AP - 46

STAGE 1 & 2 WORKPLANS

DATE:

Oct. 14, 2005

STAGE 1 ABATEMENT PLAN

EME K-6 LINE LEAK SITE

T20S, R37E, SECTION 6, UNIT LETTER K
LEA COUNTY, NEW MEXICO

Prepared for:

RICE *Operating Company*
122 West Taylor
Hobbs, New Mexico 88240

SUBMITTED BY:

DATE:

Gilbert J. Van Deventer

OCTOBER 14, 2005

GILBERT J. VAN DEVENTER

R. T. HICKS CONSULTANTS, LTD.

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1.0 EXECUTIVE SUMMARY

The K-6 vent junction box site is operated by Rice Operating Company (ROC) and is located in township 20 south, range 37 east, section 6, unit letter K approximately 4 miles west-southwest of Monument, NM.

Identification of soil and ground water impacts occurred during line replacement being performed as part of the approved Junction Box Upgrade Program in January 2002. This Stage I Abatement Plan incorporates the preliminary findings from previous investigations and contents of the previously submitted Investigation and Characterization Plan (ICP) to satisfy the required elements of a Stage I Abatement Plan in accordance with New Mexico Oil Conservation Division (NMOCD) Rule 19. Section 7.0 of this report describes the abatement options that were evaluated and proposed to further satisfy the Stage I elements. Quality assurance protocols and the proposed schedule of activities are included in sections 8.0 and 9.0, respectively.

We propose the work elements, which are described in detail in section 7.0, to delineate the extent and magnitude of regulated constituents of concern in the vadose zone and to determine if the ground water impact observed at the site is due to the historical releases from the vent junction box or is due to releases from non-ROC off site sources. The constituents of concern are chloride, sulfate, total dissolved solids (TDS), benzene, toluene, ethylbenzene, and xylenes (BTEX). The purpose of these work elements is to assist ROC in selecting the appropriate soil and/or ground water remedy. The proposed work elements are summarized below:

- Define regional ground water flow direction, potential sources of chloride in ground water and ambient ground water chemistry
- Install soil borings and, if necessary, monitoring wells, for evaluation of constituents of concern in the vadose zone and ground water.
- Evaluate chloride flux in the vadose zone using HYDRUS-1D model.
- Evaluate BTEX flux in the vadose zone using NMOCD or NMED-approved models

When implementing any proposed remedy or investigative work, ROC will confirm that there is a reasonable relationship between the benefits created by the proposed remedy or assessment and the economic and social costs.

ROC is the service provider (operator) for the EME SWD System and has no ownership of any portion of the pipeline, well, or facility. The System is owned by a consortium of oil producers, (System Partners) who provide all operating capital on a percentage ownership/usage basis. Environmental projects of this magnitude require System Partner authorization for expenditure (AFE) approval and work begins as funds are received. In general, project funding is not forthcoming until NMOCD approves the work plan.

2.0 CHRONOLOGY OF EVENTS

The upgrade of the EME K-6 vent junction box was initiated in January 2002, which included the replacement of the existing vent junction box with a lined watertight plastic junction box and replacement of the 10-inch diameter transite pipeline with 6-inch diameter PVC pipeline.

The subsurface soils at the K-6 vent junction box site were investigated as part of the approved Junction Box Upgrade Program on January 22, 2002, by trenching with a backhoe and field-tested for chloride and hydrocarbon levels. This investigation indicated chloride and hydrocarbon impact to the vadose zone.

A monitoring well (MW-1) was installed within a few feet of the former vent junction box on January 23, 2002, and has been sampled and analyzed for BTEX, major ions, and TDS on a quarterly basis since that date. ROC submitted notification of ground water impact to the NMOCD on February 4, 2002. The 2004 Monitor Well Report for the K-6 vent junction box site was submitted on January 21, 2005.

Trident Environmental submitted an Investigation and Characterization Plan (ICP) on March 3, 2005, to address potential environmental concerns at the above-referenced site. On May 5, 2005, Mr. Daniel Sanchez of the NMOCD requested that ROC submit an abatement plan to the NMOCD pursuant to Rule 19. Appendix A shows photographs from the site.

3.0 BACKGROUND

3.1 SITE LOCATION AND LAND USE

The K-6 vent junction box site is located on Bureau of Land Management (BLM) Land in township 20 south, range 37 east, section 6, unit letter K approximately 4 miles west-southwest of Monument, NM as shown on the attached Site Location Map (Plate 1). Land in the site area is primarily utilized for crude oil production and cattle ranching. ChevronTexaco and Amerada Hess operate area crude oil production.

3.2 NATURE OF RELEASE AND SUMMARY OF PREVIOUS WORK

The upgrade of the EME K-6 vent junction box was initiated in January 2002, which included the replacement of the existing vent junction box with a lined watertight plastic junction box and replacement of the 10-inch diameter transite pipeline with 6-

inch diameter PVC pipeline, as shown in the attached photographs. Also, 36 cubic yards of hydrocarbon-impacted soils were removed and transported to an NMOCD-approved land farm.

Produced water gathered by the EME SWD System in the site area is sent to the M-5 SWD well, which is located approximately $^{2}/_{3}$ miles east of the K-6 Junction Box site. A monitoring well (MW-1) was installed within a few feet of the former vent junction box on January 23, 2002, and has been sampled and analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX), major ions, and total dissolved solids (TDS) on a quarterly basis since that date. ROC submitted notification of ground water impact to the NMOCD on February 4, 2002. The 2004 Monitor Well Report for the K-6 vent junction box site was submitted on January 21, 2005.

4.0 GEOLOGY AND HYDROGEOLOGY

4.1 REGIONAL AND LOCAL GEOLOGY

According to published information (Nicholson and Clebsch, 1961, Barnes, 1976, and Anderson, Jones, and Green, 1997) the site is underlain by Quaternary eolian and piedmont deposits composed of sand, silt, and gravel deposited by slopewash, and talus from the Ogallala Formation. The eolian and piedmont deposits are often calichified (indurated with cemented calcium carbonate) with caliche layers from 1 to 20 feet thick. The lithology of the eolian and piedmont deposits is very similar to that of the Ogallala since the Ogallala is the source of these re-deposited colluvial sediments. The nearest outcropping of the Ogallala Formation occurs approximately one mile north of Monument along what is known as the Llano Estacado (caprock). The thickness of the colluvium deposits and Ogallala Formation is approximately 75 feet, however it varies locally as a result of significant paleo-topography at the top of the underlying Triassic Dockum Group. Since Cretaceous Age rocks in the region have been removed by pre-Tertiary erosion, the colluvial deposits and Ogallala Formation rest unconformably on the Triassic Dockum Group. The uppermost unit of the Dockum Group is the Chinle Formation, which primarily consists of micaceous red clay and shale but also contains thin interbeds of fine-grained sandstone and siltstone. The red clays and shale of the Chinle Formation act as an aquitard beneath the water bearing colluvial deposits and therefore limit the amount of recharge to the underlying Dockum Group. The thickness of the Dockum Group is estimated at approximately 300 feet in the site area although its thickness in southern Lea County varies from 0 to 1,270 feet thick (Nicholson and Clebsch, 1961). Plate 2 shows the surface geology of the site.

The first few feet from ground surface are dominated by fine to medium-grained dune sand. Based on the descriptions provided in lithologic logs the subsurface soils

are composed of caliche, sand, sandstone stringers, and some clay. A lithologic log is included in the Appendix B.

4.2 REGIONAL AND LOCAL HYDROGEOLOGY

Potable ground water used in southern Lea County is derived primarily from the Ogallala Formation (including the colluvial deposits) and the Quaternary alluvium. Lower yields have also been provided by water bearing zones within the Triassic Dockum Group in a few scattered areas within southern Lea County. No potable water is known to be derived below the Triassic Dockum Group. Water from the Ogallala and alluvium aquifers in southern Lea County is used for irrigation, stock, domestic, industrial, and public supply purposes.

Nicholsen and Clebsch (1961) found that the regional gradient of the Ogallala and interconnected colluvial aquifer in the site area generally flows toward the southeast and the hydraulic gradient varies from approximately 0.001 to 0.01 feet/feet. Recent data from ROC sites within a mile from the K-6 vent junction box site (P-6, N-5, E-5, and M-5) confirm a similar potentiometric surface.

Recharge to the Ogallala aquifer occurs primarily by infiltration of precipitation at a slow rate (typically one quarter to one half inch of water per year) is due to the characteristically arid climate of southern Lea County (Nicholson and Clebsch, 1961). In the Monument Area, the colluvium is recharged by both precipitation and by flow from the Ogallala Aquifer into the colluvium. Monument Springs is a surface expression of the connection between the two saturated units.

Hydraulic conductivity values are estimated between 26 and 50 feet per day and specific yields of 0.23 for the Ogallala aquifer near the site area based on limited published information (McAda, 1984). There are no surface water bodies located within a mile of the site.

Depth to ground water beneath the site area is approximately 34 feet below ground surface.

5.0 VADOSE ZONE CHARACTERISTICS

ROC conducted initial upper vadose zone delineation field activities on January 22, 2002, as part of the Junction Box Upgrade Program. Investigation activities were conducted with a backhoe by trenching to 10 to 16 feet below ground surface (bgs) at 13 locations within 50 feet of the vent junction box (Plate 3). Soil samples were analyzed in the field for chlorides using field-adapted Method 9253 (QP-03). Field chlorides ranged from a concentration of 50 milligrams per kilogram (mg/kg) to

1,000 mg/kg. ROC did not evaluate the samples for regulated hydrocarbon components during their preliminary assessment of this site.

To further delineate depth of impact in the vadose zone and to assess ground water quality, a monitoring well (MW-1) was installed within a few feet of the former vent junction box on January 23, 2002, to a depth of 40 feet bgs. A copy of the drilling log is included in Appendix B. Laboratory analytical results for gas range organics (GRO) and diesel range organics (DRO) using EPA Method 8015M of a sample near the interface of the vadose zone and saturated zone indicated a GRO concentration of less than 10 milligrams per kilogram (mg/kg) and DRO concentration of 161 mg/kg at 36 feet bgs. Chloride concentrations in the boring samples ranged from 250 mg/kg to 1,104 mg/kg. Copies of the laboratory analytical report and chain of custody form for the soil boring sample is included in Appendix C.

6.0 GROUND WATER QUALITY

6.1 MONITORING PROGRAM

Monitoring well (MW-1) has been sampled on a quarterly basis for major ions, TDS, and BTEX. A summary of historical analytical results and ground water elevations is listed in Table 1. Analytical results for the most recent sampling event conducted on May 3, 2005, are also depicted in graphical format in Figure 1. A copy of the laboratory analytical report and chain of custody form for the most recent ground water sampling event is included in Appendix C.

6.2 HYDROCARBONS IN GROUND WATER

BTEX concentrations in monitoring well MW-1 have been below the laboratory detection limit of 0.001 mg/L for each constituent and for every sampling event taken place.

6.3 OTHER CONSTITUENTS OF CONCERN

- Chloride concentrations in monitoring well MW-1 (11,200 mg/L) exceed the WQCC standard of 250 mg/L.
- Monitoring well MW-1 (4,230 mg/L) exceeds the WQCC standard of 600 mg/L for sulfate.
- The TDS concentration in monitoring well MW-1 (25,400 mg/L) exceeds the WQCC standard of 1,000 mg/L.

Background and ambient concentrations of these compounds have not been established at this time. Chloride, sulfate, and TDS concentrations in monitoring well MW-1 have remained relatively stable although some minor fluctuations have occurred. No correlations between chloride/sulfate/TDS concentrations and changes in ground water levels are evident.

7.0 STAGE I ABATEMENT PLAN

We first must test our hypothesis that operation of K-6 Vent caused ground water impairment. If this site caused, contributed to, or could contribute to ground water impairment, we must collect sufficient data to design an appropriate remedy. We propose collecting regional ground water data and a subsequent field program at the site to test our hypothesis and collect the data required for a remedy.

7.1 DEFINE REGIONAL GROUND WATER FLOW DIRECTION, POTENTIAL SOURCES OF CHLORIDE IN GROUND WATER AND AMBIENT GROUND WATER CHEMISTRY

First, we plan to examine State records for evidence of releases up-gradient from the K-6 site. We also plan to examine records at the Office of the State Engineer (NMOSE) and the USGS for water quality and water level data. This file search should provide a better understanding of ground water flow and ambient (and possibly background) water chemistry. Plate 4 presents the locations of NMOCD file data, OSE wells, NMED data and USGS data that we have collected to date and we can draw upon for this examination. The water well inventory will also assist in to identify the location of potential water supply receptors (domestic, irrigation, or livestock wells).

Second, we will use ROC ground water elevations and water chemistry data from nearby wells to compliment the data already in NMOCD and NMED files. Plate 4 shows the location of nearby ROC monitoring wells where we have data. Plate 4 also shows the locations of other sites where we may find it helpful to collect data to assist us in understanding the contribution of the K-6 site to the observed regional chemistry.

7.2 EVALUATE CONSTITUENTS OF CONCERN IN THE VADOSE ZONE AND GROUND WATER

We will complete at least two soil borings to delineate the lateral and vertical extent of impact to the vadose zone. Soil samples will be collected at regular intervals no less than five feet from ground surface to the water table. We will screen each sample in the field

using a PID and field test each sample for chlorides (QP-03). Soil lithology and the presence of any observed staining or odor will be recorded. Ten percent (10%) of the soil samples will be submitted for laboratory analysis of chlorides as confirmation of our field analysis. The following concentrations of analytes will be used to delineate the lateral and vertical extent of impact to the vadose zone:

- 100 ppm OVM, and/or 10 mg/kg benzene, and 50 mg/kg BTEX
- 250 ppm chloride

The number and placement of the soil borings is dependent on determinations made in the field of the delineation parameters listed above. Ground water samples from the existing monitoring well suggest ground water impairment, therefore we will construct a downgradient monitoring well 100 feet to 200 feet southeast from the existing monitoring well. Since regional data is insufficient to determine the ambient chloride concentration in this area, we will also complete an up gradient monitoring well. We will complete these monitoring wells consistent with NMOCD and industry guidance with 5 feet of screen above the water table and a minimum of 10 feet of screen below the water table. We plan to drill to the underlying Triassic red beds (Chinle Formation) for the up gradient monitoring well to define the saturated thickness in the area.

We believe that Task 1 will identify existing monitoring and water wells that may be employed to collect representative samples down gradient and up gradient from the K-6 site for expanded assessment of potential upgradient sources. Assuming that we can obtain access to the wells, ROC will include applicable wells in their sampling program.

7.3 Evaluate Chloride Flux from the Vadose Zone to Ground Water

We propose to employ HYDRUS-1D and a simple ground water mixing model to evaluate the potential of chlorides to impair ground water quality at the site. We will employ predictions of the migration of chlorides from the vadose zone to ground water then select an appropriate remedy for the land surface and underlying vadose zone. For this simulation, we will employ the input parameters to HYDRUS and the mixing model as outlined in Table 2.

7.4 Evaluate BTEX Flux from the Vadose Zone to Ground Water

If we find that regulated constituents (BTEX) exist in the vadose zone above published risk-based concentrations (e.g. NMED Tier 1 levels) we propose to employ the New Mexico Risk-Based Decision Making computational software and/or the VLEACH fate and transport model (or other NMOCD or NMED-approved model) to evaluate the

potential of the BTEX constituents to impair ground water quality at the site. We will employ predictions of the migration of each BTEX constituent from the vadose zone to ground water then select an appropriate remedy for the land surface and underlying vadose zone.

7.5 CORRECTIVE ACTION/CLOSURE

If simulation experiments suggest that residual constituents pose a threat to ground water quality or if the field program demonstrates impairment, we will expand upon the fate and transport model predictions described above to develop a remedy for the vadose zone.

8.0 QUALITY ASSURANCE / QUALITY CONTROL

Sampling and analytical procedures shall be performed in accordance with Title 20 NMAC 6.3107.B and Section 103 of the Water Quality Standards for Interstate and Intrastate Streams in New Mexico (20 NMAC 6.1). Specific quality procedures for collecting and analyzing soil and ground water samples are included in Appendix D.

9.0 PROPOSED SCHEDULE OF ACTIVITIES

The proposed schedule of activities is listed in below.

Task	Task Goals	Task Completion Schedule
1	Submission of Progress Reports to NMOCD	Quarterly, beginning 30 days hence approval of Stage 1 Abatement Plan by NMOCD
2	Ground water Monitoring	Continued on a quarterly basis
3	Define regional ground water flow direction, potential sources of chloride in ground water and ambient ground water chemistry	Within 30 days of Stage 1 Abatement Plan approval by NMOCD
4	Install soil borings and monitoring wells, if necessary, for evaluation of constituents of concern in the vadose zone and ground water	Within 45 days of Stage 1 Abatement Plan approval by NMOCD
5	Review laboratory analytical results	Within 15 days of submitting samples to the lab
6	Evaluate chloride flux in the vadose zone using HYDRUS-1D model.	Within 15 days of reviewing laboratory analytical results
7	Evaluate BTEX flux in the vadose zone using NMOCD or NMED-approved model.	Within 15 days of reviewing laboratory analytical results
8	Submission of further corrective action recommendations or request for closure	Within 15 days of evaluation of chloride and BTEX flux in the vadose zone

TABLES

Table 1. Summary of Groundwater Monitoring Results

Monitoring Well	Sample Date	Depth to Groundwater (feet BTOC)	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylene (mg/L)
MW-1	01/25/02	37.20	**12,096**	---	**23,370**	<0.002	<0.002	0.002	0.006
	05/14/02	37.30	**12,000**	**3,960**	**26,700**	0.001	0.003	<0.001	0.004
	08/28/02	37.52	**13,796**	**4,086**	**29,180**	<0.002	<0.002	0.003	<0.006
	11/11/02	38.65	**12,200**	**3,780**	**26,400**	0.001	0.001	0.001	0.003
	02/27/03	37.78	**12,800**	**4,830**	**25,900**	0.001	0.001	0.001	0.003
	05/29/03	37.80	**12,400**	**3,880**	**27,000**	0.002	0.001	0.001	0.001
	08/21/03	37.90	**12,000**	**3,060**	**26,400**	0.003	<0.001	0.002	0.004
	11/19/03	38.17	**11,500**	**3,720**	**26,500**	0.003	0.001	<0.001	0.001
	02/18/04	38.40	**11,796**	**1,903**	**26,172**	0.003	<0.002	<0.002	<0.006
	05/27/04	37.60	**13,800**	**6,020**	**25,700**	0.001	<0.001	<0.001	0.001
	09/07/04	37.96	**11,500**	**3,640**	**24,600**	0.003	<0.001	0.001	0.003
	11/24/04	37.53	**10,800**	**4,140**	**23,900**	0.005	0.004	0.005	0.015
	02/09/05	36.54	**11,200**	**4,670**	**23,500**	0.003	<0.001	<0.001	0.002
	05/03/05	35.60	**11,200**	**4,230**	**25,400**	0.003	0.001	0.002	0.001
		WQCC Standards	250	600	1000	0.01	0.75	0.75	0.62

Total Dissolved Soilds (TDS), chloride, sulfate, and BTEX concentrations listed in milligrams per liter (mg/L)

Analyses performed by Environmental Lab of Texas (Odessa TX) or Cardinal Laboratories (Hobbs NM).

Values in boldface type indicate concentrations exceed New Mexico Water Quality Commission (WQCC) standards.

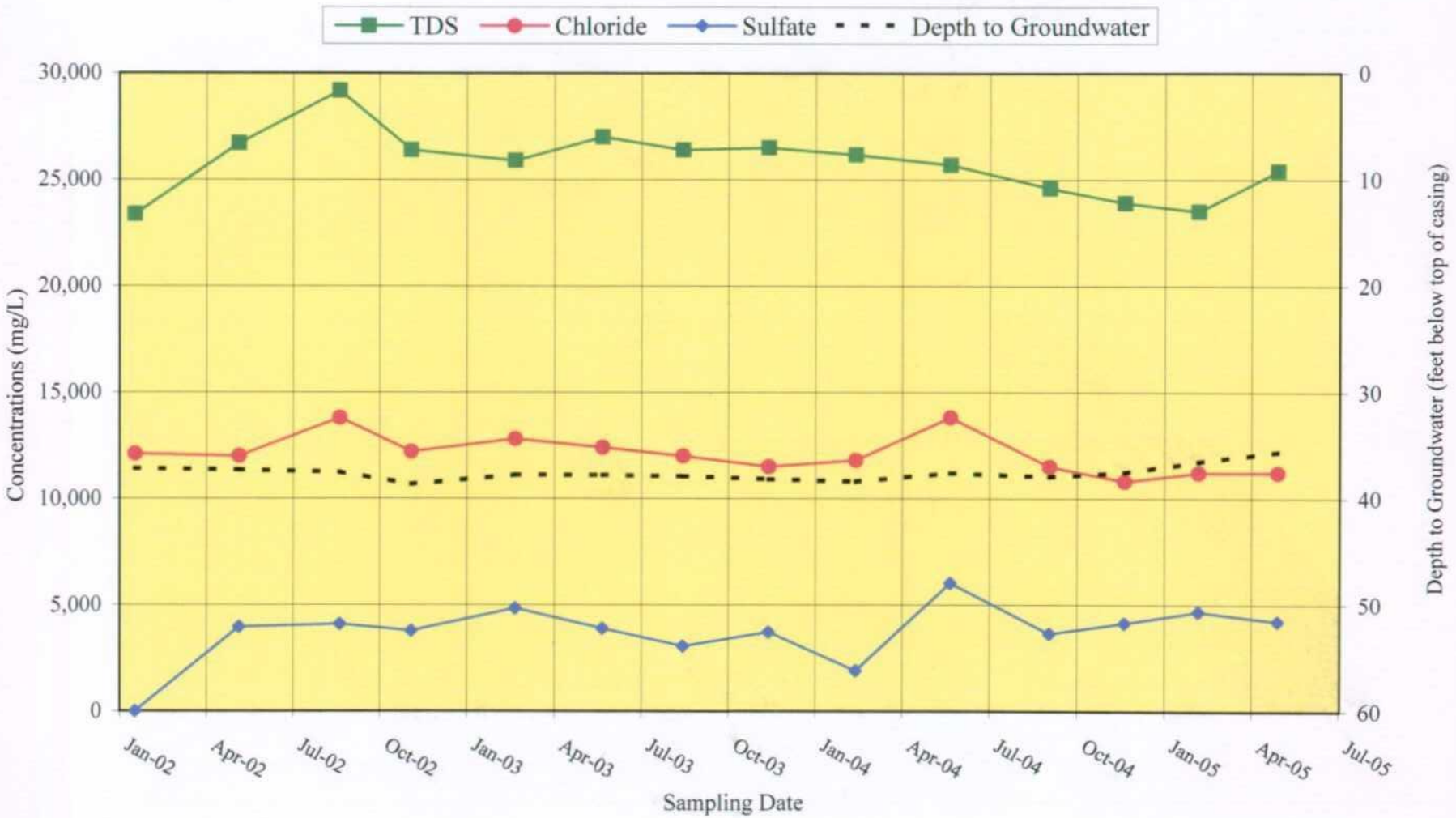
T20S-R37E-Sec 6-Unit K
NMOCD CASE # 1R0427-88
EME K-6 Vent Junction Box Site - Stage I Abatement Plan

Table 2. HYDRUS-1D Parameter Sources

Input Parameter	Source
Vadose Zone Thickness	Nearby water supply well logs
Vadose Zone Texture	Nearby water supply well logs and on-site borings
Dispersion Length	Professional judgment
Soil Moisture – wet	Professional judgment
Vadose Zone Chloride Load – 34 kg/m^2	Calculated from soil boring data
Length of release perpendicular to ground water flow	Field measurements (Plate 2)
Climate	Pearl, NM (Hobbs)
Background chloride in ground water	Analyses from nearby wells
Ground Water Flux	Calculated from regional hydraulic data
Aquifer thickness	On-site wells and nearby water supply wells

FIGURES

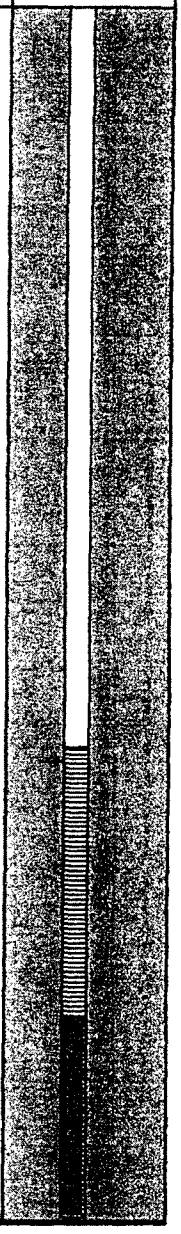
Figure 1
Chloride, Sulfate, TDS, and Depth to Groundwater Values Versus Time Graph (MW-1)



T20S-R37E-Sec 6-Unit K
NMOCD Case # 1R0427-88
EME K-6 Vent Junction Box Site - Stage 1 Abatement Plan

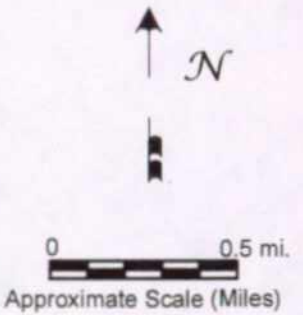
DRILLING LOG	Site Name/Location				Logged by: FDR
RICE *Operarting Company* 122 West Taylor Hobbs, New Mexico 88240 Phone: (505) 393-9174 Fax: (505) 397-1471	**Jct. Box K-6** **6-T20S-R37E** **EME** **SWD System** **Lea County, NM**	Well No.: MW 1	Date Drilled: 1/23/02	Driller: Eades	Construction: Installed 2" PVC *monitor well*, sand & grout.
		Well Depth: 40'	Boring Depth: 40'	Well Material:PVC	
		Casing Length: 43'	Boring Diameter: 6"	Casing Size: 2"	
		Screen Length: 15'	Drilling Method: Air Rotary	Slot Size:	

DEPTH	SUBSURFACE LITHOLOGY	SAMPLE TYPE	TEST (ppm) Cl	TPH	REMARKS	Boring
0	Ground surface					
1	Top Soil					
2						
3	Caliche					
4						
5		Grab	250	odor	Field Test	
6						
7						
8						
9	Sand					
10		Grab	250	odor	Field Test	
11						
12			300	odor	Field Test	
13						
14		Grab	250	odor	Field Test	
15						
16		Grab	250	odor	Field Test	
17						
18		Grab	275	odor	Field Test	
19						
20		Grab	275	odor	Field Test	
21	Sand and sandstone stringers(moist)					
22		Grab	250	odor	Field Test	
23						
24		Grab	250	odor	Field Test	
25	Sand and clay (moist)					
26		Grab	250	odor	Field Test	
27						
28		Grab	250	odor	Field Test	
29						
30		Grab	450	odor	Field Test	
31						
32	Sand (moist)	Grab	450	odor	Field Test	
33						
34						
35						
36		Grab	600	odor	Field Test	
37			1104	161	Lab Test	
38		Grab	600	odor	Field Test	
39						
40		Water Sample	12,096	<0.002	Lab Test	



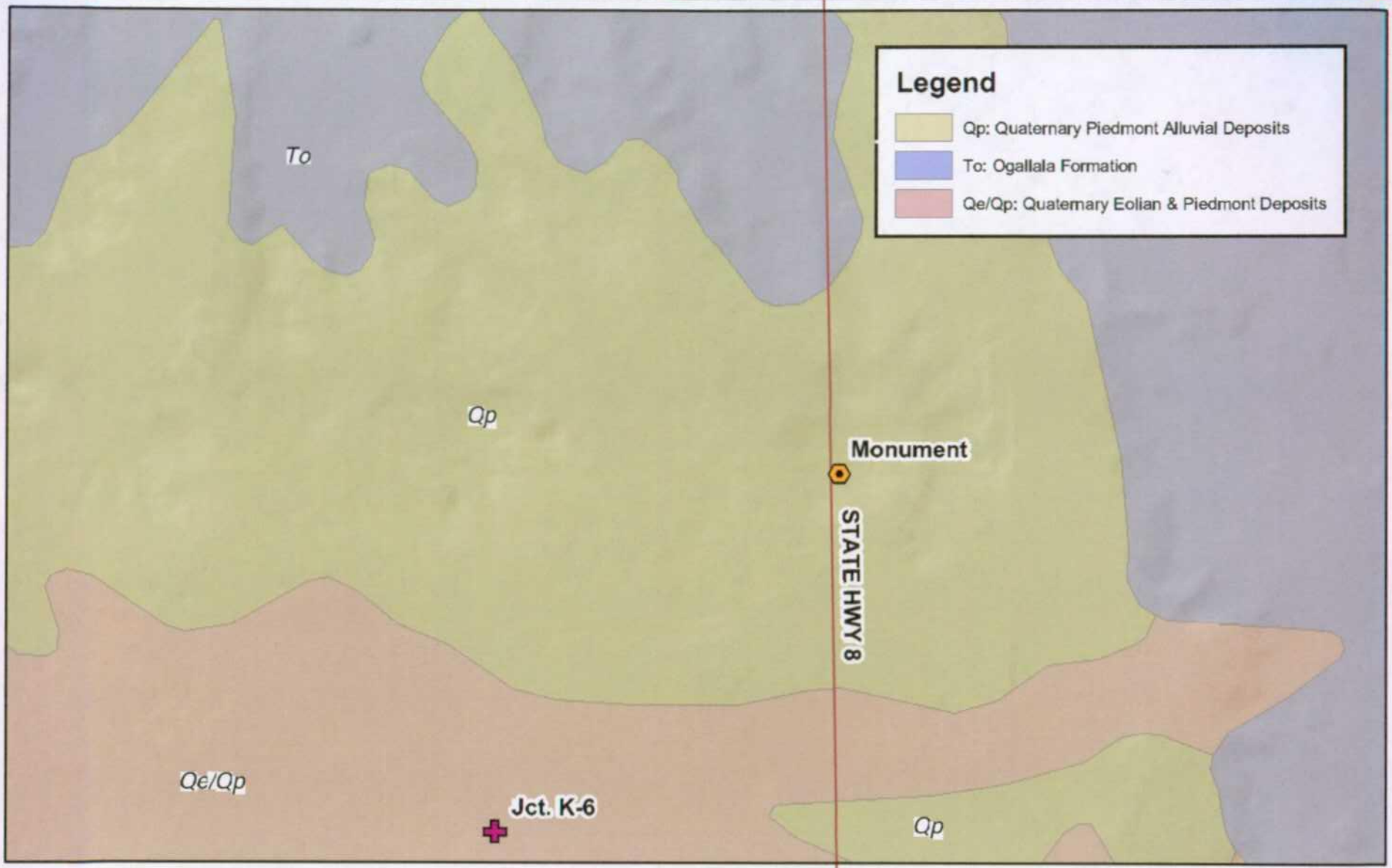
PLATES

SITE LOCATION MAP
EME K-6 Vent Site
T20S-R36E-Section 6 K



Directions: From the junction of Hwy 322 and Hwy 8 in Monument proceed 2 miles west on Hwy 322 then 0.5 miles south. Turn left onto CR 41 (Maddox Rd) and continue 1/2 mile south. Turn left onto caliche lease road and proceed southeast 0.6 miles. Turn right on sandy road and continue 0.15 miles south. Turn right and proceed 100 ft west to site.

R. T. HICKS CONSULTANTS, LTD. 1909 Brunson Ave., Midland TX 79701	Site: EME K-6 Vent Junction Box Site Date: October 14, 2005 Approximate Scale: 1 inch = 0.5 mile	PLATE 1 SITE LOCATION MAP



Source: NMBMMR, 1997. Anderson, Jones, & Green.
USGS Open File Report OF-97-52

0 0.5 1 2 Miles

N W E S

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	Geologic Map: Stage 1 Abatement Plan	Plate 2
	Rice Operating Company	August 2005

...\GIS\Projects2005\ROC_K6\plates\P2_geo.mxd

Sample Location	Depth (Ft bgs)	Chloride (ppm)
A	2	100
	6	100
	10	300
	12	350
B	2	NA
	6	NA
	14	NA
C	14	300
D	2	50
	6	100
	8	100
	10	300
E	14	250
F	6	NA
	12	NA
	15	NA
G	2	200
	6	300
	10	350
	14	500
H	2	100
	6	350
	10	300
	14	400
I	6	500
	8	500
	10	500
	12	500
	14	350
	16	300
J	2	100
	6	250
	10	400
K	6	300
	10	500
	14	800
L	2	100
	6	300
	10	500
	12	1,000
	14	1,000
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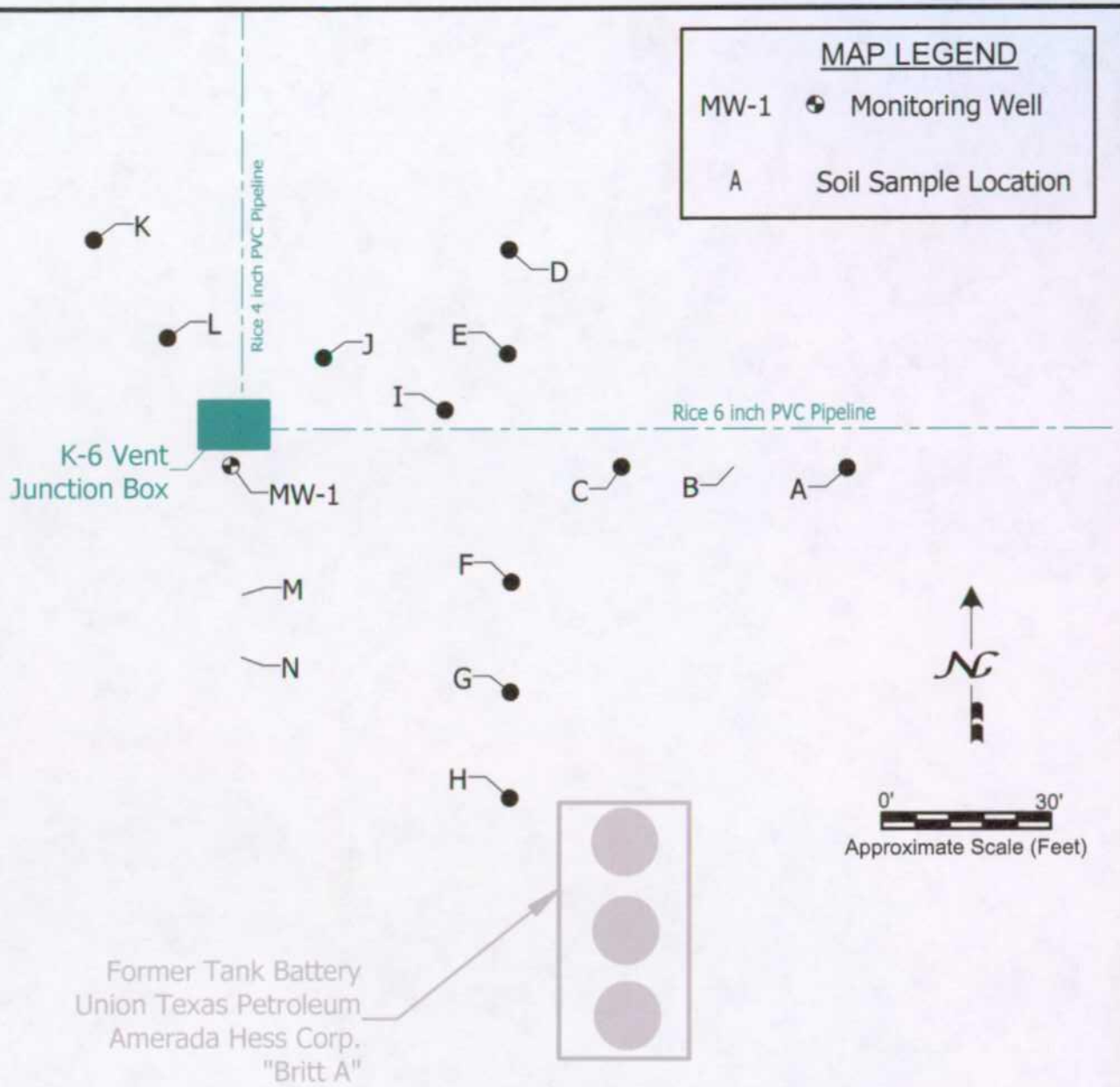
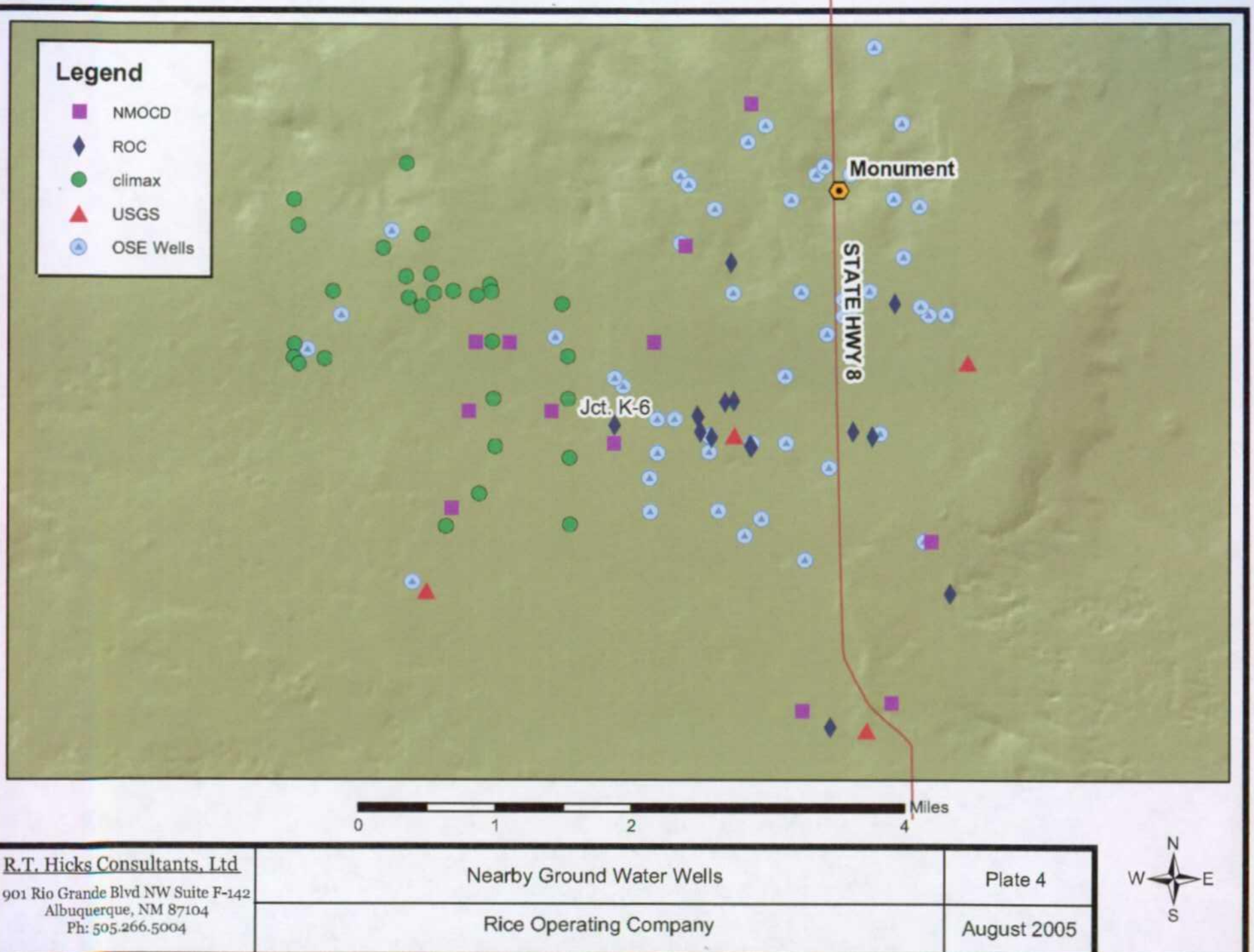
	4	200
	6	NA
	10	200
N	2	NA



R. T. HICKS CONSULTANTS, LTD.
1909 Brunson Ave., Midland TX 79701

Site: EME K-6 Vent Junction Box Site
Sampling Date: January 22, 2002
Sampled By: R. E. Environmental Services
Approximate Scale: 1 inch = 30 feet

PLATE 3
PRELIMINARY SOIL SAMPLE RESULTS



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 Ph: 505.266.5004	Nearby Ground Water Wells	Plate 4
	Rice Operating Company	August 2005

...\GIS\Projects2005\ROC_K6\plates\P4_wells.mxd

PHOTODOCUMENTATION

View of K-6 vent site after pipeline upgrade from 10-inch A/C to 6-inch PVC.

View of K-6 vent junction box (in background) after upgrade to lined watertight plastic junction box. Monitoring Well (MW-1) is shown in foreground.

LABORATORY ANALYTICAL REPORTS

AND

CHAIN OF CUSTODY DOCUMENTATION

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
RICE OPERATING CO.
ATTN: D. ANDERSON
122 W. TAYLOR
HOBBS, NM 88240
FAX TO: (505) 397-1471

Receiving Date: 02/13/02
Reporting Date: 02/15/02
Project Number: JCT K-6
Project Name: EME JCT K-6
Project Location: NOT GIVEN

Sampling Date: 01/23/02
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: BC
Analyzed By: BC/AH

LAB NUMBER	SAMPLE ID	GRO (C_6-C_{10}) (mg/Kg)	DRO (>C_{10}-C_{28}) (mg/Kg)	Cl* (mg/Kg)
ANALYSIS DATE		02/13/02	02/13/02	02/14/02
H6500-1	K-6 SB 36'	<10.0	161	1104
Quality Control		800	804	970
True Value QC		800	800	1000
% Recovery		100	100	97.0
Relative Percent Difference		0.9	5.5	6.9

METHODS: TPH GRO & DRO: EPA SW-846 8015 M; Cl^-: Std. Methods 4500-Cl^-B
*Analysis performed on a 1:4 w:v aqueous extract.

Chemist

2/15/02
Date

H6500A.XLS

CARDINAL LABORATORIES

PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
RICE OPERATING CO.
ATTN: D. ANDERSON
122 W. TAYLOR
HOBBS, NM 88240
FAX TO: (505) 397-1471

Receiving Date: 02/13/02
Reporting Date: 02/15/02
Project Number: JCT K-6
Project Name: EME JCT K-6
Project Location: NOT GIVEN

Sampling Date: 01/23/02
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: BG
Analyzed By: BC

LAB NUMBER SAMPLE ID	BENZENE (mg/Kg)	TOLUENE (mg/Kg)	ETHYL BENZENE (mg/Kg)	TOTAL XYLENES (mg/Kg)
ANALYSIS DATE	02/13/02	02/13/02	02/13/02	02/13/02
H6500-1 K-6 SB 36'	<0.005	<0.005	<0.005	<0.015
Quality Control	0.108	0.108	0.108	0.310
True Value QC	0.100	0.100	0.100	0.300
% Recovery	108	108	108	103
Relative Percent Difference	0.8	1.2	0.4	1.1

METHOD: EPA SW-846 8260

Chemist

2/15/02
Date

CARDINAL LABORATORIES, INC.

2111 Beechwood, Abilene, TX 79603 101 East Marland, Hobbs, NM 88240
(915) 673-7001 Fax (915) 673-7020 (505) 393-2326 Fax (505) 393-2476

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Page 1 of 1

Company Name:	KICE Operating Company	BILL TO	
Project Manager:	D. Anderson	P.O. #:	716
Address:	122 W Taylor	Company:	COC
City:	Hobbs State: NM Zip: 88240	Attn:	D. Anderson
Phone #:	393 9174 Fax #: 397 1471	Address:	
Project #:	JCT K-6 Project Owner: ROC	City:	Same
Project Name:	EME JCT K-6	State:	Zip:
Project Location:		Phone #:	
Sampler Name:	D Anderson	Fax #:	

FOR LAB USE ONLY				MATRIX						PRESERV.			SAMPLING		ANALYSIS REQUEST											
Lab I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	GROUNDWATER	WASTEWATER	SOIL	CRUDE OIL	SLUDGE	OTHER:	ACID/BASE:	ICE / COOL	OTHER:	DATE	TIME	Chloride	TPH 8015 mod.	BTEX									
H6500-1	K-6 SB 36'	✓	1			✓					✓		021302	-	✓	✓	✓									

PLEASE NOTE: Liability and Damages. Cardinal's liability and client's exclusive remedy for any claim arising whether based in contract or tort, shall be limited to the amount paid by the client for the analyses. All claims including those for negligence and any other cause whatsoever shall be deemed waived unless made in writing and received by Cardinal within 30 days after completion of the applicable service. In no event shall Cardinal be liable for incidental or consequential damages, including without limitation, business interruptions, loss of use, or loss of profits incurred by client, its subsidiaries, affiliates or successors arising out of or related to the performance of services hereunder by Cardinal, regardless of whether such claim is based upon any of the above stated reasons or otherwise.

Terms and Conditions: Interest will be charged on all accounts more than 30 days past due at the rate of 24% per annum from the original date of invoice, and all costs of collections, including attorney's fees.

Sampler Relinquished:	Date: 021302 Time: 1411	Received By:	
Relinquished By:	Date: Time:	Received By: (Lab Staff)	
Delivered By: (Circle One) Sampler - UPS - Bus - Other:	Sample Condition Cool: Yes / No Intact: Yes / No	CHECKED BY: (Initials)	

Phone Result: ☐ Yes ☐ No Add'l Phone #:
Fax Result: ☐ Yes ☐ No Add'l Fax #:
REMARKS:

† Cardinal cannot accept verbal changes. Please fax written changes to 505-393-2476.

ENVIRONMENTAL LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Kristin Farris

Rice Operating Co.

122 W. Taylor

Hobbs, NM 88240

Project: EME System K-6 Junction Box Site

Project Number: V117K6

Location: T20S, R36E, Sec 6, Unit Letter K

Lab Order Number: 5E09005

Report Date: 05/16/05

Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-1	5E09005-01	Water	05/03/05 12:25	05/06/05 16:40

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (5E09005-01) Water									
Benzene	**0.00308**	0.00100	mg/L	1	EE51006	05/10/05	05/11/05	EPA 8021B	
Toluene	**J [0.000992]**	0.00100	"	"	"	"	"	"	
Ethylbenzene	**0.00188**	0.00100	"	"	"	"	"	"	
Xylene (p/m)	**0.00218**	0.00100	"	"	"	"	"	"	
Xylene (o)	**0.00114**	0.00100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*89.5 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*90.5 %*	*80-120*		"	"	"	"	

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (5E09005-01) Water									
Total Alkalinity	**554**	2.00	mg/L	1	EE51104	05/09/05	05/09/05	EPA 310.2M	
Chloride	**11200**	100	"	200	EE51001	05/09/05	05/09/05	EPA 300.0	
Total Dissolved Solids	**25400**	20.0	"	4	EE51105	05/09/05	05/10/05	EPA 160.1	
Sulfate	**4230**	100	"	200	EE51001	05/09/05	05/09/05	EPA 300.0	

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

Total Metals by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (5E09005-01) Water									
Calcium	**889**	1.00	mg/L	100	EE50905	05/09/05	05/09/05	EPA 6010B	
Magnesium	**266**	0.0500	"	50	"	"	"	"	
Potassium	**73.5**	0.500	"	10	"	"	"	"	
Sodium	**7450**	10.0	"	1000	"	"	"	"	

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE51006 - EPA 5030C (GC)										
Blank (EE51006-BLK1)				Prepared & Analyzed: 05/10/05						
Benzene	ND	0.00100	mg/L							
Toluene	ND	0.00100	"							
Ethylbenzene	ND	0.00100	"							
Xylene (p/m)	ND	0.00100	"							
Xylene (o)	ND	0.00100	"							
Surrogate: a,a,a-Trifluorotoluene	*23.1*		*ug/l*	*20.0*		*116*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*18.8*		*"*	*20.0*		*94.0*	*80-120*			
LCS (EE51006-BS1)				Prepared & Analyzed: 05/10/05						
Benzene	94.7		ug/l	100		94.7	80-120			
Toluene	107		"	100		107	80-120			
Ethylbenzene	110		"	100		110	80-120			
Xylene (p/m)	226		"	200		113	80-120			
Xylene (o)	109		"	100		109	80-120			
Surrogate: a,a,a-Trifluorotoluene	*20.2*		*"*	*20.0*		*101*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*22.2*		*"*	*20.0*		*111*	*80-120*			
LCS Dup (EE51006-BSD1)				Prepared & Analyzed: 05/10/05						
Benzene	105		ug/l	100		105	80-120	10.3	20	
Toluene	110		"	100		110	80-120	2.76	20	
Ethylbenzene	108		"	100		108	80-120	1.83	20	
Xylene (p/m)	212		"	200		106	80-120	6.39	20	
Xylene (o)	98.7		"	100		98.7	80-120	9.92	20	
Surrogate: a,a,a-Trifluorotoluene	*19.5*		*"*	*20.0*		*97.5*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*20.2*		*"*	*20.0*		*101*	*80-120*			
Calibration Check (EE51006-CCV1)				Prepared: 05/10/05 Analyzed: 05/11/05						
Benzene	104		ug/l	100		104	80-120			
Toluene	107		"	100		107	80-120			
Ethylbenzene	106		"	100		106	80-120			
Xylene (p/m)	214		"	200		107	80-120			
Xylene (o)	102		"	100		102	80-120			
Surrogate: a,a,a-Trifluorotoluene	*22.1*		*"*	*20.0*		*110*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*23.3*		*"*	*20.0*		*116*	*80-120*			

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

Organics by GC - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE51006 - EPA 5030C (GC)										
Matrix Spike (EE51006-MS1)	**Source: 5E06003-16**			Prepared: 05/10/05 Analyzed: 05/11/05						
Benzene	115		ug/l	100	0.658	114	80-120			
Toluene	120		"	100	1.02	119	80-120			
Ethylbenzene	115		"	100	1.03	114	80-120			
Xylene (p/m)	242		"	200	2.17	120	80-120			
Xylene (o)	113		"	100	1.99	111	80-120			
Surrogate: a,a,a-Trifluorotoluene	*26.6*		"	*20.0*		*133*	*80-120*			*S-04*
Surrogate: 4-Bromofluorobenzene	*26.2*		"	*20.0*		*131*	*80-120*			*S-04*

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

General Chemistry Parameters by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE51001 - General Preparation (WetChem)										
Blank (EE51001-BLK1)				Prepared & Analyzed: 05/09/05						
Sulfate	ND	0.500	mg/L							
Chloride	ND	0.500	"							
LCS (EE51001-BS1)				Prepared & Analyzed: 05/09/05						
Chloride	10.5		mg/L	10.0		105	80-120			
Sulfate	10.9		"	10.0		109	80-120			
Calibration Check (EE51001-CCV1)				Prepared & Analyzed: 05/09/05						
Sulfate	11.2		mg/L	10.0		112	80-120			
Chloride	11.0		"	10.0		110	80-120			
Duplicate (EE51001-DUP1)	**Source: 5E09002-01**			Prepared & Analyzed: 05/09/05						
Sulfate	263	10.0	mg/L		264			0.380	20	
Chloride	178	10.0	"		179			0.560	20	
Batch EE51104 - General Preparation (WetChem)										
Blank (EE51104-BLK1)				Prepared & Analyzed: 05/09/05						
Total Alkalinity	ND	2.00	mg/L							
Duplicate (EE51104-DUP1)	**Source: 5E09002-01**			Prepared & Analyzed: 05/09/05						
Total Alkalinity	191	2.00	mg/L		190			0.525	20	
Reference (EE51104-SRM1)				Prepared & Analyzed: 05/09/05						
Bicarbonate Alkalinity	231		mg/L	200		116	80-120			

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

General Chemistry Parameters by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE51105 - Filtration Preparation										
Blank (EE51105-BLK1)				Prepared: 05/09/05 Analyzed: 05/10/05						
Total Dissolved Solids	ND	5.00	mg/L							
Duplicate (EE51105-DUP1)	**Source: 5E09002-01**			Prepared: 05/09/05 Analyzed: 05/10/05						
Total Dissolved Solids	1030	5.00	mg/L		1060			2.87	20	

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

Total Metals by EPA / Standard Methods - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EE50905 - 6010B/No Digestion										
Blank (EE50905-BLK1)				Prepared & Analyzed: 05/09/05						
Calcium	ND	0.0100	mg/L							
Magnesium	ND	0.00100	"							
Potassium	ND	0.0500	"							
Sodium	ND	0.0100	"							
Calibration Check (EE50905-CCV1)				Prepared & Analyzed: 05/09/05						
Calcium	1.87		mg/L	2.00		93.5	85-115			
Magnesium	2.17		"	2.00		108	85-115			
Potassium	1.77		"	2.00		88.5	85-115			
Sodium	1.71		"	2.00		85.5	85-115			
Duplicate (EE50905-DUP1)	**Source: 5E09002-01**			Prepared & Analyzed: 05/09/05						
Calcium	30.2	0.100	mg/L		32.4			7.03	20	
Magnesium	9.97	0.0100	"		9.90			0.705	20	
Potassium	24.4	0.500	"		24.9			2.03	20	
Sodium	262	0.500	"		293			11.2	20	

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Rice Operating Co.	Project: EME System K-6 Junction Box Site	Fax: (505) 397-1471
122 W. Taylor	Project Number: V117K6	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Farris	05/16/05 14:18

Notes and Definitions

S-04	The surrogate recovery for this sample is outside of established control limits due to a sample matrix effect.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	*Relative Percent Difference*
LCS	Laboratory Control Spike
MS	Matrix Spike
Dup	Duplicate

Report Approved By: Raland K Tuttle Date: 5/16/2005

Raland K. Tuttle, Lab Manager
Celey D. Keene, Lab Director, Org. Tech Director
Peggy Allen, QA Officer
Jeanne Mc Murrey, Inorg. Tech Director
James L. Hawkins, Chemist/Geologist
Sandra Sanchez, Lab Tech.

Environmental Lab of Texas

12600 West I-20 East
Odessa, Texas 79765
Phone: 432-563-1800
Fax: 432-563-1713

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: Kristin Farris
Company Name: RICE Operating Company
Company Address: 122 West Taylor
City/State/Zip: Hobbs, New Mexico 88240
Telephone No: 505-393-9174
Fax No: 505-397-1471
Sampler Signature:

Project Name: EME System K-6 Junction Box Site
Project #: V117K6
Project Location: T20S, R36E, Sec 6, Unit Letter K
COC #: V117K6-0505

LAB # (lab use only)	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Preservative: Ice	HNO3	HCl	NaOH	H2SO4	None	Other (Specify)	Matrix: Water	Sludge	Soil	Other (specify):	Analyze For: TPH: 418.1 8015M 1005 1006	Cations (Ca, Mg, Na, K)	Anions (Cl, SO4, CO3, HCO3)	SAR / ESP / CEC	Metals: As Ag Ba Cd Cr Pb Hg Se	Volatiles	Semivolatiles	BTEX 80218/5030 or BTEX 8260	RCI	N.O.R.M.	Total Dissolved Solids				RUSH TAT (Pre-Schedule)	Standard TAT
560905																TCLP:															
																TOTAL:															
-01	MW-1	5-3-05	1225	3	✓		✓ BTEX only					✓					✓	✓					✓			✓					✓

Special Instructions: Please email results to both gil@trident-environmental.com and to enviro@leaco.net

Sample Containers Intact? (Y) N
Temperature Upon Receipt: 4.0°C
Laboratory Comments: 1 L plastic 2 VOA 2/1

Relinquished by:	Date	Time	Received by:	Date	Time
	05/05/05	4:40p			
Relinquished by:	Date	Time	Received by ELOT:	Date	Time
			Carie Kelly	5/6/05	9:40

Environmental Lab of Texas
Variance / Corrective Action Report – Sample Log-In

Client: Rice Operating

Date/Time: 5/6/05 5:00

Order #: SE09005

Initials: CK

Sample Receipt Checklist

Temperature of container/cooler?	Yes	No	4.0 C
Shipping container/cooler in good condition?	Yes	No	
Custody Seals intact on shipping container/cooler?	Yes	No	Not present
Custody Seals intact on sample bottles?	Yes	No	Not present
Chain of custody present?	Yes	No	
Sample Instructions complete on Chain of Custody?	Yes	No	
Chain of Custody signed when relinquished and received?	Yes	No	
Chain of custody agrees with sample label(s)	Yes	No	
Container labels legible and intact?	Yes	No	
Sample Matrix and properties same as on chain of custody?	Yes	No	
Samples in proper container/bottle?	Yes	No	
Samples properly preserved?	Yes	No	
Sample bottles intact?	Yes	No	
Preservations documented on Chain of Custody?	Yes	No	
Containers documented on Chain of Custody?	Yes	No	
Sufficient sample amount for indicated test?	Yes	No	
All samples received within sufficient hold time?	Yes	No	
VOC samples have zero headspace?	Yes	Nc	Not Applicable

Other observations:

Variance Documentation:

Contact Person: - Date/Time: Contacted by:

Regarding:

Corrective Action Taken:

(Jm)

* sample date changed as per attached e-mail fax

May 9, 2005

Ms. Jeanne Mc Murrey, Technical Director
Environmental Lab of Texas
12600 West I-20 East
Odessa, Texas 79765

Ms. Mc Murrey:

Please note that during groundwater sampling activities last week I incorrectly assigned the wrong day of the month as the sample date on the chains-of-custody for *each* groundwater sample submitted. Starting with Monday May 2nd I started dating all samples by the previous day that it was actually sampled on. One day should be added for each sample to report the correct date of sampling. For clarity, the correct sample dates are listed in the table below.

COC No.	Project Name	Field Code	Date Sampled
V117M9-0505	M-9 SWD Site	WW-1	May 2, 2005
		MW-1	May 2, 2005
		MW-2	May 2, 2005
		MW-3	May 2, 2005
		MW-4	May 2, 2005
V117N5-0505	N-5 Junction Box Site	MW-1	May 2, 2005
V117K6-0505	K-6 Junction Box Site	MW-1	May 3, 2005
V117P6-0505	P-6 Line Leak Site	P6-1	May 3, 2005
		P6-2	May 3, 2005
V117M5-0505	M-5 SWD Site	M5-1	May 3, 2005
V117E5-0505	E-5 Junction Box Site	MW-1	May 3, 2005
V117D1-0505	D-1 Junction Box and Line Leak Site	MW-1	May 3, 2005
V118J26-0505	J-26 Junction Box Site	MW-1	May 4, 2005
		MW-2	May 5, 2005
		MW-3	May 5, 2005
		Windmill #138	May 4, 2005
		Windmill #220	May 4, 2005
		Wallach #914	May 4, 2005
		Wallach #36.211	May 4, 2005
		Well # 23.333	May 5, 2005

Thank you for your assistance in this matter. Please feel free to call me at 432-638-3106, if you have any questions.

Sincerely,

Gilbert J. Van Deventer

Gilbert J. Van Deventer, REM, PG, NMCS
Trident Environmental - Project Manager

cc: CDH, KFP, file

QUALITY PROCEDURES

Rice Operating Company

QUALITY PROCEDURE

Sampling and Testing Protocol Chloride Titration Using .282 Normal Silver Nitrate Solution

1.0 Purpose

This procedure is to be used to determine the concentration of chloride in soil.

2.0 Scope

This procedure is to be used as the standard field measurement for soil chloride concentrations.

3.0 Sample Collection and Preparation

3.1 Collect at least 80 grams of soil from the sample collection point. Take care to insure that the sample is representative of the general background to include visible concentrations of hydrocarbons and soil types. If necessary, prepare a composite sample for soils obtained at several points in the sample area. Take care to insure that no loose vegetation, rocks or liquids are included in the sample(s).

3.2 The soil sample(s) shall be immediately inserted into a one-quart or larger polyethylene freezer bag. Care should be taken to insure that no cross-contamination occurs between the soil sample and the collection tools or sample processing equipment.

3.3 The sealed sample bag should be massaged to break up any clods.

4.0 Sample Preparation

4.1 Tare a clean glass vial having a minimum 40 ml capacity. Add at least 10 grams of the soil sample and record the weight.

4.2 Add at least 10 grams of reverse osmosis water to the soil sample and shake for 20 seconds.

4.3 Allow the sample to set for a period of 5 minutes or until the separation of soil and water.

4.4 Carefully pour the free liquid extract from the sample through a paper filter into a clean plastic cup if necessary.

5.0 Titration Procedure

5.1 Using a graduated pipette, remove 10 ml extract and dispense into a clean plastic cup.

5.2 Add 2-3 drops potassium chromate (K_2CrO_4) to mixture.

5.3 If the sample contains any sulfides (hydrogen or iron sulfides are common to oilfield soil samples) add 2-3 drops of hydrogen peroxide (H_2O_2) to mixture.

5.4 Using a 1 ml pipette, carefully add .282 normal silver nitrate (one drop at a time) to the sample while constantly agitating it. Stop adding silver nitrate when the solution begins to change from yellow to red. Be consistent with endpoint recognition.

5.5 Record the ml of silver nitrate used.

6.0 Calculation

To obtain the chloride concertration, insert measured data into the following formula:

$$\frac{.282 \times 35{,}450 \times \text{ml } AgNO_3}{\text{ml water extract}} \times \frac{\text{grams of water in mixture}}{\text{grams of soil in mixture}}$$

Using Step 5.0, determine the chloride concentration of the RO water used to mix with the soil sample. Record this concentration and subtract it from the formula results to find the net chloride in the soil sample.

Record all results on the delineation form.