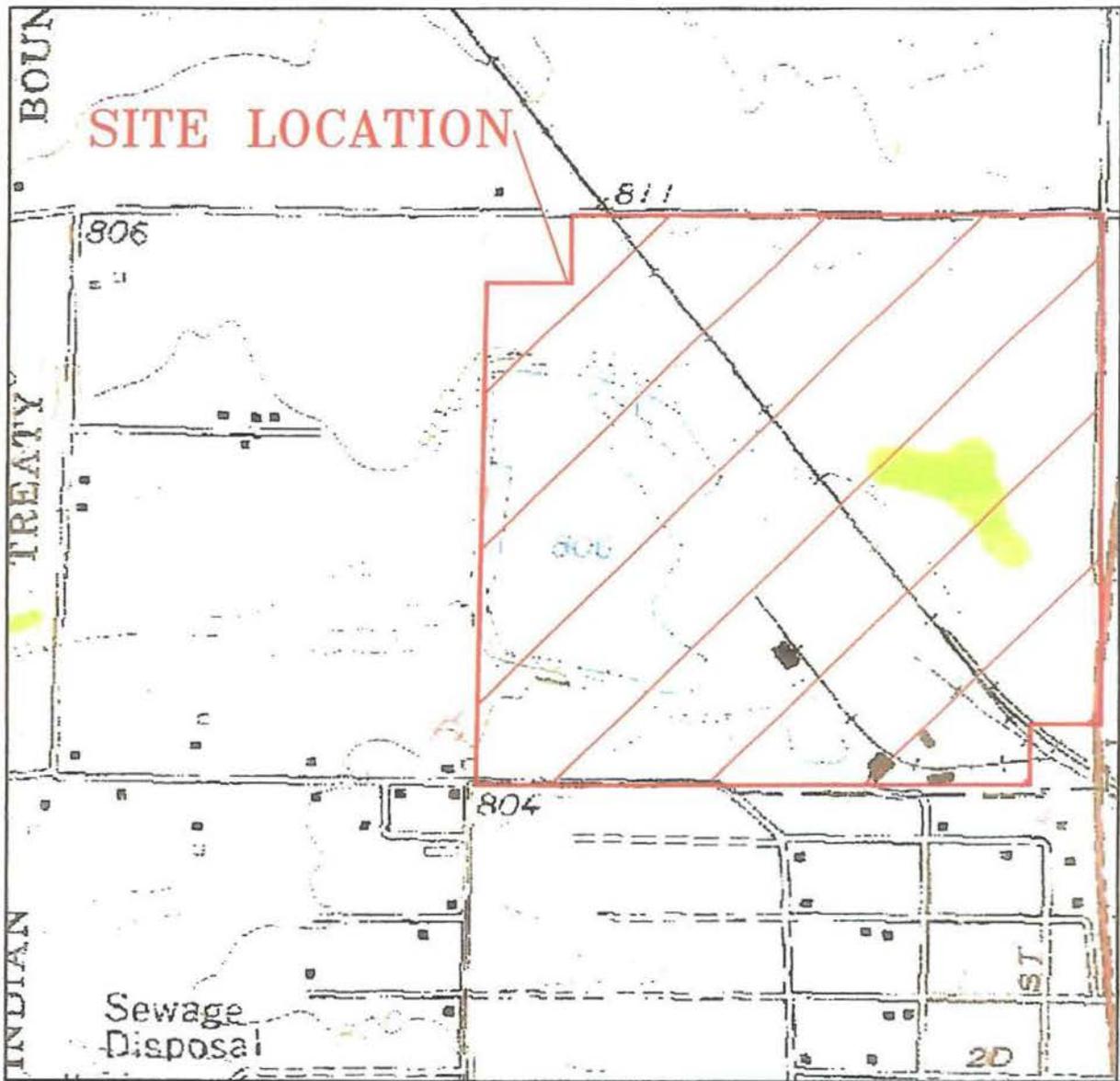
Well No.	TOC El. MSL Ft.	August, 2003		September, 2003		October, 2003		November, 2003	
		Water Depth Ft.	Groundwater Elevation MSL Ft.	Water Depth Ft.	Groundwater Elevation MSL Ft.	Water Depth Ft.	Groundwater Elevation MSL Ft.	Water Depth Ft.	Groundwater Elevation MSL Ft.
MW-1	805.52	8.65	796.87	6.0	799.52	5.65	799.87	4.14	801.38
MW-2D	806.08	DRY	NA	10.6	795.48	10.4	795.68	10.73	795.35
MW-2S	806.20	DRY	NA	DRY	NA	DRY	NA	DRY	NA
MW-3	805.15	8.5	796.65	7.55	797.6	3.38	801.77	3.23	801.92
MW-4	804.47	DRY	NA	5.8	798.67	4.6	799.87	4.41	800.06
MW-5	815.845	9.11	806.735	7	808.845	5	810.845	3.82	812.025
MW-6	802.150	11.64	790.51	11.2	790.95	11.01	791.14	10.92	791.23
MW-7	799.805	11.33	788.475	7.1	792.705	6.52	793.285	8.82	790.985
MW-8	797.07	10.33	786.74	3.3	793.77	3.33	793.74	3.75	793.32
TH-1	810.08	11.66	798.42	9.75	800.33	7.87	802.21	7.62	802.46
TH-2	809.48	8.36	801.12	7.68	801.8	6.38	803.1	6.55	802.93
TH-3	808.80	6.25	802.55	5.8	803.00	5.35	803.45	5.25	803.55
TH-9	821.67	DRY	NA	8.85	812.82	6.91	814.76	8.09	813.58

**Table 3**

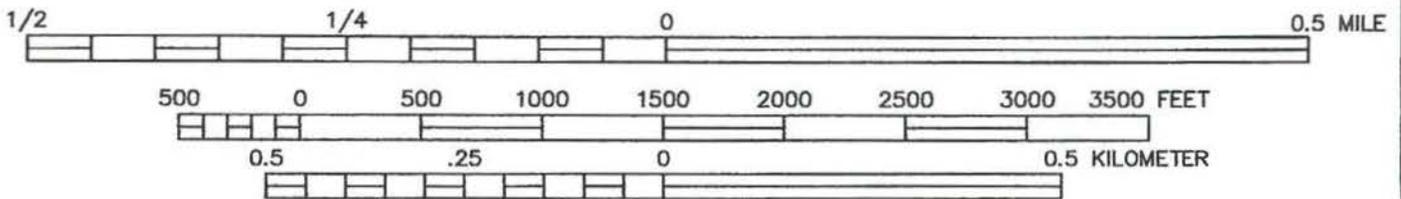
**ANALYTICAL RESULTS OF GROUND WATER SAMPLES**  
**National Zinc Site**  
**Cherryvale, Kansas**

<b>PARAMETERS</b>	<b>MW-5</b>	<b>MW-6</b>	<b>MW-7</b>	<b>MW-8</b>
<b>August, 2003</b>				
PH (Field)	7.23	7.24	7.28	6.51
Specific Conductance. (Field)	640	2550	2300	2175
Mercury (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100
Arsenic (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Cadmium (mg/L)	<0.00100	<0.00100	<0.00100	<0.00100
Chromium (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100
Lead (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Silver (mg/L)	<0.00200	<0.00200	<0.00200	<0.00200
<b>September, 2003</b>				
PH (Field)	7.39	7.73	7.65	7.65
Specific Conductance. (Field)	960	2800	3215	4695
Mercury (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100
Arsenic (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Cadmium (mg/L)	<0.00100	<0.00100	<0.00100	<0.00100
Chromium (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100
Lead (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Silver (mg/L)	<0.00200	<0.00200	<0.00200	<0.00200
<b>October, 2003</b>				
PH (Field)	7.24	7.48	7.54	7.50
Specific Conductance. (Field)	1085	4560	3330	2855
Mercury (mg/L)	<0.000100	<0.000100	<0.000100	<0.000100
Arsenic (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Cadmium (mg/L)	<0.00100	<0.00100	<0.00100	<0.00100
Chromium (mg/L)	<0.0100	<0.0100	<0.0100	<0.0100
Lead (mg/L)	<0.00500	<0.00500	<0.00500	<0.00500
Silver (mg/L)	<0.00200	<0.00200	<0.00200	<0.00200

**Figures**



**CHERRYVALE QUADRANGLE  
MONTGOMERY COUNTY, KANSAS**



**A & M ENGINEERING AND  
ENVIRONMENTAL SERVICES, INC.**

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

**TOPOGRAPHIC LOCATION MAP**

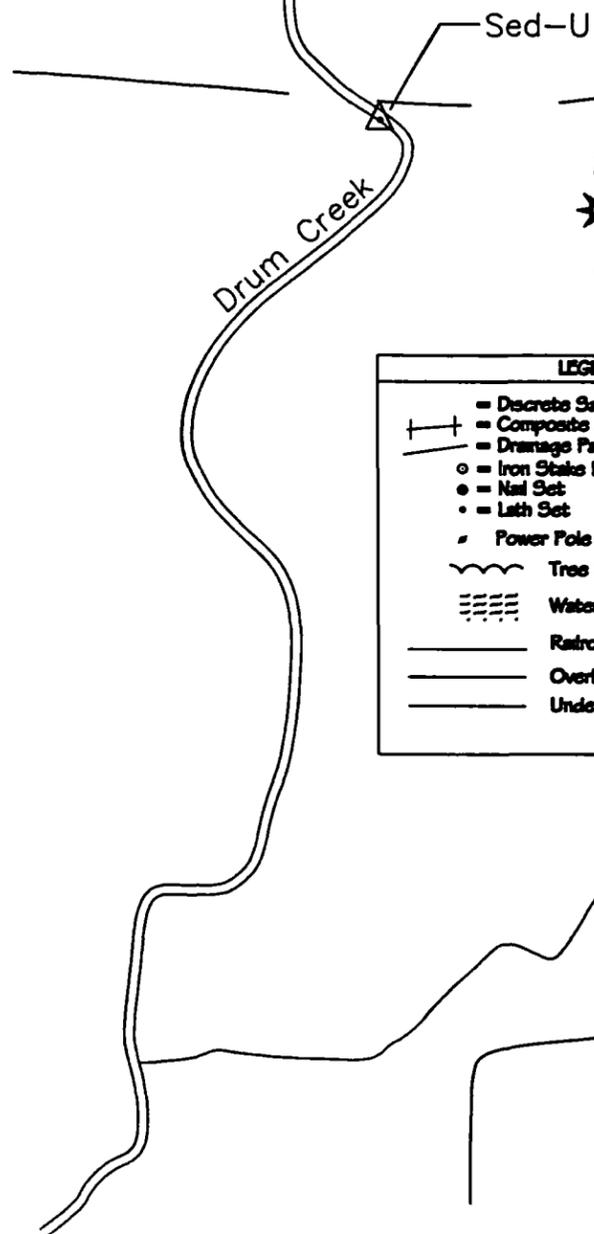
SCALE: AS	DATE: 11/17/03	FIGURE NO. FIGURE 1
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC

GRAPHIC SCALE



( IN FEET )  
1 inch = 500 ft.



**LEGEND**

- Discrete Sample Location
- Composite Sample Interval
- Drainage Path
- Iron Stake Found
- Nail Set
- Lath Set
- Power Pole
- ~ Trees Line
- Water
- Railroad
- Overhead Electric
- Underground Natural Gas

**Benchmarks**

Project No. 180-02 11-0203-01  
 BM2487 - Chilled square on West end of South headst, 3.6 Feet Left of South, Station 98+29 Elevation 797.21  
 BM2488 - A chilled 1" Southwest corner concrete set at the Southwest corner of Map, 623 Feet Right of South, Station 323+67 Elevation 821.67  
 Site Bench Mark - Iron bar located on the Southwest property corner being the Center of Section 8 T22S R27E of the 6th PM Elevation 821.67

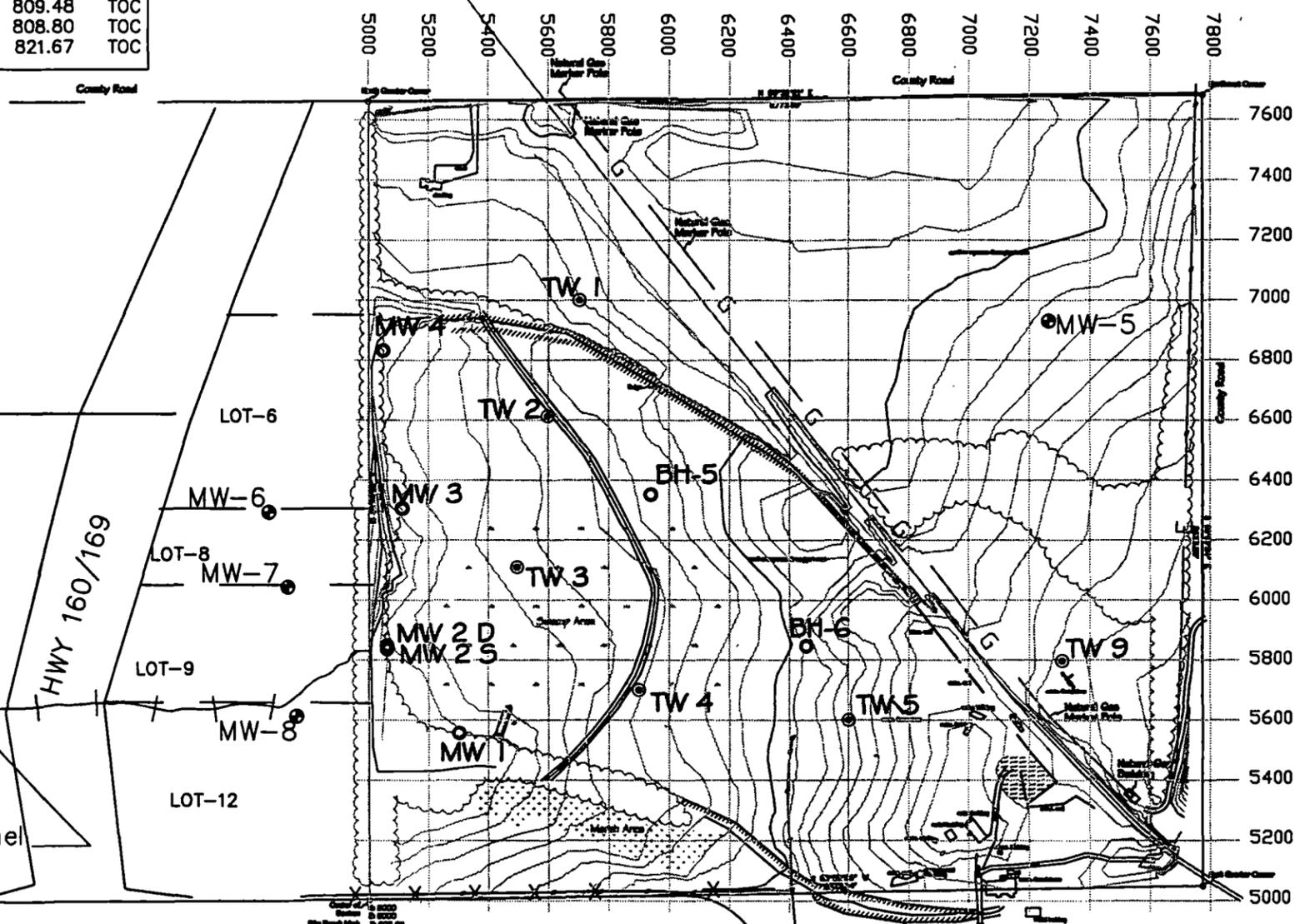
**MONITORING WELL KEY**

- MW/BH INSTALLED IN 1978
- ◎ TW INSTALLED IN 1999
- ⊕ MW INSTALLED IN 2003

**A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.**  
 ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

SCALE: 1"=500'	DATE: 11/20/03	FIGURE NO. 2
APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002

**SITE MAP**  
 NATIONAL ZINC SITE  
 CHERRYVALE, KANSAS



System	Series	Stage	Group	Formation or rock unit	Thickness, in feet	Lithology	Water supply <sup>1</sup>
Quaternary	Pleistocene			Alluvium	0-60	Unconsolidated clay, silt, sand, and gravel. Basal part contains 0 to 14 feet of sand and gravel.	Yields moderate supplies of water in parts of the Verdigris River valley and in major tributary valleys.
				Terrace deposits	0-38		Yields moderate supplies of water to wells in low terrace deposits. Intermediate and high terrace deposits yield lesser amounts to wells or may be above water table.
Pennsylvanian	Upper Pennsylvanian	Virgilian	Douglas	Lawrence Formation	140	Chiefly olive-gray shale. As much as 30 feet of sandstone in upper part. Thin bed of Haskell Limestone Member at base.	Yields very small supplies of water to shallow wells in weathered zones. Sandstone beds generally above water table.
				Stranger Formation	100-175	Gray shale and siltstone, and gray fine-grained sandstone. Thin bed of Westphalia Limestone Member in upper part.	Generally yields small to moderate supplies of water to wells in areas underlain by sandstone. Where sandstone beds are absent, yields very small to small supplies to shallow wells in weathered zone.
		Lansing		Stanton Limestone	70-130	Consists of three limestone and two shale members. Limestones include fine-grained dense limestone, oolitic and sandy limestone, and fine-grained to coarsely crystalline limestone. Lower shale member locally includes a black fissile shale. Upper shale contains sandstone beds in outcrops in southern part of county.	Generally yields very small supplies of water to wells. Yields very small to small supplies of water to wells in areas underlain by thick limestone beds or shale. In southwestern part of county, yields very small to moderate supplies of water to wells in sandstone.
				Vilas Shale	50-120	Chiefly medium-gray shale.	Generally yields little or no water to wells except in the shallow zone of weathering.
				Plattsburg Limestone	0-70	Thick gray fine-grained to crystalline limestone in northern part of county. Thin or absent south of Elk River.	
		Kansas City		Dunbar Springs Shale and Lane Shale	85-150	Gray silty to argillaceous shale.	Generally yields little or no water to wells except in the shallow zone of weathering. Yields small supplies to wells locally from black shale.
				Iola Limestone	2-10	Consists of two limestones separated by a black fissile shale containing phosphatic concretions. Lower limestone locally sandy or may be absent.	
				Chanute Shale	80-200	Chiefly gray shale and fine-grained sandstone. The Nuxta Sandstone Member occurs extensively in the lower part and the Cottage Grove Sandstone Member in the upper part. The middle part contains the Thayer coal bed, one to three thin limestones, and gray shale.	Widespread aquifer. Generally yields small to moderate supplies of water to wells from sandstone beds at depths of as much as 400 feet.
				Drum Limestone	0-60	Light-gray fine-grained limestone and light-gray crossbedded very fossiliferous oolitic limestone.	Generally yields little or no water to wells except in the shallow zone of weathering.
				Cherryvale Shale	0-90	Chiefly bluish-gray shale with flagstones at top in outcrops in northern part of county. Flags increase in abundance southward.	
	Dennis Limestone			10-70	Light-gray to bluish-gray limestone, locally sandy or oolitic in upper part. Gray shale and black fissile shale in lower part. Locally contains a 1- to 4-foot thick limestone at base.	In northeast area, yields very small to small supplies of water to wells at depths of as much as 200 feet. Elsewhere, generally yields little or no water except in the shallow zone of weathering.	
	Coffeyville Formation			200	Chiefly medium-gray shale and siltstone. Upper part locally contains much fine-grained sandstone and several thin coals. Lower beds contain medium- to dark-gray and black shale. The Swops Limestone, 1 to 8 feet of gray limestone, occurs near the middle.	Generally yields little or no water to wells from the gray shales, siltstones, and thin limestones. Beds of sandstone and black shales locally yield small supplies of water to wells.	
	Checkerboard Limestone			1-14	Consists of two thin limestones separated by gray shale where thickest. Lower limestone is brown-weathering crossbedded coquina.		
	Seminole Formation	5-10	Chiefly medium- to dark-gray shale. Locally contains a thin fine-grained sandstone at base.				
	Middle Pennsylvanian	Desmoinesian	Marmaton	Holdenville Shale	3-25	Gray and bluish-green fossiliferous shale.	Generally yields little or no water to wells.
				Lenapah Limestone	7-18	Upper massive limestone and lower nodular bedded limestone separated by a thin gray shale.	Yields very small to small supplies of water to wells generally less than 50 feet deep.
				Novata Shale	3-30	Medium- to light-gray shale, locally contains some fine-grained sandstone.	
				Altamont Limestone	15-20	Upper and lower light-gray limestone members separated by gray and black fissile shale.	
				Bandera Shale	60-150	Gray shale and sandstone.	

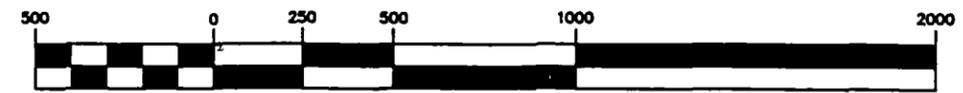
<sup>1</sup> In this report, very small supplies refers to yields generally less than 1 gpm, small supplies to 1 to 5 gpm, and moderate supplies to 5 to 100 gpm.

**FIGURE 3**  
**GEOLOGIC PROFILE OF**  
**MONTGOMERY COUNTY**  
 National Zinc Site  
 Expanded Site Inspection  
 Cherryvale, Kansas  
 March, 2001

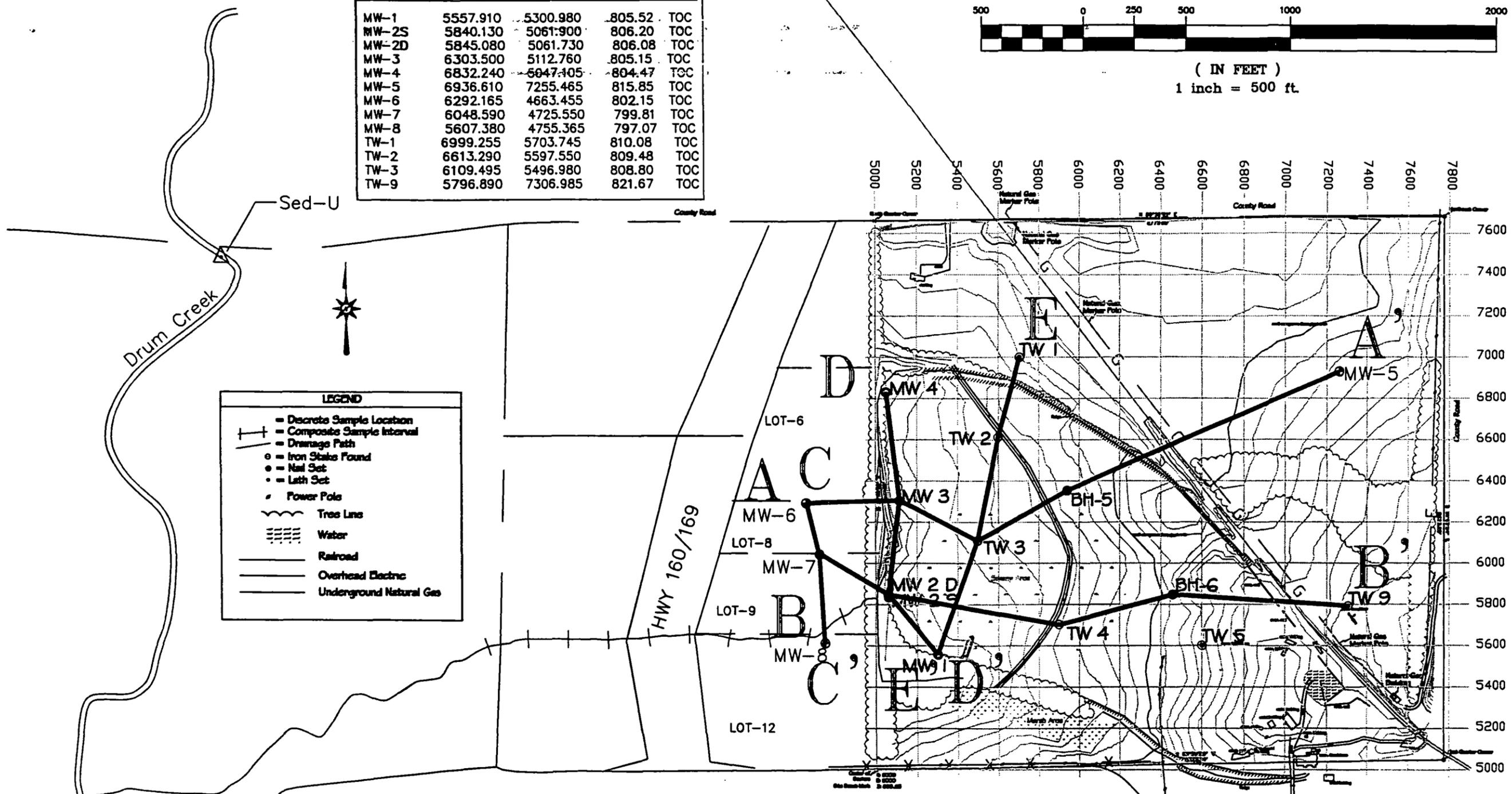
Source: "Geology and Ground-Water Resources of Montgomery County, Southeastern Kansas." *Kansas Geol. Survey Ground-Water Ser. No. 1, 1974.*

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.405	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC

GRAPHIC SCALE



( IN FEET )  
1 inch = 500 ft.



**LEGEND**

- Discrete Sample Location
- Composite Sample Interval
- Drainage Path
- o Iron Stake Found
- o Nail Set
- o Lath Set
- o Power Pole
- ~ Tree Line
- Water
- Railroad
- Overhead Electric
- Underground Natural Gas

**Benchmarks**

Project No. 159-03 1-026-01

BM027 - Olded square on West end of South roadcut, 262 feet left of benchline, Station 58+09 Elevation 797.21

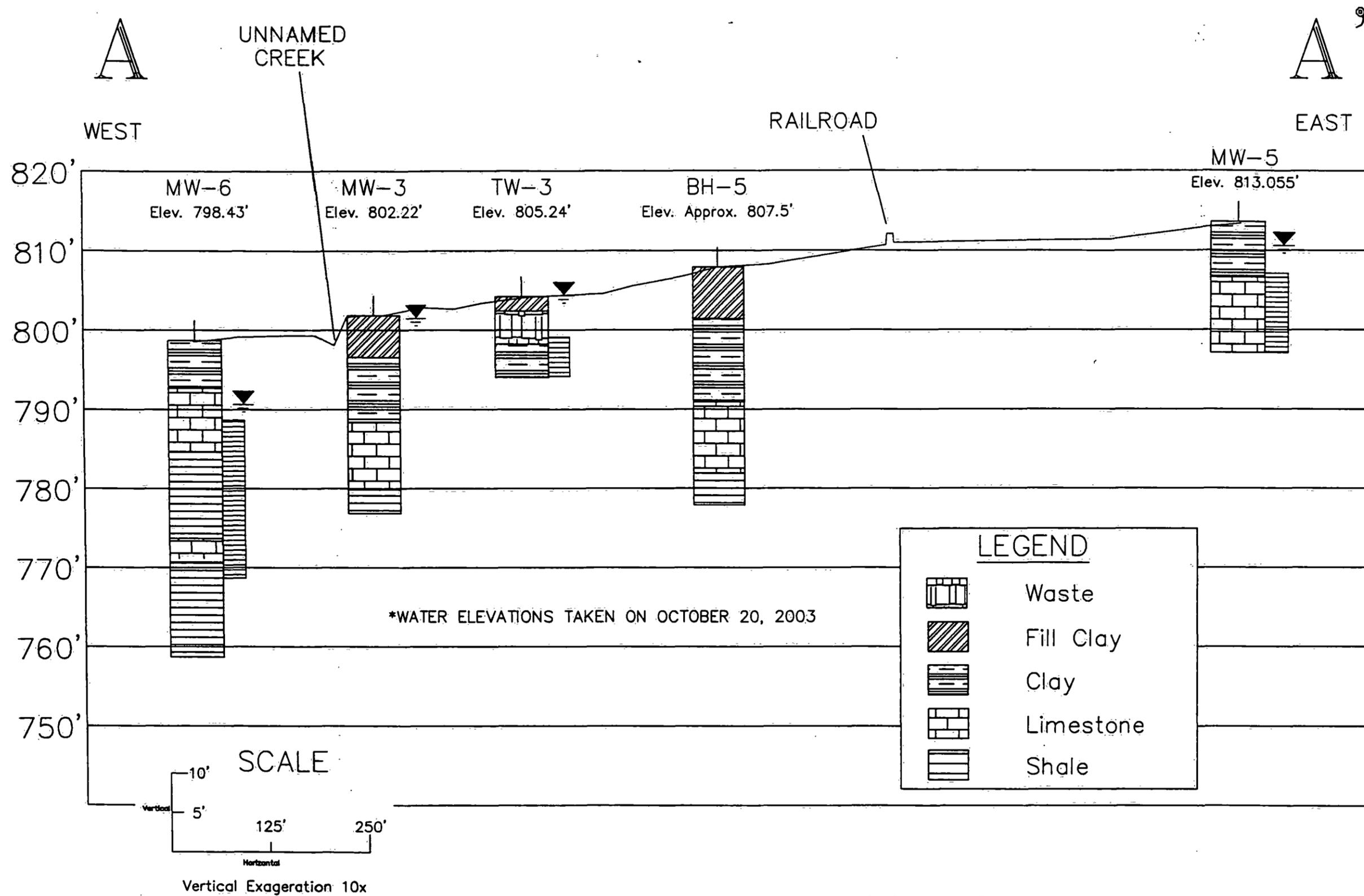
BM028 - A chiseled 1" Southwest corner concrete nail at the Southwest corner of Midg. 425 feet right of benchline, Station 28+68 Elevation 825.33

Site Bench Mark - Iron bar located on the Southwest property corner being the Center of Section 8 T28S R27E of the 6th P.M. Elevation 825.25

**MONITORING WELL KEY**

- o MW/BH INSTALLED IN 1978
- o TW INSTALLED IN 1999
- o MW INSTALLED IN 2003

<p><b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b> ENGINEERING - ENVIRONMENTAL - CONSTRUCTION</p>	SCALE: 1"=500'	DATE: 11/20/03	FIGURE NO. FIGURE 4	<p><b>CROSS-SECTION LOCATIONS</b> NATIONAL ZINC SITE CHERRYVALE, KANSAS</p>
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	



**A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.**

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

SCALE: AS  
APPROVED BY: AME

DATE: 11/20/03  
DRAWN BY: GJJ

FIGURE NO. FIGURE 5  
PROJECT NO.

CROSS-SECTION A-A'  
NATIONAL ZINC SITE  
CHERRYVALE, KANSAS

B

B'

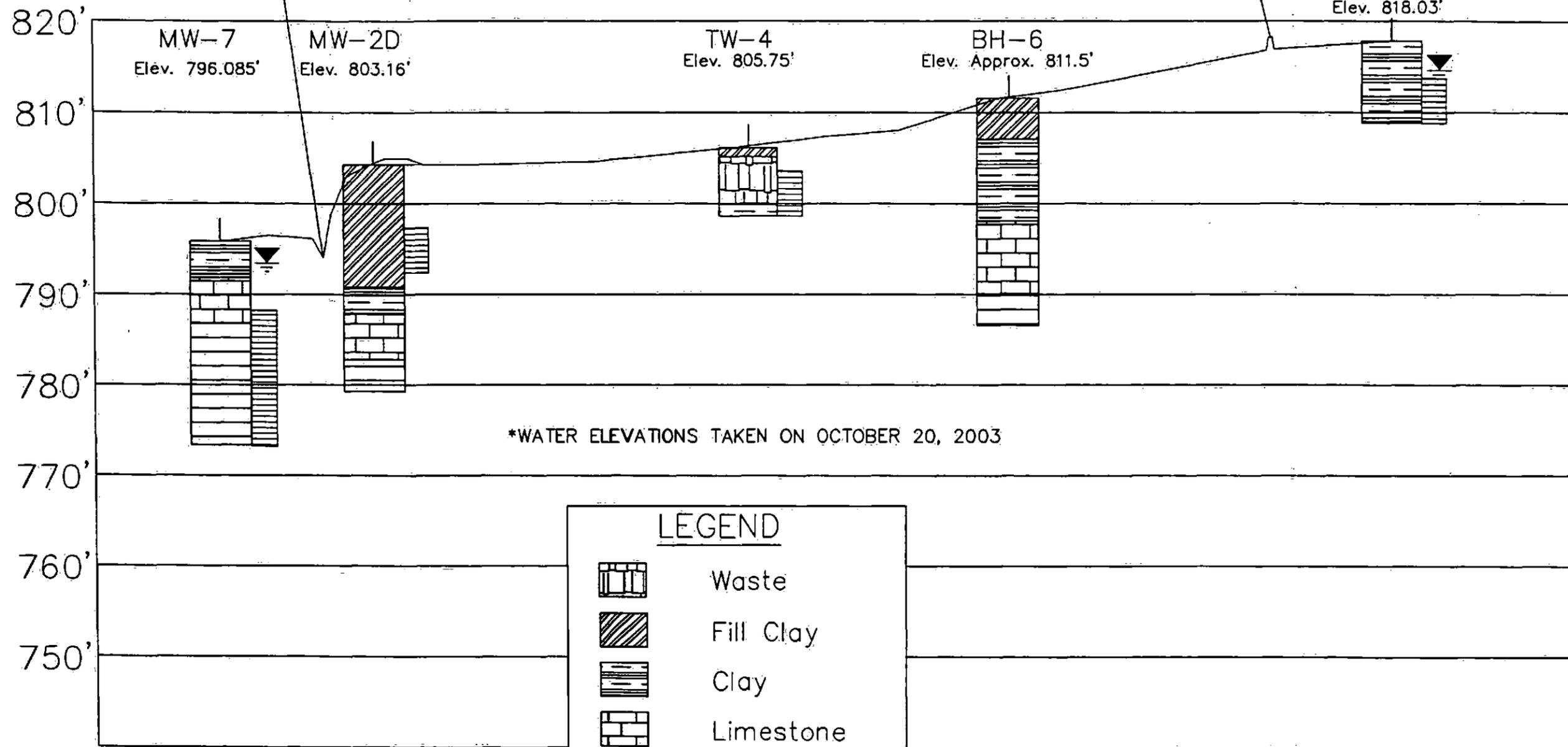
WEST

EAST

UNNAMED CREEK

RAILROAD

TW-9  
Elev. 818.03'

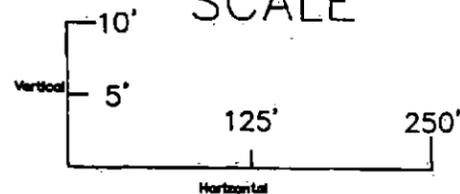


\*WATER ELEVATIONS TAKEN ON OCTOBER 20, 2003

LEGEND

-  Waste
-  Fill Clay
-  Clay
-  Limestone
-  Shale

SCALE



Vertical Exaggeration: 10x

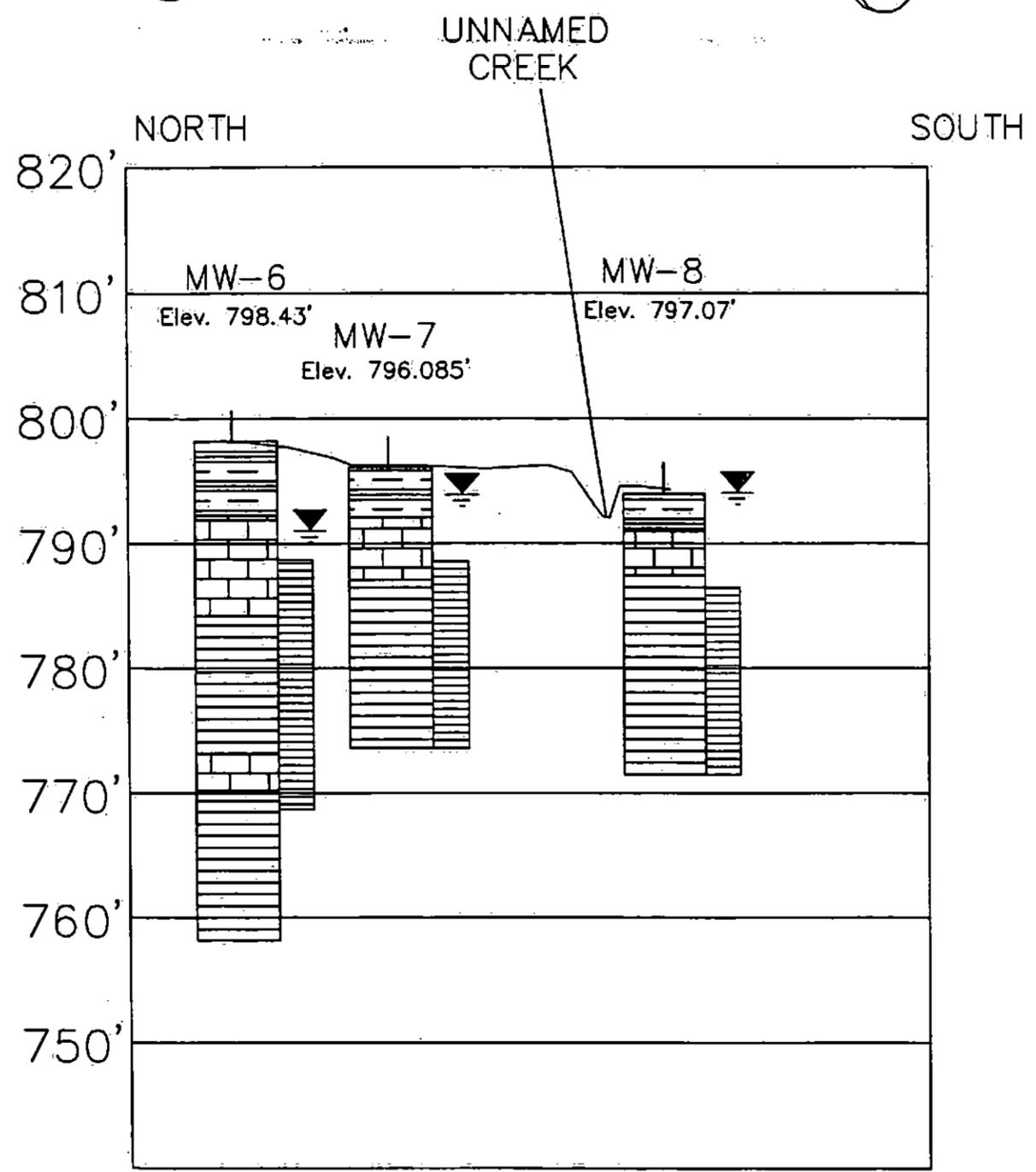


A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 6	CROSS-SECTION B-B' NATIONAL ZINC SITE CHERRYVALE, KANSAS
APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

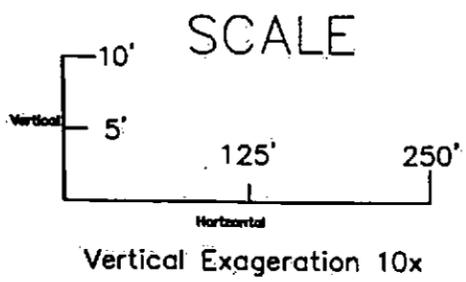
C C'



\*WATER ELEVATIONS TAKEN ON OCTOBER 20, 2003

**LEGEND**

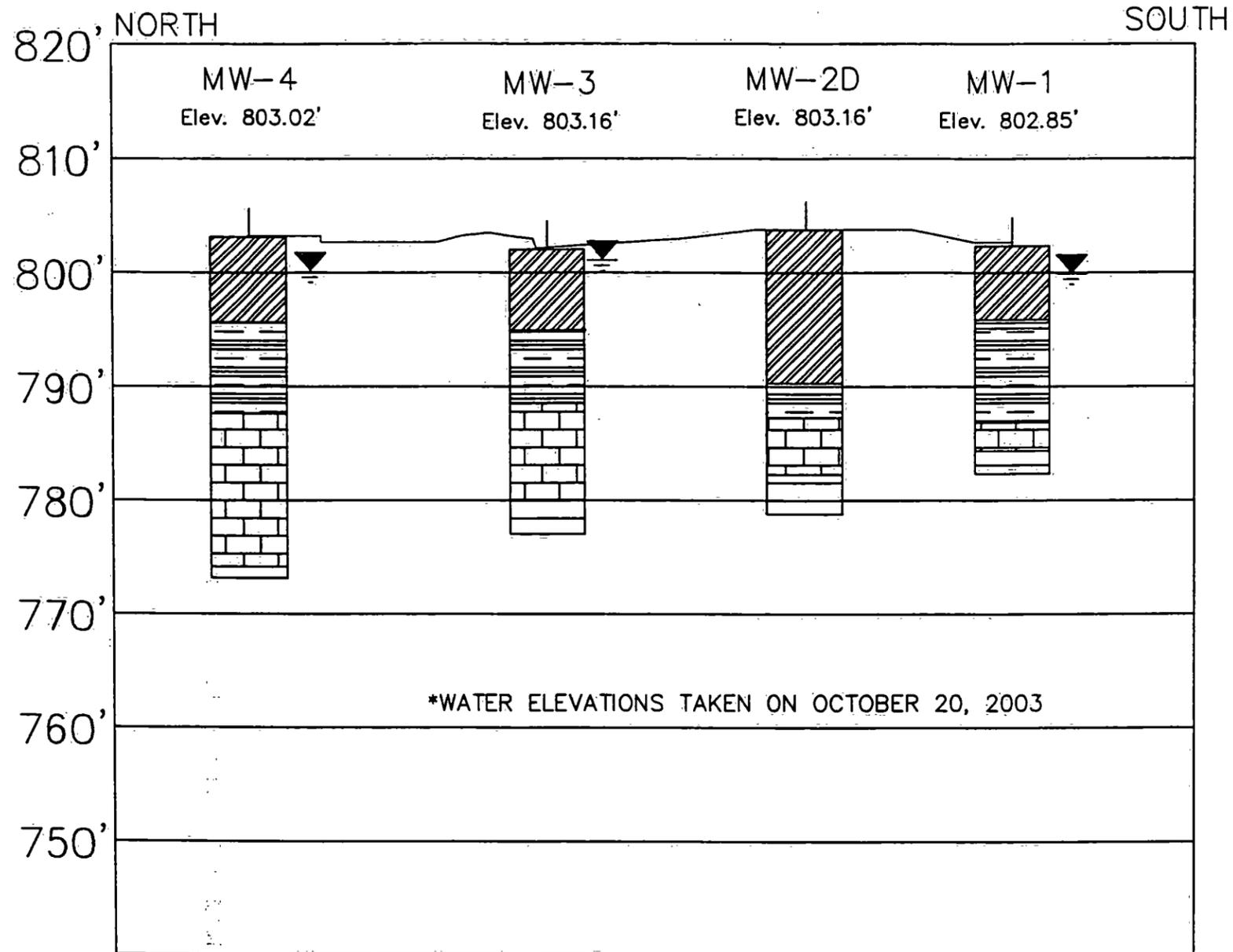
-  Waste
-  Fill Clay
-  Clay
-  Limestone
-  Shale



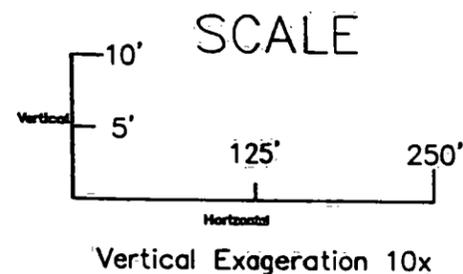
 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b> <small>ENGINEERING - ENVIRONMENTAL - CONSTRUCTION</small>	SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 7	<b>CROSS-SECTION C-C'</b> NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

D

D'



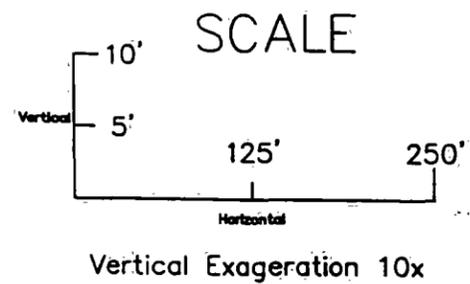
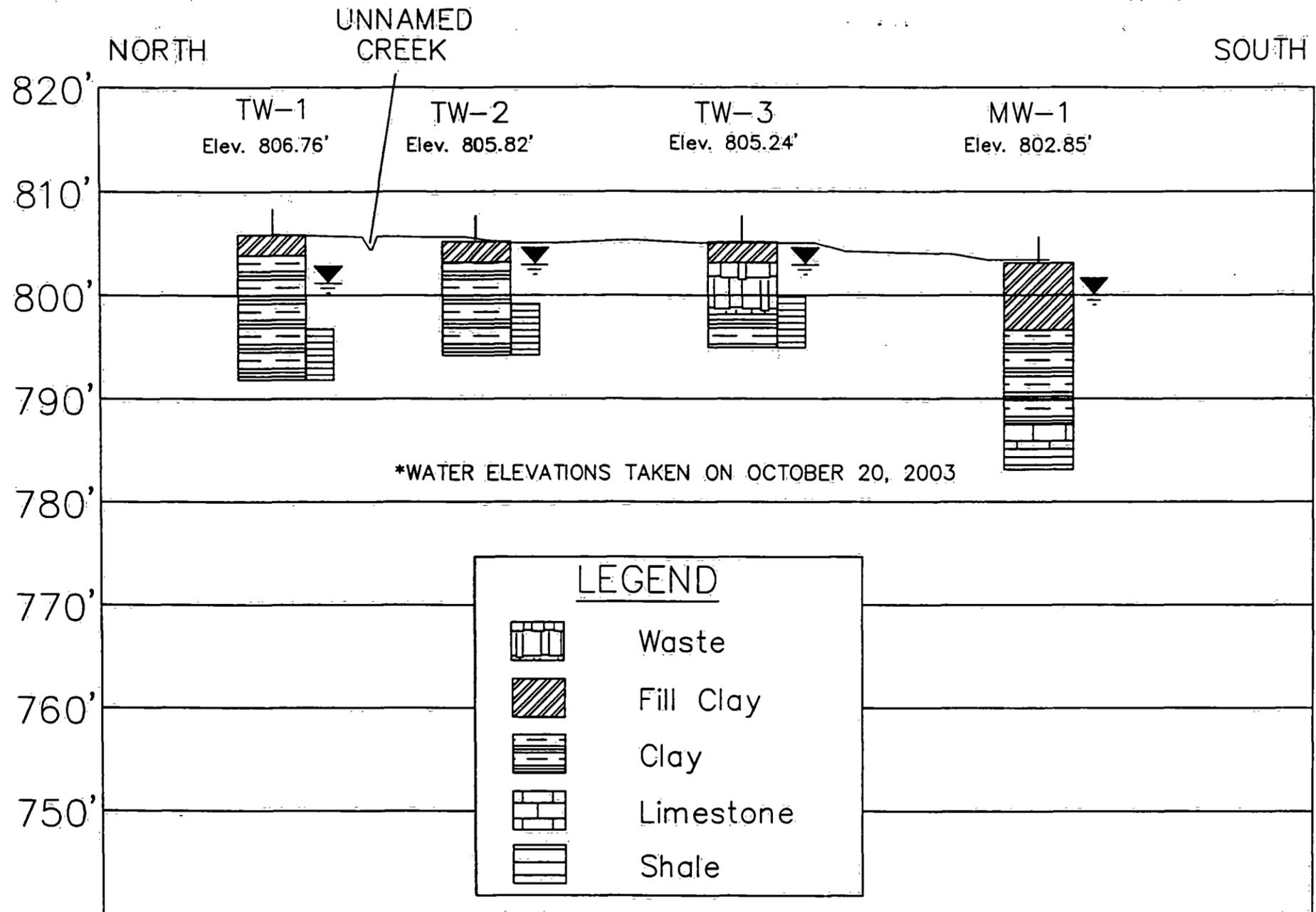
LEGEND	
	Waste
	Fill Clay
	Clay
	Limestone
	Shale



 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b> <small>ENGINEERING - ENVIRONMENTAL - CONSTRUCTION</small>	SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 8	<b>CROSS-SECTION D-D'</b> NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

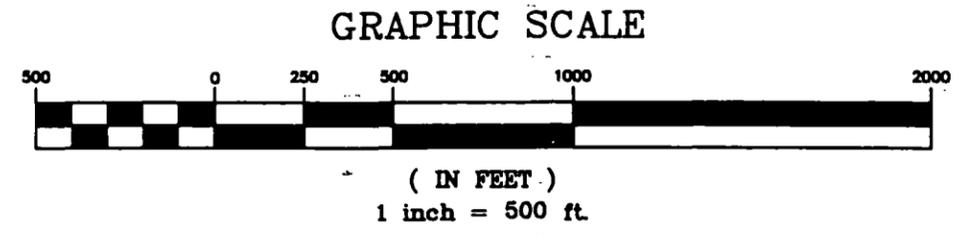
E

E<sup>9</sup>

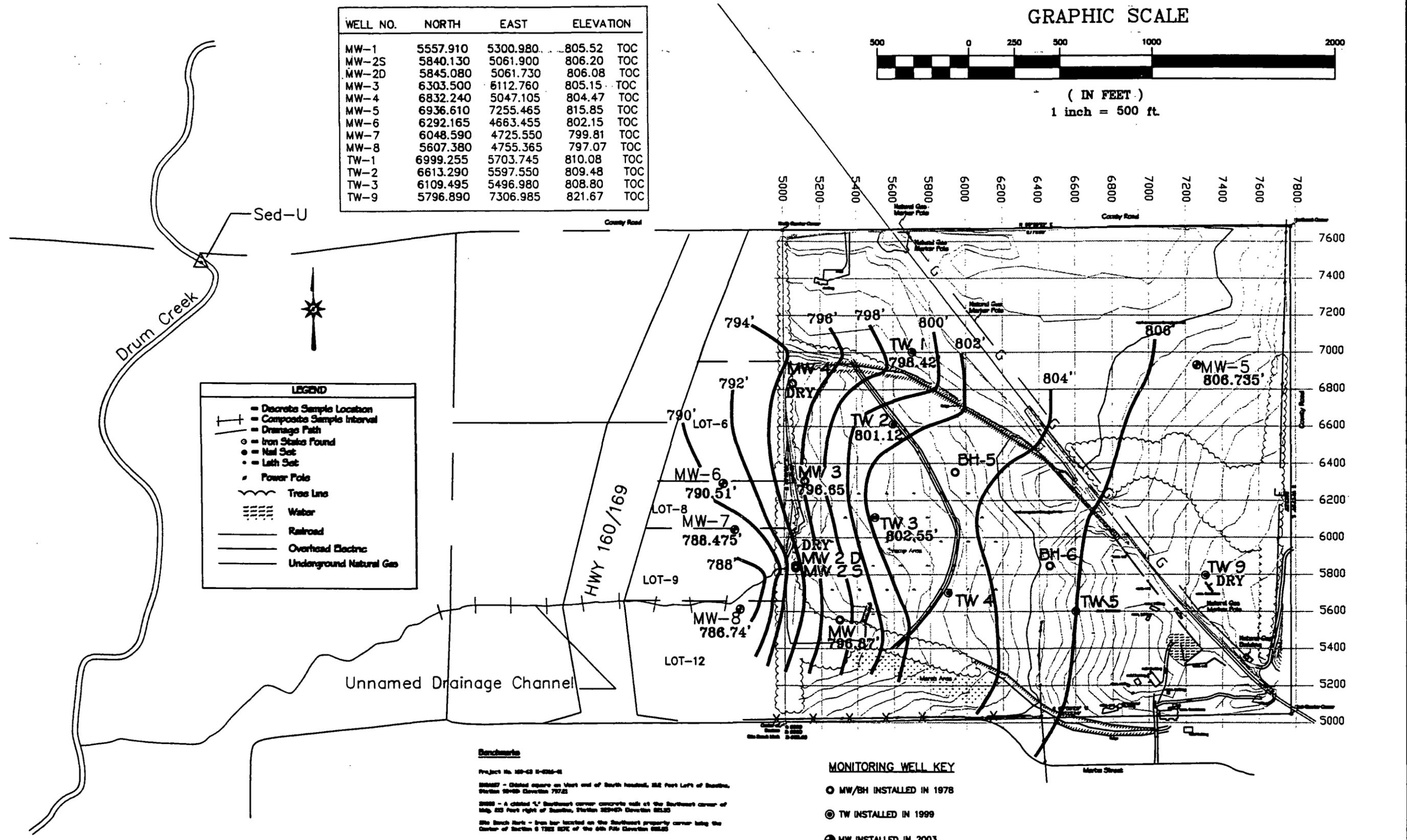


 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b> <small>ENGINEERING - ENVIRONMENTAL - CONSTRUCTION</small>	SCALE: AS	DATE: 11/20/03	FIGURE NO. FIGURE 9	<b>CROSS-SECTION E-E'</b> NATIONAL ZINC SITE CHERRYVALE, KANSAS
	APPROVED BY: AME	DRAWN BY: GJJ	PROJECT NO.	

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	6112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC



LEGEND	
	Concrete Sample Location
	Composite Sample Interval
	Drainage Path
	Iron Stake Found
	Nail Set
	Lath Set
	Power Pole
	Tree Line
	Water
	Railroad
	Overhead Electric
	Underground Natural Gas



**Benchmarks**  
 Project No. 180-02 0-020-01  
 229227 - Old steel square on West end of South road, 1/2 Mile West of Sedalia, Station 229227 Elevation 797.25  
 229228 - A chiseled "L" Southwest corner concrete sill at the Southwest corner of Map 223 feet right of Sedalia, Station 229228 Elevation 821.25  
 The Bench Mark - Iron bar located on the Southwest property corner being the Center of Section 9 T22S R22E of the 6th P.M. Elevation 821.25

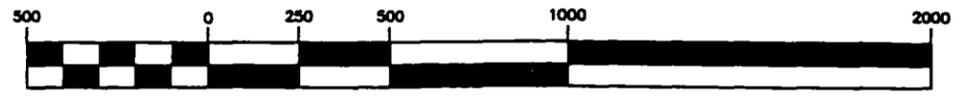
MONITORING WELL KEY	
	MW/BH INSTALLED IN 1978
	TW INSTALLED IN 1999
	MW INSTALLED IN 2003

\*GROUNDWATER ELEVATIONS ON AUGUST 6, 2003

 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b> <small>ENGINEERING - ENVIRONMENTAL - CONSTRUCTION</small>	SCALE: 1"=500'	DATE: 11/20/03	FIGURE NO. FIGURE 10	<b>GROUNDWATER CONTOUR MAP</b> <b>NATIONAL ZINC SITE</b> <b>CHERRYVALE, KANSAS</b>
	APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002	

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC

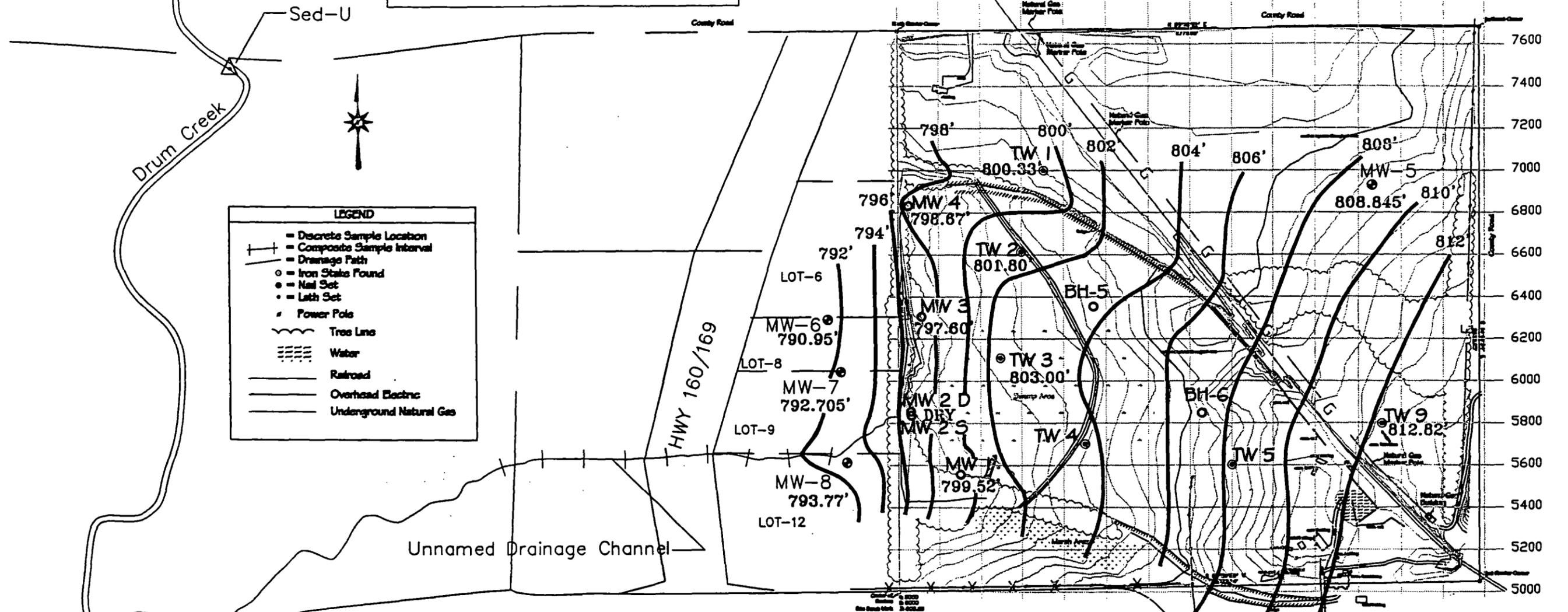
GRAPHIC SCALE



( IN FEET )  
1 inch = 500 ft.

**LEGEND**

- Concrete Sample Location
- Composite Sample Interval
- - - Drainage Path
- Iron Stake Found
- Nail Set
- Lath Set
- Power Pole
- ~ Tree Line
- Water
- Railroad
- Overhead Electric
- Underground Natural Gas



Sed-U

Drum Creek

County Road

County Road

Unnamed Drainage Channel

HWY 160/169

Marion Street

**Benchmarks**

Project No. 189-03 K-026-01  
 89267 - Chilled square on West end of South Road, 2.2 Feet Left of Baseline, Station 18+00 Elevation 797.02  
 8928 - A chilled "L" Southeast corner concrete slab at the Southwest corner of Map 623 Feet right of Baseline, Station 22+00 Elevation 823.20  
 One Bench Mark - Iron bar located on the Southwest property corner being the Center of Section 8 T2E 237E of the 6th PA Elevation 824.23

**MONITORING WELL KEY**

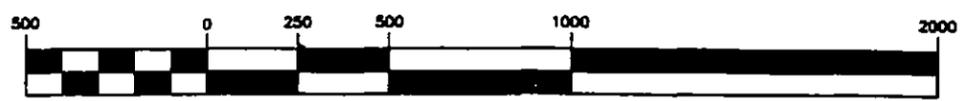
- MW/BH INSTALLED IN 1978
- TW INSTALLED IN 1999
- ⊗ MW INSTALLED IN 2003

\*GROUNDWATER ELEVATIONS ON SEPTEMBER 23, 2003

<p><b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b> ENGINEERING - ENVIRONMENTAL - CONSTRUCTION</p>	SCALE: 1"=500'	DATE: 11/20/03	FIGURE NO. FIGURE 11	<p><b>GROUNDWATER CONTOUR MAP</b> NATIONAL ZINC SITE CHERRYVALE, KANSAS</p>
	APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002	

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5647.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC

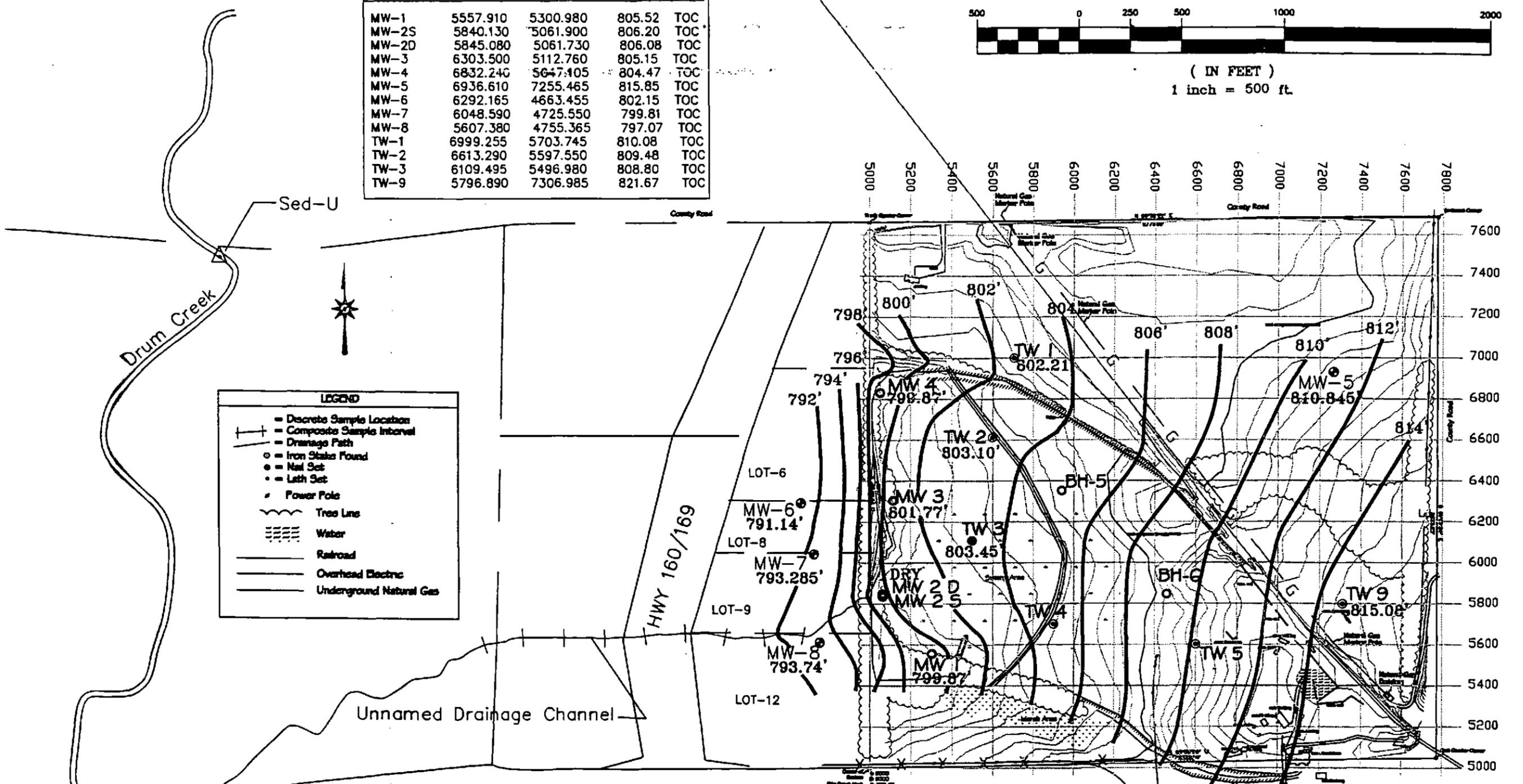
GRAPHIC SCALE



( IN FEET )  
1 inch = 500 ft.

**LEGEND**

- Discrete Sample Location
- Composite Sample Interval
- Drainage Path
- o Iron Stakes Found
- Nail Set
- Lath Set
- Power Pole
- Tree Line
- Water
- Railroad
- Overhead Electric
- Underground Natural Gas



**Benchmarks**

Project No. 00-03 E-026-01

20002 - Olded square on West end of South road, 0.4 feet left of South, Station 99+00 Direction 797.0

20020 - A chiseled "L" Southwest corner concrete nail at the Southwest corner of Map 023 feet right of South, Station 209+00 Direction 803.0

Old Bench Mark - Iron bar located on the Southwest property corner using the Center of Section 6 T2S R2E of the 6th Pile Direction 805.0

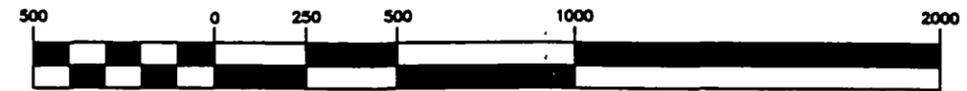
- MONITORING WELL KEY**
- o MW/BH INSTALLED IN 1978
  - TW INSTALLED IN 1999
  - MW INSTALLED IN 2003

\*GROUNDWATER ELEVATIONS ON OCTOBER 20, 2003

<p><b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b></p> <p>ENGINEERING - ENVIRONMENTAL - CONSTRUCTION</p>	SCALE: 1"=500'	DATE: 11/20/03	FIGURE NO. FIGURE 12	<p><b>GROUNDWATER CONTOUR MAP</b></p> <p>NATIONAL ZINC SITE CHERRYVALE, KANSAS</p>
	APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1804-002	

WELL NO.	NORTH	EAST	ELEVATION	
MW-1	5557.910	5300.980	805.52	TOC
MW-2S	5840.130	5061.900	806.20	TOC
MW-2D	5845.080	5061.730	806.08	TOC
MW-3	6303.500	5112.760	805.15	TOC
MW-4	6832.240	5047.105	804.47	TOC
MW-5	6936.610	7255.465	815.85	TOC
MW-6	6292.165	4663.455	802.15	TOC
MW-7	6048.590	4725.550	799.81	TOC
MW-8	5607.380	4755.365	797.07	TOC
TW-1	6999.255	5703.745	810.08	TOC
TW-2	6613.290	5597.550	809.48	TOC
TW-3	6109.495	5496.980	808.80	TOC
TW-9	5796.890	7306.985	821.67	TOC

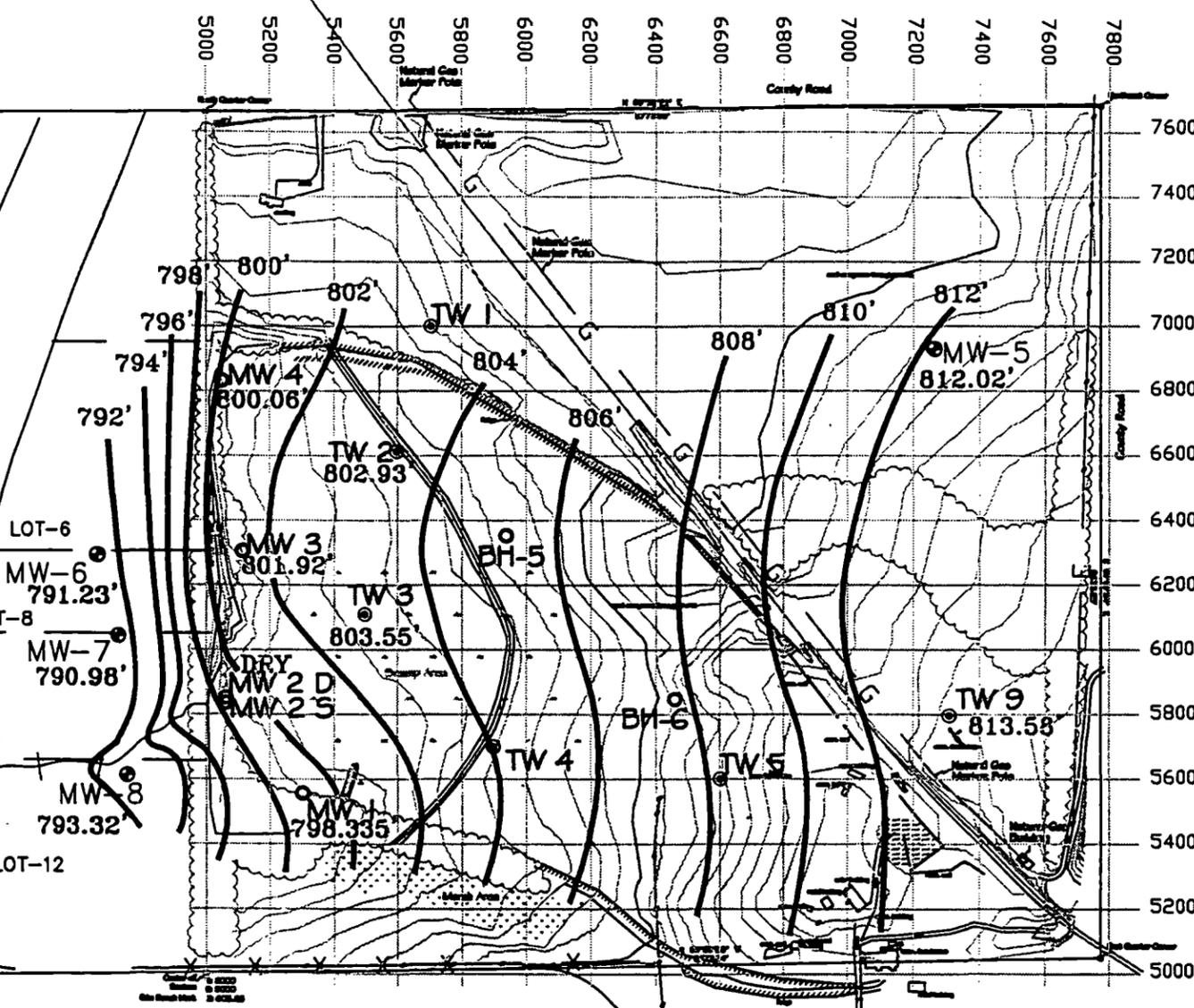
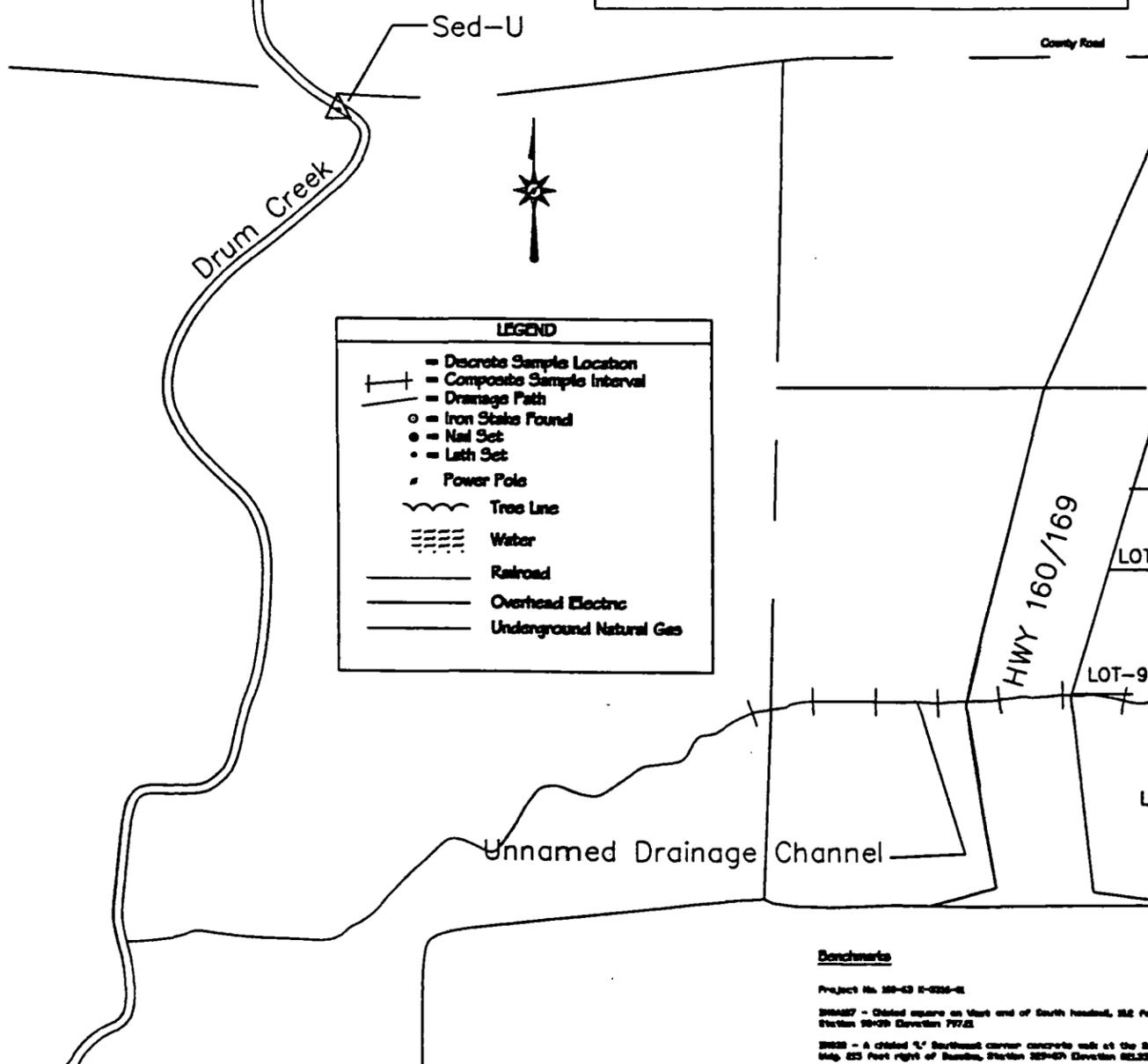
GRAPHIC SCALE



( IN FEET )  
1 inch = 500 ft.

**LEGEND**

- Decrete Sample Location
- Composite Sample Interval
- Drainage Path
- Iron Stake Found
- Nail Set
- Lath Set
- Power Pole
- Trees Line
- Water
- Railroad
- Overhead Electric
- Underground Natural Gas



**Benchmarks**  
 Project No. 184-002 0-000-01  
 BM1857 - Chisled square on West end of South road, 1/2 Mile Left of Route, Station 28+00 Elevation 777.01  
 BM1858 - A chisled 1/2" Southwest corner concrete set at the Southwest corner of 640' E25 Foot right of Route, Station 28+40 Elevation 823.23  
 Site Bench Mark - Iron bar located on the Southwest property corner being the Center of Section 9 T22S R20E of the 6th P.M. Elevation 803.23

**MONITORING WELL KEY**

- MW/BH INSTALLED IN 1978
- TW INSTALLED IN 1999
- MW INSTALLED IN 2003

\*GROUNDWATER ELEVATIONS ON NOVEMBER 18, 2003

 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b> ENGINEERING - ENVIRONMENTAL - CONSTRUCTION	SCALE: 1"=500'	DATE: 11/20/03	FIGURE NO. FIGURE 13	<b>GROUNDWATER CONTOUR MAP</b>  <b>NATIONAL ZINC SITE</b> <b>CHERRYVALE, KANSAS</b>
	APPROVED BY: IT	DRAWN BY: GJJ	PROJECT NO. 1840-002	

**Appendix 1**  
**Report of 1978-79 Site Investigation**

GEOLOGIC AND SOIL ENGINEERING REPORT  
LAGOON EMBANKMENT EVALUATION  
CHERRYVALE, KANSAS

6-98

PREPARED FOR

NATIONAL ZINC COMPANY  
BARTLESVILLE, OKLAHOMA 74003

June 9, 1978

PREPARED BY

WICHITA TESTING LABORATORIES  
810 EAST MURDOCK  
WICHITA, KANSAS 67214

(316) 264-4328

LAGOON EMBANKMENT EVALUATION  
CHERRYVALE, KANSAS  
GEOLOGY AND SITE CONDITIONS

The site of existing lagoon is located near the northwest limits of Cherryvale, Kansas in the N 1/2, Sec. 8, T32S, R17E.

The lagoon embankment, which has a maximum height of about 15 feet, presently ponds approximately 20± surface acres of water. This embankment was originally constructed in the late 1940's to entrap and pond contaminated surface runoff from the zinc plant property. The impoundment was designed to be an evaporating lagoon; however, to satisfactorily perform this function the embankment was subsequently modified several times by both increasing the height and constructing a new dike to enlarge the storage area. We were informed by personnel from the National Zinc Company that the existing impoundment has performed satisfactorily as an evaporating lagoon. We were also informed that several areas of seepage noted in the lower portion of the dike along the west downstream side have occurred since the embankment first impounded water.

The subject site is located within the Osage Cuestas section of the Osage Plains physiographic province, which is characterized by rolling, steep-sided hills that are dissected by intermittent streams with flat alluvial valleys. Specifically this site is on a drainage tributary

of Drum Creek which is in turn a tributary of the Verdigris River. The upper bedrock in this area is composed of limestones and shales of the Dennis Limestone formation of upper Pennsylvanian geologic age. In Borings 1 through 6 the Winterset limestone and Stark shale members of the Dennis Limestone formation were encountered. In each of these borings the upper portion of the Winterset limestone (surface bedrock) was found to be broken, weathered and containing seepage water perched above the underlying hard and relatively unweathered bedrock materials. The Winterset was encountered as high as elevation 80.6 feet (datum this survey) in Boring 6 to as low as elevation 75.6 feet (datum this survey) in Boring 2. Where penetrated, the thickness of the Winterset varied from 2.5 to 9.0 feet.

The soils encountered in the embankment portion of this site consist of medium and high plasticity (CL & CH) silty clay fill overlying the natural silty clay and sandy clay mantle soils which occur above the Winterset limestone. A thin topsoil zone was encountered below the fill in most borings and the entire embankment is capped with approximately one foot of cinder and brick used as a road bed. At the test hole locations the natural mantle soils, including topsoil zone, vary in thickness from 3 to 10 feet above bedrock. Geologic and Surface Profiles at the locations of Borings 1 through 4 are shown on the enclosed Figure Numbers 11 through 14 respectively.

The boring locations are shown on the enclosed Figure No. 1. The boring logs (Figures 2 through 10) present data obtained in this exploration. The logs include the surface elevation; depths and elevations of major changes in the character of the subsurface materials; visual descriptions of the materials in accordance with the Unified Soil Classification System; groundwater data; penetration resistance recorded in 0.5 ft. increments of depth; and the location of undisturbed soil samples.

The elevations shown on the Boring Logs were referenced to the floor level at the west entrance to the Filter House Building. This benchmark was assigned an elevation of 100.00 feet.

Observation wells were constructed by a licensed well driller at the location of Borings 1 through 4. The well driller was instructed to place one well point using PVC plastic pipe, through the embankment soils and into the underlying bedrock at each of these locations. In addition, near the location of Boring 2, one observation well was to be placed in the embankment fill above natural soils approximately 12 feet below grade. It is our understanding that the purpose of these observation wells is for National Zinc Company and/or the Kansas State Department of Health and Environment to monitor the seepage water level and quality.

Submitted By:

WICHITA TESTING LABORATORIES

By 

Richard L. Luke  
Engineering Geologist

WICHITA TESTING LABORATORIES  
Materials Engineers  
Wichita, Kansas

PROJECT  
Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

BORING LOG

Boring Method: 6-in. continuous flight auger		Standard Penetration Test		Boring No. 1
Undisturbed Soil Sampler: 3-in. od. thin-walled tube		140-lb. Hammer	30-in. Fall	2-in. od. Split-barrel Sampler
Sheet 1 of 1	w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot	Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.7	0		Fill: cinders, brick, tile, etc.; loose.			
90.7	1	CH	Fill: silty clay; dark yellowish brown mottled with very dark brown and grayish brown; wet; med. plasticity; stiff.	1		W=23.6 D=101.5
					6	N=13
					7	
					6	
86.2	5.5		As above but saturated in seams.			
85.2	6.5	CH	Silty Clay: very dark gray and dark grayish brown; wet to saturated in seams; high plasticity; medium stiff to stiff. (possible fill)			Water Level @ 8.0' (Elev. 83.7) After 24 Hours
84.2	7.5	CL				
82.7	9	CH	Silty Clay: very dark gray; minor organics; saturated; med plasticity; medium stiff. (old topsoil zone)	2		W=27.1 D=94.5
					2	N=7
			Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.		2	
					5	
79.2	12.5		As above but some limestone gravel.			
					3	W=33.4 D=87.6
76.2	15.5		Limestone: broken and weathered.			
75.2	16.5		Limestone: light gray and hard. (possible Winterset Limestone)			
73.7	18		Shale: dark gray to gray; hard. (possible Stark Shale)			
71.7	20		Coal Seam			

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Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 2
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.1	0		Fill: cinders, brick, tile, etc.; loose.			
91.1	1	CH & CL	Fill: silty clay; very dark grayish brown, dark yellowish brown and reddish brown; wet; medium and high plasticity; stiff.	4		W=25.5 D=98.6
89.1	3		As above but saturated in seams.		3 4 5	N=9
84.1	8	▽	Very wet to saturated.	5		Water Level @ 7.7' (Elev. 84.4) After 24 Hours W=32.1 D=90.3
					2 4 5	N=9
				6		W=30.2 D=94.9
78.6	13.5	CL	Silty Clay: some organics; very dark gray; very wet to saturated; medium plasticity; medium stiff. (old topsoil)		1 2 3	N=5
77.1	15	CH	Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.	7		W=27.3 D=94.9
75.6	16.5		Limestone: weathered and broken.			
73.1	19		Limestone: hard; light yellowish brown. (possible Winterset Limestone)			

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Boring Method: 6-in. continuous flight auger      Standard Penetration Test      Boring No. 2  
 Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube / 40-lb. Hammer    30-in. Fall    2-in. o.d. Split-barrel Sampler    Sheet 2 of 2  
 w=Moisture Content, %    D=Dry Density, pcf      Penetration Resistance: N=Blows per foot      Date: 4-18-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
72.1	20		<u>Limestone:</u> as before; but shaley; dark gray and hard.			
70.6	21.5		<u>Shale:</u> dark gray with thin limestone stringers. (possible Stark Shale)			
67.1	25					

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Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 3
Undisturbed Soil Sampler: 3-in. od. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. od. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.3	0		<u>Fill:</u> cinders, brick, clay tile, etc.			
90.3	1	CH	<u>Fill:</u> silty clay; dark yellowish brown, grayish brown, reddish brown and gray; wet; high plasticity; stiff to medium stiff with depth.	8		W=25.5 D=94.8
87.3	4	CL	<u>Fill:</u> silty clay; very dark brown and yellowish brown; wet with saturated seams; medium plasticity; medium stiff.		2 2 3	N=5  W=28.5 D=95.5
83.8	7.5	CL	<u>Silty Clay:</u> very dark gray with some organics; wet; medium plasticity; med. stiff to stiff. (old topsoil zone)	10		Water Level @ 7.7' (Elev. 83.6) After 24 Hours  W=24.3 D=98.0
83.3	8	CH				
82.3	9		<u>Silty Clay:</u> dark gray with lime concretions; wet; high plasticity; medium stiff to stiff.		3 4 4	N=8
80.3	11	CH	As above but dark yellowish brown. <u>Gravelly Clay:</u> 20% fine to medium gravel (chert); dark yellowish brown; wet; high plasticity; stiff.	11		W=22.4 D=107.6
77.8	13.5		<u>Limestone:</u> dark yellowish brown; broken and weathered. (possible Winterset Limestone)			
74.8	16.5		<u>Limestone:</u> light yellowish brown; fossiliferous; medium hard. (Winterset Limestone)			

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Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
71.3	20		<u>Limestone</u> : gray; hard.			
69.3	22		<u>Shale</u> : dark gray (possible Stark Shale).			
68.3	23		<u>Calcareous</u>			
67.8	23.5		Shale as before.			
66.3	25					

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Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.1	0		<u>Fill</u> : cinders, brick, clay, tile, etc.			
91.1	1	CL	<u>Fill</u> : <u>silty clay</u> ; dark yellowish brown, gray and reddish brown; wet; medium plasticity; medium stiff.	12		W=25.4 D=97.9
88.1	4	CH & CL	<u>Fill</u> : <u>silty clay</u> ; very dark gray and dark gray; wet to saturated in seams; high and medium plasticity; medium stiff.		2 3 5	N=8
84.6	7.5	CH w/ CL ▽	<u>Silty Clay</u> : dark yellowish brown with iron stains; wet to very wet; high plasticity; with medium plasticity zones; medium stiff.	13		W=25.7 D=96.9
					2 3 4	Water Level @ 9.5' (Elev. 82.6') After 24 Hours N=7
				14		W=27.1 D=92.8
80.1	12	CH	<u>Gravelly Clay</u> : 20 to 25% fine to medium gravel; dark yellowish brown; very wet; high plasticity; stiff.		4 5 5	N=10
77.6	14.5		As above but saturated.			
76.6	15.5		<u>Limestone</u> : broken and weathered.			
75.1	17		<u>Limestone</u> : light gray; hard. (possible Winterset Limestone)			
72.1	20					

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Boring Method: 6-in. continuous flight auger		Standard Penetration Test			Boring No. 4
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube		140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
72.1	20		As before.			
71.1	21		<u>Limestone</u> : sandy and shaley; dark gray.			
63.1	29					
62.1	30		<u>Shale</u> : fissile; black; hard. (possible Stark Shale)			

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Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 5

Undisturbed Soil Sampler: 3-in. od. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. od. Split-barrel Sampler

Sheet 1 of 2

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		<u>Fill</u> : Cinders.			
90.1	4	▽	As above but saturated.			Water @ 4.0' After Drilling. (perched in cinders above silty clay)
87.6	6.5	CL	<u>Silty Clay</u> : very dark grayish brown; very wet; low to medium plasticity; medium stiff.			
86.1	8	CH	<u>Silty Clay</u> : brownish gray with olive yellow and iron staining; very wet; medium to high plasticity; medium stiff.			
82.1	12		As above but yellowish brown with light gray to gray mottling; iron stain; 10 to 15% coarse sand; stiff.			
78.1	16		As above but with 15 to 25% gravel.			
77.1	17		<u>Limestone</u> : yellowish brown; weathered; medium hard.			
75.1	19		<u>Limestone</u> : yellowish brown to light gray; hard.			

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Boring Method: 6-in. continuous flight auger		Standard Penetration Test			Boring No. 5
Undisturbed Soil Sampler: 3-in. ad. thin-walled tube		140-lb. Hammer	30-in. Fall	2-in. ad. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
74.1	20		<u>Limestone</u> : as before.			
72.6	21.5		<u>Limestone</u> : shaley; medium hard.			
71.1	23		<u>Limestone</u> : hard.			
68.1	26		<u>Shale</u> : dark gray; hard.			
64.1	30		<u>Calcareous</u>			

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Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

BORING LOG

Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 6

Undisturbed Soil Sampler: 3-in. od. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. od. Split-barrel Sampler

Sheet 1 of 2

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		<u>Fill</u> : cinders and ash with brick and tile rubble; saturated @ 3.0'; loose.			Water @ 3.9' After Drilling (Perched above silty clay)
89.6	4.5	CH	<u>Silty Clay</u> : very dark gray; traces of fine sand; very wet; medium to high plasticity; medium stiff.			
88.1	6		As above but olive gray, gray and yellowish brown mottled.			
85.6	8.5	CH	<u>Silty Clay</u> : yellowish brown mottled with light gray to gray; very wet; high plasticity; medium stiff to stiff.			
82.1	12		As above with 20 to 25% limestone gravel; stiff.			
80.6	13.5		<u>Limestone</u> : yellowish brown; broken and weathered. (possible Winterset Limestone)			
78.6	15.5		<u>Limestone</u> : light gray; hard. (Winterset Limestone)			
77.6	16.5		As above but broken in part.			
74.6	19.5		<u>Limestone</u> : hard. (Winterset Limestone)			

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BORING LOG

PROJECT

Lagoon Embankment Evaluation

National Zinc Company

Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 6
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-12-78

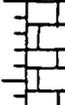
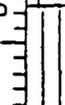
Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
74.1	20		<u>Limestone</u> : as before.			
72.6	21.5		<u>Shale</u> : gray and light gray; sandy; high plasticity; hard. (possible Stark Shale)			
69.1	25					

Figure 7a

Drilled By: William P. Giesel

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 Wichita, Kansas  
 BORING LOG

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 National Zinc Company  
 Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger		Standard Penetration Test			Boring No. 8
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube		140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 1
w = Moisture Content, %	D = Dry Density, pcf	Penetration Resistance: N = Blows per foot			Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.0	0		Fill: cinders.			
91.0	1	CH	Fill: silty clay; dark brown mottled with dark yellowish brown and reddish brown; wet; high plasticity; stiff.			
88.0	4	CH	Fill: silty clay; gray; yellowish brown and dark gray; very wet; high plasticity; stiff.			
85.0	7	CL	Silty Clay: very dark gray; very wet; medium to high plasticity; medium stiff. (old topsoil zone)			
84.0	8	CH	Silty Clay: dark gray; very wet; high plasticity; medium stiff to stiff.			
85.0	9	CH	Silty Clay: dark yellowish brown; very wet; high plasticity; stiff.			
78.5	13.5		Weathered Limestone.			
78.0	14					

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 Wichita, Kansas  
 BORING LOG

PROJECT  
 Lagoon Embankment Evaluation  
 National Zinc Company  
 Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 9
Undisturbed Soil Sampler: 3-in. ad. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. ad. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.0	0		<u>Fill</u> : cinders, brick, tile, etc.; loose.			
91.0	1	CH	<u>Fill</u> : <u>silty clay</u> ; dark yellowish brown, brown and grayish brown; wet; high plasticity; stiff.			
88.0	4	CL	<u>Silty Clay</u> : very dark gray to dark gray with some organics; saturated; medium plasticity; soft to medium stiff. (old topsoil zone)	15		
87.0	5	CH	<u>Silty Clay</u> : dark gray; very wet; high plasticity; medium stiff.			
85.5	6.5		As above but dark yellowish brown and stiff.			
77.0	15	✓	Saturated.			
76.5	15.5	✓	Weathered Limestone.			
76.0	16					

W=30.5  
 D=90.6

ELEV.

140

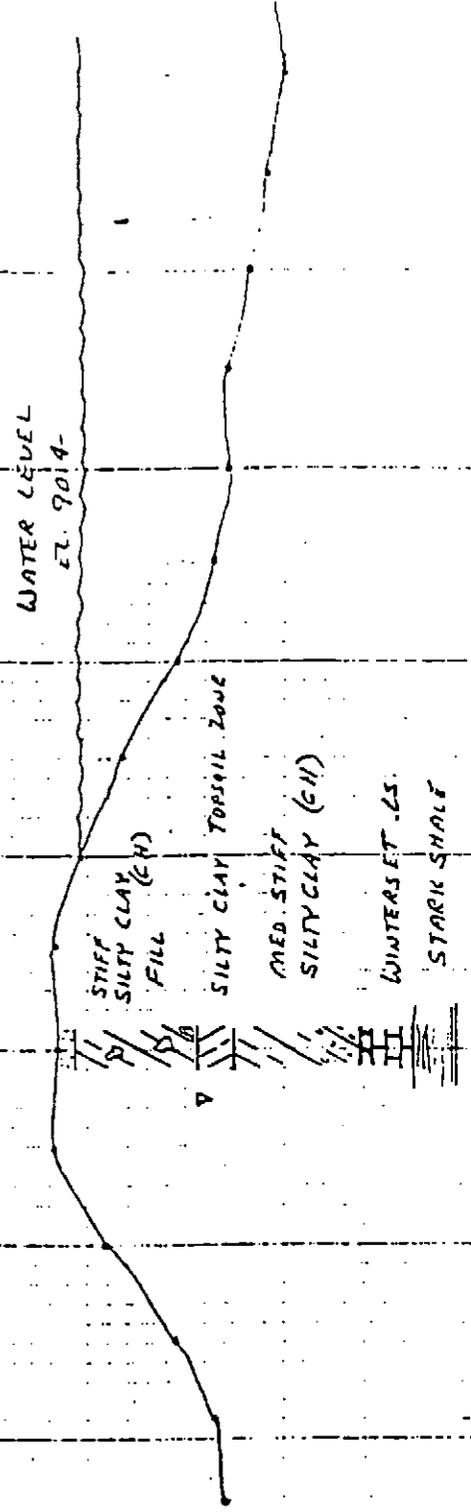
90

80

70

60

Q  
B-1



HORIZONTAL : 1" = 10'  
VERTICAL : 1" = 10'

GEOLOGIC SURFACE PROFILE  
BORING  
NATIONAL ZINC COMPANY  
CHERRYVALE, KANSAS

FIGURE 11

ELEV.

100

90

80

70

60

♀  
B:2

WATER LEVEL  
Elev. 90.4

STIFF  
SILTY CLAY (CH)  
FILL

SILTY CLAY TOBACCO ZONE (CL)  
SILTY CLAY (CH)

WINTHROP L.S.

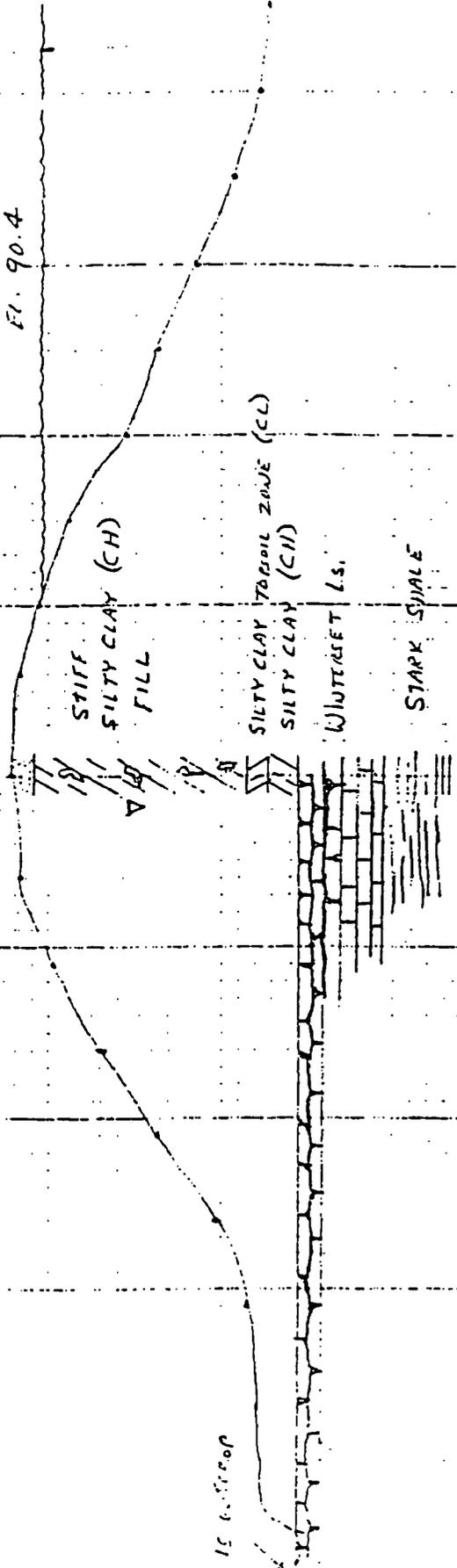
STARK SHALE

15' SECTION

HORIZONTAL : 1" = 10'  
VERTICAL : 1/4" = 10'

GEOLOGIC & SURFACE PROFILE  
BORING 7  
NATIONAL ZINC COMPANY  
CHERRYVALE, KANSAS

FIGURE 12



ELEV

100

90

80

70

60

DRAINAGE CHANNEL

44.0'

♀  
B-3

WATER LEVEL  
EL. 90.4

MED. STIFF SILTY CLAY (CN)  
FILL  
OLD TIPSOIL ZONE  
MEDIUM STIFF SILTY CLAY (CN)

WINTERSET LS. (WEATHERED)  
(HARD)

STARK SHALE

HORIZONTAL: 1" = 10'  
VERTICAL: 1" = 10'

GEOLOGIC & SURFACE PROFILE  
BORING 3  
NATIONAL ZINC COMPANY  
CHERRY VALE, KANSAS

FIGURE 13

ELEV

100

90

80

70

60

DRAINAGE CHANDEL

B-4

WATER LEVEL  
EL. 90A

MED. STIFF  
SILTY CLAY (CN)  
FILL

MED. STIFF - STIFF  
SILTY CLAY (CN)

WINTERSET LS.

STARK SHALE

HORIZONTAL: 1" = 10'  
VERTICAL: 1" = 10'

GEOLOGIC & SURFACE PROFILE

BORING 4

NATIONAL ZINC COMPANY

CHERRYVALE, KANSAS

FIGURE 14

SOILS ENGINEERING REPORT  
LAGOON EMBANKMENT EVALUATION  
CHERRYVALE, KANSAS

I. INTRODUCTION

This is a report of subsurface and soil conditions for the existing wastewater lagoon at National Zinc Company plant near Cherryvale, Kansas. The lagoon has been used as a sedimentation basin to collect contaminated surface runoff from the plant area. The wastewater lake was designed as an evaporating lagoon. Numerous height and area additions have been constructed subsequent to initial construction to provide adequate storage.

This investigation was authorized by a contract between National Zinc Company and Wichita Testing Laboratories, dated April 3, 1978.

The purpose of this investigation was to provide an evaluation of the stability of the lagoon embankment as it exists.

Since no guidelines were designated for evaluating the existing embankment we used Soil Conservation Service criteria (Earth Dams and Reservoirs, SCS Technical Release No. 60) in our stability analysis. The embankment stability analysis was made utilizing Class (a) dam criteria. It should be noted that our investigation does not include a flood routing study.

## II. FOUNDATION CHARACTERISTICS

1. Bedrock. Limestones and shales of upper Pennsylvanian geologic age underlie the lagoon. The bedrock is believed to be the upper portion of the Dennis Limestone, a member of the Kansas City group. The upper few feet of the limestone bedrock was generally weathered and broken at the boring locations. Residual gravelly clays and silty clay colluvium mantle the bedrock beneath the lagoon embankment. Some seepage was noted at the toe of the embankment at various locations along the west and southwest sides of the wastewater lagoon.
2. Classification. The naturally occurring soils above the bedrock have medium to high plasticity and medium stiff to stiff consistency. Liquid limit (ASTM: D-423) values of 40, 47, 53 and 45 and plasticity indices (ASTM: D-424) of 20, 28, 31 and 26 were obtained for Lab. Sample Nos. 2, 10, 11 and 13 respectively. Based on laboratory tests a visual inspection of the natural soils were classified as gravelly and silty clay (CL and/or CH) according to the Unified Classification System.
3. Density. Six undisturbed samples of the natural foundation soil above the bedrock were obtained using 3 and 5 inch diameter shelly tube samplers. The in situ dry densities varied from 1.49 to 1.72 gm/cc and the soil moisture contents varied from 22.4 to 27.3 percent.

4. Shear Strength. Consolidated-undrained (CU and  $\overline{\text{CU}}$ ) triaxial tests were made on 1.4 inch diameter test specimens trimmed from Lab. Sample No. 7. The test specimens were saturated by backpressure prior to consolidation and shearing. Measurement of pore pressure response gave B parameters of 0.98 to 1.00. The total stress shear parameters interpreted from the test data for Lab Sample No. 7 are  $\phi = 13.8^\circ$  with  $c = 540$  psf. The effective stress parameters are interpreted to be  $\phi = 32.0$  and  $c = 0$  psf.
5. Permeability. Falling head permeability tests were made on four undisturbed samples of the natural foundation soils beneath the embankment. The permeability rate was determined for each sample at a confining pressure of 0.5 KSF. Permeability rates of  $3.4 \times 10^{-5}$ ,  $4.6 \times 10^{-8}$ ,  $2.1 \times 10^{-4}$  and  $5.3 \times 10^{-8}$  cm/sec were obtained for Lab. Sample Nos. 2, 10, 11 and 13 respectively. Using an average permeability value of  $6 \times 10^{-5}$ , the seepage beneath the maximum section of the embankment (near Boring No. 2) was calculated to be about 0.14 cubic feet per day per lineal foot of embankment. Using the dimensions of this maximum section for the effective length of the embankment (assumed to be 2000 feet), the total quantity of seepage beneath the embankment is calculated to be about 280 cubic feet per day.

As can be seen from the laboratory test data, the permeability rates of the foundation soils can vary greatly. The weathered, broken portions of the limestone can also be highly pervious. The seepage rates will differ greatly at various locations beneath the embankment. The actual total quantity of seepage beneath the embankment may be from 200 to possibly 500 cubic feet per day.

6. Dispersion. The results of the dispersion tests on Lab. Sample Nos. 2, 10, 11 and 13 indicated dispersions of 33, 30, 6 and 37 respectively. These values indicate the foundation soils are low to non-dispersive.

### III. EXISTING EMBANKMENT MATERIALS

1. Classification. Seven samples of material from the existing embankment were tested in the laboratory for classification in accordance with the Unified Soil Classification System. The liquid limits ranged from 39 to 60 and the plasticity indices varied from 19 to 42 for the embankment samples. The embankment materials were classified as silty clay and as CL and/or CH.
2. Density. Seven relatively undisturbed samples of the embankment material were obtained for inspection and laboratory testing. The insitu dry densities of these samples ranged from 1.45 to 1.63 gm/cc and their moisture contents varied from 23.6 to 32.1%
3. Shear Strength. A triaxial shear test (CU and  $\overline{\text{CU}}$ ) was performed on specimens trimmed from Lab. Sample No. 6. The test specimen was saturated by backpressure prior to consolidation and shearing. Measurement of pore pressure response gave B parameters of 0.97 to 0.99. The total stress shear parameters interpreted from the test data are  $\phi = 22.7^\circ$  with  $c = 330$  psf. The effective stress parameters for the sample are interpreted to be  $\phi = 28.0^\circ$  and  $c = 300$  psf.

#### IV. SLOPE STABILITY ANALYSIS

Computer analyses of slope stability were performed using the modified Swedish circle method for steady seepage conditions at the maximum section of the lagoon embankment (near Boring No. 2). In our analyses we assumed a downstream slope of 1.7 from the top of the embankment (about elevation 92.0) to the top of the natural ground surface (about elevation 79.6). The embankment section used in our analyses had a top width of 12 feet. We also used a 2:1 slope for the upstream slope (the side facing the lagoon). We made our analyses assuming that a theoretical phreatic surface would develop at the water level in the lagoon (at elevation 90.4 resulting in 1.6 feet of freeboard) and would extend to the toe of the downstream slope (about elevation 79.6). Effective stress shear parameters ( $\overline{CU}$ ) were used for steady seepage analysis.

The safety factors for both normal and earthquake conditions were determined for the maximum section as described above. A safety factor of 1.46 was obtained for static conditions using a total of 184 trial arcs. This factor of safety met the 1.4 minimum requirement (SCS, TR-60). A factor of safety of 1.16 was obtained for earthquake conditions in a static analysis, assuming a horizontal acceleration of 0.10 g. This met the 1.0 minimum factor of safety requirement (SCS, TR-60).

## V. CONCLUSIONS AND RECOMMENDATIONS

### CONCLUSIONS

Based on the field and laboratory test data obtained from this investigation and on current Soil Conservation Service criteria, we conclude that the National Zinc Company waste water lagoon has adequate slope stability for the existing slope configurations and lake level. As stated in the introduction to this report, we did not conduct a flood routing study.

### RECOMMENDATIONS

- (1) We recommend an in-depth hydrology study made to determine the potential for overtopping the lagoon embankment.
- (2) At the time of this investigation the lagoon water level was at elevation 90.4 which provides only 1.6 feet of freeboard at the maximum section. We concur with the State of Kansas Department of Health and Environment suggestion in their letter to National Zinc Company dated January 31, 1978 stating that the plant area be graded so as to divert all uncontaminated storm water runoff from entering the subject lagoon system.

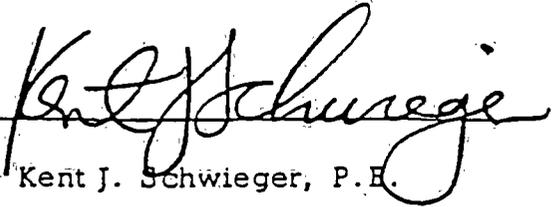
(3) Seepage does not appear critical at the present time; however, timely observations, measurements, and analysis of data are recommended as a safeguard for future continued use of the lagoon. The seepage quantities could be determined economically by constructing weirs. The seepage quantities could then be monitored by studying the weir readings taken periodically. Tests of the dissolved and suspended solids in the seepage water could be monitored for indications of leaching or piping. The seepage water in the installed observation wells could be similarly tested and monitored. Pump-in or pump-out tests of the observation wells could also provide useful information.

If the quantity of seepage beneath the embankment is considered excessive at any time it may be controlled by pressure grouting through the embankment or possibly by application of bentonite to the reservoir surface. A cement grout appears preferable over other forms of chemical grout. Bentonite could be applied to those sections of the reservoir where seepage is to be controlled. This may be accomplished by broadcasting pelleted bentonite over the water surface.

If you have questions concerning this report, please give us a call  
at your convenience.

Submitted By:

WICHITA TESTING LABORATORIES

By   
Kent J. Schwieger, P.E.

TEST SAMPLE NUMBER	FIELD NUMBER	LOCATION AND DESCRIPTION	DEPTH Feet	FIELD CLASSI- FICATION	MECHANICAL ANALYSIS														
					GRAIN SIZE DISTRIBUTION EXPRESSED AS PERCENT FINER BY DRY WEIGHT														
					FIRES					SAND					GRAVEL				
#20 0.85	#40 0.425	#60 0.25	#100 0.15	#200 0.075	#400 0.375	#600 0.25	#840 0.175	#1060 0.15	#1490 0.106	#2000 0.075	#2.8 0.6	#4.75 1.18	#7.5 1.9	#14.75 3.75	#30 7.5				
1	1	Boring No. 1	2.0- 3.5	CL	23	32	62	86	92	96	97	98	99	100					
2	2	Boring No. 1	8.0- 9.5	CL	16	29	57	87	96	98	99	100							
4	4	Boring No. 2	2.0- 3.5	CH	16	31	63	84	89	93	96	97	98	100					
5	5	Boring No. 2	7.0- 8.5	CL	22	39	63	91	96	99	99	100							
6	6	Boring No. 2	12.0- 13.5	CH	40	54	76	90	94	98	100								
7	7	Boring No. 2	15.5- 16.5	CH	15	38	60	72	76	82	87	89	95	99	100				
8	8	Boring No. 3	2.0- 3.5	CH	18	37	63	83	88	92	95	96	98	100					
9	9	Boring No. 3	5.0- 6.5	CH	36	52	73	87	92	96	99	100							
10	10	Boring No. 3	7.0- 8.5	CL	27	37	63	88	95	98	99	100							
11	11	Boring No. 3	12.0- 13.5	CH	25	45	65	77	81	87	90	92	95	100					
12	12	Boring No. 4	2.0- 3.5	CL	10	34	61	90	94	98	99	99	100						
13	13	Boring No. 4	7.0- 8.5	CL	21	43	64	89	95	99	99	100							
14	14	Boring No. 4	10.0- 11.5	CH	21	43	66	85	91	97	98	99	99	100					

MATERIALS TESTING REPORT WESTERN LABORATORIES *Materials Engineers* TRIAXIAL SHEAR TEST

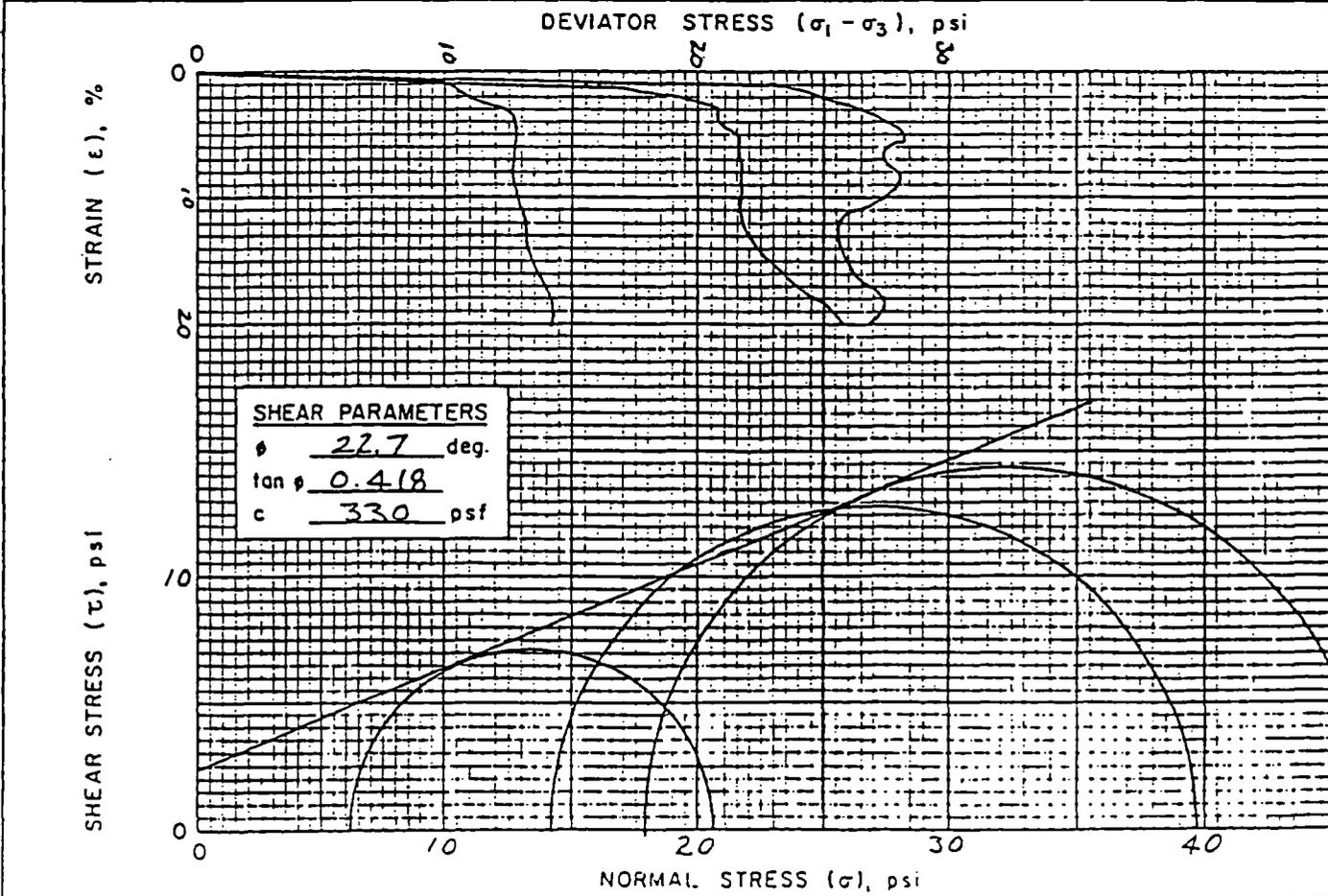
PROJECT and STATE: NATIONAL ZINC Co. SAMPLE LOCATION: E Embankment @ B-2

FIELD SAMPLE NO. 6 DEPTH 12.8' - 13.2' GEOLOGIC ORIGIN

TYPE OF SAMPLE: UNDISTURBED TESTED AT: LINCOLN, NEBR APPROVED BY: DATE: 5-5-78

INDEX TEST DATA		SPECIMEN DATA		TYPE OF TEST
USCS _____; LL _____; PI _____	HEIGHT <u>3.0</u> "; DIAMETER <u>1.4</u> "	UU <input type="checkbox"/> CU <input type="checkbox"/> C $\bar{U}$ <input checked="" type="checkbox"/> CD <input type="checkbox"/>		
% FINER (mm): 0.002 _____; 0.005 _____; 0.074 (# 200) _____	MATERIALS TESTED PASSED _____ SIEVE			
G <sub>s</sub> (-#4) _____; G <sub>s</sub> (+#4) _____	METHOD OF PREPARATION <u>Trimmed from an undisturbed core</u>			
STANDARD: $\gamma_d$ MAX. _____ pcf; w <sub>o</sub> _____ %	MOLDING MOISTURE _____ %			
MODIFIED: $\gamma_d$ MAX. _____ pcf; w <sub>o</sub> _____ %	MOLDED AT _____ % OF $\gamma_d$ MAXIMUM			

DRY DENSITY		Brometer	MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS $\sigma_3$ (psi)	DEVIATOR STRESS $\sigma_1 - \sigma_3$ (psi)	AXIAL STRAIN AT FAILURE, $\epsilon$ (%)
INITIAL pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>	CONSOLIDATED pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>		START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
89.9	93.2	.98	30.8	96.2	33.9	15	6.2	14.4	19.40
89.4	88.8	.99	30.8	95.2	34.1	15	14.1	25.7	20.14
92.3	96.9	.97	29.0	96.4	33.9	16	17.8	28.5	5.39



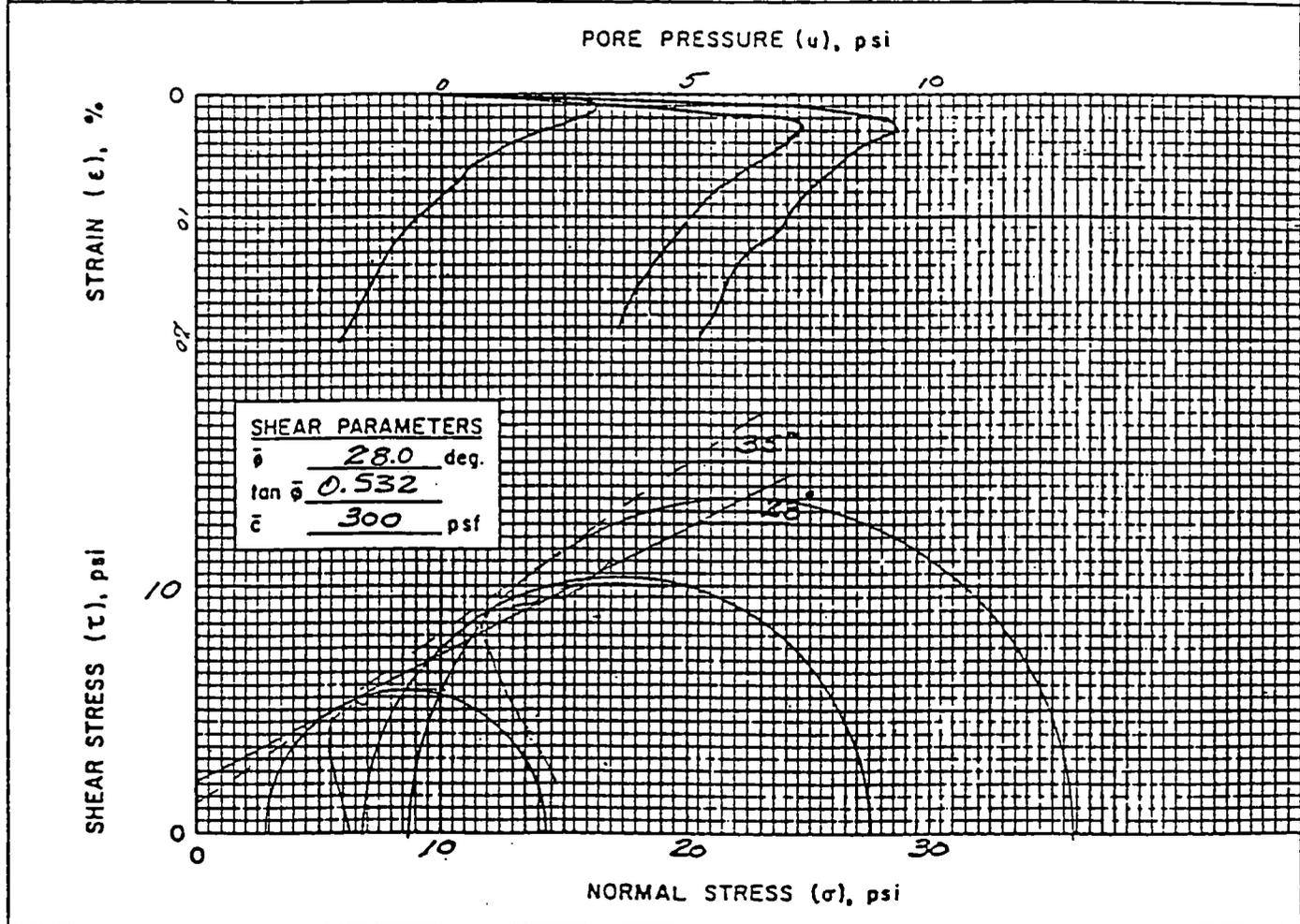
REMARKS

MATERIALS TESTING REPORT WESTERN LABORATORIES *Materials Engineers* TRIAXIAL SHEAR TEST with pore pressure measured

PROJECT AND STATE National Line SAMPLE LOCATION @ Embankment @ B-2

TYPE OF SAMPLE Undisturbed TESTED AT Lincoln, NE APPROVED BY \_\_\_\_\_ DATE 5/5/78

MINOR PRINCIPAL STRESS, $\sigma_3$ (psi)	PORE PRESSURE, $u$ (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, $\epsilon$ (%)
6.2	3.3	2.9	11.3	$\frac{\sigma_1}{\sigma_3}$	1.00
14.1	7.3	6.8	20.8		2.69
17.8	9.1	8.7	27.2		3.37



REMARKS Envelope based on vector curves

MATERIALS TESTING REPORT **WESTERN LABORATORIES** *Materials Engineers* **TRIAXIAL SHEAR TEST**

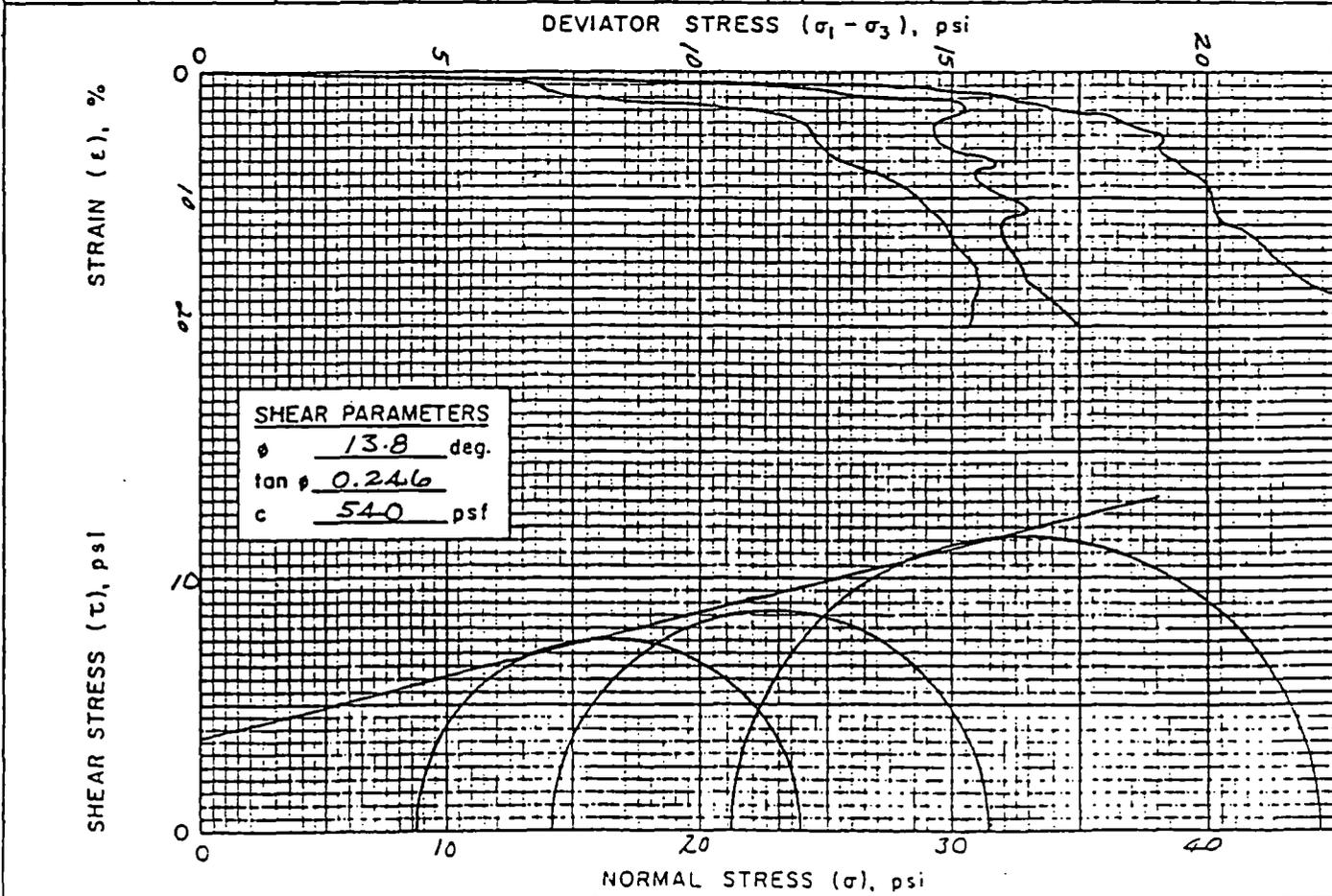
PROJECT and STATE NATIONAL - ZINC Co. SAMPLE LOCATION E Embankment @ B-2

FIELD SAMPLE NO. 7 DEPTH 15.7'-16.4' GEOLOGIC ORIGIN \_\_\_\_\_

TYPE OF SAMPLE UNDISTURBED TESTED AT LINCOLN, NEBR APPROVED BY \_\_\_\_\_ DATE 5-4-78

INDEX TEST DATA		SPECIMEN DATA		TYPE OF TEST	
USCS _____; LL _____; PI _____	HEIGHT <u>3.0</u> "; DIAMETER <u>1.4</u> "	UU <input type="checkbox"/>			
% FINER (mm): 0.002 _____; 0.005 _____; 0.074 (# 200) _____	MATERIALS TESTED PASSED _____ SIEVE	CU <input type="checkbox"/>			
G <sub>s</sub> (-#4) _____; G <sub>s</sub> (+#4) _____	METHOD OF PREPARATION <u>Trimmed from an undisturbed core</u>	CU <input checked="" type="checkbox"/>			
STANDARD: γ <sub>d</sub> MAX. _____ pcf; w <sub>0</sub> _____ %	MOLDING MOISTURE _____ %	CD <input type="checkbox"/>			
MODIFIED: γ <sub>d</sub> MAX. _____ pcf; w <sub>0</sub> _____ %	MOLDED AT _____ % OF γ <sub>d</sub> MAXIMUM				

DRY DENSITY		B Parameter	MOISTURE CONTENT, %			TIME OF CONSOLIDATION (hrs.)	MINOR PRINCIPAL STRESS σ <sub>3</sub> (psi)	DEVIATOR STRESS σ <sub>1</sub> - σ <sub>3</sub> (psi)	AXIAL STRAIN AT FAILURE, ε (%)
INITIAL pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>	CONSOLIDATED pcf <input checked="" type="checkbox"/> g/cc <input type="checkbox"/>		START OF TEST	DEG. OF SAT. AT START OF TEST	END OF TEST				
96.7	103.0	.98	27.3	100.8	26.7	17	8.7	15.5	16.72
94.9	100.6	1.00	27.3	96.5	24.5	15	14.1	17.5	20.16
92.9	96.9	.99	27.3	91.9	27.0	17	21.1	23.1	20.14



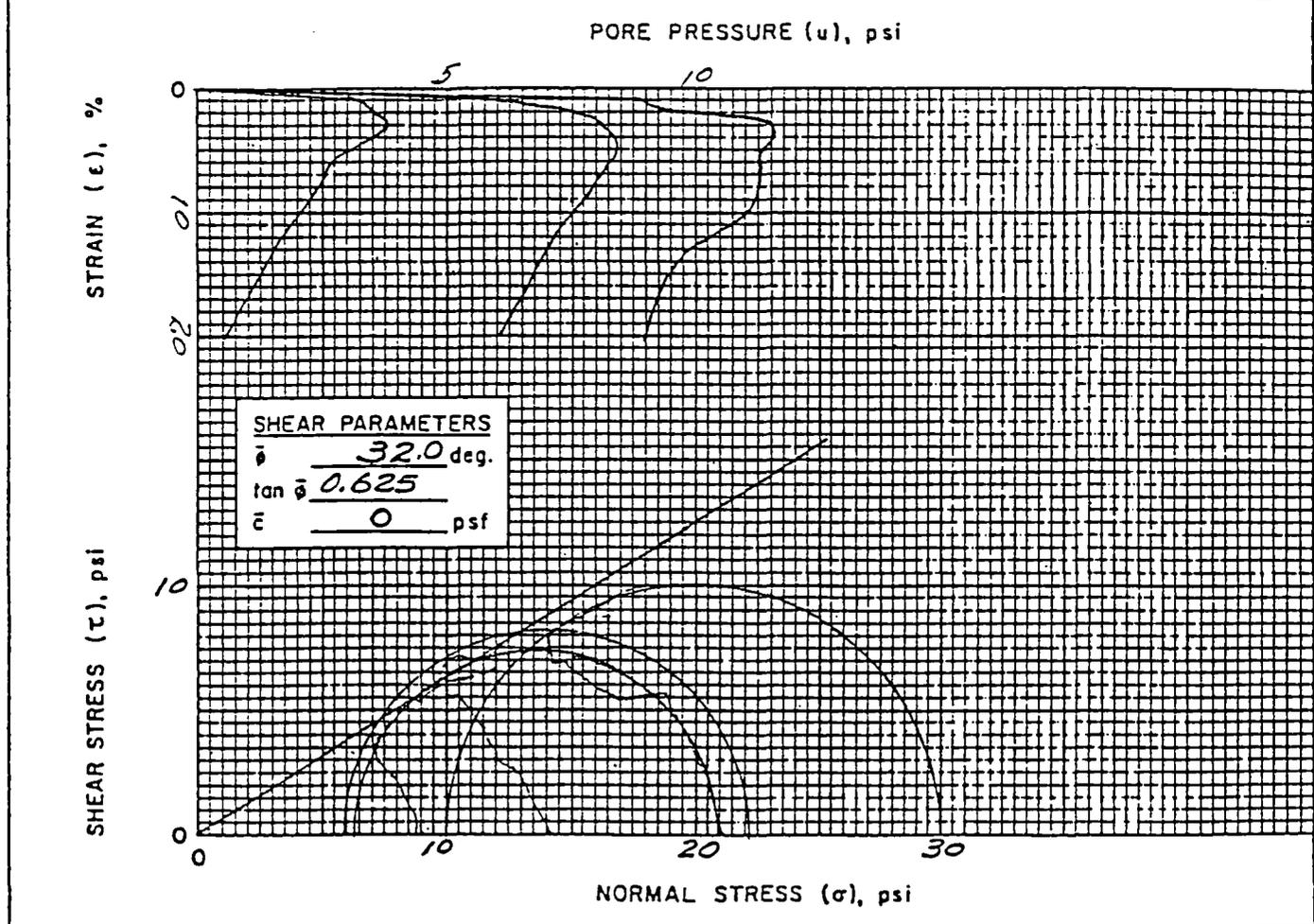
REMARKS

MATERIALS TESTING REPORT **WESTERN LABORATORIES** *Materials Engineers* **TRIAXIAL SHEAR TEST**  
with pore pressure measured

PROJECT AND STATE *Highway E. 100 P.* SAMPLE LOCATION *E Embankment @ B-2*

TYPE OF SAMPLE *Undisturbed* TESTED AT *Lincoln, NE* APPROVED BY \_\_\_\_\_ DATE *7/4/78*

MINOR PRINCIPAL STRESS, $\sigma_3$ (psi)	PORE PRESSURE, $u$ (psi)	EFFECTIVE MINOR PRINCIPAL STRESS, $\bar{\sigma}_3$ (psi)	DEVIATOR STRESS, $\sigma_1 - \sigma_3$ (psi)	FAILURE CRITERIA	AXIAL STRAIN AT FAILURE, $\epsilon$ (%)
8.7	2.3	6.4	14.4	$\frac{\sigma_1}{\sigma_3}$ 4.3	9.36
14.1	8.2	5.9	16.1		6.40
21.1	11.1	10.0	19.9		8.06

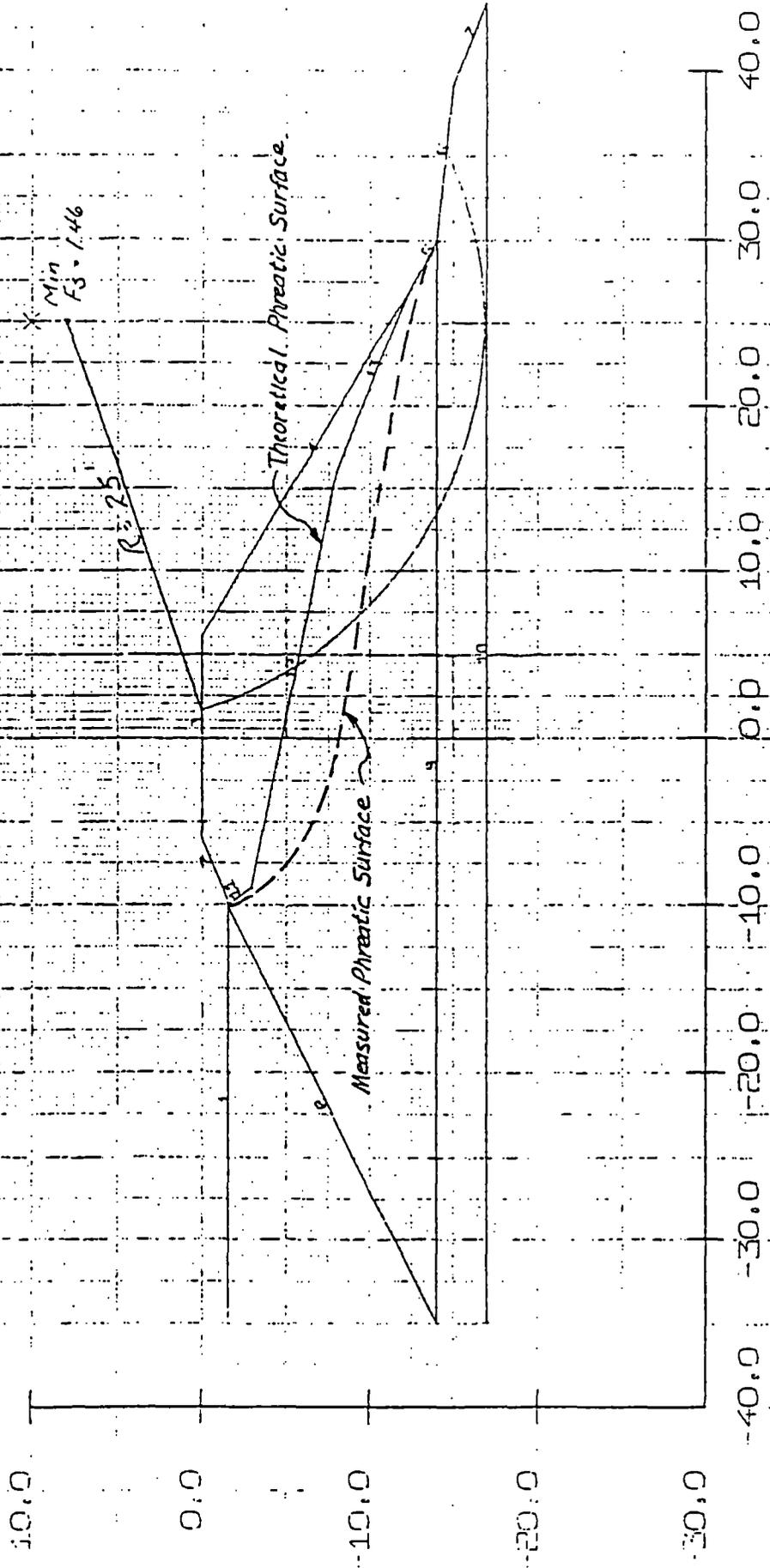


REMARKS *Envelope based on vector curves*

SLOPE STABILITY ANALYSIS  
EMBANKMENT CROSS-SECTION

NATIONAL ZINC COMPANY - MAXIMUM SECTION  
Near Hole B-2

JOB NO. 78/5041



**Appendix 2**

**Lithology and Completion Logs of New Monitor Wells**

# COMPLETION WELL LOG

<b>A</b> & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	DRILLING METHOD: AIR ROTARY	BORING NO. MW-5
	6 1/4" AIR HAMMER	SHEET 1 OF 1
SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS	SAMPLING METHOD:	DRILLING
	WATER LEVEL	START TIME
	GL. ELEV.	FINISH TIME
WEATHER SUNNY	TEMP 100 F	DATE
DATUM MSL	TDC ELEV.	DATE 7-22-03
DRILL RIG: ATV AIR HAMMER	TYPE GRAVEL:	CASING DIA: 2"
ANGLE	BEARING	TYPE BENTONITE:
SAMPLE HAMMER TORQUE	FT.-LBS	SCHED: 40 PVC
		SCREEN DIA: 2"
		SLOT SIZE: 0.01

DEPTH IN FEET	BLOW COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
			TOP SOIL, GRAY, SILTY, MOIST		CEMENT GROUT 0-2.5'
5			CLAY, BROWN, LIGHT BROWN, MOIST PLASTIC, STIFF		BENTONITE 2.5-4.5'
10			LIMESTONE, BROWN, CREAM, FRACTURED, WITH SHALE STREAKS, HARD, WET		SAND 4.5-16.5'
15			LIMESTONE, BROWN, DARK BROWN, CRYSTALLINE, HARD, WET STREAKS TO 13'		SCREEN 6.5-16.5'
			13'-16.5' DRY		
			TD-16.5'		
20					
25					
30					

DRILLING CONTR MOHAWK DRILLING, TULSA OK

DRILLER: ALLAN BRANTLEY

LOGGED BY ENIS TANER

DATE JULY 29, 2003 CHK'D BY IT

# COMPLETION WELL LOG

 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b>		DRILLING METHOD: AIR ROTARY		BORING NO. MW-7		
		6 1/4" AIR HAMMER		SHEET 1 OF 1		
SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS		SAMPLING METHOD:		DRILLING		
		WATER LEVEL		START TIME	FINISH TIME	
		GL. ELEV.		DATE	DATE	
WEATHER SUNNY		TEMP 100 F	CASING DEPTH	7-23-03 7-23-03		
DATUM MSL	TOC ELEV.	DRILL RIG: ATV AIR HAMMER		TYPE GRAVEL:	CASING DIA: 2"	
ANGLE BEARING		TYPE BENTONITE:		SCHED: 40 PVC	SCREEN DIA: 2"	
SAMPLE HAMMER TORQUE FT.-LBS					SLOT SIZE: 0.01	

DEPTH IN FEET	BLOW COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
		[Symbol]	TOP SOIL, GRAY, MOIST, STIFF	[Symbol]	
		[Symbol]	CLAY, GRAY, DARK GRAY, MOIST, STIFF, PLASTIC	[Symbol]	CEMENT GROUT 0-35'
5		[Symbol]	LIMESTONE, BROWN, CREAM, WITH SHALE STREAKS	[Symbol]	BENTONITE 3.5-5.5'
10		[Symbol]	SHALE, GRAY, WITH THIN LIMESTONE STREAKS	[Symbol]	CASING
15		[Symbol]	SHALE, BLACK, FISSILE	[Symbol]	SAND 5.5-22.5'
20		[Symbol]	SHALE, GRAY, BLuish GRAY, SLIGHTLY MOIST, MEDIUM SOFT	[Symbol]	SCREEN 7.5-22.5'
25		[Symbol]	TD-22.5'	[Symbol]	
30		[Symbol]		[Symbol]	

DRILLING CONTR MID-HAWK DRILLING, TULSA, OK

DRILLER: ALLAN BRANTLEY

LOGGED BY ENIS TANER

DATE JULY 20, 2003 CHK'D BY IT

# COMPLETION WELL LOG

 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b>		DRILLING METHOD: AIR ROTARY				BORING NO. MV-6	
		6 1/4" AIR HAMMER				SHEET 1 OF 1	
<b>SITE NAME AND LOCATION</b> LANDFILL EXPANSION (RODNEY PROPERTY) QUARRY RECYCLING AND DISPOSAL FACILITY TULSA, OKLAHOMA		SAMPLING METHOD:				DRILLING	
		WATER LEVEL		TIME		START TIME	FINISH TIME
		GL. ELEV.		DATE		7-23-03	7-23-03
		TOC ELEV.		CASING DEPTH			
WEATHER SUNNY		TEMP 100 F					
DATUM MSL							
DRILL RIG: ATV AIR HAMMER		TYPE GRAVEL:		CASING DIA: 2"		SCREEN DIA: 2"	
ANGLE		BEARING		TYPE BENTONITE:		SCHED: 40 PVC	
SAMPLE HAMMER TORQUE		FT.-LBS				SLOT SIZE: 0.01	

DEPTH IN FEET	BLVD COUNT	SYMBOL	DESCRIPTION OF MATERIAL	WELL TYPICAL	WELL NOTES
10		[Symbol: Horizontal lines]	SOIL, GRAY, MOIST	[Symbol: Horizontal lines]	
		[Symbol: Horizontal lines]	CLAY, BROWN, DARK BROWN, MOIST, PLASTIC, WITH GRAVEL LAYER AT 5.0'	[Symbol: Horizontal lines]	CEMENT GROUT 0-5'
		[Symbol: Horizontal lines]	LIMESTONE, LIGHT BROWN, CREAM, HARD, FRACTURED, PARTLY CRYSTALLINE	[Symbol: Horizontal lines]	BENTONITE 5-8'
		[Symbol: Horizontal lines]	SHALE, BLACK, FISSILE, HARD INTERBEDDED WITH GRAY SHALE	[Symbol: Horizontal lines]	CASING
20		[Symbol: Horizontal lines]	SHALE, GRAY, BLUISH GRAY, SLIGHTLY MOIST, SOFT	[Symbol: Horizontal lines]	SAND 8-30'
		[Symbol: Horizontal lines]	LIMESTONE, BROWN, GRAY, HARD, DRY	[Symbol: Horizontal lines]	SCREEN 10-30'
30		[Symbol: Horizontal lines]	SHALE, GRAY, BLUISH GRAY, SOFT, MICACEOUS	[Symbol: Horizontal lines]	
		[Symbol: Horizontal lines]	SHALE, GRAY, DARK GRAY, FISSILE MEDIUM HARD	[Symbol: Horizontal lines]	30 TO 40 FT PLUGGED BACK
40		[Symbol: Horizontal lines]	TD-40'	[Symbol: Horizontal lines]	
50		[Symbol: Horizontal lines]		[Symbol: Horizontal lines]	
60		[Symbol: Horizontal lines]		[Symbol: Horizontal lines]	

DRILLING CONTR: MD-HAVK DRILLING, TULSA, OK

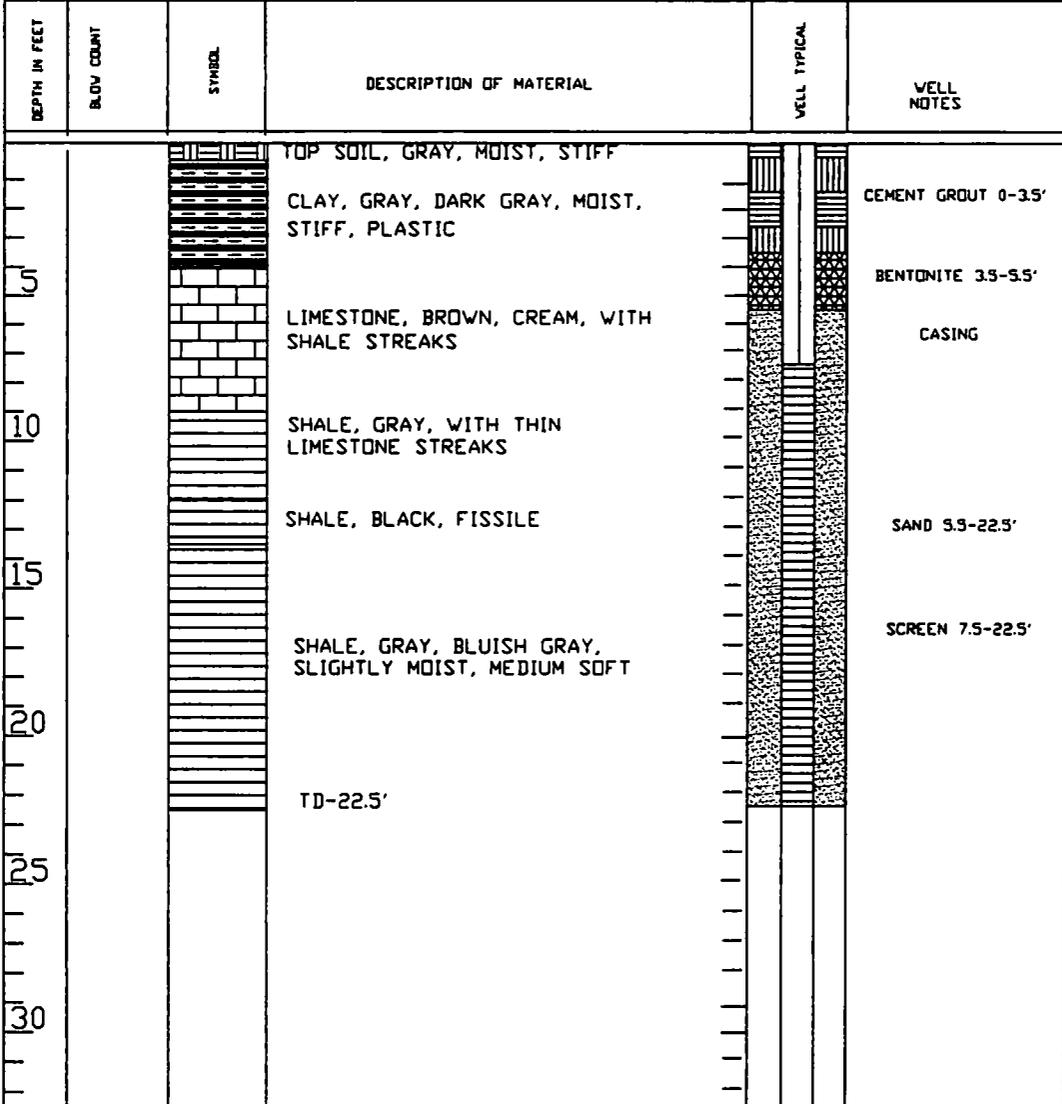
DRILLER: ALLAN BRANTLEY

LOGGED BY: ENIS TANER

DATE: JULY 30, 2003 CHK'D BY: IT

# COMPLETION WELL LOG

 <b>A &amp; M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.</b>	DRILLING METHOD: AIR ROTARY			BORING NO.
	6 1/4" AIR HAMMER			MW-7
SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS	SAMPLING METHOD:			SHEET
				1 OF 1
				DRILLING
WEATHER SUNNY	TEMP 100 F	TIME		START TIME
	G.L. ELEV.	DATE		FINISH TIME
DATUM MSL	TOC ELEV.	CASING DEPTH		7:30 AM
DRILL RIG: ATV AIR HAMMER	TYPE GRAVEL:	CASING DIA: 2"	SCREEN DIA: 2"	
ANGLE	BEARING	TYPE BENTONITE:	SCHED: 40 PVC	SLOT SIZE: 0.01
SAMPLE HAMMER TORQUE	FT.-LBS			



DRILLING CONTR MOHAWK DRILLING, TULSA OK

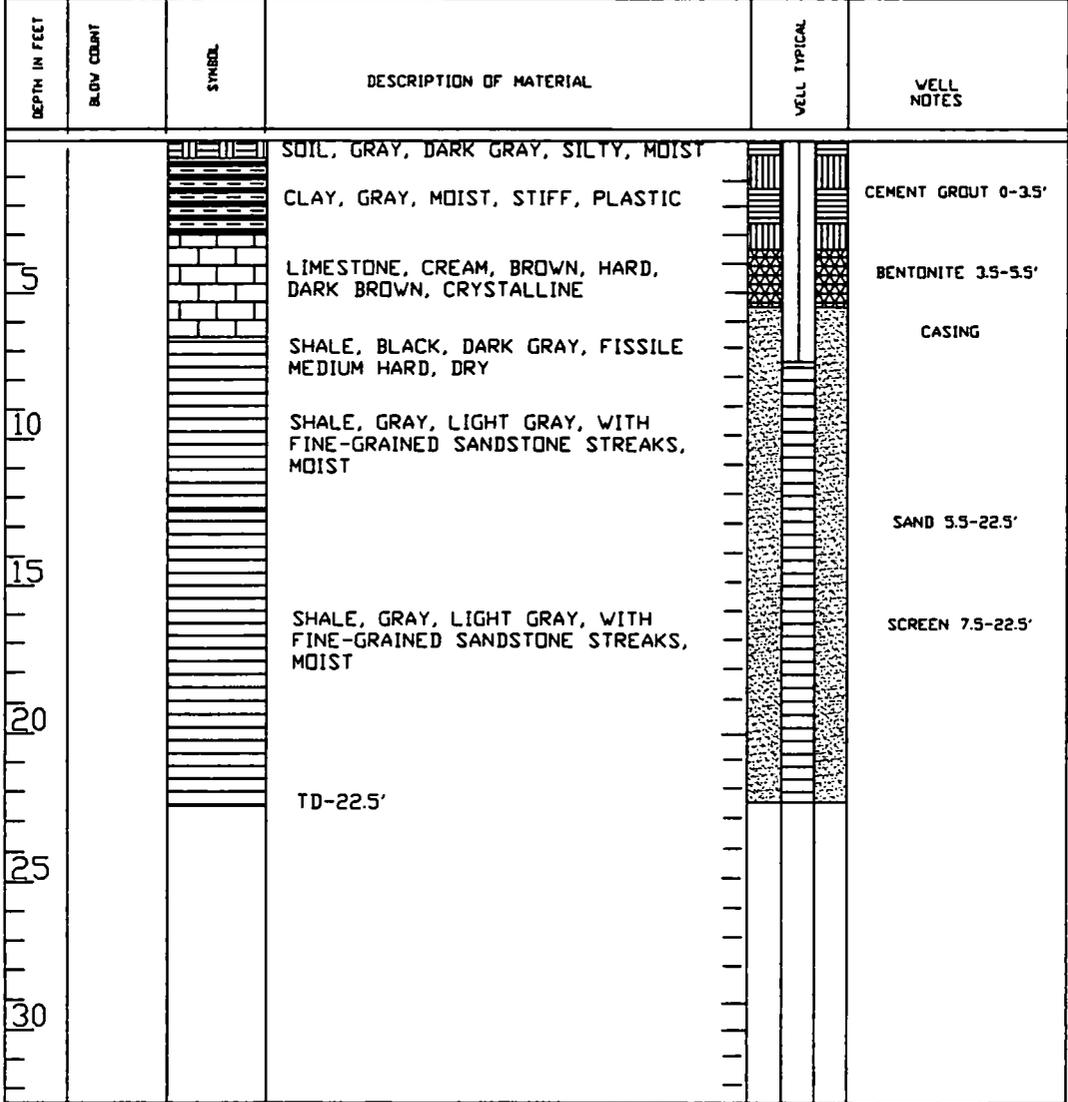
DRILLER: ALLAN BRANTLEY

LOGGED BY ENIS TANER

DATE JULY 30, 2003 CHK'D BY IT

# COMPLETION WELL LOG

<b>M</b>	A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.	DRILLING METHOD: AIR ROTARY				BORING NO. MW-8	
		6 1/4" AIR HAMMER				SHEET 1 OF 1	
SITE NAME AND LOCATION NATIONAL ZINC SITE CHERRYVALE, KANSAS		SAMPLING METHOD:				DRILLING	
		WATER LEVEL				START TIME	FINISH TIME
WEATHER SUNNY		TEMP 100 F		DATE	DATE	DATE	
DATUM MSL		G.L. ELEV.		CASING DEPTH		7-22-03	
DRILL RIG: ATV AIR HAMMER		TYPE GRAVEL:		CASING DIA: 2"		SCREEN DIA: 2"	
ANGLE		BEARING		TYPE BENTONITE:		SCHED: 40 PVC	
SAMPLE HAMMER TORQUE		FT.-LBS		SLOT SIZE: 0.01			



DRILLING CONTR. MOHAWK DRILLING, TULSA, OK  
 DRILLER: ALLAN BRANTLEY

LOGGED BY: ENIS TANER  
 DATE: JULY 30, 2003 CHK'D BY: IT

**Appendix 3**  
**Lithology and Completion Logs of Existing Wells**

OWNER: **LDHE** GEOLOGIST: **Candy Brown**

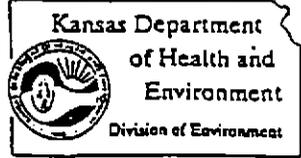
SITE: **National Zinc TW-1 ES+00** PROJECT: **Nat. Zinc BTA**

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	SAMPLES				TESTS		
			DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:								
	0-1 Dark brown silty clay, dry Hard layer at 1'		CL-ML						XRF (lead) @ average (mg/kg)
	1-4 Black clay trace cinders and slag, fat, slightly to moderately stiff, to moisture		CH						100.6
	4-8 Mottled dark gray to olive clay, trace of sandstone and shale inclusions		CH						89.4
	8-14 Tan to brown silty clay, wet, medium to high plasticity, moderately stiff		CH						97
	14- Sandstone refusal TO 14 5' 1010 Schedule 40 Screen <sup>covered</sup> Sand to SS 3' Bentonite chips (3/8") <sup>metal</sup> snail recover 14' Abs								94

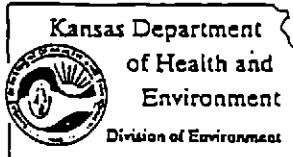
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA: 4 9/8 WELL DIA: 2" PVC

WATER LEVEL OBSERVATIONS Abs.

WL	7.9 TOC	WD	6.8	SWL
WL				
WL	TOC 14' Abs TO 15.1 TOC			



BORING STARTED	08/16/99
BORING COMPLETED	08/16/99
RIG	B-3300
FOREMAN	J. J. Regan
APPROVED	JOB #

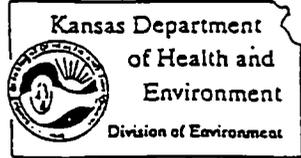
OWNER <b>KDHE</b>		GEOLOGIST <b>Randy Brown</b>																						
SITE <b>NATIONAL ZONE TW-2 N6600 E5600</b>		PROJECT <b>Net. Zinc BTA</b>																						
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	SAMPLES				TESTS																	
			DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)														
	<p>TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:</p> <p>0-2 DK brown silty loam, root TS</p> <p>2-4.5 Tan to reddish brown to brown silty clay, slightly fatty, very stiff, mostly dry, low plasticity</p> <p>4.5-9.5 Same, but with trace moisture</p> <p>9.5-11.1 Same, wet with shale and sand stone residuum</p> <p>11.1 Refusal TO 11.1 5' Old schedule 40 PVC screen, TOC 3 7/8" ABS, Sand to 3.5', Bentonite (3/8 chips) to 0.5', steel locked protective cover</p>		<p>M</p> <p>CL</p> <p>CL</p>						<p>XCC Lead (A&amp;E) mg/kg!</p> <p>L81.5</p> <p>L64.3</p> <p>L70.7</p>															
<p>THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.</p>			<p>BOREHOLE DIA: 4 1/8"</p> <p>WELL DIA: 2 1/2"</p>																					
<p>WATER LEVEL OBSERVATIONS</p> <table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:10%;">WL</td> <td style="width:10%;">8.12</td> <td style="width:10%;">TOC</td> <td style="width:10%;">WD</td> <td style="width:10%;">ABS</td> <td style="width:10%;">SWL</td> </tr> <tr> <td>WL</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>WL</td> <td>TD 14.8</td> <td>TOC</td> <td></td> <td></td> <td></td> </tr> </table>			WL	8.12	TOC	WD	ABS	SWL	WL						WL	TD 14.8	TOC				 <p>Kansas Department of Health and Environment Division of Environment</p>		<p>BORING STARTED 08/16/99</p> <p>BORING COMPLETED 08/16/99</p> <p>RIG B-3300 FOREMAN J. Ryan</p> <p>APPROVED _____ JOB # _____</p>	
WL	8.12	TOC	WD	ABS	SWL																			
WL																								
WL	TD 14.8	TOC																						

OWNER <b>LDHE</b>		GEOLOGIST <b>Randy Brown</b>							
SITE <b>National Zinc N6100 ESSCO TWS</b>		PROJECT <b>Nat Zinc BTA</b>							
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS	
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:								
	0-1 Dark brown silty loam, roots		ML						866
	2-5 Black, gritty micst clay cinders, high plasticity, very stiff		CH						451
	5-7 Same		CH						
	7-9 Dark brown silty clay, trace of sandstone residuum, very stiff, moderately moist, medium plasticity		CH						100,7
	9-10.2 Same, more sandstone residuum		CH						
	JD 10.2		CL						
	5' 1010 Schedule 40 PVC Screen installed Sand to 5' BGS Bentonite (3/8" chips) to 0.6' Steel protective cover installed locked Top of casing 3,75' A6S								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA: 4.718"  
WELL DIA: 7"

WATER LEVEL OBSERVATIONS			
WL	17.06 <sup>TWC</sup>	WD	7.31 <sup>ABS</sup>
WL	JD 14.1 (JOC)		
WL			



BORING STARTED 08/17/99	
BORING COMPLETED 08/17/99	
RIG B-3300	FOREMAN J. L. Grayson
APPROVED	JOB #

OWNER: KOHE  
 GEOLOGIST: Randy Brown

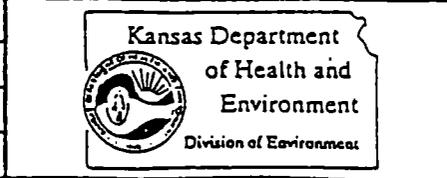
SITE: National Zinc <sup>TW-4</sup> N5700 E5900  
 PROJECT: Nat Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	SAMPLES				TESTS			
			DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:									
	0-1.5 Dark brown silty clay loam, plant roots		ML							XRF Clear Ave. (ppm)
	1.5-4 Cinders, gritty w/ clay black, wet at bottom		Cl7							136.9
	4-7 Dark gray to black clay with cinders, wet		Cl4							1316.3
	7-7.5 Dark gray clay, Sandstone residuum Actual 7.5 TD 7.5		Cl4							1075.6
	5" ID Schedule 40 PVC screen Sand to 1" Bentonite to 6.5. 38 chips Completed w/ steel above ground casing locked		Cl4							204.4
	TOC 3.83' Abs									45.1

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.  
 BOREHOLE DIA: 4 7/8"  
 WELL DIA: 2"

WATER LEVEL OBSERVATIONS

WL	8.21	TOC	WD	4.46	Abs SWL
WL					
WL	TD 10174	from TOC			



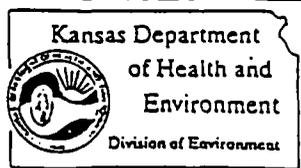
BORING STARTED	08/07/49
BORING COMPLETED	08/11/49
RIG	B-3300
FOREMAN	S. L. Regan
APPROVED	JOB #

OWNER: K D HE  
 GEOLOGIST: Randy Brown  
 SITE: National Zinc N 5600 E 6600 TW-5  
 PROJECT: Natl Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	SAMPLES				TESTS			
			DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)
	0-2 Dark brown silty loam			ML						86.3
	2-4.5 Dark brown silty clay, to olive roots, trace of brick fragments			CL-CH						<del>77.3</del>
	4.5-9 Dark brown to slightly reddish brown silty clay, fair, moderately stiff, medium to high plasticity, trace of sandstone residuum			CH						77.3
	9-13 Same, saturated TO 13			CH						86.3
	5' @ 10 Schedule 40 PVC <sup>Screen</sup> casing Sand to 3.5' Bentonite to 0.5' A6S Completed with a bare ground steel protective cover TOC 2.13' A6S									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.  
 BOREHOLE DIA: 4.78" WELL DIA: 2"

WATER LEVEL OBSERVATIONS	
WL $\frac{7}{8}$ 5.00 <sup>TOC</sup> $\frac{7}{8}$ A6S	WD $\frac{7}{8}$ 2.87 SWL
WL TD	
WL TOC 15.00 from TOC	



BORING STARTED	08/17/99
BORING COMPLETED	08/17/99
RIG B-3300	FOREMAN J. Grayson
APPROVED	JOB #

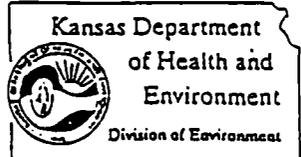
OWNER: National Zinc / KDHE  
 GEOLOGIST: Randy Brown

SITE: National Zinc TW-6  
 PROJECT: National Zinc BTA

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	SAMPLES				TESTS			
			DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.: 300' Nat Martin Strip + etc									
	In Visible Right-of-Way, East Side									
	0-4 Dark brown silty loam, plant roots		1	ML						765
	4-7 Dark brown to reddish brown silty clay, dry, low plasticity, trace sandstone residuum		2	CL						7617
	Refusal 710 Sandstone									
	5' 1010 Schedule 40 PVC screen									
	Sand for 1.5 Bentonite + 0									
	Ground surface completed w/ locked steel protective cover									
	TOL 36' Abs Dry at completion									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.  
 BOREHOLE DIA: 4 7/8"  
 WELL DIA: 2"

WATER LEVEL OBSERVATIONS		
WL	≅ Dry	WD ≅ Dry SWL
WL		
WL	TD 10.6 from TOL	



BORING STARTED	08/17/99
BORING COMPLETED	08/17/99
RIG R-3300	FOREMAN J. Lujan
APPROVED	JOB #

OWNER: **KDHE** GEOLOGIST: **Randy Brown**

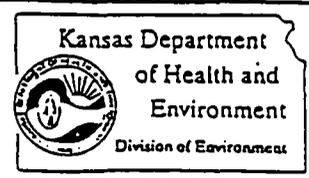
SITE: **National Zinc TW-7** PROJECT: **National Zinc BTA**

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS			
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	XRF Lead Ac (um/kg)
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:										
	In new Vis. lkd Right-of-Way, <del>South</del> East side 600' of TW 6										
	0-1 Dark brown to reddish brown silty loam, plant roots		ML								
	1-3, 5 Reddish brown clayey silt w/ sandstone residuum		CL								29213
	TD 4.0 Refused in sandstone										
	5' Screen, 1010 schedule 40 Sand to 1.0' Bentonite chips to ground surface 3/8" chips										
	TOC 3.48' Abs Completed w/ Steel protective cover, locked Dry at completion										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA: **4 9/8"** WELL DIA: **2 1/2"**

WATER LEVEL OBSERVATIONS						
WL	☐	Dry	WD	☐	Dry	SWL
WL						
WL						

TOC 3.48' Abs TD 7.4' from TC.



BORING STARTED	08/17/99
BORING COMPLETED	08/17/99
RIG	B-3300
FOREMAN	S. Litman
APPROVED	JOB #

OWNER: **KONE** GEOLOGIST: **Randy Brown**  
 SITE: **National Zinc TW-8** PROJECT: **New Zinc BTA**

GRAPHIC LOG	DESCRIPTION	WELL DETAIL		SAMPLES				TESTS			
		DEPTH (FT.)		USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)	
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:										
	In vis. 164 Right of-way, East Side 500' South of Intersection Road 5200 and New U.S. 164										
	0-3.0 Reddish brown, clayey Silty abundant sandstone residuum			M- CL							
	3.0-3.5 light gray siltstone weathered, friable			OP							L90
	3.5 Actual sandstone/siltstone										
	5' 0/0 Green trimmed schistite 40										
	Sand to 15' Bentonite to surface										
	TOC 3.68' Abs Completed with a bare ground steel protective cover Dry at completion										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA: **4 7/8"**  
 WELL DIA: **2 1/2"**

WATER LEVEL OBSERVATIONS			
WL	☐	Dry	SWL
WL	☐	Dry	
WL		at 7.2' TO TOC	



BORING STARTED	08/17/99
BORING COMPLETED	08/17/99
RIG	R-3300
APPROVED	FOREMAN J. Gray
	JOB #

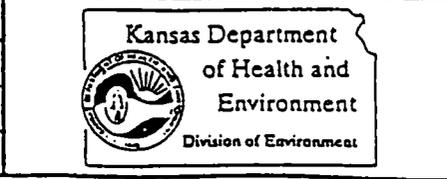
OWNER: **KOHE** GEOLOGIST: **Randy Brown**

SITE: **National Zinc TW-9 NS800 E7300** PROJECT: **Nat Zinc B7A**

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	SAMPLES				TESTS			
			DEPTH (FT.)	USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS (PPM)
	TOP OF PROTECTOR PIPE: TOP OF CASING: GROUND SURFACE ELEV.:									
	0-2 Dark brown silty clay loam, plant roots, dry		ML							Asst Lead Ave (m/kg)
	2-4 Dark brown silty clay, mottled, w/reddish brown silty clay, dry, friable		CL							83
	4-6 Orange to reddish brown clay, fat, high plasticity, very stiff		CH							85
	6-8 Same but with increasing sandstone residuum with depth		CH							77
	Refusal @ 5' .010 schedule 40 PVC Screen Sand to 2.5 Bentonite to @.5 (1/8" chips)		CP							85
	TOC 382 Abs TD 13.80 Dry at completion, although water filling screen section slowly.									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA: 4.718" WELL DIA: 2"

WATER LEVEL OBSERVATIONS		
WL	WD	SWL
	Dry	
TD 13.80 from TOC		



BORING STARTED	08/19/99
BORING COMPLETED	08/19/99
RIG	B3300
FOREMAN	S. Gray
APPROVED	JOB #

WICHITA TESTING LABORATORIES

Materials Engineers

Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation

National Zinc Company

Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 2

Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. o.d. Split-barrel Sampler

Sheet 1 of 2

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.1	0		Fill: cinders, brick, tile, etc.; loose.			
91.1	1	CH & CL	Fill: silty clay; very dark grayish brown, dark yellowish brown and reddish brown; wet; medium and high plasticity; stiff.	4		W=25.5 D=98.6
89.1	3		As above but saturated in seams.		3 4 5	N=9
84.1	8	▽	Very wet to saturated.	5		Water Level @ 7.7' (Elev. 84.4) After 24 Hours W=32.1 D=90.3
78.6	13.5	CL	Silty Clay: some organics; very dark gray; very wet to saturated; medium plasticity; medium stiff. (old topsoil)		2 4 5	N=9
77.1	15	CH	Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.	7		W=27.3 D=94.9
75.6	16.5		Limestone: weathered and broken.			
73.1	19		Limestone: hard; light yellowish brown. (possible Winterset Limestone)			

WICHITA TESTING LABORATORIES

Materials Engineers

Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation

National Zinc Company

Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 2

Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. o.d. Split-barrel Sampler

Sheet 2 of 2

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-18-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
72.1	20		<u>Limestone:</u> as before; but shaley; dark gray and hard.			
70.6	21.5		<u>Shale:</u> dark gray with thin limestone stringers. (possible Stark Shale)			
67.1	25					

WICHITA TESTING LABORATORIES  
Materials Engineers  
Wichita, Kansas

PROJECT  
Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

BORING LOG

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.3	0		Fill: cinders, brick, clay tile, etc.			
90.3	1	CH	Fill: silty clay; dark yellowish brown, grayish brown, reddish brown and gray; wet; high plasticity; stiff to medium stiff with depth.	8		W=25.5 D=94.8
87.3	4	CL	Fill: silty clay; very dark brown and yellowish brown; wet with saturated seams; medium plasticity; medium stiff.		2 2 3	N=5 W=28.5 D=95.5
83.8	7.5	CL	Silty Clay: very dark gray with some organics; wet; medium plasticity; med. stiff to stiff. (old topsoil zone)	10		Water Level @ 7.7' (Elev. 83.6) After 24 Hours W=24.3 D=98.0
83.3	8	CH				
82.3	9		Silty Clay: dark gray with lime concretions; wet; high plasticity; medium stiff to stiff.		3 4 4	N=8
80.3	11	CH	As above but dark yellowish brown. Gravelly Clay: 20% fine to medium gravel (chert); dark yellowish brown; wet; high plasticity; stiff.	11		W=22.4 D=107.6
77.8	13.5		Limestone: dark yellowish brown; broken and weathered. (possible Winterset Limestone)			
74.8	16.5		Limestone: light yellowish brown; fossiliferous; medium hard. (Winterset Limestone)			

WICHITA TESTING LABORATORIES

Materials Engineers

Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation

National Zinc Company

Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger		Standard Penetration Test			Boring No. 3
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler		Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
71.3	20		<u>Limestone</u> : gray; hard.			
69.3	22		<u>Shale</u> : dark gray (possible Stark Shale).			
68.3	23		<u>Calcareous</u>			
67.8	23.5		Shale as before.			
66.3	25					

WICHITA TESTING LABORATORIES  
 Materials Engineers  
 Wichita, Kansas  
 BORING LOG

PROJECT  
 Lagoon Embankment Evaluation  
 National Zinc Company  
 Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 4
Undisturbed Soil Sampler: 3-in. ad. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler	Sheet 1 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks	
92.1	0		<u>Fill</u> : cinders, brick, clay, tile, etc.				
91.1	1	CL	<u>Fill</u> : <u>silty clay</u> ; dark yellowish brown, gray and reddish brown; wet; medium plasticity; medium stiff.	12		W=25.4 D=97.9	
88.1	4	CH&CL	<u>Fill</u> : <u>silty clay</u> ; very dark gray and dark gray; wet to saturated in seams; high and medium plasticity; medium stiff.		2 3 5		N=8
84.6	7.5	CH w/CL ▽	<u>Silty Clay</u> : dark yellowish brown with iron stains; wet to very wet; high plasticity; with medium plasticity zones; medium stiff.	13			W=25.7 D=96.9
80.1	12	CH	<u>Gravelly Clay</u> : 20 to 25% fine to medium gravel; dark yellowish brown; very wet; high plasticity; stiff.		2 3 4	Water Level @ 9.5' (Elev. 82.6') After 24 Hours N=7	
77.6	14.5		As above but saturated.	14		W=27.1 D=92.8	
76.6	15.5		<u>Limestone</u> : broken and weathered.		4 5 5	N=10	
75.1	17		<u>Limestone</u> : light gray; hard. (possible Winterset Limestone)				
72.1	20						

WICHITA TESTING LABORATORIES  
Materials Engineers  
Wichita, Kansas

PROJECT

Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

BORING LOG

Boring Method: 6-in. continuous flight auger		Standard Penetration Test			Boring No. 4
Undisturbed Soil Sampler: 3-in. od. thin-walled tube		140-lb. Hammer	30-in. Fall	2-in. od. Split-barrel Sampler	Sheet 2 of 2
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot			Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
72.1	20		As before.			
71.1	21		<u>Limestone</u> : sandy and shaley; dark gray.			
63.1	29		<u>Shale</u> : fissile; black; hard. (possible Stark Shale)			
62.1	30					

Figure 5a

Drilled By: William B. Cappel

WICHITA TESTING LABORATORIES

Materials Engineers  
Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test			Boring No. 1
Undisturbed Soil Sampler: 3-in. od. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. od. Split-barrel Sampler	Sheet 1 of 1
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
91.7	0		Fill: cinders, brick, tile, etc.; loose.			
90.7	1	CH	Fill: silty clay; dark yellowish brown mottled with very dark brown and grayish brown; wet; med. plasticity; stiff.	1		N=13 W=23.6 D=101.5
					6	
					7	
					6	
86.2	5.5		As above but saturated in seams.			
85.2	6.5	CH	Silty Clay: very dark gray and dark grayish brown; wet to saturated in seams; high plasticity; medium stiff to stiff. (possible fill)			Water Level @ 8.0' (Elev. 83.7) After 24 Hours
84.2	7.5	CL	Silty Clay: very dark gray; minor organics; saturated; med. plasticity; medium stiff. (old topsoil zone)	2		
82.7	9	CH	Silty Clay: dark yellowish brown; saturated; high plasticity; medium stiff.		2	
					2	N=7 W=27.1 D=94.5
					5	
79.2	12.5		As above but some limestone gravel.			
						W=33.4 D=87.6
76.2	15.5		Limestone: broken and weathered.	3		
75.2	16.5		Limestone: light gray and hard. (possible Winterset Limestone)			
73.7	18		Shale: dark gray to gray; hard. (possible Stark Shale)			
71.7	20		Coal Seam			

WICHITA TESTING LABORATORIES  
 Materials Engineers  
 Wichita, Kansas  
 BORING LOG

PROJECT  
 Lagoon Embankment Evaluation  
 National Zinc Company  
 Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger	Standard Penetration Test		Boring No. 5
Undisturbed Soil Sampler: 3-in. od. thin-walled tube	140-lb. Hammer	30-in. Fall	2-in. od. Split-barrel Sampler
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot	Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		<u>Fill: Cinders.</u>			
90.1	4	▽	As above but saturated.			Water @ 4.0' After Drilling. (perched in cinders above silty clay)
87.6	6.5	CL	<u>Silty Clay:</u> very dark grayish brown; very wet; low to medium plasticity; medium stiff.			
86.1	8	CH	<u>Silty Clay:</u> brownish gray with olive yellow and iron staining; very wet; medium to high plasticity; medium stiff.			
82.1	12		As above but yellowish brown with light gray to gray mottling; iron stain; 10 to 15% coarse sand; stiff.			
78.1	16		As above but with 15 to 25% gravel.			
77.1	17		<u>Limestone:</u> yellowish brown; weathered; medium hard.			
75.1	19		<u>Limestone:</u> yellowish brown to light gray; hard.			

WICHITA TESTING LABORATORIES  
Materials Engineers  
Wichita, Kansas

PROJECT

Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

BORING LOG

Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 5

Undisturbed Soil Sampler: 3-in. ad. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. o.d. Split-barrel Sampler

Sheet 2 of 2

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-11-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
74.1	20		<u>Limestone</u> : as before.			
72.6	21.5		<u>Limestone</u> : shaley; medium hard.			
71.1	23		<u>Limestone</u> : hard.			
68.1	26		<u>Shale</u> : dark gray; hard.			
			<u>Calcareous</u>			
64.1	30					

WICHITA TESTING LABORATORIES

Materials Engineers

Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation

National Zinc Company

Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger		Standard Penetration Test		Boring No. 6
Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube		140-lb. Hammer	30-in. Fall	2-in. o.d. Split-barrel Sampler
w=Moisture Content, %	D=Dry Density, pcf	Penetration Resistance: N=Blows per foot		Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
94.1	0		<u>Fill</u> : cinders and ash with brick and tile rubble; saturated @ 3.0'; loose.			Water @ 3.9' After Drilling (Perched above silty clay)
89.6	4.5	▽				
88.1	6	CH	<u>Silty Clay</u> : very dark gray; traces of fine sand; very wet; medium to high plasticity; medium stiff.			
			As above but olive gray, gray and yellowish brown mottled.			
85.6	8.5	CH	<u>Silty Clay</u> : yellowish brown mottled with light gray to gray; very wet; high plasticity; medium stiff to stiff.			
82.1	12		As above with 20 to 25% limestone gravel; stiff.			
80.6	13.5		<u>Limestone</u> : yellowish brown; broken and weathered. (possible Winterset Limestone)			
78.6	15.5		<u>Limestone</u> : light gray; hard. (Winterset Limestone)			
77.6	16.5		As above but broken in part.			
74.6	19.5		<u>Limestone</u> : hard. (Winterset Limestone)			

WICHITA TESTING LABORATORIES

Materials Engineers  
Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 6

Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. o.d. Split-barrel Sampler

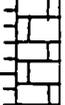
Sheet 2 of 2

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
74.1	20		<u>Limestone</u> : as before.			
72.6	21.5		<u>Shale</u> : gray and light gray; sandy; high plasticity; hard. (possible Stark Shale)			
69.1	25					

WICHITA TESTING LABORATORIES

Materials Engineers  
Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation  
National Zinc Company  
Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 8

Undisturbed Soil Sampler: 3-in. ad. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. o.d. Split-barrel Sampler

Sheet 1 of 1

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-12-78

st.)

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.0	0		<u>Fill:</u> cinders.			
91.0	1	CH	<u>Fill:</u> silty clay; dark brown mottled with dark yellowish brown and reddish brown; wet; high plasticity; stiff.			
88.0	4	CH	<u>Fill:</u> silty clay; gray; yellowish brown and dark gray; very wet; high plasticity; stiff.			
85.0	7	CL	<u>Silty Clay:</u> very dark gray; very wet; medium to high plasticity; medium stiff. (old topsoil zone)			
84.0	8	CH	<u>Silty Clay:</u> dark gray; very wet; high plasticity; medium stiff to stiff.			
85.0	9	CH	<u>Silty Clay:</u> dark yellowish brown; very wet; high plasticity; stiff.			
78.5	13.5		Weathered Limestone.			
78.0	14					

WICHITA TESTING LABORATORIES

Materials Engineers

Wichita, Kansas

BORING LOG

PROJECT

Lagoon Embankment Evaluation

National Zinc Company

Cherryvale, Kansas

Boring Method: 6-in. continuous flight auger

Standard Penetration Test

Boring No. 9

Undisturbed Soil Sampler: 3-in. o.d. thin-walled tube

140-lb. Hammer

30-in. Fall

2-in. o.d. Split-barrel Sampler

Sheet 1 of 1

w=Moisture Content, %

D=Dry Density, pcf

Penetration Resistance: N=Blows per foot

Date: 4-12-78

Elevation	Depth	Group Symbol	Description of Materials	Sample No.	Blows	Remarks
92.0	0		Fill: cinders, brick, tile, etc.; loose.			
91.0	1	CH	Fill: silty clay; dark yellowish brown, brown and grayish brown; wet; high plasticity; stiff.			
88.0	4	CL	Silty Clay; very dark gray to dark gray with some organics; saturated; medium plasticity; soft to medium stiff. (old topsoil zone)	15		
87.0	5	CH	Silty Clay; dark gray; very wet; high plasticity; medium stiff.			
85.5	6.5		As above but dark yellowish brown and stiff.			
77.0	15		Saturated.			
76.5	15.5		Weathered Limestone.			
76.0	16					

W=30.5  
D=90.6

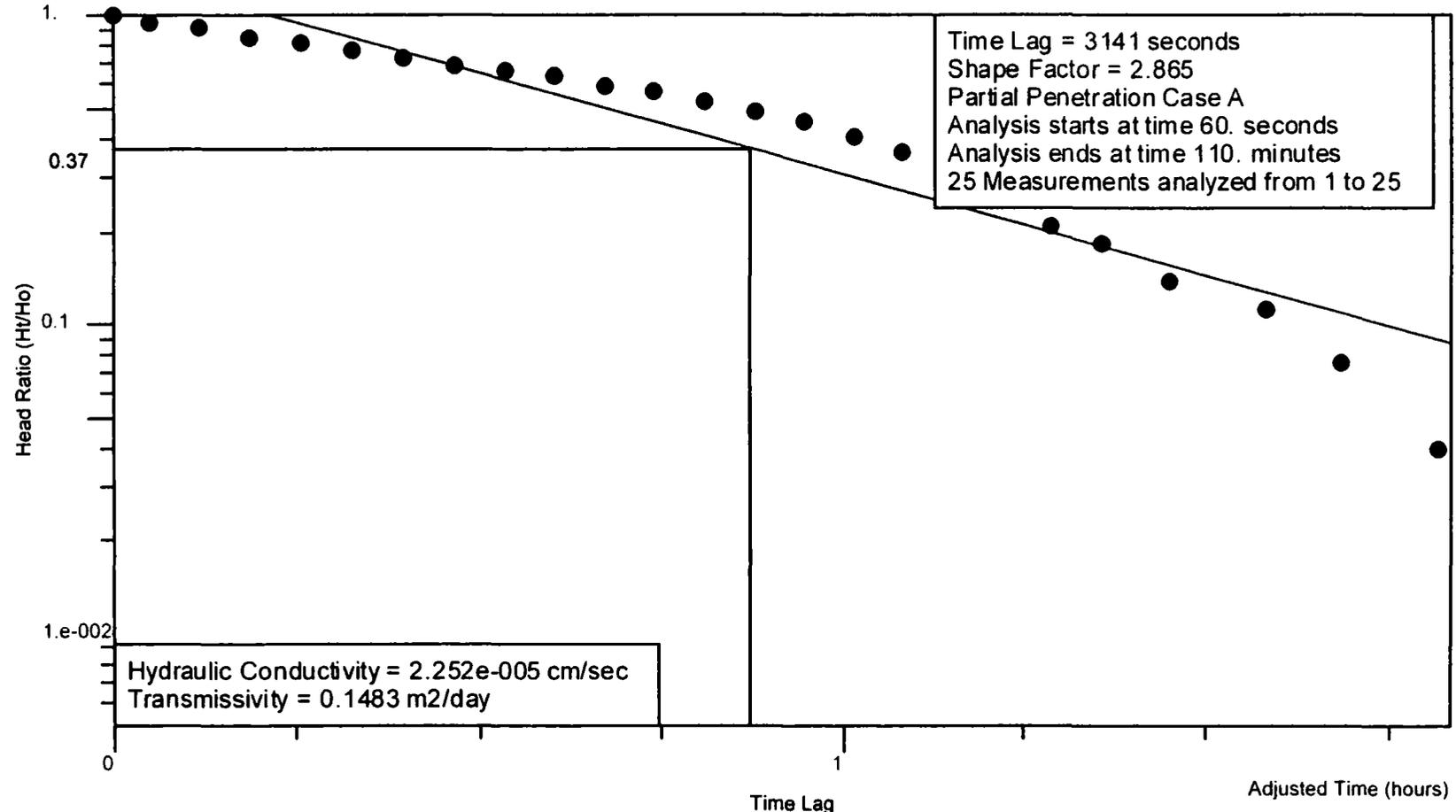
**Appendix 4**  
**Slug Test Data and Graphs**

# Cherryvale, KS

8/4/2003

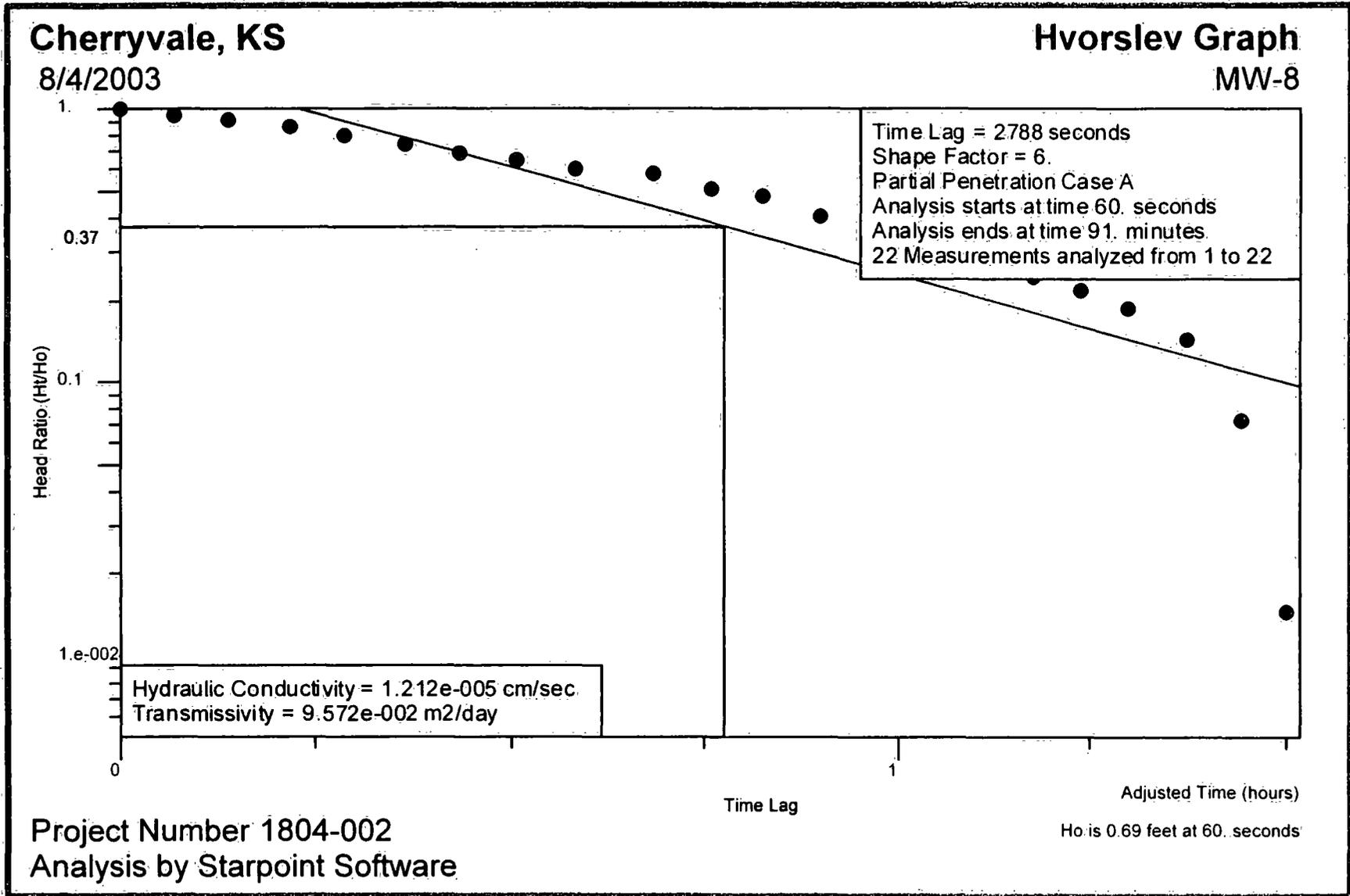
# Hvorslev Graph

MW-5



Project Number 1804-002  
Analysis by Starpoint Software

$H_o$  is 2.51 feet at 60. seconds



**Appendix 5**

**Groundwater Sampling Field Data Sheets and Laboratory Analytical  
Reports**

# FIELD WATER QUALITY SAMPLING AND ANALYSIS DATA SHEET

PROJECT NAME: Chemvale PROJECT NO: 1804-002-203  
 SAMPLER NAME: Jon Vukobrat PERSON PRESENT: \_\_\_\_\_  
 WEATHER: Cloudy AIR TEMP: 83° F LAST PRECIPIT. \_\_\_\_\_

*Duplicate*

LOCATION (STATION NO.)	MW# 5	MW# 6	MW# 7	MW# 8
DATE AND TIME WATER LEVEL MEASURED	9/23/03 12:20	9/23/03 13:20	9/23/03 13:29	9/23/03
DATE AND TIME PURGED	9/23/03 13:45	9/23/03 14:30	9/23/03 14:05	9/23/03 15:00
DATE AND TIME SAMPLED	9/23/03 16:00	9/23/03 16:30	9/23/03 16:40	9/23/03 16:50
SAMPLING METHOD	Bales	Bales	Bales	Bales
TOP OF CASING ELEV.				
DEPTH TO WATER (DTW)	7.0	11.2	7.1	3.3
TOTAL DEPTH (TD)	19.3	34.1	26.35	26.0
REQUIRED PURGE VOLUME	9.5	14.69	12.91	
VOLUME PURGED				
THICKNESS OF NAPL/ONAPL	None	None	None	None
SUBSTANCE ON WATER	None	None	None	None
SAMPLING TEMP.	22.5   20.9	18.5   17.3	20.9   18.8	19.6   17.6
	18.7   19.6	16.8   16.5	17.7   17.9	16.5   16.1
SAMPLING PH	7.44   7.39	7.66   7.63	7.66   7.56	7.79   7.62
(INST. NAME)	7.38   7.36	7.81   7.82	7.60   7.77	7.60   7.58
SAMPLING SPEC. COND	1040   <del>930</del>	2600   2700	2810   3180	4020   4210
(INST. NAME)	930   930	2890   3000	3400   3460	5020   5520
COLOR	Clear -> murky	Clear -> murky	Clear -> murky	Clear -> murky
ODOR	None	None	Salty surface	Salty surface
SEDIMENT	Slight	Some	Slight	Slight
FIELD TREATMENT PRESERVATION	Preserved	Preserved	Preserved	Preserved
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?	yes	yes	yes	yes

NOTE: \_\_\_\_\_

Volume calculation: 2" - 0.163 gal/ft, 3" - 0.367 gal/ft, 4" - 0.553 gal/ft  $(((TD-DTW) \times \text{gal/ft}) \times 3) + 3.5 \text{ gal} = \text{volume to evac.}$

PROJECT NAME Cherryvale PROJECT NUMBER \_\_\_\_\_

SAMPLER NAME Jon PERSON PRESENT \_\_\_\_\_

WEATHER Clear AMBIENT AIR TEMP. 95 LAST PRECIP. \_\_\_\_\_

LOCATION (STATION NO.)	MW# 5	MW 6	MW 7	MW 6				
CONDITION OF WELL	Good	Good	Good	Good				
WATER SOURCES	Ground	Ground	Ground	Ground				
DATE AND TIME WATER LEVEL MEASURED	8-6-03 12:00	8-6-03 12:31	8-6-03 1:08	8-6-03 1:26				
DATE AND TIME PURGED	8-6-03/12:02	8-6-03 12:33	8-6-03 1:02	8-6-03 1:28				
DATE AND TIME SAMPLED	8-6-03 3:31	8-6-03 3:47	8-6-03 3:57	8-6-03 4:05				
SAMPLING METHOD	Bailer	Bailer	Bailer	Bailer				
TOTAL WELL DEPTH (WD)	19.45	26.01	26.28	33.63				
WATER DEPTH (WD) <sup>Wd</sup> <sub>Wd</sub>	9.11	10.33	11.33	11.64				
THICKNESS OF NAPL/NAPL	none	none	none	none				
VOLUME TO EVACUATE	8.6	11.2	10.8	14.3				
PUMP RATE WHILE PURGING								
SUBSTANCE ON WATER	none	Slight	none	none				
SAMPLING TEMPERATURE	20.7 19.8	19.5 <del>18.9</del> 18.9	18.9 16.7	17.8 16.7	22.5 18.5	19.1 17.7	19.2 18.6	19.5 17.6
SAMPLING pH	7.00 7.30	7.21 7.39	7.00 7.33	7.23 7.39	7.26 7.28	7.34 7.24	6.46 6.55	6.46 6.57
SAMPLING SPECIFIC CONDUCTANCE	<del>620</del> 630	640 670	2000 2900	2400 2900	2000 2300	2200 2700	2000 2200	2100 2400
COLOR	<del>cloudy</del> Cloudy	Clear	Clear → murky					
ODCR	None	None	None	None	salty	salty	none	none
SEDIMENT	Medium	Medium	Medium	Medium	medium	medium	medium	medium → heavy
FIELD TREATMENT PRESERVATION	Prepreserved	Prepreserved	Prepreserved	Prepreserved	Prepreserved	Prepreserved	Prepreserved	Prepreserved
PURGING/SAMPLING PLAN	Yes	yes	yes	yes	yes	yes	yes	yes

VOLUME CALCULATION: 2" - 0.163 GAL/FT. 3" - 0.367 GAL/FT. 4" - 0.653 GAL/FT.  
 ((TWO-WD) X GAL/FT) X 3 + 3.5 GAL = VOLUME TO EVAC.  
 ONE BAILER = 0.24 GAL.

# FIELD WATER QUALITY SAMPLING AND ANALYSIS DATA SHEET

PROJECT NAME: Cherryvale, KS PROJECT NO: 1904-002

SAMPLER NAME: Garin James PERSON PRESENT: Oklay Fortoguel

WEATHER: Cloudy AIR TEMP: 50°F LAST PRECIPIT. 3hrs.

LOCATION (STATION NO.)	MW-4	MW-5	MW-6	MW-7
DATE AND TIME WATER LEVEL MEASURED	11/14/03 3:15	11/15/03 3:25	11/15/03 3:28	11/18/03 3:35
DATE AND TIME PURGED				
DATE AND TIME SAMPLED				
SAMPLING METHOD				
TOP OF CASING ELEV.				
DEPTH TO WATER (DTW)	4.41'	3.82'	10.92'	8.82'
TOTAL DEPTH (TD)				
REQUIRED PURGE VOLUME				
VOLUME PURGED				
THICKNESS OF NAPL/DNAPL				
SUBSTANCE ON WATER				
SAMPLING TEMP.				
SAMPLING PH (INST. NAME )				
SAMPLING SPEC. COND (INST. NAME )				
COLOR				
ODOR				
SEDIMENT				
FIELD TREATMENT PRESERVATION				
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?				
OTHER				

NOTE: \_\_\_\_\_

Volume calculation: 2" - 0.163 gal/ft, 3" - 0.367 gal/ft, 4" - 0.653 gal/ft  $\{[(TD-DTW) \times \text{gal/ft}] \times 3\} + 3.5 \text{ gal} = \text{volume to evac.}$

# FIELD WATER QUALITY SAMPLING AND ANALYSIS DATA SHEET

PROJECT NAME: Cherryvale, KS PROJECT NO: 1804-002

SAMPLER NAME: Gavin James PERSON PRESENT: Oklay Ertugrul

WEATHER: Cloudy AIR TEMP: 50°F LAST PRECIPIT. 3hrs.

LOCATION (STATION NO.)	MW-1	MW-2S	MW-2D	MW-3
DATE AND TIME WATER LEVEL MEASURED	11/14/03 3:00pm	11/14/03 3:05pm	11/14/03 3:00pm	11/14/03 3:09
DATE AND TIME PURGED				
DATE AND TIME SAMPLED				
SAMPLING METHOD				
TOP OF CASING ELEV.				
DEPTH TO WATER (DTW)	4.14'	4.55'	10.73'	3.23'
TOTAL DEPTH (TD)				
REQUIRED PURGE VOLUME				
VOLUME PURGED				
THICKNESS OF NAPL/DNAPL				
SUBSTANCE ON WATER				
SAMPLING TEMP.				
SAMPLING PH (INST. NAME )				
SAMPLING SPEC. COND (INST. NAME )				
COLOR				
ODOR				
SEDIMENT				
FIELD TREATMENT PRESERVATION				
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?				
OTHER				

NOTE: \_\_\_\_\_

Volume calculation: 2" - 0.163 gal/ft, 3" - 0.367 gal/ft, 4" - 0.653 gal/ft  $\{[(TD-DTW) \times \text{gal/ft}] \times 3\} + 3.5 \text{ gal.} = \text{volume to evac.}$

# FIELD WATER QUALITY SAMPLING AND ANALYSIS DATA SHEET

PROJECT NAME: Cherryvale, KS PROJECT NO: 1804-002

SAMPLER NAME: Garvin James PERSON PRESENT: O. Ertugrul

WEATHER: cloudy AIR TEMP: 50°F LAST PRECIPIT. 3 hrs

LOCATION (STATION NO.)	MW-8	TW-2	TW-3	TW-9
DATE AND TIME WATER LEVEL MEASURED	11/18/03 3:39	11/18/03 4:02	11/18/03 4:05	11/18/03 4:36
DATE AND TIME PURGED				
DATE AND TIME SAMPLED				
SAMPLING METHOD				
TOP OF CASING ELEV.				
DEPTH TO WATER (DTW)	3.75'	6.55'	5.25'	8.09'
TOTAL DEPTH (TD)				
REQUIRED PURGE VOLUME				
VOLUME PURGED				
THICKNESS OF NAPL/DNAPL				
SUBSTANCE ON WATER				
SAMPLING TEMP.				
SAMPLING PH (INST. NAME )				
SAMPLING SPEC. COND (INST. NAME )				
COLOR				
ODOR				
SEDIMENT				
FIELD TREATMENT PRESERVATION				
PURGING/SAMPLING PLAN AND PROCEDURES FOLLOWED?				
OTHER				

NOTE: \_\_\_\_\_

Volume calculation: 2" - 0.163 gal/ft, 3" - 0.367 gal/ft, 4" - 0.653 gal/ft  $[(TD-DTW) \times \text{gal/ft}] \times 3 + 3.5 \text{ gal} = \text{volume to evac.}$



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(800)324-5757

Irfan Taner  
A & M Engineering  
10010 E. 16th St.  
Tulsa, OK 74128-4813  
TEL: (918)665-6574  
FAX ( ) 665-6576

August 13, 2003  
Order No.: T03080064

RE: Cherryvale

Dear Irfan Taner:

Sherry Laboratories received 6 samples on 8/7/2003 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604  
AR - ADEQ  
KS - E-10232  
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,  
Tom Gilroy

Approved By: \_\_\_\_\_

Brian Duzan, Director  
Environmental Services



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**QA/QC REPORT  
A & M Engineering  
SAMPLE # T03080064  
BATCH QC**

<b>PARAMETERS</b>	<b>LFB</b>	<b>MS % REC.</b>	<b>MSD % REC.</b>	<b>RPD</b>
Arsenic	101	98	98	0.01
Cadmium	105	103	104	0.8
Chromium	104	103	104	1.2
Lead	102	104	105	0.4
Silver	102	101	102	1.0
Mercury	110	100	102	1.5

Approved by:

SHERRY LABORATORIES/OKLAHOMA

Brian Duzan  
Laboratory Director



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**CLIENT:** A & M Engineering  
**Lab Order:** T03080064  
**Project:** Cherryvale

**Date Received:** 8/7/2003  
**Date Reported:** 13-Aug-03

**Lab ID:** T03080064-01    **Collection Date:** 8/6/2003 3:31:00 PM    **Sample ID:** MW #5

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 11:27:52	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 11:27:52	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 11:27:52	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 11:27:52	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 11:27:52	

**Lab ID:** T03080064-02    **Collection Date:** 8/6/2003 3:47:00 PM    **Sample ID:** MW #8

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:01:55	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:01:55	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:01:55	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:01:55	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:01:55	

**Lab ID:** T03080064-03    **Collection Date:** 8/6/2003 3:57:00 PM    **Sample ID:** MW #7

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:06:50	
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:06:50	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:06:50	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:06:50	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:06:50	



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**CLIENT:** A & M Engineering  
**Lab Order:** T03080064  
**Project:** Cherryvale

**Date Received:** 8/7/2003  
**Date Reported:** 13-Aug-03

**Lab ID:** T03080064-04    **Collection Date:** 8/6/2003 4:05:00 PM    **Sample ID:** MW #6

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	KR
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:11:46	KR
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:11:46	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:11:46	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:11:46	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:11:46	

**Lab ID:** T03080064-05    **Collection Date:** 8/6/2003    **Sample ID:** Duplicate

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	KR
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:16:43	KR
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:16:43	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:16:43	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:16:43	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:16:43	

**Lab ID:** T03080064-06    **Collection Date:** 8/6/2003    **Sample ID:** Equip. Blank

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			
Mercury	< 0.000100	0.000100	mg/L	8/7/2003	KR
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			
Arsenic	< 0.00500	0.00500	mg/L	8/8/2003 12:21:40	KR
Cadmium	< 0.00100	0.00100	mg/L	8/8/2003 12:21:40	
Chromium	< 0.0100	0.0100	mg/L	8/8/2003 12:21:40	
Lead	< 0.00500	0.00500	mg/L	8/8/2003 12:21:40	
Silver	< 0.00200	0.00200	mg/L	8/8/2003 12:21:40	





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Altay Ertugrul  
A & M Engineering  
10010 E. 16th St.  
Tulsa, OK 74128-4813  
TEL: (918) 665-6574  
FAX ( ) 665-6576

September 29, 2003  
Order No.: T03090311

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 6 samples on 9/24/2003 for the analyses presented in the following report.

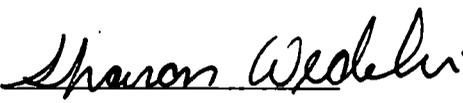
In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604  
AR - ADEQ  
KS - E-10232  
LA - 4002

A scope of Certified/Accredited parameters is available upon request.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Approved By:   
Brian Duzan, Director  
Environmental Services



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**CLIENT:** A & M Engineering  
**Lab Order:** T03090311  
**Project:** Cherryvale

**Date Received:** 9/24/2003  
**Date Reported:** 29-Sep-03

**Lab ID:** T03090311-01    **Collection Date:** 9/23/2003 4:00:00 PM    **Sample ID:** MW 5

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>	<b>E245.2</b>				<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>	<b>E200.7</b>				<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 1:59:31	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 1:59:31	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 1:59:31	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 1:59:31	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 1:59:31	

**Lab ID:** T03090311-02    **Collection Date:** 9/23/2003 4:30:00 PM    **Sample ID:** MW 6

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>	<b>E245.2</b>				<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>	<b>E200.7</b>				<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:09:16	
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 11:24:0	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:09:16	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 11:24:0	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:09:16	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 11:24:0	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:09:16	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 11:24:0	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:09:16	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 11:24:0	



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**CLIENT:** A & M Engineering  
**Lab Order:** T03090311  
**Project:** Cherryvale

**Date Received:** 9/24/2003  
**Date Reported:** 29-Sep-03

**Lab ID:** T03090311-03 **Collection Date:** 9/23/2003 4:40:00 PM **Sample ID:** MW 7

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>	<b>E245.2</b>				<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>	<b>E200.7</b>				<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:18:55	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:18:55	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:18:55	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:18:55	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:18:55	

**Lab ID:** T03090311-04 **Collection Date:** 9/23/2003 4:50:00 PM **Sample ID:** MW 8

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>	<b>E245.2</b>				<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>	<b>E200.7</b>				<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:48:09	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:48:09	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:48:09	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:48:09	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:48:09	

**Lab ID:** T03090311-05 **Collection Date:** 9/23/2003 **Sample ID:** Duplicate

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>	<b>E245.2</b>				<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>	<b>E200.7</b>				<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:53:28	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:53:28	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:53:28	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:53:28	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:53:28	



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**CLIENT:** A & M Engineering  
**Lab Order:** T03090311  
**Project:** Cherryvale

**Date Received:** 9/24/2003  
**Date Reported:** 29-Sep-03

**Lab ID:** T03090311-06    **Collection Date:** 9/23/2003

**Sample ID:** Equipment Blank

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>	<b>E245.2</b>				<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	9/24/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>	<b>E200.7</b>				<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	9/26/2003 2:59:14	
Cadmium	< 0.00100	0.00100	mg/L	9/26/2003 2:59:14	
Chromium	< 0.0100	0.0100	mg/L	9/26/2003 2:59:14	
Lead	< 0.00500	0.00500	mg/L	9/26/2003 2:59:14	
Silver	< 0.00200	0.00200	mg/L	9/26/2003 2:59:14	

CLIENT: A & M Engineering  
 Work Order: T03090311  
 Project: Cherryvale

**QC SUMMARY REPORT**

TestCode	Analyte	BatchID	QType	Result	PQL	Units	%Rec	%RPD
HG_WW	Mercury	R15859	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R15859	LCS	0.001035	0.0001	mg/L	103	
	Mercury	R15859	MS	0.000937	0.0001	mg/L	93.7	
	Mercury	R15859	MS	0.001032	0.0001	mg/L	103	
	Mercury	R15859	MSD	0.000971	0.0001	mg/L	97.1	3.56
	Mercury	R15859	MSD	0.001003	0.0001	mg/L	100	2.85
met_ww_icpt	Arsenic	R15904	mblk	< 0.0050	0.005	mg/L		
	Cadmium	R15904	mblk	< 0.0010	0.001	mg/L		
	Chromium	R15904	mblk	< 0.010	0.01	mg/L		
	Lead	R15904	mblk	< 0.0050	0.005	mg/L		
	Silver	R15904	mblk	< 0.0020	0.002	mg/L		
	Arsenic	R15904	lcs	2.017	0.005	mg/L	101	
	Cadmium	R15904	lcs	1.995	0.001	mg/L	99.7	
	Chromium	R15904	lcs	1.977	0.01	mg/L	98.8	
	Lead	R15904	lcs	1.964	0.005	mg/L	98.2	
	Silver	R15904	lcs	0.2031	0.002	mg/L	102	
	Arsenic	R15904	ms	1.988	0.005	mg/L	99.4	
	Cadmium	R15904	ms	1.99	0.001	mg/L	99.5	
	Chromium	R15904	ms	2.008	0.01	mg/L	100	
	Lead	R15904	ms	2.105	0.005	mg/L	105	
	Silver	R15904	ms	0.1993	0.002	mg/L	99.7	
	Arsenic	R15904	msd	1.971	0.005	mg/L	98.6	0.824
	Cadmium	R15904	msd	1.985	0.001	mg/L	99.2	0.279
	Chromium	R15904	msd	2.004	0.01	mg/L	100	0.192
	Lead	R15904	msd	2.093	0.005	mg/L	105	0.589
	Silver	R15904	msd	0.2007	0.002	mg/L	100	0.67

103090311

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AND  
ENVIRONMENTAL SERVICES, INC.**



TULSA, OKLAHOMA  
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

10010 E. 16th Street - TULSA, OKLAHOMA 74128-4813  
TEL: (918)665-6575 FAX: (918)665-6576 E-Mail: aandm@aandmengineering.com

SAMPLING FIRM  
A & M ENGINEERING

CLIENT CONTACT  
Irfan Tuner

PHONE NUMBER  
(918) 665-6575

PROJECT NUMBER  
1804-002-203

PROJECT NAME  
Cherryvale

ANALYTICAL TESTS REQUIRED									
<div style="display: flex; justify-content: space-around;"> <span>Arsenic</span> <span>Cadmium</span> <span>Lead</span> <span>Chromium</span> <span>Silver</span> <span>Mercury</span> </div>									

SAMPLERS: (Signature)  
*Jon Kuhn*

STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ?		ANALYTICAL TESTS REQUIRED						REMARKS
								YES	NO	Arsenic	Cadmium	Lead	Chromium	Silver	Mercury	
	9/23/03	16:00			MW 5	Liq	1		X	X	X	X	X	X	X	
	9/23/03	16:30			MW 6	Liq	1		X	X	X	X	X	X	X	
	9/23/03	16:40			MW 7	Liq	1		X	X	X	X	X	X	X	
	9/23/03	16:50			MW 8	Liq	1		X	X	X	X	X	X	X	
	9/23/03				Duplicate	Liq	1		X	X	X	X	X	X	X	
	9/23/03				Equipment Bk	Liq	1		X	X	X	X	X	X	X	

RELINQUISHED BY: (Signature) *Mary McGowan* DATE 9/24/03 TIME 10:25 RECEIVED BY: (Signature) *Jon Kuhn*

RELINQUISHED BY: (Signature) *Jon Kuhn* DATE 9/24/03 TIME 08:00 RECEIVED BY: (Signature) *Mary McGowan*

RELINQUISHED BY: (Signature) DATE TIME RECEIVED BY: (Signature)

RELINQUISHED BY: (Signature) DATE TIME RECEIVED BY: (Signature)

RELINQUISHED BY: (Signature) DATE TIME RECEIVED BY: (Signature)

REMARKS:

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Altay Ertugrul  
A & M Engineering  
10010 E. 16th St.  
Tulsa, OK 74128-4813  
TEL: (918) 665-6574  
FAX ( ) 665-6576

October 29, 2003  
Order No.: T03100263

RE: Cherryvale

Dear Altay Ertugrul:

Sherry Laboratories received 5 samples on 10/21/2003 for the analyses presented in the following report.

In accordance with your instructions, Sherry Laboratories/Oklahoma conducted the analysis shown on the following pages on samples submitted by your company. The results related only to the items tested. Unless otherwise noted, all analysis was conducted using EPA approved methodologies. Test reports meet all the NELAC requirements. All relevant sampling information is on the attached chain-of-custody form. The initials SUB as the analyst designate any testing sub-contracted by SLO.

Certifications/Accreditation: OK - 7604  
AR - ADEQ  
KS - E-10232  
LA - 4002

A scope of Certified/Accredited parameters is available upon request. If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Approved By:   
Brian Duzan, Director  
Environmental Services



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**CLIENT:** A & M Engineering  
**Lab Order:** T03100263  
**Project:** Cherryvale

**Date Received:** 10/21/2003  
**Date Reported:** 29-Oct-03

**Lab ID:** T03100263-01    **Collection Date:** 10/20/2003 3:45:00 P    **Sample ID:** MW #5

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 3:55:5	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 3:55:5	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 3:55:5	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 3:55:5	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 3:55:5	

**Lab ID:** T03100263-02    **Collection Date:** 10/20/2003 4:15:00 P    **Sample ID:** MW #6

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:00:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:00:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:00:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:00:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:00:4	

**Lab ID:** T03100263-03    **Collection Date:** 10/20/2003 4:05:00 P    **Sample ID:** MW #7

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:05:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:05:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:05:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:05:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:05:4	



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**CLIENT:** A & M Engineering  
**Lab Order:** T03100263  
**Project:** Cherryvale

**Date Received:** 10/21/2003  
**Date Reported:** 29-Oct-03

**Lab ID:** T03100263-04    **Collection Date:** 10/20/2003 3:55:00 P    **Sample ID:** MW #8

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:10:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:10:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:10:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:10:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:10:4	

**Lab ID:** T03100263-05    **Collection Date:** 10/20/2003    **Sample ID:** Duplicate

**Matrix:** AQUEOUS

<u>Analyses</u>	<u>Result</u>	<u>Detection Limit</u>	<u>Units</u>	<u>Date Analyzed</u>	<u>Analyst</u>
<b>MERCURY IN WATER, TOTAL</b>		<b>E245.2</b>			<b>KR</b>
Mercury	< 0.000100	0.000100	mg/L	10/21/2003	
<b>METALS IN WATER BY ICP, TOTAL</b>		<b>E200.7</b>			<b>KR</b>
Arsenic	< 0.00500	0.00500	mg/L	10/23/2003 4:14:4	
Cadmium	< 0.00100	0.00100	mg/L	10/23/2003 4:14:4	
Chromium	< 0.0100	0.0100	mg/L	10/23/2003 4:14:4	
Lead	< 0.00500	0.00500	mg/L	10/23/2003 4:14:4	
Silver	< 0.00200	0.00200	mg/L	10/23/2003 4:14:4	

CLIENT: A & M Engineering  
 Work Order: T03100263  
 Project: Cherryvale

**QC SUMMARY REPORT**

TestCode	Analyte	BatchID	QCType	Result	PQL	Units	%Rec	%RPD
HG_WW	Mercury	R16222	MBLK	< 0.00010	0.0001	mg/L		
	Mercury	R16222	LCS	0.001019	0.0001	mg/L	102	
	Mercury	R16222	MS	0.000935	0.0001	mg/L	93.5	
	Mercury	R16222	MSD	0.000966	0.0001	mg/L	96.6	3.26
met_ww_icpt	Arsenic	1628	mblk	< 0.0050	0.005	mg/L		
	Cadmium	1628	mblk	< 0.0010	0.001	mg/L		
	Chromium	1628	mblk	< 0.010	0.01	mg/L		
	Lead	1628	mblk	< 0.0050	0.005	mg/L		
	Silver	1628	mblk	< 0.0020	0.002	mg/L		
	Arsenic	1628	lcs	2.016	0.005	mg/L	101	
	Cadmium	1628	lcs	2.03	0.001	mg/L	101	
	Chromium	1628	lcs	2.027	0.01	mg/L	101	
	Lead	1628	lcs	2.015	0.005	mg/L	101	
	Silver	1628	lcs	0.2011	0.002	mg/L	101	
	Arsenic	1628	ms	2.023	0.005	mg/L	101	
	Cadmium	1628	ms	2.052	0.001	mg/L	103	
	Chromium	1628	ms	2.032	0.01	mg/L	102	
	Lead	1628	ms	2.069	0.005	mg/L	103	
	Silver	1628	ms	0.2041	0.002	mg/L	102	
	Arsenic	1628	msd	2.025	0.005	mg/L	101	0.0829
	Cadmium	1628	msd	2.052	0.001	mg/L	103	0.0301
	Chromium	1628	msd	2.028	0.01	mg/L	101	0.169
	Lead	1628	msd	2.071	0.005	mg/L	104	0.0795
	Silver	1628	msd	0.2041	0.002	mg/L	102	0.0199

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**A & M ENGINEERING AND ENVIRONMENTAL SERVICES, INC.**



TULSA, OKLAHOMA  
ENGINEERING - ENVIRONMENTAL - CONSTRUCTION

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SAMPLING FIRM  
**A & M ENGINEERING**

CLIENT CONTACT  
*Irfan Tunde*

PHONE NUMBER  
(918) 665-6575

PROJECT NUMBER  
*1804-002-203*

PROJECT NAME  
*Cherryvale*

SAMPLERS: (Signature)  
*[Signatures]*

										ANALYTICAL TESTS REQUIRED						REMARKS
STA. NO	DATE	TIME	COMP	GRAB	STATION LOCATION	MATRIX	NO. OF CONTAINERS	RUSH ?		Ar	Cd	Pb	Cr	Ag	Hg	
								YES	NO							
	<i>10/20/03</i>	<i>15:45</i>			<i>MW # 5</i>	<i>Lip</i>	<i>1</i>		<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	
	<i>10/20/03</i>	<i>16:15</i>			<i>MW # 6</i>	<i>Lip</i>	<i>1</i>		<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	
	<i>10/20/03</i>	<i>16:05</i>			<i>MW # 7</i>	<i>Lip</i>	<i>1</i>		<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	
	<i>10/20/03</i>	<i>15:55</i>			<i>MW # 8</i>	<i>Lip</i>	<i>1</i>		<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	
	<i>10/20/03</i>				<i>Duplicate</i>	<i>Lip</i>	<i>1</i>		<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	<i>X</i>	

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*[Signature]* *10/21/03 09:20* *[Signature]*

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REMARKS: