1R - 415

GENERAL CORRESPONDENCE

YEAR(S):

2002 - 2004

A66 61
IR415

Wayne

Here is a copy of the photos you took with my camera on the visit to the Lexington Water Field.

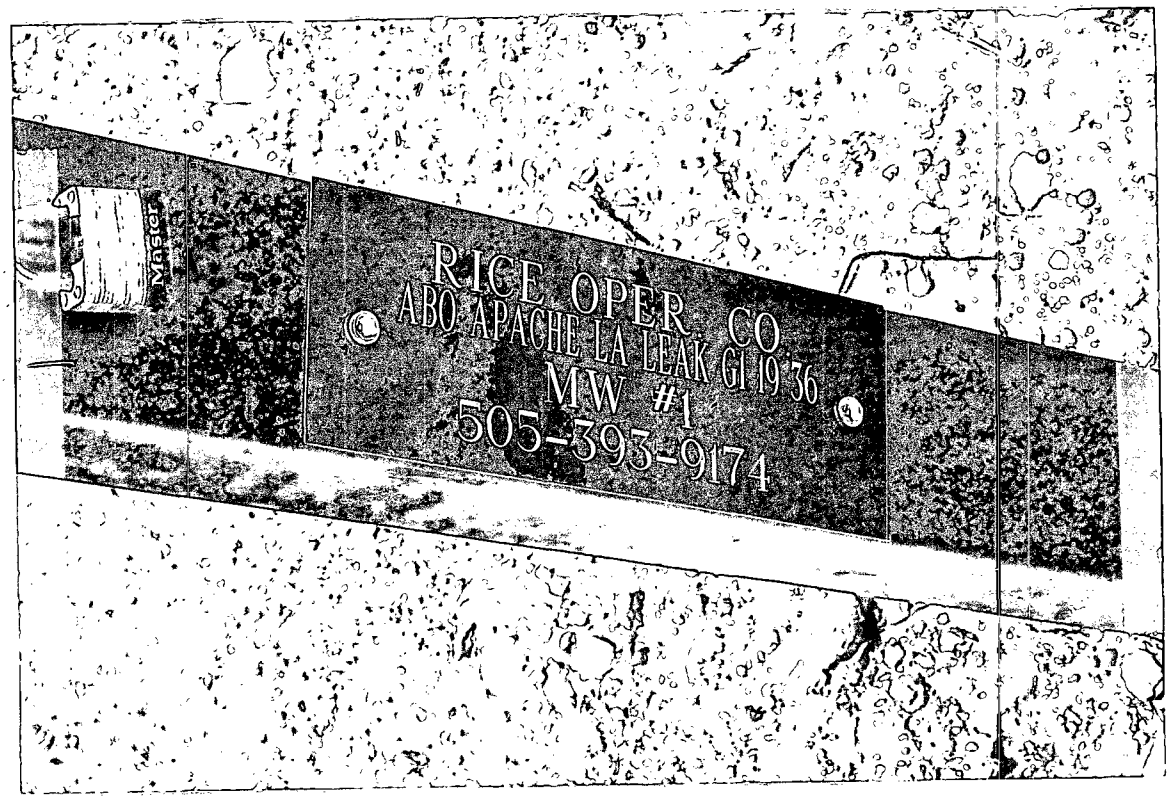
Rico Remediation

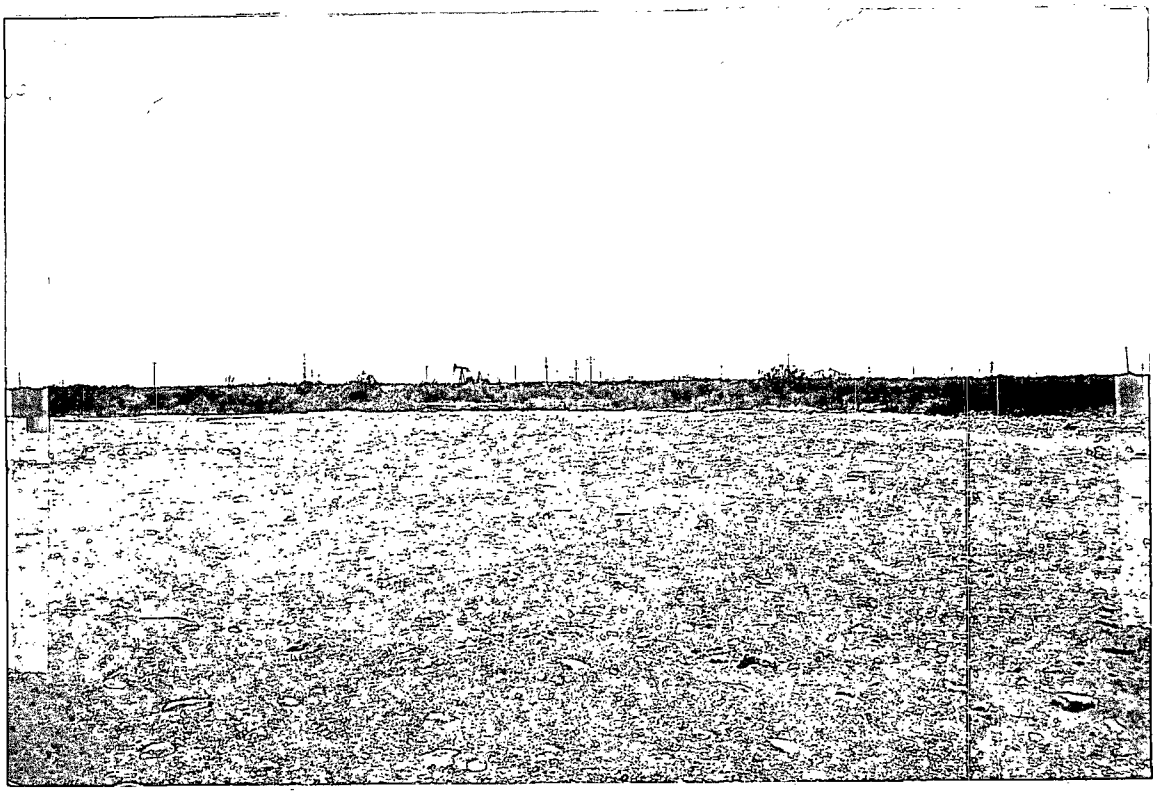
Edith Lee

2006 AUG 18 PM 2 02

Abo G-1
IR 415

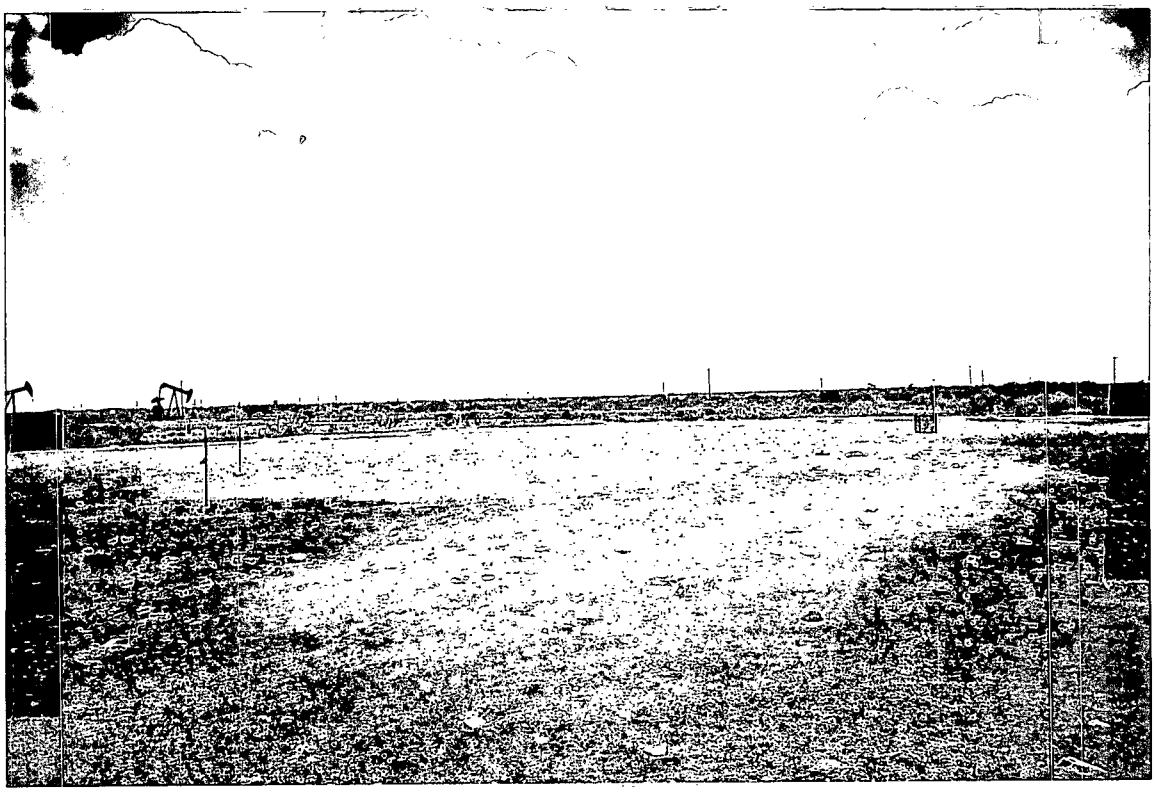
Rec'd. 8-18-06

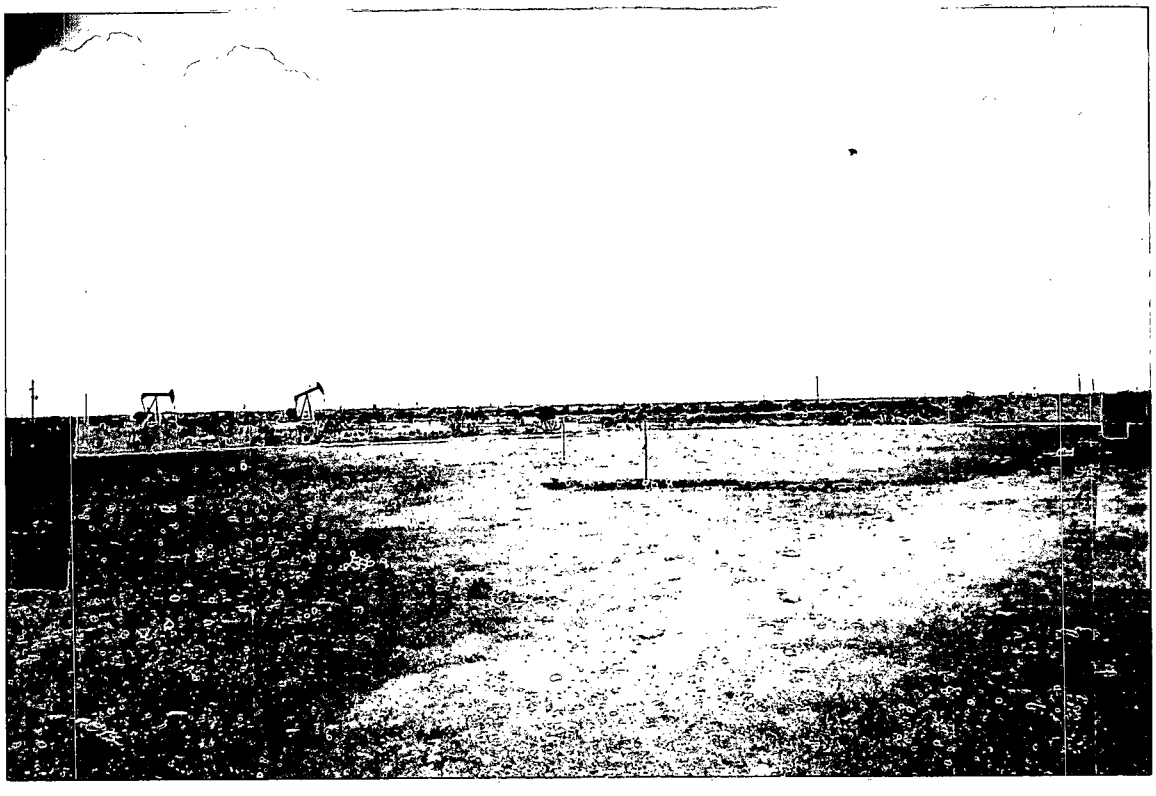




Recd. 8-18-06

Abo G-1
IR415





R. T. HICKS CONSULTANTS, LTD.

901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

January 31, 2006

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail and Federal Express

RE: Progress Report
Abo 1G Pipeline Release NMOCD Case #1R0415
Section 1, 17S, 36E, Unit G

Dear Wayne:

The vadose zone remedy for the above-referenced site is almost complete. We will forward a final report on or before February 28, after final grading of the site. The purpose of this letter is to describe the vadose zone monitoring devices that we installed to monitor the performance of the infiltration barrier and to describe several changes to the original design and the rationale for these changes.

1. Field data demonstrated that chloride did not exceed 1000 mg/kg at several locations. Examination of data collected from deep trenches show little to no material impact due to chloride in several areas, in conformance with our previous data collection program. Therefore, in conformance with the conditional approval and subsequent e-mail communication, a clay infiltration barrier is not required over the areas where the chloride concentration is less than 1000 mg/kg. A clay infiltration barrier will be installed in the northernmost and westernmost portion of the spill area where evidence demonstrates that a chloride mass resides at depth (e.g. SB-1 shows about 1400 ppm chloride at 15 feet).
2. Thirteen cells in the southwestern area, excavated to a depth of 5 feet bgs, have chloride concentrations greater than 1000 mg/kg but less than 1750 mg/kg at this depth. These cells have been excavated with an additional lateral 3-foot buffer around the perimeter and are receiving clay infiltration barriers. Cells in the southeastern area required only minimal excavation.
3. Fill, verified less than 250 mg/kg chloride concentration, was placed in the excavation and contoured.

The attached drawing is a schematic of the pan lysimeter design installed at two locations within the site. Lysimeter 1 is installed in Grid 6 in the northern excavated area and Lysimeter 2 is installed in Grid 38 in the southern excavated area. Lysimeter 1 was installed at the bottom of a trench wall dug eight feet below the excavated surface. Lysimeter 2 was installed at the bottom of a trench wall dug four feet below the excavated ground surface. With each lysimeter, two casings were installed such that the bottoms of the casings

access the vadose zone at depths of six inches below the lysimeter pan bottom and one foot above the lysimeter pan bottom. The casings allow placement of a tensiometer to measure soil matric potential and hence soil moisture content both above and below the lysimeter sampling depth. If collection of vadose zone water samples prove difficult, the soil moisture content data will provide explanation.

We propose plugging and abandonment of the monitoring well and sampling the vadose zone monitoring devices two times per year for three years.

Sincerely,
R.T. Hicks Consultants, Ltd.

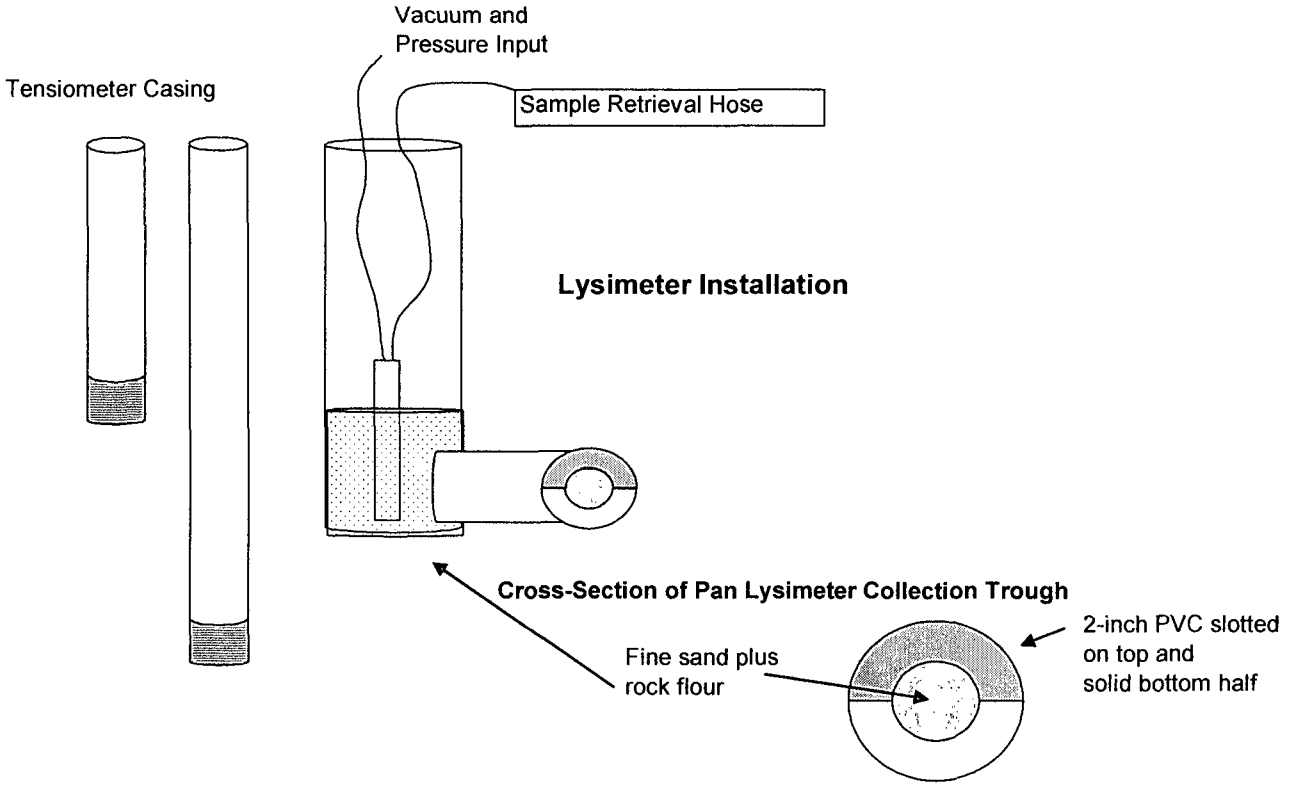
Randall T. Hicks

David J. Hamilton

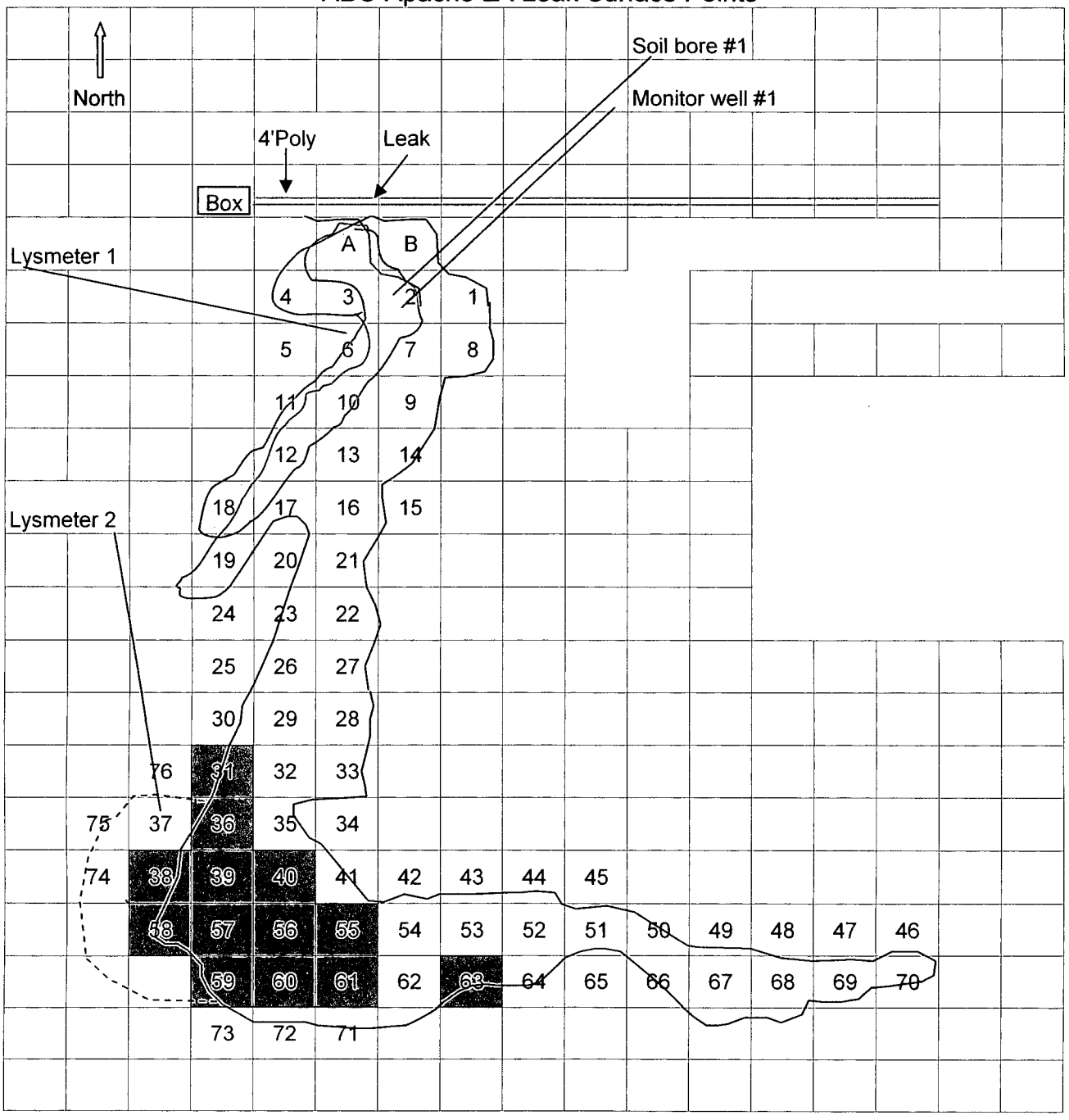
Randall Hicks
Principal

David Hamilton
Staff Hydrogeologist

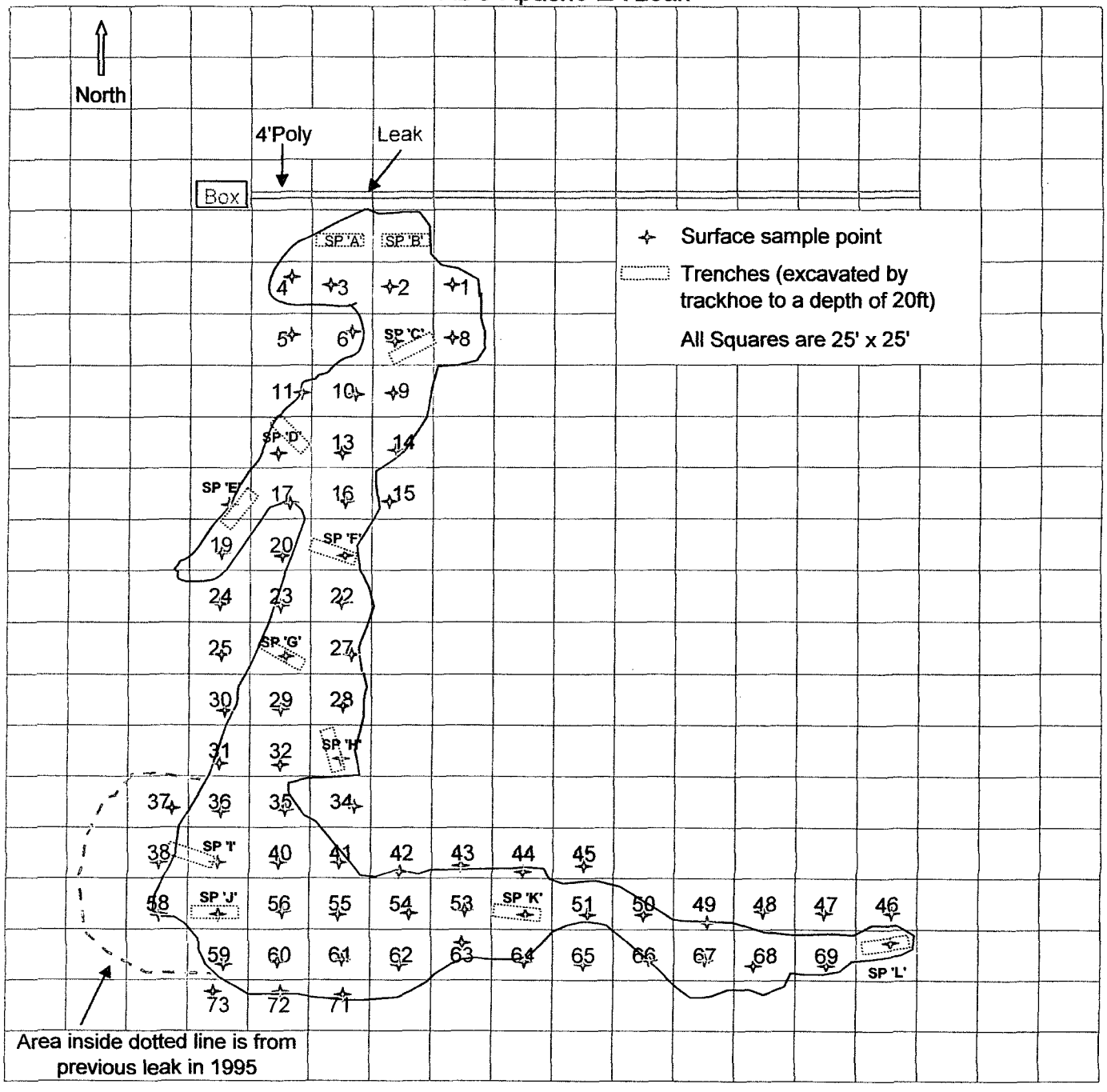
Copy: Rice Operating Company


Vacuum and
Pressure Input
Tensiometer Casing
Sample Retrieval Hose
Lysimeter Installation
Cross-Section of Pan Lysimeter Collection Trough
Fine sand plus
rock flour
2-inch PVC slotted
on top and
solid bottom half

ABO Apache LA Leak Surface Points



ABO Apache LA Leak



PATRICK H. LYONS
COMMISSIONER

State of New Mexico
Commissioner of Public Lands
310 OLD SANTA FE TRAIL
P.O. BOX 1148
SANTA FE, NEW MEXICO 87504-1148

COMMISSIONER'S OFFICE
Phone (505) 827-5760
Fax (505) 827-5766
www.nmstatelands.org

January 31, 2006

Ms. Carolyn Haynes
RICE Operating Company
122 West Taylor
Hobbs, NM 88240

RE: Road Repair Material Exceeding Guidelines
ABO IG Excavation Project, NMOCD Case # 1R0415
Section 1, Township 17S, Rage 36E, Unit G

Dear Ms. Haynes:

The New Mexico State Land Office (SLO) respectfully denies the request to place excavated caliche from the ABO IG Excavation Project (ABO Project) containing Chloride concentrations of up to 1000 ppm on SLO issued Rights-of-Way.

The Commissioner of Public Lands and the SLO have a duty to manage state trust land in a manner that includes "sound stewardship and land management practices"[1]. Placing materials that originated from City of Lovington land that exceed 250 ppm [20.6.2.3103 NMAC] on state trust lands raises issues pertaining to "sound stewardship" land management practices for the SLO. Several of those issues relate to the current lack of New Mexico Oil Conservation Division and SLO policy on the disposal of elevated Chloride materials outside permitted surface waste management facilities.

The State Land Office values RICE Operating Company as a lessee and feels the exchange regarding the subject in question as meaningful. We look forward to working with you in the future on similar issues in a cooperative manner.

Sincerely,

Jerry King, Assistant Commissioner
Surface Resources Division

Cc: Wayne Price – NMOCD
Cody Morrow – NMSLO

[1] Branson School District RE-82 v. Romer 958 F.Supp. 1501 (D.Colo.,1997)

Price, Wayne, EMNRD

From: Price, Wayne, EMNRD
Sent: Thursday, January 05, 2006 4:26 PM
To: 'Carolyn Doran Haynes'
Cc: Sanchez, Daniel J., EMNRD; 'Randall Hicks'; TKostrubala@slo.state.nm.us; Pat Wise (pwise@lovington-nm.org); Patrick B. McMahon (hsncpbm@leaco.net)
Subject: RE: Road Repair Material - ABO project

OCD hereby approves of ROC's request to recycle the soil from the ABO site for road repair with the following conditions:

1. All material shall be graded into existing roads in the Oil Center area and only on state land. Water may be added for proper placement, compaction and dust control if necessary.
2. ROC shall provide photos and location of placement areas when submitting the ABO Closure report.

Please be advised that NMOCD approval of this plan does not relieve ROC of Responsibility should their operations pose a threat to ground water, surface water, human health or the environment. In addition, NMOCD approval does not relieve ROC of responsibility for compliance with any other federal, state, or local laws and/or regulations.

From: Carolyn Doran Haynes [mailto:cdhriceswd@valornet.com]
Sent: Thursday, January 05, 2006 3:33 PM
To: Price, Wayne, EMNRD
Cc: Sanchez, Daniel J., EMNRD; 'Randall Hicks'; TKostrubala@slo.state.nm.us
Subject: Road Repair Material - ABO project

Wayne,

I have discussed the usage for road repair of <1000ppm chloride, <100ppm TPH caliche with Leon Anderson, SLO, Hobbs office. He was quite enthusiastic about it, saying that he's wanted this for a long time and he certainly supports the proposal, but was also cautious and wanted confirmation from the Santa Fe office. I contacted Thaddeus Kostrubala, environmental engineer, of the Santa Fe SLO office and will forward to him the proposal we sent to you at NMOCD. He will review and discuss with others in his office before rendering opinion.

Would you please copy the SLO on NMOCD's reply: TKostrubala@slo.state.nm.us

Rice Operating Company (ROC) wants to assure the NMOCD that the caliche material from the ABO IG Excavation Project meeting this criteria: <1000ppm Chloride and <100ppm TPH, would NOT be used on the land owned by the City of Lovington, nor will it be used within 1 mile of their perimeter.

At this time, the road repair material will be used in the Oil Center vicinity on NM State Land – Sections 1-36, T21S, R36E where groundwater is 100+ feet BGS or not available; where there are no surface bodies of water or domestic water wells within 1000 feet of the road repair site; and only where there is agreement with the surface landowner to do so.

ROC is also willing to monitor the chloride infiltration to confirm the modeling results by periodically investigating the soils beneath and near the road repair for the migration of chlorides. The effort afforded to expanding the environmental benefit of our oilfield remediation projects is effort well placed.

Thank you for your consideration of this matter.

PS: Have you had any thoughts about the February 1 meeting location? We should be installing the lysimeters and tensiometers at the ABO site around this time...any interest in seeing that? We could combine the two events.

Carolyn Doran Haynes
Engineering Manager
RICE *Operating Company*
505-393-9174
505-397-1471 (fax)

Price, Wayne, EMNRD

From: Randall Hicks [r@rthicksconsult.com]
Sent: Thursday, December 29, 2005 9:51 AM
To: Price, Wayne, EMNRD
Cc: 'Kristin Farris Pope'
Subject: Lovington Abo

Wayne

I will give you a call later today to discuss our recent submission regarding recycle-reuse of the caliche at the Abo-1G site.

As I indicated in my email of 12-19, I think that we used more conservative input parameters in our simulation than you did for your VADSAT modeling of chloride at landfarms.

As ROC begins to dig next week, we would really like to get a response from NMOCD – but first, let's talk about it.

Randy Hicks
505-266-5004
cell: 505-238-9515

Price, Wayne, EMNRD

From: Randall Hicks [r@rthicksconsult.com]
Sent: Monday, December 19, 2005 4:44 PM
To: Price, Wayne, EMNRD
Cc: 'Kristin Farris Pope'; 'Carolyn Doran Haynes'; 'David Hamilton'
Subject: Lovington Abo-1G
Attachments: Caliche_Reuse_Proposal_12.19rth6.pdf

Wayne

Please do not hesitate to give Kristin a call about this and we can set up a phone conference to discuss this proposal. I believe you will easily see that our simulation does not differ materially from the VADSAT model NMOCD ran in support of the 1000 mg/kg chloride limit for landfarms (new Surface Waste Management Rule). In other words, the output from our HYDRUS simulation agrees with your VADSAT simulation considering that each used slightly different input data.

ROC is interested in starting work on this and if you find this proposal approvable, that would help move things forward. I apologize for not getting this to you last week as I had originally thought I could.

Randy Hicks
505-266-5004
cell: 505-238-9515

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

December 19, 2005

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail and Federal Express

RE: Amended Corrective Action Plan
Abo 1G Pipeline Release NMOCD Case #1R0415
Section 1, 17S, 36E, Unit G

Dear Wayne:

We offer the following idea for NMOCD consideration. Underlying the surface soil at the site is about 1-3 feet of hard caliche with an average chloride concentration of 1,200 mg/kg (see Table 1). As part of the conditional approval of the remedy proposed in the August 2005 Amended Corrective Action Plan, NMOCD requires disposal of this material to reduce the chloride mass that exists at this spill site. Rather than dispose of this material at a landfill, we propose to excavate and remove this caliche material in the area of the excavation and cap and use the caliche for the repair of nearby roads or minor repairs to well pads. Rather than create a waste for disposal at a landfill, we propose to create a product: road gravel. ROC will work with the City of Lovington to identify nearby roads in need of repair. ROC will spread this caliche gravel on 15-foot wide roads that run perpendicular to ground water flow (essentially north-south roads) to a thickness that will not exceed an average of 6-inches.

We employed the data and assumptions discussed below and the modeling protocol outlined in the Amended Corrective Action Plan to predict the potential impact of this reduce-reuse-recycle program. Using this caliche as road gravel at nearby locations is consistent with NMOCD's stated goal of reducing the mass of chloride present at this site.

HYDRUS-1D Modeling Experiment

We employed the same modeling protocol outlined in the Amended CAP. The following assumptions and data apply to the prediction of minor well pad repairs or gravel repair of north-south running roads:

- Table 1 synopsizes the results of Rice Operating Company's chloride sampling at the Abo Apache 1-G site. From interpolated data points. We calculated an average chloride concentration of approximately 1200 mg/kg from 0.5 feet below ground surface (bgs) to 3.5 feet bgs.
- A 6-inch thickness of 1,200 mg/kg chloride material creates a chloride load of 0.34 kg/m^2.

- A comparison with the well logs from the nearby Navajo refinery allows us to conclude that the vadose zone in the area near Abo-1G is similar to that represented in the well logs at the site.
- For this HYDRUS-1D modeling experiment we used the soil profile derived from the logs of MW-1 and SB-1. Within this soil profile we installed a chloride concentration of 1200 mg/kg within the top 6 inches of the soil profile and an ambient chloride concentration of 60 mg/kg from below this horizon to ground water.
- From examination of the chloride data obtained below 50 feet bgs during the drilling of MW-1, we conclude that ambient chloride concentration beneath a road or well pad in the area is approximately 60 mg/kg.
- The field-calibrated HYDRUS-1D model used in the August 2005 Amended Corrective Action Plan adequately predicts the chloride flux to ground water in the area of the Abo-1G site
- The calibrated HYDRUS-1D model can predict the chloride flux to ground water by placing a chloride load of 0.34 kg/m^2 on the top of the lithologic and chloride profile of the background soil boring then allowing precipitation on this flat, un-vegetated surface.
- Because ground water flow is east to southeast in this area, we can assume that the maximum distance parallel to ground water flow beneath a 15 foot wide north-south road or similar well pad repair is no more than 30 feet.
- From water quality data obtained at MW-1, we calculated an average chloride concentration of 93 mg/l with in ground water and a natural variation between 72 mg/l and 120mg/l.

Careful examination of HYDRUS-1D output files from the Abo 1-G site Amended Correction Action Plan demonstrate that chloride from the spill events first reaches ground water after about 20 years from present with the center of chloride mass from the releases reaching ground water about 29 years from now.

As discussed in the Amended CAP, the HYDRUS-1D model for this area is calibrated with chloride migration data in the upper vadose zone. These data suggest migration rates of approximately 1-foot per year in well indurated caliches and approximately 3-feet per year within sand layers. The lower layers of the vadose zone in this area are dominated by sands resulting in faster migration rates through the lower horizon.

We know from the drilling and installation of MW-1 that there exists a well indurated caliche layer between 36 and 37 feet bgs. Field chloride data obtained during the 2004 and 2005 field programs shows that the hydraulic conductivity of this layer is quite low. Below this layer, chloride concentrations rapidly decline to background concentrations. The chloride at this horizon may represent the leading edge of the 1993 spill event given migration rates predicted by Hydrus 1-D (about 3.1 feet/year migration rate). However, the concentration gradient may be a result of earlier (1960s?) anthropomorphic oilfield effects in this area, which would yield a chloride migration rate of about 1-foot per year. While we can not say which the case is, the Hydrus 1-D modeling is necessarily constructed

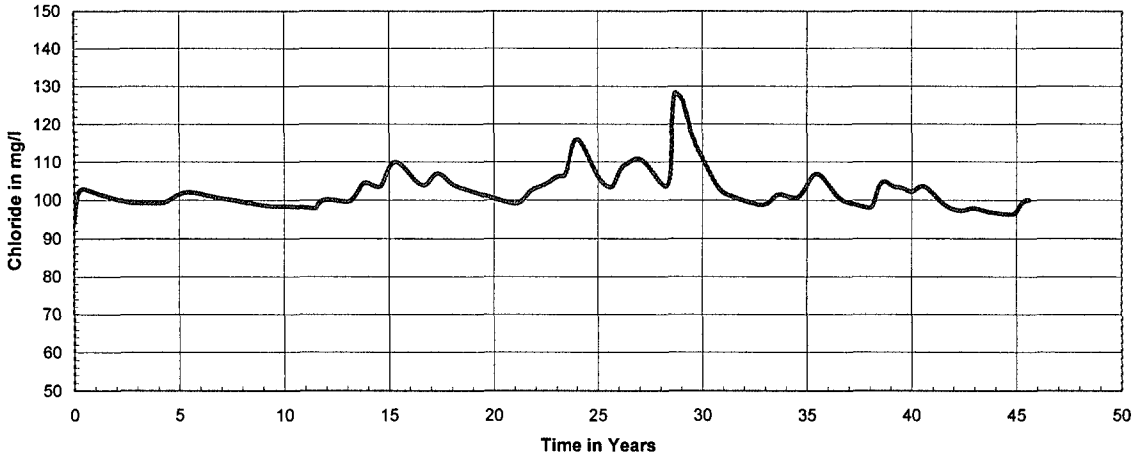
of choices conservative of ground water quality whenever field data does not provide evidence for choice of input parameters. Because we have elected to employ a average migration rate through the vadose zone of about 3-feet per year, the modeling will over predict maximum chloride concentration in ground if the migration rate is actually 1-foot per year.

A similar examination of HYDRUS-1D output files for this proposal demonstrate chloride from the road repair first reaches ground water in approximately 24 years with the center of the chloride mass entering ground water about 29 years from time=0 in agreement with the Abo 1-G results.

Figure 1 presents the model's prediction of chloride concentration in a monitoring well immediately down gradient of a road that is repaired by the application of 6 inches of caliche from the site. Within the mixing model at time = 0, ground water that enters the mixing zone has a chloride concentration of 93 mg/L, the value of the input discussed above. Soon after time=0, the additional natural chloride flux from the vadose zone to the aquifer causes the predicted chloride concentration in ground water to vary between 102 and 99 ppm until about year 12. Between year 12 and year 22, the natural flux of chloride into the aquifer increases as a result of "wet" years within the atmospheric data, causing an additional predicted increase of chloride to about 110 ppm. To reiterate, these variations in chloride concentrations predicted in the model for years 0-22 result from natural conditions and are not due to the installation of caliche road repairs.

Our analysis of the model output shows that chloride molecules from the caliche pad begin to enter ground water about year 24. The center of mass of chloride leached from the caliche road repair intercepts ground water about year 29 and creates a maximum chloride concentration of 128 mg/l or about 19 mg/L greater than the maximum concentration due to natural causes. Although the highly-conservative model predicts a natural chloride variation from 93 to 110 mg/L, the natural variation of chloride concentration is documented at MW-1 as a variation between 72 mg/L and 120 mg/L. Because the natural variation is 48 ppm, the theoretical contribution of chloride to the aquifer (19 mg/L) from the caliche road repair is too small to be detected.

Figure1 : Chloride Concentration Observed in the Aquifer at the Down Gradient Edge of a North-South Road with a 6 inch thick Layer of 1200 ppm Caliche



After year 29, predicted ground water chloride concentrations decrease and approach the model input value of 93 mg/L. This prediction is due to the model's assumption that precipitation is essentially distilled water and, therefore, salt does not accumulate in the root zone due to evapotranspiration. As the model predictions trend toward the input value of 93 mg/L, we know that the effect of the chloride load of 0.34 kg/m2 has passed through the model.

Because HYDRUS-1D over estimates the potential impact to ground water and because the example employs other conservative input, we believe this model demonstrates that the proposed reduce-reuse-recycle program protects fresh water, public health and the environment. In fact, this submittal shows that the theoretical contribution of chloride to ground water is too small to detect by ground water monitoring. Finally, we conclude that this reduce-reuse-recycle program could result in a total chloride contribution to ground water of zero because of the highly-conservative input parameters employed in our simulation.

If NMOCD concurs with this overall approach but needs additional data and/or simulations to gain the degree of assurance required for this program in an area that overlies the water supply of the City of Lovington, we would be pleased to oblige. The alternative of hauling the caliche to a landfill appears to create a greater impact to the environment and public safety than this proposal. We believe this relocation of the chloride load (i.e. caliche) from the site and dispersal of the chloride to appropriately small areas of well pads or north-south roads provides better protection of ground water than the remedy originally proposed in August 2005.

As you recall, the HYDRUS-1D model of the remedy in the Amended CAP demonstrated (to our satisfaction) that the proposed clay cap and no exportation of impacted material was protective of fresh water, public health and the environment. The exportation of the caliche from the site and landfill disposal of sandy-clay material that exceeds 2,000 mg/kg removes some of the chloride mass from the site and provides a higher degree of certainty that the proposed remedy is fully consistent with NMOCD Rules. We respectfully request you consider this reduce-reuse-recycle proposal in lieu of landfill disposal of the caliche (as suggested in your conditional approval) and the blending action as proposed in the Amended CAP.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks

David J. Hamilton

Randall Hicks
Principal

David Hamilton
Staff Hydrogeologist

Copy: Rice Operating Company

Price, Wayne, EMNRD

From: Price, Wayne, EMNRD
Sent: Thursday, November 17, 2005 12:10 PM
To: 'Carolyn Doran Haynes'; Sanchez, Daniel J., EMNRD
Cc: 'Kristin Farris Pope'; 'Randall Hicks'; Patrick B. McMahon (hsncpbm@leaco.net)
Subject: RE: Rice ABO 1G Release site 1R0415

Dear Ms. Haynes:

Point #1: OCD's intent is for ROC to remove as much chloride mass to some practical extent. If there are areas where the contamination is only three (3) feet deep then you would only be required to remove that portion.

Point#3. OCD will require clean back-fill at this site due to the sensitive nature i.e. close proximity to a public well supply.

If you have any further questions please do not hesitate to call or write.

From: Carolyn Doran Haynes [mailto:cdhriceswd@valornet.com]
Sent: Friday, November 11, 2005 12:18 PM
To: Price, Wayne, EMNRD; Sanchez, Daniel J., EMNRD
Cc: 'Kristin Farris Pope'; 'Randall Hicks'
Subject: RE: Rice ABO 1G Release site 1R0415

Wayne and Daniel,

There are 2 points of your conditions for the ABO 1G Release Site that Rice and System Partners would like clarification.

Point # 1: Remove a minimum of five (5) feet of soil in all impacted areas and dispose of at an approved OCD site.

For Example: Remove IMPACTED soils or a minimum of 5 feet – if impacted soils are only 3' deep or less (as many of the perimeter areas are) just remove the 3 feet. If impact is greater than 5 feet, remove 5 feet.

Also, for disposal of removed soils, dispose of soils greater than 1000 ppm Chlorides (or a concentration that OCD can support) and stage lesser-impacted soils for on-site blending.

Point # 3: Backfill over the barrier area with a minimum of three (3) feet of clean soil that will support vegetation.

It is ROC's experience that soils <1000 ppm Chloride can successfully support native vegetation. The API (and Dr. Lloyd E. Deuel and Texas A&M) actually supports a concentration of 800 ppm Chloride. A web site for reference would be: http://agnews.tamu.edu/drought/DRGHTPAK/SALITAB9.HTM Look for the Texas A&M University document titled "Chloride Tolerance of Agricultural Crops."

Could OCD clarify an acceptable concentration? ROC would like to retain as much of the native soil as possible to blend with fresh, foreign soil that will be hauled-in. Generally, with the consideration for 12" of compacted clay (95% of proctor test with permeability of $<1 \times 10^{-7}$ cm/sec?) we will haul in an amount equal to the hauled-out amount. We will compact all soils and slightly mound the area to compensate for settling over time.

Please respond so ROC can distribute the AFE for this work. We will meet the January closure request if we get

this out asap.

Thank you.

Carolyn Doran Haynes
Engineering Manager
RICE *Operating Company*
505-393-9174
505-397-1471 (fax)

From: Price, Wayne, EMNRD [mailto:wayne.price@state.nm.us]
Sent: Friday, November 04, 2005 3:44 PM
To: cdhriceswd@valornet.com
Cc: Sheeley, Paul, EMNRD; hsncpbm@leaco.net; seay04@leaco.net
Subject: Rice ABO 1G Release site 1R0415

Dear Ms. Haynes:

Please find enclosed the work plan approval for the Lovington ABO 1G release site. Please notify the City of Lovington and the OCD Hobbs office before starting.

Wayne Price-Senior Environmental Engr.
Oil Conservation Division
1220 S. Saint Francis
Santa Fe, NM 87505
E-mail wayne.price@state.nm.us
Tele: 505-476-3487
Fax: 505-4763462

Attachments can contain viruses that may harm your computer. Attachments may not display correctly.

Price, Wayne, EMNRD

From: Price, Wayne, EMNRD **Sent:** Fri 11/4/2005 3:43 PM
To: cdhriceswd@valornet.com
Cc: Sheeley, Paul, EMNRD; hsncpbm@leaco.net; seay04@leaco.net
Subject: Rice ABO 1G Release site 1R0415
Attachments: final clean-up requirement Request #2.doc(27KB)

Dear Ms. Haynes:

Please find enclosed the work plan approval for the Lovington ABO 1G release site. Please notify the City of Lovington and the OCD Hobbs office before starting.

Wayne Price-Senior Environmental Engr.
Oil Conservation Division
1220 S. Saint Francis
Santa Fe, NM 87505
E-mail wayne.price@state.nm.us
Tele: 505-476-3487
Fax: 505-4763462

October 24, 2005

NMOCD Environmental
ATTN: Wayne Price
P.O. Box 6429
1220 S. Saint Francis Drive
Santa Fe, NM 87504

RE: Rice ABO Leak Site
City of Lovington - Water Field

Mr. Price:

At the request of Mr. Wise and the City of Lovington, I am responding to the OCD concerning the above listed spill site.

The City of Lovington is very concerned that some time in the future this spill site may cause elevated chloride in the groundwater, above drinking water standards. The City of Lovington can not risk or compromise its water. Other companies in the field such as Pure, Duke and Saga have had no problem excavating and hauling its contamination, from the field and we feel Rice should do the same.

We would like removal of 5 to 10 ft. of the contaminated soil, install a clay barrier then replace with clean soil. We would also like a down gradient monitor well installed to monitor the groundwater.

It has been two years since this leak occurred and nothing but testing and paper work has been done. Its time Rice get stated before groundwater is contaminated.

If you have any question, please call.

Sincerely,

Eddie W. Seay

Eddie W. Seay, Agent
Eddie Seay Consulting
601 W. Illinois
Hobbs, NM 88242
(505)392-2236
seay04@leaco.net

cc: Pat Wise, City of Lovington
Patrick McMahon

You forwarded this message on 8/17/2005 11:11 AM.

Price, Wayne, EMNRD

From: Price, Wayne, EMNRD **Sent:** Tue 8/16/2005 4:09 PM
To: cdhriceswd@valornet.com
Cc: Sheeley, Paul, EMNRD; Johnson, Larry, EMNRD; hsncpbm@leaco.net
Subject: ABO 1G site 1R0415
Attachments:

Dear Ms. Haynes.

OCD records indicate Rice Operating Co. was suppose to submitt a remediation plan by August 12, 2005. As of this date OCD has not received the plan.

Please advise ASAP.

Wayne Price-Senior Environmental Engr.
Oil Conservation Division
1220 S. Saint Francis
Santa Fe, NM 87505
E-mail wayne.price@state.nm.us
Tele: 505-476-3487
Fax: 505-4763462

R.T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW σ Suite F-142 σ Albuquerque, NM 87104 σ 505.266.5004 σ Fax: 505.266.0745

Page 1 of

FAX

To: Wayne Price

Fax: 505-746 3471

Phone: Date: 8/18/05 3:30 PM

Re: Lovington Abo 1G CC: Kristin Pope

From: Randall T Hicks
e-mail R@rthicksconsult.com home page www.rthicksconsult.com

Wayne

As suggested in this letter, which was emailed to you on August 12, we were simply unable to synthesize the large number of samples obtained by ROC, place the data into HYDRUS, and develop a meaningful remedy in one week.

Rather than provide NMOCD with an incomplete remedy report that would not stand any meaningful scrutiny on August 12, our letter requested sufficient time to do the job correctly. The data collected by ROC allows us to consider the additional chloride load from the earlier release.

Thank you for your consideration.

Randall Hicks

We Reveved the data on Monday August 9 not Monday the 11th as the letter suggests.

WORD HAS AN AUTOMATIC DATE FUNCTION! WE WROTE THE LETTER ON THE 11th

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

August 12, 2005

Roger Anderson
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Re: ABO 1G Release Site OCD Case #1R0415
Unit Letter G, Sec. 1, T17S, R36E
Lea County, NM

Dear Mr. Anderson:

On Monday, August 11 R.T. Hicks Consultants received the data from the extensive characterization conducted by Rice Operating Company for the above-referenced site. Plate 1 shows the level of effort expended by ROC: analysis of 73 near surface soil samples and 120 samples from 12 20-foot deep sampling trenches. The characterization program began on July 26.

In our July meeting, we stated that the inclusion of this earlier release in the modeling experiments would likely cause the model ground water to exceed the WQCC standards. Today, we completed the data preparation and input and are initiating the first of several simulation experiments. We will employ these new data from the upper vadose zone (0-20 feet below land surface) with the data from the deeper borings in new HYDRUS-1D simulations. We will include the chloride load caused by what we now know is a 1992 release from the site and the chloride load from the 2003 release. We will also account for the increased chloride load due to man's activity in the area that raised the chloride concentration in deep soil from near 90 ppm (pre-Columbian background) to the 100-200 ppm observed in the up gradient soil boring SB-2.

The first simulation planned assumes removal of chloride from the thin soil horizon overlying the caliche and the installation of a synthetic liner on the caliche layer to prevent infiltration of precipitation. A second experiment will assume that we excavate and export the topsoil and a portion of the underlying caliche, install a sloped clay layer, import clean fill, and create a sloped vegetative cap. We plan to examine other excavation remedies in order to select the remedy that is based upon sound science, compliant with the regulations, and effectively protects ground water quality.

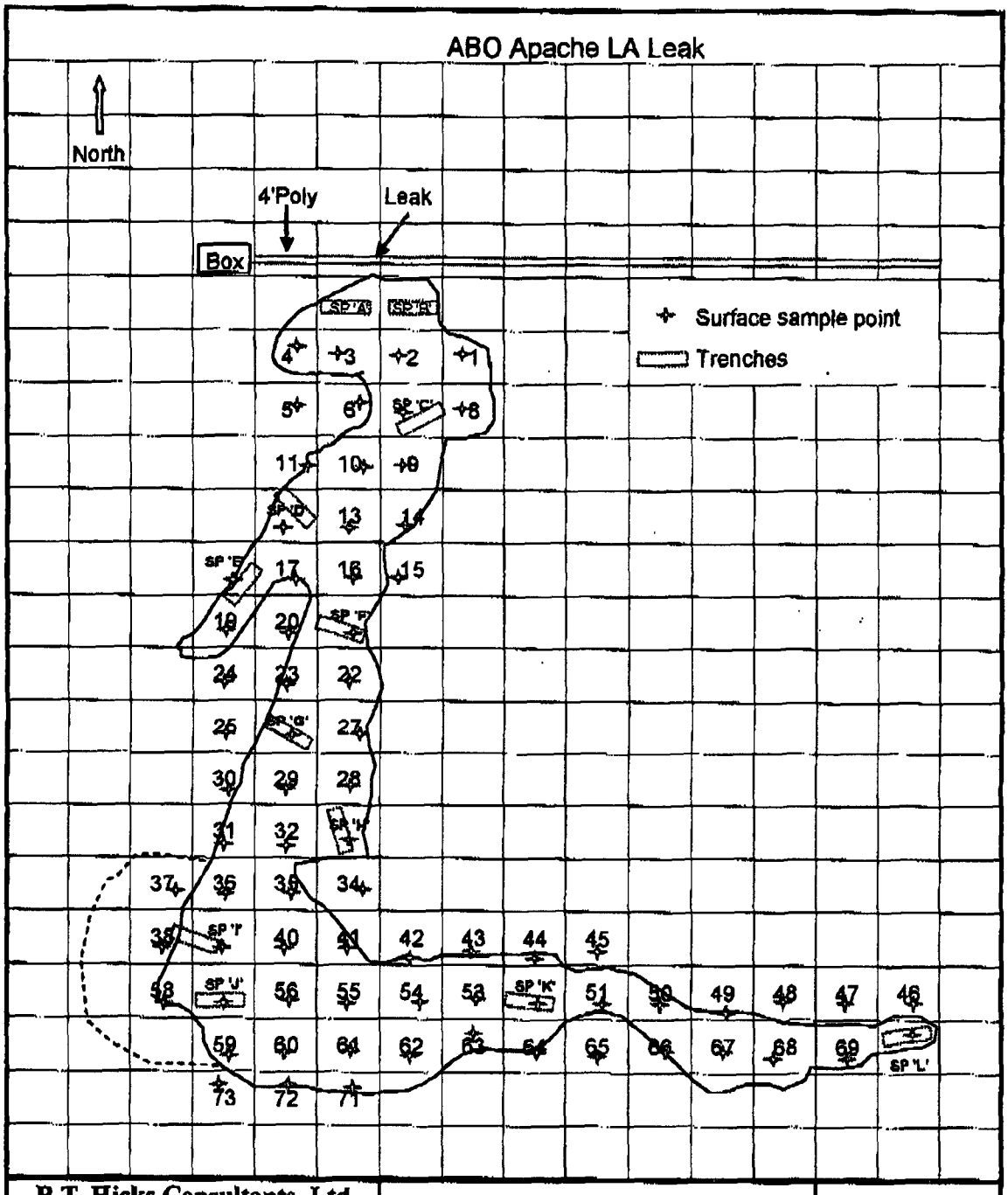
By August 31, we propose to submit to NMOCD an amended Corrective Action Plan (CAP) for the site that will address not only the 2003 release but the effects of the 1992 release. In this report we will provide an explanation of our modeling protocol, a summary of the ROC investigation, data discs that will allow NNMOCD to verify the our predictions using HYDRUS-1D, and a schedule for the proposed remedy based upon the date that NMOCD approves the CAP.

Please contact Kristin Pope if you have any questions regarding this progress report.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks
Principal

Copy:
Kristin Pope
William Carr
Carolyn Haynes



R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	**Abo Apache 1-G Release Site**	**Plate 1**
	Surface Sample and Trenching Locations	**Aug., 2005**

P.01

TRANSACTION REPORT

AUG-18-2005 THU 04:35 PM

FOR:

RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
AUG-18	04:34 PM		1'14"	4	RECEIVE	OK		

Price, Wayne, EMNRD

From: Price, Wayne, EMNRD **Sent:** Tue 8/16/2005 4:09 PM
To: cdhriceswd@valornet.com
Cc: Sheeley, Paul, EMNRD; Johnson, Larry, EMNRD; hsncpbm@leaco.net
Subject: ABO 1G site 1R0415
Attachments:

Dear Ms. Haynes.

OCD records indicate Rice Operating Co. was suppose to submitt a remediation plan by August 12, 2005. As of this date OCD has not received the plan.

Please advise ASAP.

Wayne Price-Senior Environmental Engr.
Oil Conservation Division
1220 S. Saint Francis
Santa Fe, NM 87505
E-mail wayne.price@state.nm.us
Tele: 505-476-3487
Fax: 505-4763462

NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Mark Fesmire
Director
Oil Conservation Division

Memorandum of Meeting or Conversation

Telephone _____
Personal __X_____
E-Mail _____
Location: Santa Fe,NM

Time: 1pm
Date: July 15, 2005

Originating Party: Rice Operating Co. (ROC) CDHaynes, RTHicks, BCarr

Other Parties: OCD- WPrice,GMacQuesten, DSanchez, GvonGonten,RCAnderson, EMartin City of Lovington-PMcMahon,ESeay

Subject: Rice ABO 1G 1R0415

Discussion:

ROC requested a meeting concerning OCD's letter dated July 08, 2005 requiring ROC to perform certain remedial clean-up actions at the Rice ABO 1G site located near the Lovington, NM City fresh water well field.

Mr. Carr attorney for ROC expressed a concern over the tone of the letter since he felt his client had been successfully working with OCD. Mr. Carr indicated ROC is willing and ready to perform certain actions in order to protect the Lovington City well field. Ms. Haynes, manager of ROC, presented a detailed chronology of the project. Mr. Hicks presented a response to OCD's letter and gave a reassessment of the project.

Mr. Hicks informed OCD that ROC's initial assessment of the site using the Hydrus 1-D model indicated there would not be a problem and groundwater would not be contaminated. Mr. Hicks pointed out that OCD's letter made him rethink the actual site conditions and input parameters. He indicated ROC had only modeled the upper part of the vadose zone contamination, not the deeper part. He pointed out that if this deeper historical contamination is included then he feels very confident that groundwater will be impacted in the foreseeable future.

OCD (Price-Anderson) asked the question why the model did not reflect this discrepancy since it was calibrated using on-site data, which included the deeper vadose zone. Mr. Hicks indicated that it did not include the deeper contamination that was shown on his slide. ROC only modeled the reported spill (i.e. net 60 bbls). ROC presented an old spill incident report from the early 1990's to verify there was another spill in this area.

OCD expressed its concern that although Mr. Hick's proposals always included different clean-up options generally the model always selected the "No Action Alternative". Mr. Hicks responded that he is removing that language from future proposals.

OCD expressed another concern about the monitoring time. The model generally showed that it takes many years for the contamination to reach groundwater, but ROC only proposed to monitor for two years. Ms. Haynes answered this question by explaining their procedure in proposing monitoring times. Mr. Price and Anderson emphasized that all proposals should more accurately represent the actual conditions of the site.

Mr. Carr made a closing statement requesting OCD allow ROC an opportunity to re-evaluate the site and present another clean up plan for OCD approval.

Conclusions or Agreements:

Mr. Anderson agreed to ROC's request with the stipulation that the plan would be submitted by Monday and would include a short deadline for completing the re-evaluation.

Signed:___ Wayne Price _____

CHRONOLOGY OF CORRESPONDENCE

Abo Apache 1G leak (unit 'G', Sec. 1, T17S, R36E)

Date	Event
6/26/2003	Hicks hosted HYDRUS1D workshop in Albuquerque with software author for OCD at OCD's request. Funded by ROC and others. Provided OCD with software. KP and GVD attended as representatives of ROC.
10/18/2003	Leak discovered
10/22/2003	Initial sampling and investigation
10/23/2003	Initial sampling and investigation
11/10/2003	3 soil borings in pooled areas
1/22/2004	Work Plan submitted to OCD; collect field data, run Hydrus1D, investigate possible remedies
1/27/2004	WP "Please send all of the backup information. Main plot analysis of Me[illegible] not sure how I can approve a process without seeing the modeling results which take into account the soil flushing etc. I will probably require a monitor well in this area due to its proximity to the Lovington well field and there are also many down gradient wells
1/29/2004	R.T. Hicks responds: explains it was a work plan only, not suggesting a remedy yet.
4/2/2004	Hicks emails WP: Attaches same work plan. Requests approval to proceed with work plan.
4/5/2004	WP emails Hicks "What's delineation criteria for chloride?"
4/13/2004	Hicks emails WP: 3 soil borings were performed; will employ fate and transport simulations.
6/7/2004	Corrective Action Plan submitted to OCD; enclosed results of simulations; proposed closure and re-vegetation
8/6/2004	WP "Please note due to the close proximity to the City of Lovington's fresh water well field OCD feels compelled to deny the plan as submitted. Requests plan to remove contamination by [illegible] OCD will only allow [illegible] after excavations.
8/12/2004	CDH requests 8/31/04 extension
8/31/2004	Hicks submits revised plan: remove affected topsoil, import replacement soil, seed and monitor for growth.
10/1/2004	WP email to R.T. Hicks & Pat Ward approves removal of "the affected topsoil" but requires MW. Requested "comments or concurrence so we may proceed. SAP"
10/28/2004	Hicks notified OCD of MW installation date and plans to removed the affected top soil and replace with clean and grade surface. Will submit a report comparing MW installation data to previous SB data. If Cl- migration matches Hydrus simulations; request closure. Regardless, will monitor MW quarterly for 2 yrs. If <250 Cl- for 2 yrs, P&A MW. If >250, discuss additional action with OCD; City of Lovington was copied.

11/4/2004	[illegible] approves MW installation [illegible] OCD will [illegible] results [illegible] approve the [illegible] plan. We will also [illegible] comments from the City of Lovington
11/6/2004	MW installed.
12/3/2004	Basin Env. purged and sampled MW
12/7/2004	OCD requests MW log, water analysis and site map by 12/14/04
12/14/2004	CDH emails OCD: MW sampled on 11/24/04, waiting on lab analysis
12/20/2004	requested data emailed to OCD
2/23/2005	OCD: After reviewing data, lab QA/QC [illegible] sample bottle not labeled [illegible] ROC to resample by 3/21/05 and split with OCD-Hobbs
3/1/2005	Basin Env. Sampled MW; waited on P. Sheeley (OCD-Hobbs to split); Eddie Seay (City of Lovington) also split sample.
3/16/2005	Hicks requests OCD analysis from split sample to include in report; WP agrees
3/28/2005	Amended CAP sent to OCD with 3/1/05 MW analysis; Removal of topsoil provides no environmental benefit; Could not include OCD lab analysis from 3/1/05 sampling for comparison did not receive OCD split analysis.
5/2/2005	WP: "Please note OCD never received your sampling results of the Site Monitor well. Please provide ASAP"
5/4/2005	email KP to WP: Hicks submitted work plan on 3/28 that includes a table of analysis, do you want the entire lab report? Are OCD's lab results available yet? Next quarterly sampling is 5/16, does OCD want to split again?
5/4/2005	WP requests copy of the spill report; faxed it same day.
5/4/2005	WP: spill report [illegible] photos were taken, provide them.
5/4/2005	WP emailed OCD split sample lab analysis; KP faxed ROC analysis to OCD; [illegible] photos
5/6/2005	Hicks emails WP: clarify specific data needs to evaluate the site; Hicks can provide.
5/6/2005	WP: City of Lovington says soil samples have high Cl- (11,000-22,000 mg/kg)
5/9/2005	WP: "The city of Lovington has supplied OCD with soil surface samples that show high chlorides (11,000-22,000 mg/kg). Unless I missed something we did not see levels listed that high in your reports. So I have requested the District office to go out and collect samples [illegible] next week. If you want to split call Paul Sheeley [illegible]. Once [illegible] get our sample results then our technical staff will determine a path forward hopefully that is satisfactory to all parties and will protect the environment. OCD considers this a high profile case since it is located in close proximity to the Lovington city fresh water well field. OCD [illegible] concerned about the amount of time that has passed with no remedial action. [illegible] will make a decision very soon."
5/9/2005	Hicks emails P. Sheeley (OCD-Hobbs) and asks to coordinate sampling when he is in town so that Hicks can split.
5/9/2005	Hicks to WP: anticipates splitting with PS; Explains ROC did not collect initial topsoil samples because it was crusted with salt and topsoil <6 inches underlain by fractured caliche. Surface samples that ROC did collect were after heavy rains.
5/9/2005	P. Sheeley says he will collect soil samples the next day (May 10); not enough time for Hicks [illegible].
5/23/2005	Basin Env. purged and sampled MW

6/8/2005	P. Sheeley requests access to MW to sample water well split with [illegible] (City of Lordsburg rep.)
6/8/2005	P. Sheeley called and requested a no-purge sample from the MW; KP emailed P. Sheeley latest lab report from quarterly sample.
6/13/2005	WP confirms conversation with GVD in an email. "Pursuant to our telephone conversation today, we do not purge the monitor well between now and the time GVD samples. GVD wishes to take a judgmental sample which is allowed per EPA protocols. Similar to micro-purge. This well was not constructed per GVD methods and we want to know what the groundwater quality is without dilution."
6/15/2005	P. Sheeley requested date to sample MW: Since Gil Van Deventer was now representing R. T. Hicks Consultants, attempted to contact PS for coordination. ROC preferred to have the consultant on site; GVD was available on 6/17/05; GVD received no response from PS
6/16/2005	PS called KP: not available 6/17. KP said ROC would appreciate the opportunity to have consultant present. PS said he would contact "Santa Fe." PS called back and told ROC to unlock the MW immediately so that he could sample it.
	At approx. 9:30 am, ROC personnel and P. Sheeley split water samples; PS collected samples without purging well.

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

July 13, 2005

Roger Anderson
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

Re: ABO 1G Release Site OCD Case #1R0415
Unit Letter G, Sec. 1, T17S, R36E
Lea County, NM

Dear Mr. Anderson:

This letter responds to the technical issues brought forth in the NMOCD letter to Rice Operating Company (ROC) dated July 8, 2005. Hicks Consultants collaborated with ROC staff to develop this response. The NMOCD technical comments or requirements are shown in italics and our response is presented below each comment or requirement.

1. *ROC indicated this is a modeling experiment (page 3 March 2005 report). OCD does not feel that it is appropriate to allow "experiments" in such a sensitive area that may impact thousands of people in the city of Lovington.*

In the report "experiment" is a term of science that means "a test made to demonstrate a known truth, to examine the validity of a hypothesis, or to determine the efficacy of something previously untried". The term refers to the simulation modeling, not the proposed remedy. We did not intend the word to mean anything that would suggest that ROC is not very serious regarding moving forward with an appropriate remedy that is fully supported by data and sound science. Nor did we mean to imply that the City of Lovington well field is not a "sensitive area". In our report, we refer to modeling, like monitoring or any scientific evaluation of a hypothesis, as an *experiment*. At this site, we used a simulation modeling experiment to test a null hypothesis: the residual chloride mass in the vadose zone would cause impairment of ground water quality.

2. *OCD did not have the accessibility to run the model and therefore cannot confirm the results.*

At a recent meeting of the New Mexico Oil and Gas Association, Mr. Daniel Sanchez stated that the State of New Mexico would not allow NMOCD to install the HYDRUS-1D software that ROC provided on June 26, 2003. Honestly, we were dumbfounded when NMOCD relayed this information to industry.

On June 26, 2003, Hicks Consultants and the author of the HYDRUS code, Dr. Jirka Simunek, provided NMOCD with a 1-day workshop on the use of HYDRUS. This workshop was a response to a request from NMOCD that the regulated community provide NMOCD with a copy of the HYRDRUS-1D software and instructions on how to use the code. The purposes of this workshop were outlined in the attached April 9, 2003 memorandum to Bill Olson of NMOCD and item 3 specifically states that the workshop would:

Provide NMOCD instruction on the use of HYDRUS1D and the ground water mixing model. This will enable NMOCD to review and approve remedies that employ these tools.

This seminar, which cost more than $10,000, was funded by Rice Operating Company, Champion Technologies, Marathon Oil Company, and Hicks Consultants, all of whom had employed HYDRUS-1D in submittals submitted to the agency in 2003. Furthermore, the participants offered to fund the services of Dr. Jan Hendrickx of NM Tech for hands-on assistance after NMOCD had become familiar with the code.

NMOCD comment #2 and the recent statement by Mr. Sanchez was especially disturbing because the agency has approved several work plans that specifically stated our intention to employ HYDRUS-1D in our evaluation of potential remedies. Therefore, we can only respond to this comment by asking NMOCD to identify a means to provide independent verification of our modeling if your agency is unable to do so internally.

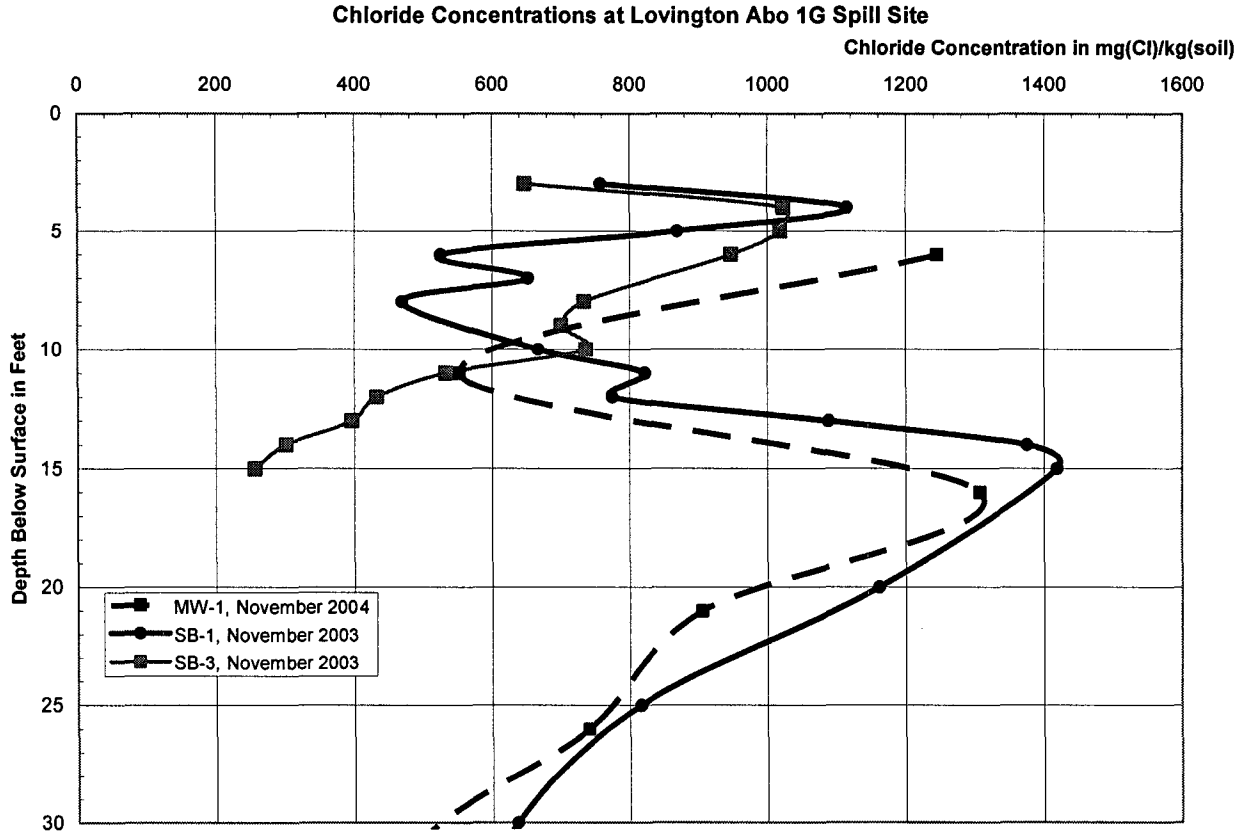
If requested by NMOCD, ROC will provide the agency with a stand-alone modeling station for use on ROC or System Partner projects. This would not become property of the State of New Mexico and we trust that NMOCD would employ this tool for evaluation of submittals from ROC or specifically-identified System Partners. We would load this computer with all of the atmospheric and other data files necessary to evaluate any ROC or System Partner submittals that employ a particular code, such as HYDRUS-1D. The original offer of ROC to provide hands-on instruction of the use of the HYDRUS-1D code by Dr. Hendrickx remains on the table as well.

3. *The spill report showed a net release of 60 barrels. The actual investigation revealed this release amount actually caused the vadose zone to be contaminated down to a depth of approximately 46 feet in approximately one year.*

Our report is obviously not clear on the depth of penetration into the vadose zone from the October 2003 release. Chloride from the October 2003 release has not penetrated the upper vadose zone to a depth of 46 feet. As discussed below and in the various submittals, produced water released in October 2003 penetrated the upper vadose zone to a depth of about 4 feet by November 2003 at the site of SB-1. By November of 2004, chloride from the October 2003 release migrated to a depth of about 6 feet below land surface, as the data from MW-1 show.

The lithology of the site, the sudden and instantaneous nature of the spill, and the excellent soil chemistry data allow a solid understanding of the mechanics of fluid flow at this site. We believe the data demonstrate that chloride from the October 2003 spill immediately drained through the fractures in the surface caliche to a depth of about 3 feet, where the base of the fractured caliche horizon is in contact with underlying "sand and caliche" (see the attached MW-1 well log, which was previously submitted to NMOCD). The release created temporary saturated conditions in this underlying unit that caused relatively rapid migration of chloride into the sand plus caliche unit identified from 3 to 5 feet below ground surface. The center of chloride mass from the October 2003 release is shown in the report but is more clearly presented below. The sampling experiments show the center of mass of chloride at a depth of about 4 feet for both SB-1 and SB-3, about one month after the documented release. These data also demonstrate a second chloride mass 15 feet below

ground surface at SB-1 and MW-1. This lower chloride mass is not present at SB-3 indicating that this mass is not part of the October 2003 release and dates from an earlier time.



The data simply do not support a hypothesis that chloride migrated to a depth 46 feet in one year. The chloride concentrations observed in SB-1 and MW-1, temporally separated by one year, could not agree in form if this were true. Rather, the data suggest that oil field activity over the past 50 years has caused an increase in chloride content in the upper vadose zone in this area, probably to a depth of about 46 feet. Perhaps produced water spills that occurred in this area decades earlier are the cause of this elevated chloride concentration. Perhaps the nature of the caliche itself contributes to the elevated chloride concentration in the uppermost vadose zone, as suggested in the report.

Our reports identified a June 2003 release of 10 barrels of produced water at this site, which may have impacted the area of SB-1 but did not impact the area characterized by SB-3. We hypothesize that the chloride released to the vadose zone in June 2003 may be the cause of the slightly higher chloride concentrations observed at the 4-foot depth at MW-1 and SB-1 relative to the concentrations observed at the same depth at SB-3.

If the area had not experienced oil field activity prior to the October 2003 release, then we would agree with NMOCD that the release caused an impact to a depth of 46 feet.

NMOCD's observation regarding the difference in chloride concentrations above 36 feet from the materially lower chloride concentrations below 46 feet is very interesting. Because the sampling data from SB-1 and MW-1 shows that chloride migration in this area is about 1-2 feet per year, one can use the depth of elevated chloride as a crude measure of when man's activities first affected the

area. This observation allows us to conclude that oil field activity in the area began 23-46 years ago. NMOCD data show that wells within Section 1 (unit letters F, G, and H) were originally drilled in the early 1950s. Because oil production, and the impact of accidental produced water releases, would have started about 47 years prior to the 2003 release, we believe NMOCD's observation supports a long-term chloride vertical migration rate of about 1-foot per year.

Using this information concerning migration rates and the data collected from SB-1 and MW-1 demonstrating initial infiltration rates, we suggest that the chloride mass at 15 feet bgs dates from 10 to 15 years ago.

> *ROC's model uses a spill input parameter of 500 barrels- almost ten times the amount of the actual spill. In other words, the model assumes that it would take a much larger release to cause contamination to a depth of 46 feet in one year.*
>
> *It is apparent that in this particular case the model results do not accurately reflect the actual field conditions. OCD does not feel comfortable in accepting the results of the model when input parameters differ so greatly from the actual conditions.*

The model's use of a 500 barrel release is consistent with the mass of chloride observed in the soil profile (between ground surface and the 4- to 6-foot depth of penetration) rather than the visual observations of field personnel. However, the sampling points of ROC were considered "worst case" samples because field personnel observed pooled produced water at these locations. We believe the use of this value, which may actually over predict the impact to ground water, is fully appropriate. As pointed out in Hendrickx and others (2005), the HYDRUS-1D model does not rely upon chloride concentrations or chloride mass as input parameters. Chloride mass is used in the simple ground water mixing model and we can employ whatever mass of chloride NMOCD wishes to use without the need to recalibrate or re-run the HYDRUS-1D portion of the simulation experiment. We look forward to your input on this mater and are pleased to re-run the mixing model and present the result.

4. *ROC's June 07, 2004 report indicated that the background concentration in the caliche/upper vadose zone was 300-ppm chlorides. . OCD received a complaint from the City of Lovington concerning where the background sample was taken. OCD does not believe that naturally occurring background levels would be this high.*

We agree that naturally occurring background concentrations are not 300 ppm in sand. We believe the data from below 50 feet shown on the well log included in the report define the natural background (i.e. pre-Columbian conditions) as less than 100 ppm in sandy horizons. However, in order to differentiate between the impact of the October 2003 spill from previous releases or other anthropomorphic influences, we needed to establish a local background concentration (i.e. ambient concentration) in the same lithology as the spill itself. Therefore, ROC obtained samples from an area not effected by the recent release and the result was a finding that ambient chloride concentrations in the upper vadose zone were 300 ppm. Please remember, the purpose of the report was to examine the effect of the October 2003 spill on the environment. The purpose of the report was neither the evaluation of 50 years of man's activity in the area nor the natural variation between chloride in sandy horizons and chloride in caliche zones. We employed the ambient chloride concentration of 300 ppm only to assist us in the characterization of the release in the upper vadose

zone.

5. *The chlorides contamination migrated down to a depth of 46 feet from October 2003 to November 2004. The groundwater depth was reported at approximately 77 feet. The March 2005 report indicated that chlorides contamination had moved an additional 30-60 cm. The June 07, 2004 report (see page 6) states that "Deeper in the Vadose zone, fractures become barriers to flow and deeply buried caliche behaves more like clay". The March 2005 report (see page 5) reiterates that the chloride migration is impeded at the depth of 35 to 36 feet by the one foot thick caliche layer. The report estimates that the migration is about 2 feet per year and the chloride peak would reach the groundwater in 35 to 42 years.*

   NMOCD's experience in shallow vadose zone excavations (down to 50 feet) does not support the theory that fractured caliche acts as a clay barrier. ROC's plan did not support this theory with any field data. In fact, OCD notes that the chlorides contamination has migrated 46 feet in just one year. This is 10 feet deeper than the caliche zone that is purported to act as a barrier. Based on the limited information provided, OCD must reject the prediction that it will take another 30-40 years to reach groundwater.

In vadose zone profiles with low water content, many scientists contend that fractures are barriers to unsaturated flow and the ability of a hydrostratigraphic unit to transmit water is depended upon the properties of the porous matrix. However, a growing body of knowledge from simulation, laboratory and field experiments suggests that the role of fractures is far more complex. At this site, our modeling experiment did not rely upon an assumption that fractures were or were not a barrier to flow. Instead, we relied upon actual field data to calibrate the HYDRUS-1D simulations. We used the field data to adjust the hydraulic input parameters of the model to permit more accurate predictions. At this site, the field data demanded that we employ hydraulic input parameters for the deep caliche horizons that were similar to clay. Conversely, we used hydraulic properties more similar to gravel to simulate movement through the highly fractured surface caliche.

We cannot comment on NMOCD's experience at other sites that may or may not have any similarity to this sudden and accidental surface release. We hope the discussion above adequately addresses the misunderstanding of the chloride migration rate at this site. We can state with a reasonable degree of scientific certainty that we have a solid understanding of the hydrogeology of this particular location.

6. *ROC's plan is to monitor groundwater for only two years and then request closure. This process does not correlate to the time that the model predicts salt will enter the groundwater, i.e., 30-40 years. OCD feels there will be no way to know if the model experiment is valid.*

If NMOCD does not have access to the HYDRUS-1D model, we are certain that NMOCD cannot validate the findings presented in the report using internal resources. We urge NMOCD to consider requesting assistance from other State of New Mexico employees, such as those employed at NM Tech, UNM, or NMED to evaluate the validity of our findings. To reiterate, if NMOCD requests a stand-alone modeling station and expert, independent assistance to further test the simulation

experiments that are the basis of our submissions, ROC is willing to fund this endeavor.

We would like to remind NMOCD that very early in this matter, ROC offered to install vadose zone monitoring devices that would be capable of measuring the migration (and sequestration) of chloride in the vadose zone. This type of monitoring is exactly what is currently approved by NMOCD, NMED and EPA within the saturated zone: Monitored Natural Attenuation. However, NMOCD stated categorically that such monitoring would be unacceptable and required the installation of a monitoring well. If requested by NMOCD, ROC is willing to provide the agency with a program to monitor the migration of chloride in the vadose zone as originally proposed.

7. *OCD and the City of Lovington recently collected soil samples and discovered that high salt levels (i.e. chlorides up to 20,000 ppm) still remain in the spill area. These results were approximately 4-5 times higher than ROC's results submitted via E-mail on October 01, 2004.*

   OCD understands that chloride mass is a very important input parameter to the model. The March 2005 submittal included a plate 3 "Calculation of Chloride Load" which showed the highest soil concentration to be 1161-ppm chlorides. As pointed out above, surface soils had concentrations 10 times the value shown on Plate 3. ROC did not justify why these values should not have been included in the calculations.

The thin surface soil layer of high chloride concentration was not considered in our calculation of chloride load because this mass of chloride is inconsequential when compared to the overall chloride mass. Also, this thin zone of high chloride soil was not considered because ROC repeatedly offered to remove this soil layer (see August 31, 2004 work plan, for example). Although NMOCD initially approved the removal of the thin high chloride layer, this approval was then retracted (see November 4, 2004 email from NMOCD).

While selective sampling of the surface soil could demonstrate high or low chloride concentrations, we observed invasion of plants in 2004 and recent photographs show that the majority of the surface soil does not exhibit sufficient chloride concentration to inhibit growth. The invasion of vegetation in 2004, which is not well described in any submittals, provides evidence that the chloride mass in the thin soil horizon does not pose a material threat. Nevertheless, if requested by NMOCD, ROC will determine the mass of residual chloride in the thin soil horizon and we will re-run the model to account for increased chloride load.

8. *The site has not been adequately delineated.*

We maintain the characterization presented in the reports adequately defines site conditions, and provides the data necessary to select and design an effective remedy. The lateral extent of the surface impact can be measured to the inch. The vertical extent of impact is also defined to the inch in two areas of the spill, SB-1 and SB-3, where ROC observed pooled produced water. Sampling at locations such as SB-1 and SB-3 provide worst case conditions – maximum chloride penetration and the highest chloride concentrations (e.g. largest mass). Designing a remedy based upon these worst case conditions provides the maximum protection.

If requested by NMOCD, ROC is willing to expand temporal sampling to create a monitoring and reporting program that conforms to the criteria of Monitored Natural Attenuation. ROC discussed this strategy with NMOCD very early in the investigative process and our installation of permanent vadose zone monitoring at the site to more accurately measure the migration of chloride in the upper vadose zone remains on the table.

Below, we present our response to the corrective actions proposed by NMOCD.

1. *ROC shall remove a minimum of 10 feet of contaminated soil in the impacted areas. This project shall start no later than July 22, 2005. All contaminated soils removed from the site shall be disposed of at an OCD approved site.*

ROC and Hicks Consultants requests an opportunity to review the technical and regulatory justification for NMOCD's selection of the 10-foot minimum excavation.

2. *The site shall be delineated both horizontally and vertically. The delineation parameters will be as follows: TPH - 100 ppm; chlorides - 250 ppm; and, total BTEX - 100 ppm.*

As stated above, we believe the effect of the October 2003 release is characterized sufficiently to develop an appropriate remedy. Nevertheless, ROC will conduct any additional field testing requested by NMOCD.

3. *Samples for laboratory confirmation shall be collected from the bottom and side walls of the final excavated area. The samples shall be analyzed for BTEX (8021), TPH (418.1 or 8015 GRO & DRO) and chlorides all using EPA approved methods.*

Any NMOCD-directed investigation by ROC will follow appropriate scientific methods.

4. *ROC shall install a barrier over the site to impede infiltration and prevent any further migration of chlorides contamination. The barrier installation shall extend at least 10 feet horizontally past any remaining contamination. A suitable amount of clean top soil similar to the pre-existing spill conditions shall be placed over the compacted clean backfill material.*

ROC has not and will not advocate a "no action" strategy. ROC had always intended to install a vegetative cap over the site that would also direct runoff away from the underlying chloride mass. This type of barrier will materially reduce the infiltration of precipitation. Because the HYDRUS-1D experiments in the reports do not consider evapotranspiration, the predictions are very conservative as a result. As stated above, we will willing to conduct a simulation experiment showing the effect of this proposed barrier as compared to excavation.

5. *An interim report shall be submitted to the OCD within 10 days of the final excavation or no later than August 15, 2005. This report shall contain the results of the analysis requested in items 2 and 3 above. The report shall contain a log of events, waste disposal manifest, photos, barrier design and conclusions. The excavated area shall not be backfilled until ROC has requested OCD's approval.*

We would be pleased to keep NMOCD apprised of all ROC actions on a regular basis.

6. *ROC will notify the OCD Santa Fe office and the OCD District office at least 72 hours in advance of all scheduled activities so that the OCD has the opportunity to witness the events and/or split samples during OCD's normal business hours.*

We will inform NMOCD of any and all field activities.

We look forward to our meeting with you on Friday, July 15, 2005.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks
Principal

Copy:

William Carr
Carolyn Haynes

Outline of Presentation

- Chronology of ROC and NMOCD Actions
- Environmental Setting
- Magnitude and Extent of Impact from the October 2003 Release
- Magnitude and Extent of Historical Impacts
- Proposed Actions

Chronology of ROC and NMOCD Actions

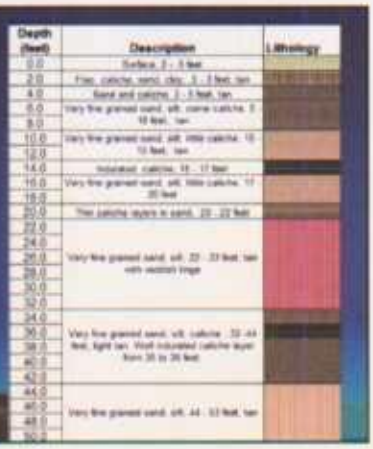
- See Handout

Environmental Setting

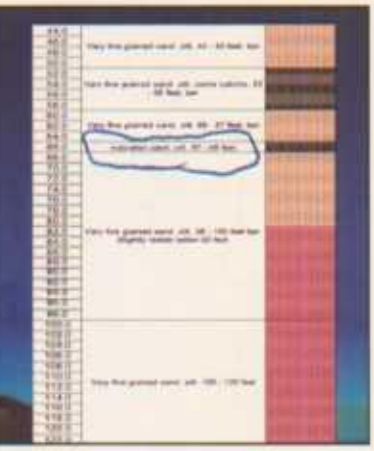
- City of Lovington water supply wells are nearby
- Oilfield operations active since the 1950s
- Caliche dominates upper vadose zone
- Fine sand dominates the lower vadose zone
- Moisture observed in drilling at 100 feet
- Static depth to water 92 feet

(30 ? feet screen)

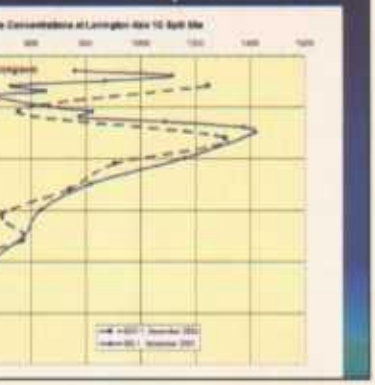
Uppermost Vadose Zone



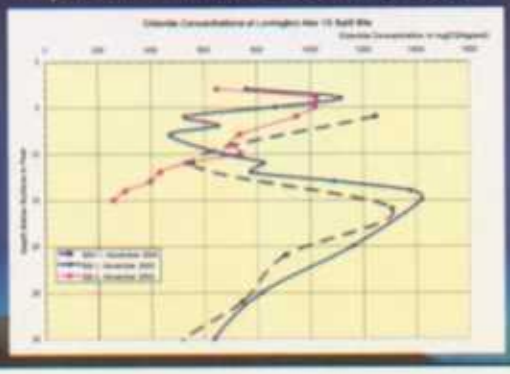
Lowermost Vadose Zone and Upper Saturated Zone



Chloride v. Depth



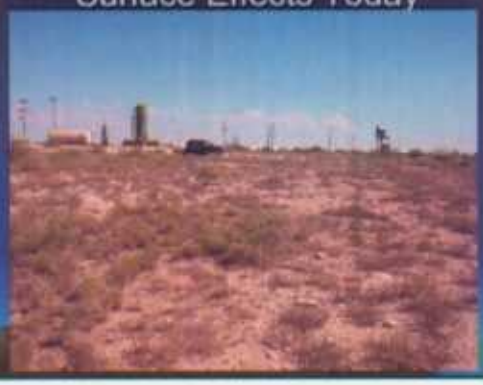
Impact from the 2003 Release



Surface Effects 2003

Photo from October 2003

Surface Effects Today



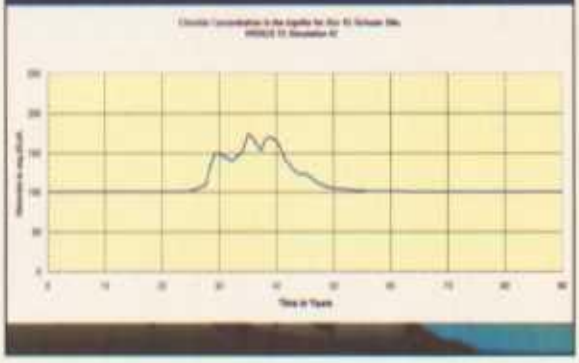
Surface Effects Today

Impacts Since 1950s

Summary of Impact

- 2003 release penetrated to 4 feet
- Historical releases caused the elevated chloride between 4 feet and 46 feet below ground surface
- Pre-Columbian conditions below 46 feet
- Unsaturated flow rate 1-2 feet per year
- No impact to ground water now
- Surface soil is undergoing natural restoration

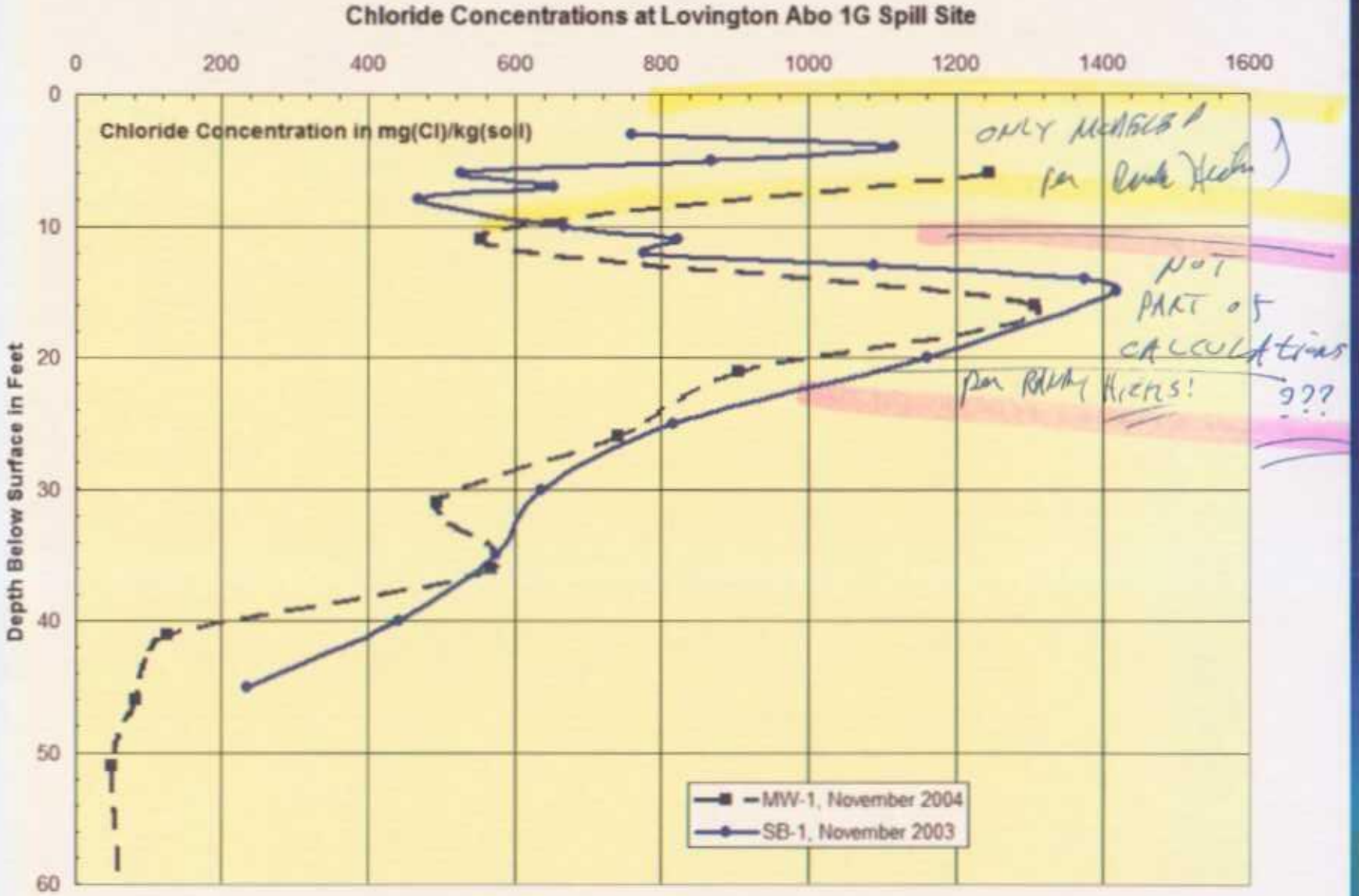
Predicted Maximum Impact from 2003 Release to Monitoring Well



Considerations

- Provide modeling station to permit NMOCD evaluation of ROC submittals
- Provide hands-on training for HYDRUS
- Simulate various excavation/cap scenarios

Chloride v. Depth



NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Mark E. Fesmire, P.E.
Director
Oil Conservation Division

July 08, 2005

Carolyn Doran Haynes
Rice Operating Company
122 West Taylor
Hobbs, New Mexico 88240

Re: ABO 1G Release Site OCD Case #1R0415
Unit Letter G, Sec. 1, T17S, R36E
Lea County, NM

Dear Ms. Haynes:

The New Mexico Oil Conservation Division (NMOCD) is in receipt of Rice Operating Company's (ROC) Amended Corrective Action Plan dated March 2005 submitted by R.T. Hicks Consultants, Ltd. The plan concluded that the produced water released represented no threat to ground water quality. These assumptions were predicted by the utilization of the HYDRUS-1D model. The following three recommendations were presented.

A. Not remove the thin layer of chloride-impacted soil from the site as was committed to in the August 31, 2004 letter to NMOCD.

B. Import clean soil to accelerate re-vegetation of the site.

C. Monitor ground water on a quarterly basis for two years as outlined in the October 28, 2004 letter to the NMOCD in order to further verify the veracity of out predictions presented herein.

Site History:

The site is located within the City of Lovington's municipal well field area located approximately 6 miles south of Lovington, NM in Lea County. The well field pumps fresh water from several wells completed in the Ogallala aquifer. In October 2003 ROC reported a major release of 190 barrels of produced water due to a pipeline failure. The report indicated that ROC recovered 130 barrels.

August 06, 2004, OCD sent ROC the following E-mail message:

OCD is in receipt of the corrective action plan dated June 07, 2004 submitted by RT Hicks. Please note due to the close proximity to the City of Lovington's fresh water well field OCD feels compelled to deny the plan as submitted. Please re-submit with a plan to remove the salt contaminated soil within some practical limit. Please submit by August 13, 2004. The longer "no action" is performed the deeper the salt will migrate into the vadose zone and a higher potential of groundwater contamination exists. We will not accept a model that allows groundwater contamination and dilution in this area. The model may be used after excavation to demonstrate no further threat exist.

As of this date ROC has not complied with OCD's request.

OCD has the following comments concerning the work plans:

1. ROC indicated this is a modeling experiment (page 3 March 2005 report). OCD does not feel that it is appropriate to allow "experiments" in such a sensitive area that may impact thousands of people in the city of Lovington.

2. OCD did not have the accessibility to run the model and therefore cannot confirm the results.

3. The spill report showed a net release of 60 barrels. The actual investigation revealed this release amount actually caused the vadose zone to be contaminated down to a depth of approximately 46 feet in approximately one year.

   ROC's model uses a spill input parameter of 500 barrels- almost ten times the amount of the actual spill. In other words, the model assumes that it would take a much larger release to cause contamination to a depth of 46 feet in one year.

   It is apparent that in this particular case the model results do not accurately reflect the actual field conditions. OCD does not feel comfortable in accepting the results of the model when input parameters differ so greatly from the actual conditions.

4. ROC's June 07, 2004 report indicated that the background concentration in the caliche/upper vados zone was 300-ppm chlorides. . OCD received a complaint from the City of Lovington concerning where the background sample was taken. OCD does not believe that naturally occurring background levels would be this high.

5. The chlorides contamination migrated down to a depth of 46 feet from October 2003 to November 2004. The groundwater depth was reported at

approximately 77 feet. The March 2005 report indicated that chlorides contamination had moved an additional 30-60 cm. The June 07, 2004 report (see page 6) states that "Deeper in the Vadose zone, fractures become barriers to flow and deeply buried caliche behaves more like clay". The March 2005 report (see page 5) reiterates that the chloride migration is impeded at the depth of 35 to 36 feet by the one foot thick caliche layer. The report estimates that the migration is about 2 feet per year and the chloride peak would reach the groundwater in 35 to 42 years.

OCD's experience in shallow vadose zone excavations (down to 50 feet) does not support the theory that fractured caliche acts as a clay barrier. ROC's plan did not support this theory with any field data. In fact, OCD notes that the chlorides contamination has migrated 46 feet in just one year. This is 10 feet deeper than the caliche zone that is purported to act as a barrier. Based on the limited information provided, OCD must reject the prediction that it will take another 30-40 years to reach groundwater .

6. ROC's plan is to monitor groundwater for only two years and then request closure. This process does not correlate to the time that the model predicts salt will enter the groundwater, *i.e.,* 30-40 years. OCD feels there will be no way to know if the model experiment is valid.

7. OCD and the City of Lovington recently collected soil samples and discovered that high salt levels (i.e. chlorides up to 20,000 ppm) still remain in the spill area. These results were approximately 4-5 times higher than ROC's results submitted via E-mail on October 01, 2004.

   OCD understands that chloride mass is a very important input parameter to the model. The March 2005 submittal included a plate 3 "Calculation of Chloride Load" which showed the highest soil concentration to be 1161-ppm chlorides. As pointed out above, surface soils had concentrations 10 times the value shown on Plate 3. ROC did not justify why these values should not have been included in the calculations.

8. The site has not been adequately delineated.

As a result of the above issues and the fact that ROC has failed to take any corrective actions as of to date, the OCD hereby denies the plan as submitted and requires ROC to take the following corrective actions immediately:

1. ROC shall remove a minimum of 10 feet of contaminated soil in the impacted areas. This project shall start no later than July 22, 2005. All contaminated soils removed from the site shall be disposed of at an OCD approved site.

2. The site shall be delineated both horizontally and vertically. The delineation parameters will be as follows: TPH - 100 ppm; chlorides - 250 ppm; and, total BTEX - 100 ppm.

3. Samples for laboratory confirmation shall be collected from the bottom and side walls of the final excavated area. The samples shall be analyzed for BTEX (8021), TPH (418.1 or 8015 GRO & DRO) and chlorides all using EPA approved methods.

4. ROC shall install a barrier over the site to impede infiltration and prevent any further migration of chlorides contamination. The barrier installation shall extend at least 10 feet horizontally past any remaining contamination. A suitable amount of clean top soil similar to the pre-existing spill conditions shall be placed over the compacted clean backfill material.

5. An interim report shall be submitted to the OCD within 10 days of the final excavation or no later than August 15, 2005. This report shall contain the results of the analysis requested in items 2 and 3 above. The report shall contain a log of events, waste disposal manifest, photos, barrier design and conclusions. The excavated area shall not be backfilled until ROC has requested OCD's approval.

6. ROC will notify the OCD Santa Fe office and the OCD District office at least 72 hours in advance of all scheduled activities so that the OCD has the opportunity to witness the events and/or split samples during OCD's normal business hours.

Failure to perform the above requested actions will result in OCD setting this case for a compliance hearing in front of an OCD hearing examiner. The OCD will ask for corrective actions and civil penalties.

Sincerely;

Roger Anderson-Environmental Bureau Chief

cc: OCD Hobbs Office
City of Lovington, NM
Daniel Sanchez- Compliance and Enforcement Manager

Price, Wayne

From: Sheeley, Paul
Sent: Monday, May 09, 2005 10:44 AM
To: 'Randall Hicks'
Cc: Price, Wayne; Johnson, Larry; Williams, Chris
Subject: FW: Lovington Abo

1R0415

Randy,
will be collecting samples at the Lovington ABO tomorrow Tuesday, May 10, 2005 at 09:00. Eddy Seay was contacted and will ittend.
Thanks,
Paul S
----Original Message-----
From: Price, Wayne
Sent: Friday, May 06, 2005 2:42 PM
To: 'Randall Hicks'; Price, Wayne; Martin, Ed
Cc: 'Kristin Farris Pope'; Sheeley, Paul; Patrick B. McMahon (E-mail); Martin, Ed; Mike Griffin (E-mail)
Subject: RE: Lovington Abo

Hi Randy, the city of Lovington has supplied OCD with soil surface samples that show high chlorides (11,000-22,000 mg/kg). Unless I missed something we did not see levels listed that high in your reports. So, I have requested the District office to go out and collect samples early next week. If you want to split call Paul Sheeley (OCD). Once I get our sample results then our technical staff will determine a path forward hopefully that be satisfactory to all parties and will protect the environment. OCD considers this a high profile case since it is located in close proximity to the Lovington City fresh water well field. OCD is concerned about the amount of time that has passed with no remedial action. OCD will make a decision very soon.

Starting Last week OCD Environmental Bureau was instructed by our Bureau Chief that no files may leave the office but can be copied in our office for $.25 per copy.

I quickly reviewed the data base and did not find any Devon Projects near Buckeye. I do have two Devon projects 1R0432 and 1R0433 which included some analysis using the Hydrus 1D. These projects were both amended by the contractor and basically turned out to be very large excavation projects which are still in progress. Both may have groundwater contamination and reports are due in July 05. If they do have groundwater contamination then most likely they will be subject to Rule 19.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Friday, May 06, 2005 1:23 PM
To: 'Price, Wayne'; emartin@state.nm.us
Cc: 'Kristin Farris Pope'
Subject: Lovington Abo

Wayne

Here is what I understand you need for your evaluation of the Lovington Abo 1G spill site:

1. An photo or digital image of the original spill
2. Results of any surface soil analyses
3. A spill report – which I believe Kristin faxed to you.

If there is anything else we can do, let us know.

As discussed earlier today, I would like a copy of the NMOCD file for the site that Jan Hendrickx told me that he performed some modeling. Jan suggested that it was a Devon site near Buckeye –

a CD Dickerson site or something like that?

By this email I am alerting **Kinko** of Santa Fe to call Wayne Price at 476-3487 to schedule a time for the file pick-up. In your absence, I am asking KINKOs to call Ed Martin at NMOCD to retrieve the file.

Thanks

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Monday, May 09, 2005 11:53 AM
To: 'Price, Wayne'
Cc: 'Sheeley, Paul'; 'Kristin Farris Pope'
Subject: FW: Lovington Abo

Wayne

Thanks for the information. I hope to meet with Paul Sheeley in Lovington on another matter and perhaps we can simply combine the trips. I am on the phone to Paul after I finish this.

With respect to surface soil samples, I understand that ROC did not collect surface samples for two reasons:

1. Soon after the release, one could easily see that the surface soil was coated with salt. Therefore, surface samples would not provide more information than the photograph on the cover of the June 2004 report – the chloride concentration on the surface would be very high. The samples from NMOCD confirm what the photograph shows.
2. More importantly from my perspective is the fact that the surface soils in the area range in thickness from zero to, perhaps, six inches. You can see the rocks of caliche in the photograph and when I walked the site much of the ground surface was predominantly **fractured** caliche. I think that we all felt that the main mass of chloride would be below the fractured caliche, not in the thin layer of overlying soil.

Therefore, we had no surface samples to report to NMOCD. We did have an analysis of the produced water, the area of the spill and a relatively good guess as to the volume released. This data regarding the nature of the spill also gave us sufficient confidence to proceed without detailed characterization of the thin surface soil. We thought that even with high concentrations of chloride in the surface soil, the thin layer of soil would not hold a large mass. We concentrated our efforts at characterization of the material beneath the fractured caliche. ROC did take some surface soil samples, but these were taken after several rainfall events.

I fear that after the precipitation of 2004-05 that surface soil samples will provide little additional benefit over the deep soil samples obtained from the monitoring well boring.

ROC and Hicks Consultants fully understand the importance of protecting the ground water resources of New Mexico and we understand that the proximity of the water supply wells makes this situation worthy of careful consideration by all parties. We are applying the best science to the problem to develop the best solution. We appreciate your help and counsel.

Randy

-----Original Message-----
From: Price, Wayne [mailto:WPrice@state.nm.us]
Sent: Friday, May 06, 2005 2:42 PM
To: 'Randall Hicks'; Price, Wayne; Martin, Ed
Cc: 'Kristin Farris Pope'; Sheeley, Paul; Patrick B. McMahon (E-mail); Martin, Ed; Mike Griffin (E-mail)
Subject: *RE: Lovington Abo*

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Randy Hicks
505-266-5004 - office
505-238-9515 - cell

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For more information please visit http://www.messagelabs.com/email

Price, Wayne

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To: 'Randall Hicks'; Price, Wayne; Martin, Ed
Cc: 'Kristin Farris Pope'; Sheeley, Paul; Patrick B. McMahon (E-mail); Martin, Ed; Mike Griffin (E-mail)
Subject: RE: Lovington Abo

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Randy Hicks
505-266-5004 - office

505-238-9515 - cell

FAX TRANSMITTAL

FROM: EDDIE SEAY CONSULTING
601 W. ILLINOIS
HOBBS, NM 88242
(505)392-2236
FAX: (505)392-6949
E-MAIL: seay04@leaco.net

DATE: 5/5/05

TO: NMOCD

ATTENTION: Mr. Wayne Price

FAX #: 505.476.3462

SPECIAL INSTRUCTIONS: Sampling conducted for City of Lovington

TOTAL PAGES TRANSMITTED (INCLUDING COVER): 4

Jo Ann

392-8736

Tom

932-682-8559

Tim

720-344-3719

NEX Hall [illegible]

Scott Stoner

STONER@ [illegible] Texan [illegible]

.com

CARDINAL LABORATORIES

PHONE (325) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
EDDIE SEAY CONSULTING
ATTN: EDDIE SEAY
601 W. ILLINOIS
HOBBS, NM 88242
FAX TO: (505) 392-6949

Receiving Date: 05/04/05
Reporting Date: 05/05/05
Project Owner: CITY OF LOVINGTON
Project Name: RICE ABO SPILL SITE
Project Location: S. OF LOVINGTON, NM

Analysis Date: 05/05/05
Sampling Date: 05/04/05
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: AH
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Cl^- (mg/Kg)
H9776-1	ABO #1	11037
H9776-2	ABO #2	22793
H9776-3	ABO #3	12796
Quality Control		970
True Value QC		1000
% Recovery		97.0
Relative Percent Difference		3.5

METHOD: Standard Methods	4500-ClˉB

Note: Analyses performed on 1:4 w:v aqueous extracts.

Amy Hill
Chemist

5/5/05
Date

CARDINAL LABORATORIES, INC.

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

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

Page ____ of ____

Company Name: Eddie Seay Consulting	PO #:
Project Manager: Eddie Seay	Company:
Address: 601 W Illinois	Attn: Same
City: Hobbs State: NM Zip: 88242	Address:
Phone #: 392-2236	City:
Fax #: 392-6949	State: Zip:
Project #: Rice Abo Project Owner: City of Lovington	Phone #:
Project Name: Rice Abo Spill site	Fax #:
Project Location: S. Lovington	

ANALYSIS REQUEST: Chlorides

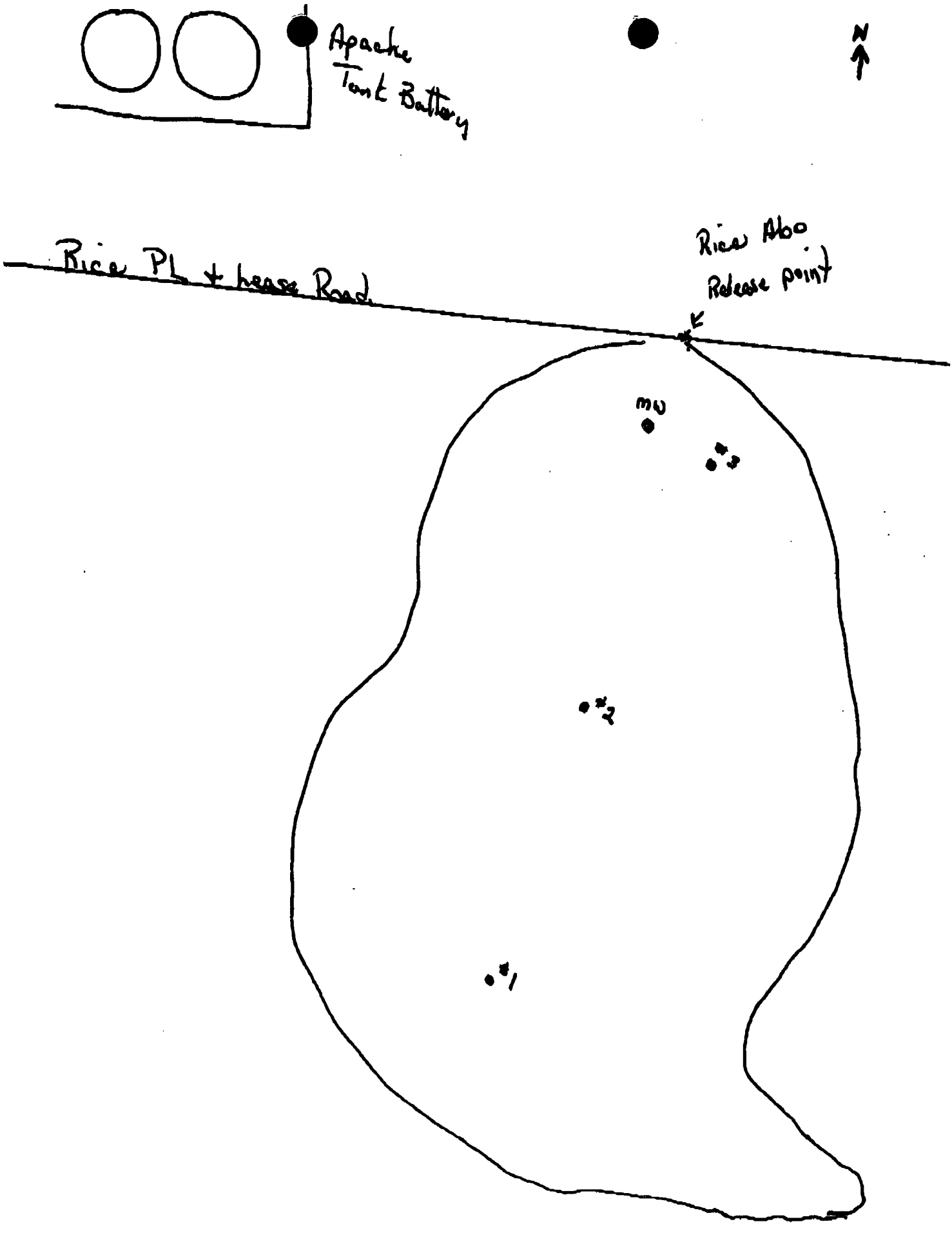
FOR LAB USE ONLY LAB I.D.	Sample I.D.	(G)RAB OR (C)OMP.	# CONTAINERS	MATRIX: GROUNDWATER	WASTEWATER	SOIL	OIL	SLUDGE	OTHER:	PRES.: ACID:	ICE / COOL	OTHER:	SAMPLING: DATE	TIME	Chlorides
H9776-1	Abo #1	G	1			X					X		5/4	11:00	X
-2	Abo #2	G	1			X					X		"	11:20	X
-3	Abo #3	G	1			X					X		"	11:40	X

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 collection, including attorney's fees.

Relinquished: Eddie Seay	Date: 5/4 Time: 3:00	Received By:	Phone Result: ☐ Yes ☐ No Additional Fax #:
Relinquished By:	Date: 5/4/05 Time: 2:00	Received By: (Lab Staff) Amy Hill	Fax Result: ☐ Yes ☐ No REMARKS: Same Sample
Delivered By: (Circle One) Sampler - UPS - Bus - Other:	Sample Condition Cool: ☐ Yes ☐ No Intact: ☐ Yes ☐ No	CHECKED BY: (Initials)	

† Cardinal cannot accept verbal changes. Please fax written changes to 915-673-7020.


Apache
Tank Battery
N
Rice PL + lease Road
Rice Abo
Release point
mw
#3
#2
#1

P.01

TRANSACTION REPORT

MAY-05-2005 THU 01:42 PM

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DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
MAY-05	01:40 PM	5053926949	2'02"	4	RECEIVE	OK		

Price, Wayne

From: Price, Wayne
Sent: Thursday, May 05, 2005 9:10 AM
To: Price, Wayne; Sheeley, Paul
Subject: RE: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Paul, please disregard the last sentence. It is important for OCD to determine the facts so we can make a sound decision.

-----Original Message-----
From: Price, Wayne
Sent: Thursday, May 05, 2005 8:52 AM
To: Sheeley, Paul
Subject: RE: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Good Ideal, Wait even longer if you wish. I think maybe even a week, that will give time for the salt residue to collect at the surface. It is important for us to show that the salt is still there.

-----Original Message-----
From: Sheeley, Paul
Sent: Thursday, May 05, 2005 8:49 AM
To: Price, Wayne
Subject: RE: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Wayne-The site is wet with rain. I will wait until it dry's out. Monday. Thanks-PS

-----Original Message-----
From: Price, Wayne
Sent: Wednesday, May 04, 2005 3:39 PM
To: Price, Wayne; Sheeley, Paul
Cc: 'Patrick B. McMahon (E-mail)'; 'Eddie Seay (E-mail)'
Subject: RE: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Paul please sample for General Chemistry unless you see hydrocarbons then include BTEX and TPH.

-----Original Message-----
From: Price, Wayne
Sent: Wednesday, May 04, 2005 3:37 PM
To: Sheeley, Paul
Cc: Patrick B. McMahon (E-mail); Eddie Seay (E-mail)
Subject: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Dear Paul:

Please find enclosed a map and plot plan for this site. Please ASAP goto site and collect 4 surface soil samples that show evidence of the salt water spill. If you can see visible salt on the surface please collect in those areas or low areas where it may have pooled. Mark the plot plan and take photos of the sample areas. The Rice-Hicks report has samples starting at 3 feet below the surface but nothing on the surface. They are attempting to use a model to demonstrate "No Action" required.

This is in close proximity to the city of Lovington's fresh water well field and they are very anxious for this to be resolved as is OCD. You might want to call Patrick McMahon or Eddie Seay to let them split samples.

OCD considers this to be a very high priority since it may impact thousands of people.

Thanks for your help.

<< File: map and plot plan.doc >>

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From: Sanchez, Daniel
Sent: Wednesday, May 04, 2005 3:43 PM
To: Price, Wayne
Subject: RE: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Sounds good to me. Keep me posted and keep on Paul to get those samples as soon as possible.

-----Original Message-----
From: Price, Wayne
Sent: Wednesday, May 04, 2005 3:41 PM
To: Sanchez, Daniel
Subject: FW: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Daniel I has chosen to collect soil samples before proceeding. As soon as I get the results then we can make a logical determination as to how this site needs to be cleaned-up.

-----Original Message-----
From: Price, Wayne
Sent: Wednesday, May 04, 2005 3:39 PM
To: Price, Wayne; Sheeley, Paul
Cc: 'Patrick B. McMahon (E-mail)'; 'Eddie Seay (E-mail)'
Subject: RE: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Paul please sample for General Chemistry unless you see hydrocarbons then include BTEX and TPH.

-----Original Message-----
From: Price, Wayne
Sent: Wednesday, May 04, 2005 3:37 PM
To: Sheeley, Paul
Cc: Patrick B. McMahon (E-mail); Eddie Seay (E-mail)
Subject: Rice ABO IG release site 1R0415 UL G Sec 1-Ts17s-R36e

Dear Paul:

Please find enclosed a map and plot plan for this site. Please ASAP goto site and collect 4 surface soil samples that show evidence of the salt water spill. If you can see visible salt on the surface please collect in those areas or low areas where it may have pooled. Mark the plot plan and take photos of the sample areas. The Rice-Hicks report has samples starting at 3 feet below the surface but nothing on the surface. They are attempting to use a model to demonstrate "No Action" required.

This is in close proximity to the city of Lovington's fresh water well field and they are very anxious for this to be resolved as is OCD. You might want to call Patrick McMahon or Eddie Seay to let them split samples.

OCD considers this to be a very high priority since it may impact thousands of people.

Thanks for your help.

<< File: map and plot plan.doc >>

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462

E-mail: WPRICE@state.nm.us

Price, Wayne

From: Kristin Farris Pope [enviro@leaco.net]
Sent: Wednesday, May 04, 2005 12:01 PM
To: Price, Wayne
Subject: Re: Rice ABO 1G 1R0415

found our analysis. I'll have to fax it.
Kristin

----- Original Message -----
From: "Price, Wayne" <WPrice@state.nm.us>
To: "'Kristin Farris Pope'" <enviro@leaco.net>
Sent: Wednesday, May 04, 2005 11:52 AM
Subject: RE: Rice ABO 1G 1R0415

> Please find attached OCD's analytical report. It's called ABO Apache I
> hope this is the right one. I think the date of March 01, 2005 verifies.
>
> -----Original Message-----
> From: Kristin Farris Pope [mailto:enviro@leaco.net]
> Sent: Wednesday, May 04, 2005 9:55 AM
> To: Price, Wayne
> Cc: Randall Hicks; Carolyn Haynes
> Subject: Re: Rice ABO 1G 1R0415
>
>
> faxed it today.
>
> Kristin
>
> ----- Original Message -----
> From: "Price, Wayne" <WPrice@state.nm.us>
> To: "Kristin Farris Pope (E-mail)" <enviro@leaco.net>
> Sent: Tuesday, May 03, 2005 4:26 PM
> Subject: Rice ABO 1G 1R0415
>
>
>> In October of 2003 Rice filed a sprill report for this site. I am in the
>> process of reviewing the work plan and need a copy of the spill report.
>> Please submit by fax or E-mail.
>>
>> Sincerely:
>>
>> Wayne Price
>> New Mexico Oil Conservation Division
>> 1220 S. Saint Francis Drive
>> Santa Fe, NM 87505
>> 505-476-3487
>> fax: 505-476-3462
>> E-mail: WPRICE@state.nm.us
>>
>>
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NEW MEXICO ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT

BILL RICHARDSON
Governor
Joanna Prukop
Cabinet Secretary

Mark E. Fesmire, P.E.
Director
Oil Conservation Division

FAX

TO: Wayne

FROM: Paul S.

RE: Rice — ABO Apache GWM

DATE: 5-4-05 Samples 050301

Anal. Report to

NO. OF PAGES 13 INCLUDING COVERSHEET

TRACEANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
155 McCutcheon, Suite H El Paso, Texas 79932 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

Analytical and Quality Control Report

Paul Sheeley
New Mexico Oil Conservation Div.
1625 N. French Dr.
Hobbs, NM 88240

Report Date: March 11, 2005

Work Order: 5030209

Project Location: ABO Apache
Project Name: Rice GWM
Project Number: 050301

Enclosed are the Analytical Report and Quality Control Report for the following sample(s) submitted to TraceAnalysis, Inc.

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
56076	0503011415	water	2005-03-01	14:15	2005-03-02
56077	0503011420	water	2005-03-01	14:20	2005-03-02

These results represent only the samples received in the laboratory. The Quality Control Report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

This report consists of a total of 11 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

Report Date: March 11, 2005 Work Order: 5030209 Page Number: 1 of 1
050301 Rice GWM ABO Apache

Summary Report

Paul Sheeley
New Mexico Oil Conservation Div.
1625 N. French Dr.
Hobbs, NM 88240

Report Date: March 11, 2005

Work Order: 5030209

Project Location: ABO Apache
Project Name: Rice GWM
Project Number: 050301

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
56076	0503011415	water	2005-03-01	14:15	2005-03-02
56077	0503011420	water	2005-03-01	14:20	2005-03-02

	BTEX			
Sample - Field Code	Benzene (mg/L)	Toluene (mg/L)	Ethylbenzene (mg/L)	Xylene (mg/L)
56076 - 0503011415	<0.00100	<0.00100	<0.00100	<0.00100

Sample: 56077 - 0503011420

Param	Flag	Result	Units	RL
Hydroxide Alkalinity		<1.00	mg/L as CaCo3	1.00
Carbonate Alkalinity		<1.00	mg/L as CaCo3	1.00
Bicarbonate Alkalinity		156	mg/L as CaCo3	4.00
Total Alkalinity		156	mg/L as CaCo3	4.00
Specific Conductance		812	µMHOS/cm	0.00
Chloride		99.6	mg/L	0.500
Fluoride		1.45	mg/L	0.200
Sulfate		79.5	mg/L	0.500
Nitrate-N		2.64	mg/L	0.200
pH		7.72	s.u.	0.00
Dissolved Calcium		98.0	mg/L	0.500
Dissolved Magnesium		15.0	mg/L	0.500
Dissolved Potassium		3.42	mg/L	0.500
Dissolved Sodium		45.1	mg/L	0.500
Total Dissolved Solids		506.0	mg/L	10.00

Analytical Report

Sample: 56076 - 0503011415

Analysis:	BTEX	Analytical Method:	S 8021B	Prep Method:	S 5030B
QC Batch:	16375	Date Analyzed:	2005-03-04	Analyzed By:	MS
Prep Batch:	14469	Sample Preparation:	2005-03-04	Prepared By:	MS

Parameter	Flag	RL Result	Units	Dilution	RL
Benzene		<0.00100	mg/L	1	0.00100
Toluene		<0.00100	mg/L	1	0.00100
Ethylbenzene		<0.00100	mg/L	1	0.00100
Xylene		<0.00100	mg/L	1	0.00100

Surrogate	Flag	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
Trifluorotoluene (TFT)		0.0876	mg/L	1	0.100	88	48.4 - 119
4-Bromofluorobenzene (4-BFB)		0.0911	mg/L	1	0.100	91	17.1 - 138

Sample: 56077 - 0503011420

Analysis:	Alkalinity	Analytical Method:	SM 2320B	Prep Method:	N/A
QC Batch:	16522	Date Analyzed:	2005-03-10	Analyzed By:	RS
Prep Batch:	14593	Sample Preparation:	2005-03-10	Prepared By:	RS

Parameter	Flag	RL Result	Units	Dilution	RL
Hydroxide Alkalinity		<1.00	mg/L as CaCo3	1	1.00
Carbonate Alkalinity		<1.00	mg/L as CaCo3	1	1.00
Bicarbonate Alkalinity		156	mg/L as CaCo3	1	4.00
Total Alkalinity		156	mg/L as CaCo3	1	4.00

Sample: 56077 - 0503011420

Analysis:	Conductivity	Analytical Method:	SM 2510B	Prep Method:	N/A
QC Batch:	16406	Date Analyzed:	2005-03-04	Analyzed By:	RS
Prep Batch:	14480	Sample Preparation:	2005-03-04	Prepared By:	WB

Parameter	Flag	RL Result	Units	Dilution	RL
Specific Conductance		812	µMHOS/cm	1	0.00

Sample: 56077 - 0503011420

Analysis:	Ion Chromatography	Analytical Method:	E 300.0	Prep Method:	N/A
QC Batch:	16392	Date Analyzed:	2005-03-02	Analyzed By:	WB
Prep Batch:	14396	Sample Preparation:	2005-03-02	Prepared By:	WB

continued ...

sample 56077 continued ...

Parameter	Flag	RL Result	Units	Dilution	RL

Parameter	Flag	RL Result	Units	Dilution	RL
Chloride		99.6	mg/L	5	0.500
Fluoride		1.45	mg/L	5	0.200
Sulfate		79.5	mg/L	5	0.500

Sample: 56077 - 0503011420

Analysis:	NO3 (IC)	Analytical Method:	E 300.0	Prep Method:	N/A
QC Batch:	16392	Date Analyzed:	2005-03-02	Analyzed By:	WB
Prep Batch:	14396	Sample Preparation:	2005-03-02	Prepared By:	WB

Parameter	Flag	RL Result	Units	Dilution	RL
Nitrate-N		2.64	mg/L	5	0.200

Sample: 56077 - 0503011420

Analysis:	pH	Analytical Method:	SM 4500-H+	Prep Method:	N/A
QC Batch:	16335 [a]	Date Analyzed:	2005-03-02	Analyzed By:	RS
Prep Batch:	14431	Sample Preparation:	2005-03-02	Prepared By:	RS

[a]sample run in laboratory

Parameter	Flag	RL Result	Units	Dilution	RL
pH		7.72	s.u.	1	0.00

Sample: 56077 - 0503011420

Analysis:	Salts, Dissolved	Analytical Method:	E 200.7	Prep Method:	N/A
QC Batch:	16322	Date Analyzed:	2005-03-04	Analyzed By:	RR
Prep Batch:	14385	Sample Preparation:	2005-03-03	Prepared By:	TP

Parameter	Flag	RL Result	Units	Dilution	RL
Dissolved Calcium		98.0	mg/L	1	0.500
Dissolved Magnesium		15.0	mg/L	1	0.500
Dissolved Potassium		3.42	mg/L	1	0.500
Dissolved Sodium		45.1	mg/L	1	0.500

Sample: 56077 - 0503011420

Analysis:	TDS	Analytical Method:	SM 2540C	Prep Method:	N/A
QC Batch:	16332	Date Analyzed:	2005-03-03	Analyzed By:	WB
Prep Batch:	14419	Sample Preparation:	2005-03-02	Prepared By:	WB

Parameter	Flag	RL Result	Units	Dilution	RL
Total Dissolved Solids		506.0	mg/L	2	10.00

Method Blank (1) QC Batch: 16322

Parameter	Flag	MDL Result	Units	RL
Dissolved Calcium		<0.102	mg/L	0.5
Dissolved Magnesium		<0.110	mg/L	0.5
Dissolved Potassium		<0.0454	mg/L	0.5
Dissolved Sodium		<0.0114	mg/L	0.5

Method Blank (1) QC Batch: 16332

Parameter	Flag	MDL Result	Units	RL
Total Dissolved Solids		<5.000	mg/L	10

Method Blank (1) QC Batch: 16375

Parameter	Flag	MDL Result	Units	RL
Benzene		<0.000650	mg/L	0.001
Toluene		<0.00101	mg/L	0.001
Ethylbenzene		<0.000840	mg/L	0.001
Xylene		<0.000737	mg/L	0.001

Surrogate	Flag	Result	Units	Dilution	Spike Amount	Percent Recovery	Recovery Limits
Trifluorotoluene (TFT)		0.0999	mg/L	1	0.100	100	48.4 - 119
4-Bromofluorobenzene (4-BFB)		0.103	mg/L	1	0.100	103	17.1 - 138

Method Blank (1) QC Batch: 16392

Parameter	Flag	MDL Result	Units	RL
Nitrate-N		<0.0217	mg/L	0.2

Method Blank (1) QC Batch: 16392

Parameter	Flag	MDL Result	Units	RL
Chloride		<0.337	mg/L	0.5

continued ...

method blank continued ...

Parameter	Flag	MDL Result	Units	RL
Fluoride		<0.0594	mg/L	0.2
Sulfate		<0.409	mg/L	0.5

Method Blank (1) QC Batch: 16406

Parameter	Flag	MDL Result	Units	RL
Specific Conductance		2.33	µMHOS/cm	

Method Blank (1) QC Batch: 16522

Parameter	Flag	MDL Result	Units	RL
Hydroxide Alkalinity		<1.00	mg/L as CaCo3	1
Carbonate Alkalinity		<1.00	mg/L as CaCo3	1
Bicarbonate Alkalinity		<4.00	mg/L as CaCo3	4
Total Alkalinity		<4.00	mg/L as CaCo3	4

Duplicate (1) QC Batch: 16332

Param	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
Total Dissolved Solids	1562	1544	mg/L	2	1	14.9

Duplicate (1) QC Batch: 16335

Param	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
pH	7.22	7.22	s.u.	1	0	0.4

Duplicate (1) QC Batch: 16406

Param	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
Specific Conductance	122000	122000	µMHOS/cm	1	0	2.4

Duplicate (1) QC Batch: 16522

Param	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
Hydroxide Alkalinity	<1.00	<1.00	mg/L as CaCo3	1	0	20

continued ...

duplicate continued...

Param	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
Carbonate Alkalinity	<1.00	<1.00	mg/L as CaCo3	1	0	20
Bicarbonate Alkalinity	42.0	42.0	mg/L as CaCo3	1	0	20
Total Alkalinity	42.0	42.0	mg/L as CaCo3	1	0	4.6

Laboratory Control Spike (LCS-1) QC Batch: 16322

Param	LCS Result	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	RPD	Rec. Limit	RPD Limit
Dissolved Calcium	50.3	51.4	mg/L	1	50.0	<0.102	101	2	88.4 - 107	20
Dissolved Magnesium	50.7	50.9	mg/L	1	50.0	<0.110	101	0	85 - 112	20
Dissolved Potassium	50.5	52.2	mg/L	1	50.0	<0.0454	101	3	88 - 113	20
Dissolved Sodium	50.3	52.1	mg/L	1	50.0	<0.0114	101	4	90.9 - 112	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1) QC Batch: 16375

Param	LCS Result	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	RPD	Rec. Limit	RPD Limit
Benzene	0.0987	0.0966	mg/L	1	0.100	<0.000650	99	2	81.9 - 114	20
Toluene	0.104	0.101	mg/L	1	0.100	<0.00101	104	4	82.8 - 112	20
Ethylbenzene	0.102	0.103	mg/L	1	0.100	<0.000840	102	0	82.2 - 111	20
Xylene	0.274	0.260	mg/L	1	0.300	<0.000737	91	5	83.5 - 112	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Surrogate	LCS Result	LCSD Result	Units	Dil.	Spike Amount	LCS Rec.	LCSD Rec.	Rec. Limit
Trifluorotoluene (TFT)	0.0982	0.0964	mg/L	1	0.100	98	96	48.4 - 119
4-Bromofluorobenzene (4-BFB)	0.0944	0.0916	mg/L	1	0.100	94	92	17.1 - 138

Laboratory Control Spike (LCS-1) QC Batch: 16392

Param	LCS Result	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	RPD	Rec. Limit	RPD Limit
Nitrate-N	2.36	2.45	mg/L	1	2.50	<0.0217	94	4	90 - 110	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1) QC Batch: 16392

Param	LCS Result	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	RPD	Rec. Limit	RPD Limit
Chloride	11.9	12.0	mg/L	1	12.5	<0.337	95	1	90 - 110	20
Fluoride	2.36	2.39	mg/L	1	2.50	<0.0594	94	1	90 - 110	20
Sulfate	12.2	12.2	mg/L	1	12.5	<0.409	98	0	90 - 110	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) QC Batch: 16322 Spiked Sample: 56077

Param	MS Result	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	RPD	Rec. Limit	RPD Limit
Dissolved Calcium	164	159	mg/L	1	50.0	98	132	3	75 - 125	20
Dissolved Magnesium	69.8	65.9	mg/L	1	50.0	15	110	6	75 - 125	20
Dissolved Potassium	60.4	55.5	mg/L	1	50.0	3.42	114	8	75 - 125	20
Dissolved Sodium	101	96.3	mg/L	1	50.0	45.1	112	5	75 - 125	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) QC Batch: 16392 Spiked Sample: 56100

Param	MS Result	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	RPD	Rec. Limit	RPD Limit
Nitrate-N	253	254	mg/L	100	2.50	27.1	90	0	78.8 - 116	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) QC Batch: 16392 Spiked Sample: 56100

Param	MS Result	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	RPD	Rec. Limit	RPD Limit
Chloride	1590	1630	mg/L	100	12.5	453	91	2	70.7 - 124	20
Fluoride	238	252	mg/L	100	2.50	14.4	89	6	70.9 - 126	20
Sulfate	2570	2580	mg/L	100	12.5	1370	96	0	82.5 - 123	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Standard (ICV-1) QC Batch: 16322

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Dissolved Calcium		mg/L	50.0	51.7	103	95 - 105	2005-03-04
Dissolved Magnesium		mg/L	50.0	51.9	104	95 - 105	2005-03-04
Dissolved Potassium		mg/L	50.0	51.0	102	95 - 105	2005-03-04
Dissolved Sodium		mg/L	50.0	51.9	104	95 - 105	2005-03-04

Standard (CCV-1) QC Batch: 16322

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Dissolved Calcium		mg/L	50.0	51.9	104	90 - 110	2005-03-04
Dissolved Magnesium		mg/L	50.0	50.8	102	90 - 110	2005-03-04
Dissolved Potassium		mg/L	50.0	48.4	97	90 - 110	2005-03-04
Dissolved Sodium		mg/L	50.0	48.6	97	90 - 110	2005-03-04

Standard (ICV-1) QC Batch: 16332

[1]Matrix spike recoveries out of control limits due to matrix spike being diluted out. Use LCS/LCSD to demonstrate analysis is under control.

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Dissolved Solids		mg/L	1000	998.0	100	90 - 110	2005-03-03

Standard (CCV-1) QC Batch: 16332

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Dissolved Solids		mg/L	1000	<5.000		90 - 110	2005-03-03

Standard (ICV-1) QC Batch: 16335

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
pH		s.u.	7.00	6.99	100	98 - 102	2005-03-02

Standard (CCV-1) QC Batch: 16335

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
pH		s.u.	7.00	6.98	100	98 - 102	2005-03-02

Standard (CCV-1) QC Batch: 16375

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Benzene		mg/L	0.100	0.0969	97	85 - 115	2005-03-04
Toluene		mg/L	0.100	0.0976	98	85 - 115	2005-03-04
Ethylbenzene		mg/L	0.100	0.100	100	85 - 115	2005-03-04
Xylene		mg/L	0.300	0.266	88	85 - 115	2005-03-04

Standard (CCV-2) QC Batch: 16375

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Benzene		mg/L	0.100	0.0976	98	85 - 115	2005-03-04
Toluene		mg/L	0.100	0.0988	99	85 - 115	2005-03-04
Ethylbenzene		mg/L	0.100	0.102	102	85 - 115	2005-03-04
Xylene		mg/L	0.300	0.272	90	85 - 115	2005-03-04

Standard (ICV-1) QC Batch: 16392

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Nitrate-N		mg/L	2.50	2.40	96	90 - 110	2005-03-02

Standard (ICV-1) QC Batch: 16392

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Chloride		mg/L	12.5	11.9	95	90 - 110	2005-03-02
Fluoride		mg/L	2.50	2.41	96	90 - 110	2005-03-02
Sulfate		mg/L	12.5	12.1	97	90 - 110	2005-03-02

Standard (CCV-1) QC Batch: 16392

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Nitrate-N		mg/L	2.50	2.50	100	90 - 110	2005-03-02

Standard (CCV-1) QC Batch: 16392

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Chloride		mg/L	12.5	12.2	98	90 - 110	2005-03-02
Fluoride		mg/L	2.50	2.47	99	90 - 110	2005-03-02
Sulfate		mg/L	12.5	12.1	97	90 - 110	2005-03-02

Standard (ICV-1) QC Batch: 16406

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Specific Conductance		µMHOS/cm	1410	1430	101	90 - 110	2005-03-04

Standard (CCV-1) QC Batch: 16406

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Specific Conductance		µMHOS/cm	1410	1390	98	90 - 110	2005-03-04

Standard (ICV-1) QC Batch: 16522

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Alkalinity		mg/L as CaCo3	250	242	97	90 - 110	2005-03-10

Report Date: March 11, 2005 Work Order: 5030209 Page Number: 10 of 11
050301 Rice GWM ABO Apache

Standard (CCV-1) QC Batch: 16522

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Alkalinity		mg/L as CaCo3	250	240	96	90 - 110	2005-03-10

5101 Aberdeen Avenue, Ste 9
Lubbock, Texas 79424
Tel (806) 794-1296
Fax (806) 794-1298
1 (800) 378-1296

195 McCutcheon, Suite H
El Paso, Texas 79932
Tel (915) 585-3443
Fax (915) 585-4944
1 (888) 588-3443

TraceAnalysis, Inc.

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

LAB Order ID # 5030209

Company Name:	New Mexico Oil Consevation Div.
Phone #:	505 393 6161 x113
Address: (Street, City, Zip)	1625 N. French Dr
Fax #:	393 0720
Contact Person:	~~Ed Martin~~ Paul Sheeley x113
Invoice to: (If different from above)	Ed Martin 505 476 3492
Project #:	050301
Project Name:	ABOVE GWM
Project Location:	ABO Apache
Sampler Signature:	

ANALYSIS REQUEST
(Circle or Specify Method No.)

LAB # (LAB USE ONLY)	FIELD CODE	# CONTAINERS	Volume/Amount	MATRIX: WATER	SOIL	AIR	SLUDGE	PRESERVATIVE METHOD: HCl	HNO3	H2SO4	NaOH	ICE	NONE	SAMPLING: DATE	TIME	MTBE 8021B/8260	BTEX 8021B/602	TPH 418.1/TX1005	PAH 8270C	Total Metals Ag As Ba Cd Cr Pb Se Hg 6010B/6200.7	TCLP Metals Ag As Ba Cd Cr Pb Se Hg	TCLP Volatiles	TCLP Semi Volatiles	TCLP Pesticides	RCI	GC/MS Vol 8260B/624	GC/MS Semi Vol 8270C/625	PCB's 8082/608	Pesticides 608/Aroclor	BOD TSS pH	General Chemistry	Turn Around Time if different from standard	Rush
56076	050301 1415	2	40ml	X				X				X		3/1	1415	X														X			
077	050301 1420	1	1L	X								X		3/1	1420															X			

Relinquished by:	Date:	Time:	Received by:
			Date: Time:
Relinquished by:	Date:	Time:	Received by:
			Date: Time:
Relinquished by:	Date:	Time:	Received at Laboratory by: Brenda Ward
			Date: 3/2/05 Time: 9:56

LAB USE ONLY
Intact Y / N
Headspace Y / N
Temp 1° C
Log-in Review DS

REMARKS:

☐ Check if Special Reporting Limits Are Needed

Carrier # INMD 903 292-520-9

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56076-11

Page 1 of 1

6701 Aberdeen Avenue, Ste. 9
Lubbock, Texas 79424
Tel (806) 794-1296
Fax (806) 794-1298
1 (800) 378-1296

TraceAnalysis, Inc.

155 McCutcheon, Suite H
El Paso, Texas 79932
Tel (915) 585-3443
Fax (915) 585-4944
1 (888) 588-3443

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

LAB Order ID # 5030209

Company Name: New Mexico Oil Conservation Div. Phone #: 505 3936161 x113

Address: (Street, City, Zip) 1625 N. French Dr Fax #: 3930720

Contact Person: ~~Ed Martin~~ Paul Sheeley x113

Invoice to: (If different from above) Ed Martin 505 476 3492

Project #: 050301 Project Name: BICE-GWM

Project Location: ABO Apache Sampler Signature:

LAB # (LAB USE ONLY)	FIELD CODE	# CONTAINERS	Volume/Amount	MATRIX: WATER	SOIL	AIR	SLUDGE	PRESERVATIVE METHOD: HCl	HNO_3	H_2SO_4	NaOH	ICE	NONE	SAMPLING: DATE	TIME
56076	050301 1415	2g	40ml	X				X				X		3-1	1415
077	050301 1420	1p	1L	X								X		3-1	1420

MTBE 8021B/602	BTEX 8021B/602	TPH 418.1/TX1005	PAH 8270C	Total Metals Ag As Ba Cd Cr Pb Se Hg 6010B/200.7	TCLP Metals Ag As Ba Cd Cr Pb Se Hg	TCLP Volatiles	TCLP Semi Volatiles	TCLP Pesticides	RCI	GC/MS Vol. 8260B/624	GC/MS Semi. Vol. 8270C/625	PCB's 8082/608	Pesticides 8081A/608	BOD, TSS, pH	General Chemistry	Turn Around Time if different from standard	Hold
	X														X		

ANALYSIS REQUEST
(Circle or Specify Method No.)

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
	3-1-05	1530			
Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received at Laboratory by: Brenda Ward	3/2/05	9:56

LAB USE ONLY
Intact Y / N
Headspace Y / N
Temp 1° C
Log-In Review DS

REMARKS:

☐ Check If Special Reporting Limits Are Needed

3 1/1 Fed

Carrier # TNMO 903 292 520-9

Submittal of samples constitutes agreement to Terms and Conditions listed on reverse side of C.O.C.

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MAY-04-05 08:04 From:8152219 15053939758 T-256 P.14/14 Job-794

P.01

TRANSACTION REPORT

MAY-04-2005 WED 09:09 AM

FOR:

RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
MAY-04	09:05 AM	15053939758	3′34″	14	RECEIVE	OK		

March 2005

Amended Corrective Action Plan

Lovington Abo 1G Release Site

R.T. Hicks Consultants, Ltd.

901 Rio Grande Blvd. NW, Suite F-142, Albuquerque, NM 87104

March 25, 2005

Amended Corrective Action Plan

LOVINGTON ABO
1G RELEASE SITE

Prepared for:

Rice Operating Company
122 West Taylor
Hobbs, NM 88240

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142, Albuquerque, NM 87104

1.0 SUMMARY

In November 2004, Hicks Consultants oversaw sampling of the vadose zone and installation of a monitoring well at the Lovington Abo 1G site. We conducted the field activities in accordance with industry standard protocols and our work was consistent with our workplan, which NMOCD approved on November 4, 2004. This document is an amendment to the June 2004 Corrective Action Plan.

Our analysis of the data from the November field program consisted of the following:

1. Addition of October 2003 to December 2004 weather data to the 47-year weather record of our previous simulation. This data addition allowed HYDRUS-1D simulations to reflect the effect of the recent unusually heavy precipitation in the area.

2. Using the original hydrologic input data of our simulation presented in our June 2004 report and the new weather data, we allowed HYDRUS-1D to refine the original predictions.

3. Careful lithologic examination of cuttings and core from the November monitoring well boring and evaluation of penetration rates allowed us to refine the lithologic profile data employed in our June 2004 Report. We used this more accurate lithologic profile as input to an additional HYDRUS-1D simulation, as described below.

4. Because the newly-drilled well (LA MW-1) is only a few meters from the original boring SB-1, we used the vertical migration of the chloride in the upper vadose zone, the weather data for the period between these two sampling events, and the more accurate lithologic data to calibrate our final HYDRUS-1D simulation to the field data.

When we compared the predictions of the original June 2004 simulation with a calibrated simulation that employed the recent weather data (#4 above) we found:

a. Neither simulation suggests that the produced water release poses a threat to ground water quality.

b. The calibrated simulation predicted a maximum chloride concentration in ground water of less than 175 mg/L whereas the 2004 simulation predicted less than 250 mg/L. This difference is due to

a mathematical error in our 2004 simulation input data. Because of the error our 2004 simulation overestimated the volume of the release. In our 2004 report, the simulation employed an unrealistic release volume of more than 1,000 barrels, although the text of our report stated that we employed a spill volume of about 500 barrels. The 2005 calibrated simulation employed a release volume of 500 barrels, which is consistent with our evaluation of the field data.

c. The June 2004 simulation predicted a maximum chloride concentration in ground water (estimated at 77 feet to ground water in 2004) about 30 years from now. The calibrated simulation suggests the highest chloride concentration in ground water (measured in 2005 at about 90 feet from land surface) will occur about 35 years from present.

d. The unusually heavy precipitation from November 2004 to November 2005 caused the chloride center of mass in the upper vadose zone (about 2 meters below land surface) to move about 60 cm deeper into the profile (according to the sampling results). In the deeper vadose zone, at a depth of about 4 meters, chloride migration was less than 30 cm for this same time.

e. The calibrated model suggests that natural restoration of the root zone (0-2 meters) will occur in approximately 11 years.

f. Importation of clean soil may accelerate surface restoration of the site and further minimize the predicted impact to ground water quality.

2.0 RESULTS OF FIELD ACTIVITIES

Plate 1 presents a site map showing the location of LA MW-1 relative to the other borings and samples obtained at the site. Table 1 presents the analyses of field samples from the vadose zone during the construction of the monitoring well. Figure 1 compares the chloride concentration versus depth for SB-1 (November 2003) and LA MW-1 (November 2004). The lithologic log of MW-1 and that of SB-1 are included in Plates 2 & 3.

LA MW-1 Nov. 5, 2004		
Depth (feet)	Chloride mg/kg	PID ppm
6	1245	6.3
11	552	7.3
16	1307	5.2
21	905	8.2
26	741	1.1
31	493	0.3
36	566	0.8
41	126	3.3
46	83	2.0
51	49	1.0
61	59	2.4
71	50	2.9
81	59	3.7
91	55	2.7

Table 1. Analyses of samples from the vadose zone.

The lithology of LA MW-1 is primarily a very fine-grained sand silt interbedded with a complex series of caliche beds (See Plate 2). Layers featuring some caliche exist from 0.5 to 10 feet bgs, 33 to 44 feet bgs, and 53 to 60 feet bgs. In addition to these zones, three well indurated layers of caliche exist at 0.5 to 3 feet bgs, 15 to 17 feet bgs, 20 to 22 feet bgs, and 35 to 36 feet bgs. There also exists a well indurated layer of sandstone at 67 to 68 feet bgs.

As stated in our June 2004 Report, at the SB-1/LA MW-1 location, there exist two chloride masses. The lower chloride mass at 15 feet bgs at this location is the result of an earlier release event which we believe flowed only several meters from the ruptured line. Other boreholes show a chloride v. depth signature that reflects the effect of the October 2003 spill only: a center of mass at 5 feet below land surface and near-background chloride concentrations below 7 feet. Because a chloride center of mass at SB-1/LA MW-1 resides at a depth of 15 feet below land surface, chloride movement is not materially affected by upward wicking due to evaportranspiration. This mass resides above and within the well indurated caliche at 15 to 17 feet bgs. There exists a similar retardation of chloride movement by the caliche layer at 35 to 36 feet bgs. As a note, we employed the observed chloride transport rates at these depths to calibrate the HYDRUS-1D simulation.

The density of chloride measurements from the ROC November 2003 field program is quite good and clearly defines the location of the chloride center of mass at the SB-1 location. The data from the November 2004 event at LA MW-1 does not allow us to identify the center of chloride mass with the same degree of precision, but for the purposes of our modeling experiment, the data are more than sufficient.

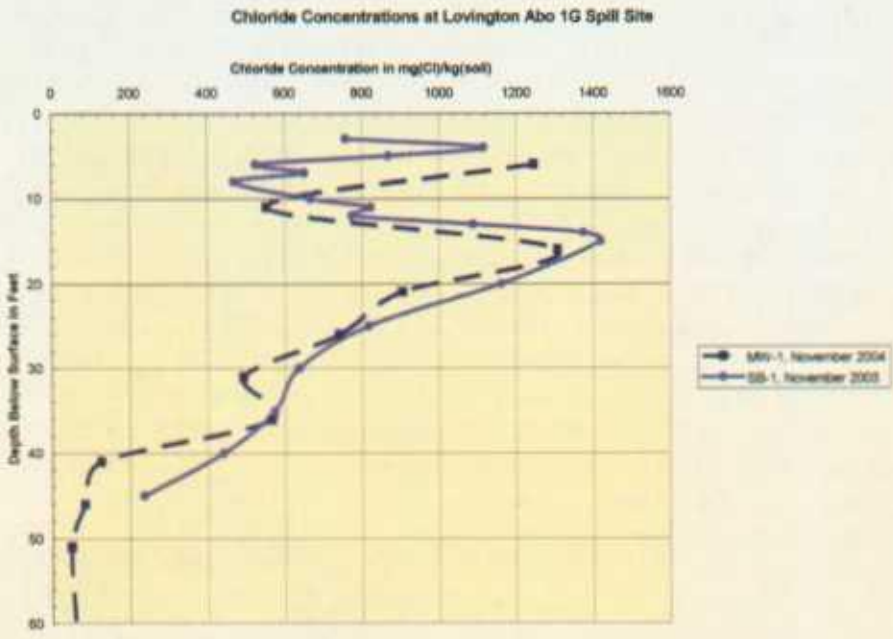


Figure 1. Chloride concentrations v. depth.

Figure 1 shows that peak measured chloride concentration of the upper chloride center of mass has migrated approximately two feet downward in the 12-month period (November 2003 to November 2004). We believe that the recent rain events may have temporarily created saturated flow in the upper soil profile moving the chloride into the sand and caliche layer below the upper fractured caliche.

The minimum chloride concentration between the two masses was at a depth of approximately 8 feet bgs in November 2003 and was located at approximately 11 feet bgs in November 2004. The chloride at these depths is within a very fine-grained sand silt featuring little caliche. Considering sampling depth approximations, this suggests a chloride migration rate of two to three feet per year.

The recent precipitation did not affect the downward migration of the 2003 peak chloride concentration (at 15 feet) in the same manner. As Figure 1 implies, the 2004 peak chloride concentration is at a depth of 16 feet, suggesting a migration rate of approximately one foot per year.

At 35 to 36 feet bgs we note virtually identical chloride concentrations from both drilling events. At this depth, a hard caliche layer exists.

These materials feature extremely low hydraulic conductivities acting as barriers to flow. Below this caliche layer, chloride concentrations decline to background levels.

We conclude that the recent precipitation events have resulted in movement of the upper chloride mass downwards about 2 feet. The minimum chloride concentration has migrated downwards two to three feet. The lower mass of chloride has migrated downwards about one foot through the caliche at this horizon. A lower rate of chloride migration is present at the 35 to 36 foot caliche layer. The rates of chloride migration, when weighted by thickness of soil material, suggest a rate of chloride migration of about two feet per year. Using this estimate, the peaks of chloride concentration will enter ground water about 35 years and 42 years from now.

Basin Environmental obtained samples from LA MW-1 on 12/3/04 and on 3/1/05. The results of these samples are presented in Table 2. As expected, the results show no evidence of ground water impact. Please note that the results of both analysis are in general agreement. The TDS result from the 3/1/05 sampling was analyzed outside of the "hold time", but we are confident that the result is representative. Additional ground water sampling is proposed later in this Corrective Action Plan Ammendment.

Table 2. Ground Water Analyses LA MW-1

Date Sampled	Cl	TDS	SO4	Ca	Mg	K	Na	Benzene	Toluene	Ethylbenzene	Xylenes
	(ppm)							(ppb)			
3/1/2005	120	532	91.8	85.2	13.5	5.1	48.3	ND	ND	ND	ND
12/3/2004	80.5	329	85.7	60	12.9	2.6	42.4	ND	ND	ND	ND

3.0 SIMULATION OF CHLORIDE FATE AND TRANSPORT

SUMMARY OF JUNE 2004 SIMULATIONS

Our June 2004 report predicted the chloride concentration soil profile shown in Figure 2. This simulation did not employ climate data that correlated with the time between the release and the time of the sampling. The period between the release and the sampling is characterized by greater precipitation than what was in the climate record employed for this original HYDRUS-1D simulation. In arid climates, the transport of chloride in the near-term (weeks or months) depends upon weather while the long-term transport depends upon climate. Therefore, it can be difficult or impossible to compare actual field data with predicted chloride values unless the simulation uses the weather data for the period in question. Despite the difference in weather data, we adjusted the hydraulic properties of the 2004 vadose zone model such that the center of chloride mass for the field data and the prediction were relatively close (Figure 2). Because of this field verification, we felt sufficiently confident to make predictions of the long-term impact to ground water. The June report predicted a chloride concentration v. time for a 10-foot thick aquifer would resemble Figure 3.

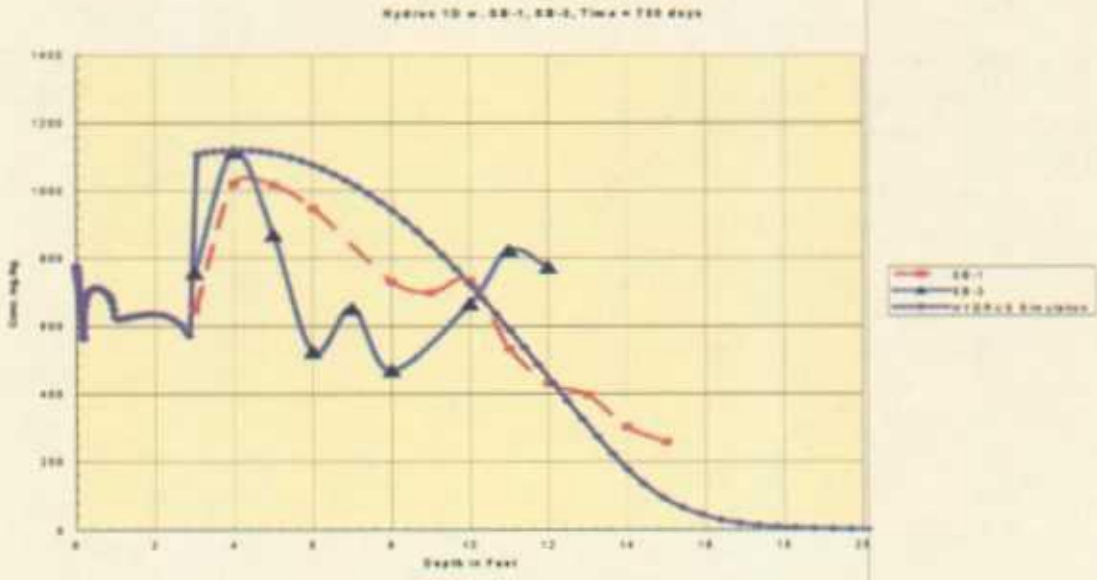


Figure 2. Chloride concentration soil profile prediction from June 2004 report

Figure 3 shows that chloride concentration in a monitor well immediately adjacent to the spill site will reach a maximum chloride concentration of about 240 ppm in 2033 – if the aquifer is 10 feet thick. If chloride mixes in the entire 130-foot thick aquifer of the area, then the June report simulation predicted a response shown in Figure 4. In our investigations of other areas of Lea County, we have found that chloride mixes throughout the aquifer and we maintain that Figure 4, which shows a maximum chloride concentration less than 120 ppm, better represents the potential chloride concentrations in ground water near the site based upon the input available to us in June 2004.

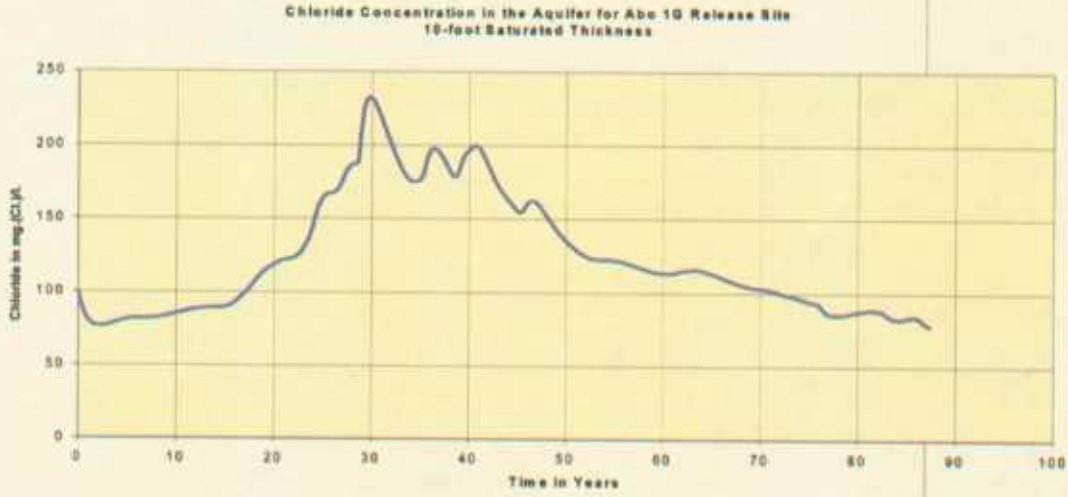


Figure 3. Chloride concentration assuming an aquifer thickness of 10 feet.

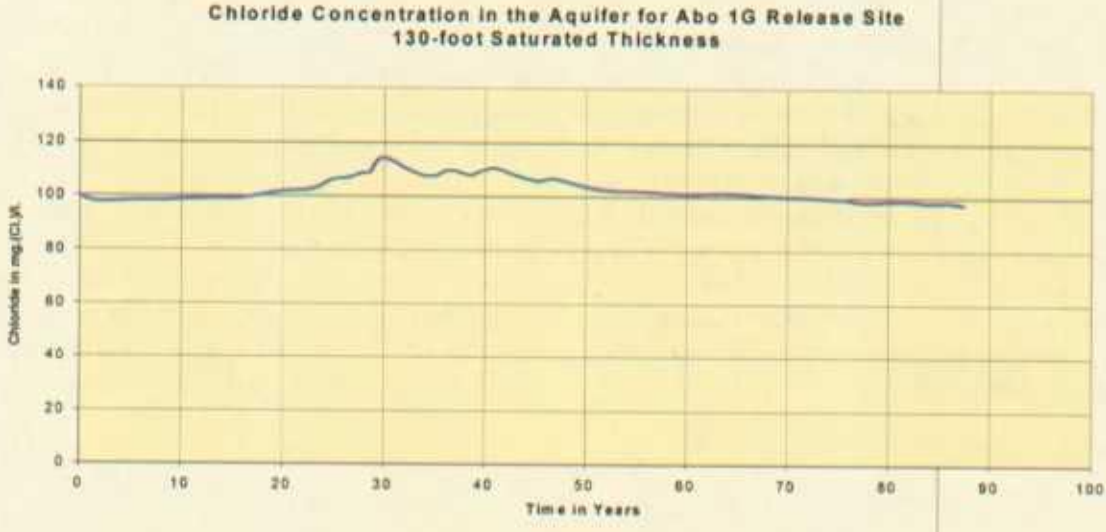


Figure 4. Chloride concentration assuming an aquifer thickness of 130 feet.

INPUT FOR JANUARY 2005 SIMULATIONS

Because the release lies adjacent to water supply wells for the City of Lovington, NMOCD expressed concern with the level of certainty associated with the 2004 modeling exercise. NMOCD requested the monitoring well and vadose zone sampling program presented in the previous section of this CAP ammendment. Because of this new data, we were able to increase the certainty of the modeling exercise in several ways:

1. We acquired and installed the weather data for Hobbs, New Mexico from October 1, 2003 to November 6, 2004 into the HYDRUS-1D simulation for the site. This data is collected approximately 12 miles south of the spill site. As data from the Lovington Airport is not complete for these dates, this is the closest available weather data to the site. We then began the simulation using weather data for October 2003, when the release actually occurred. The input data in the June 2004 report was used with this new weather data to determine the importance of this new data on the prediction of ground water quality. An amount of chloride corresponding to 500 barrels at 20,000 ppm chloride was installed in the soil profile with a distribution shape similar to the SB-3 chloride profile. Appropriately dated atmospheric data was installed. This is 2005 Simulation #1.

2. Because of the need for certainty, we collected a very detailed description of the vadose zone for the MW-1 boring (See Plate 2). This improved vadose zone profile data was used in a second simulation. To calibrate the model, the chloride concentration data obtained by ROC at SB-1 in their November 2003 field event was installed as an initial condition. We then ran the model for one year with the November to November Hobbs weather data. We made slight adjustments to the hydraulic properties in order to calibrate the 2005 model predictions to the chloride migration observed in the field data. Into this field calibrated model, we installed a chloride load of 500 barrels at 20,000 ppm in the soil profile that we consider representative of the site. This is 2005 Simulation #2.

In a forthcoming CD, we will provide the input parameters for both of the simulations.

RESULTS OF JANUARY 2005 SIMULATIONS

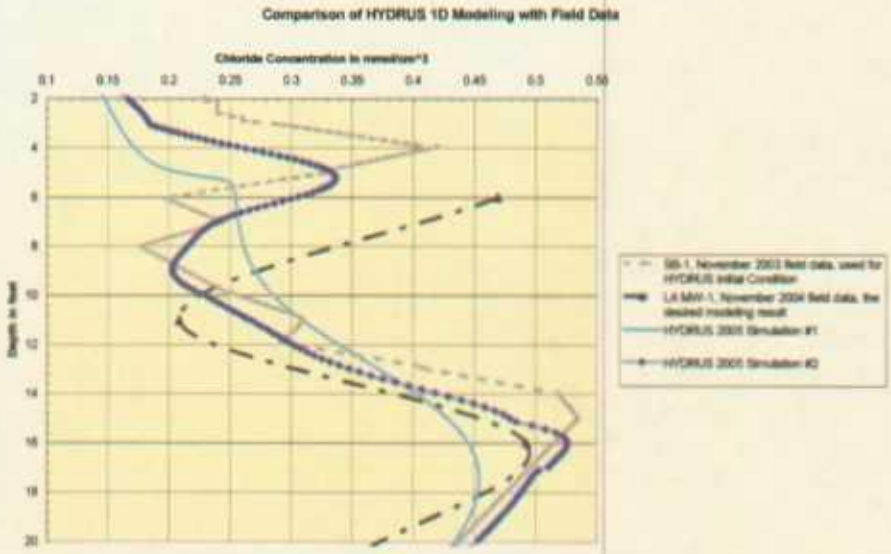


Figure 5. Predicted chloride concentrations of January 2005 simulations

Figure 5 plots the predicted chloride concentrations of Simulations 1 (data shown in a solid line) and Simulation 2 (calibrated simulation, line marked with diamonds) versus the observed field data obtained in November 2003 (SB-1, dashed line) and November 2004 (MW-1, dashed line with triangles). See Plate 4 for the full profiles. According to Figure 1 of this submission, the upper center of chloride mass moved downwards about two feet during the period between the sampling of SB-1 and the sampling of LA MW-1. The lower chloride mass moved slightly over one foot within the caliche layer at 15 to 17 feet bgs during this time interval. Clearly the density of data represented in Figure 1 introduces some error to these estimates. For the purposes of this report we accept these estimates and assume that Figure 1 shows the actual migration rate of the chloride.

The HYDRUS-1D 2005 Simulation #1, run with the recent Hobbs weather data shows a dispersion of the upper chloride mass (See Figure 5) for November 2004. The lower chloride mass also shows dispersion along with a downwards migration of the peak chloride concentration to a depth of 17 feet.

In our calibrated HYDRUS-1D 2005 simulation #2, the center of the upper chloride mass migrated about 1.5 feet downwards from November 2003 to November 2004. The minimum chloride concentration has migrated slightly over one foot downwards. The center of the lower chloride mass migrated 1.1 feet in the same time interval, about 10 percent more than observed.

This model was calibrated by using extremely conservative dispersion coefficients. We believe that the model's conservative prediction of the rate of movement of chloride in the upper ten feet of the soil profile are

due to the difficulty of accounting for the hydraulic properties of the uppermost fractured caliche bed. These fractures act as aids to flow in saturated conditions and as a hindrance to flow during the unsaturated conditions between severe precipitation events. We believe that the rate of movement of the lower chloride mass demonstrates a good agreement of the model with the field data.

Because we see a match between the 2004 field chloride concentrations and the predicted chloride concentration of Simulation #2, we believe that the HYDRUS-1D 2005 Simulation #2 is a better representation of the situation. Vertical migration rates and preservation of the two separate chloride concentrations are clearly a better match to field data.

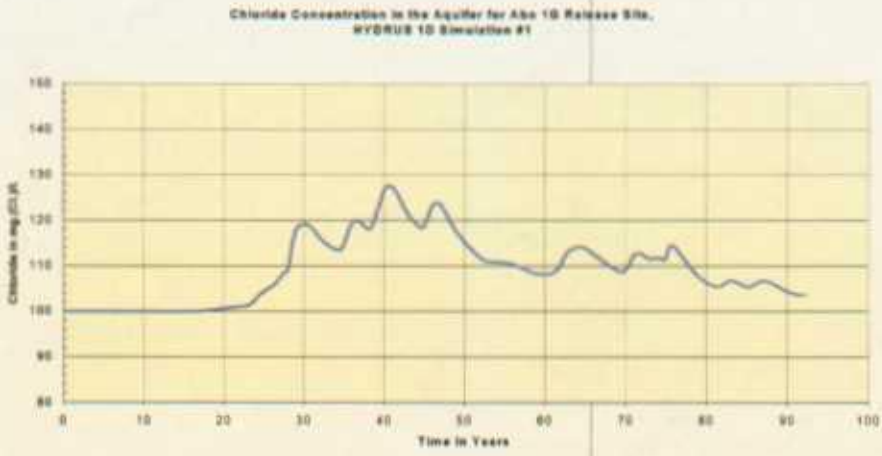


Figure 6. Chloride concentrations predicted for simulation 1.

The predictions of chloride concentrations in ground water for each simulation are not materially different. Figure 6 shows the predicted results for Simulation #1 and Figure 7 shows the results for Simulation #2. As mentioned earlier, Simulation #1 allows more dispersion. As such, the spread out pulses of chloride have an earlier effect on chloride concentrations in the aquifer. Peak concentrations of chloride are reduced within the aquifer. Finally, the dispersed pulse of chloride also effects aquifer chloride concentrations for longer time.

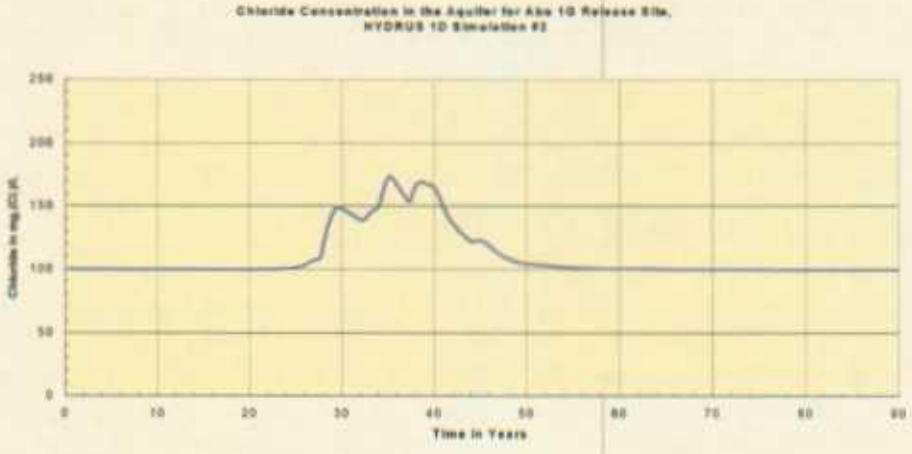


Figure 7. Chloride concentrations predicted in simulation 2

Simulation #2, with very conservative dispersion coefficients preserves higher chloride concentrations. The results are that aquifer chloride concentrations are effected later in time; peak concentrations are higher; and that the time interval for which aquifer chloride concentrations are effected is shorter. In neither case do the simulations predict an increase of chloride concentration in the aquifer above 175 mg/l.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The field data and revised HYDRUS-1D predictions continue to support the conclusions and recommendations presented in the 2004 Report:

1. The produced water release represents no threat to ground water quality.

2. The center of chloride mass associated with the release will migrate very slowly through the vadose zone, reaching the water table in about 30-60 years if vegetation does not return to the surface.

3. If the surface is re-vegetated, the rate of chloride migration and the impact to ground water will be less than predicted by the HYDRUS-1D simulations.

4. Removal of the thin layer of soil at the site will reduce the chloride load but will create no material environmental benefit because the residual chloride in the vadose zone will not cause ground water to exceed the New Mexico Ground Water Standards.

5. Importation of clean soil may accelerate surface restoration of the land. We do not believe that weather patterns could allow the chloride mass observed at 5-feet below land surface to wick upward and cause sterilization of imported soil.

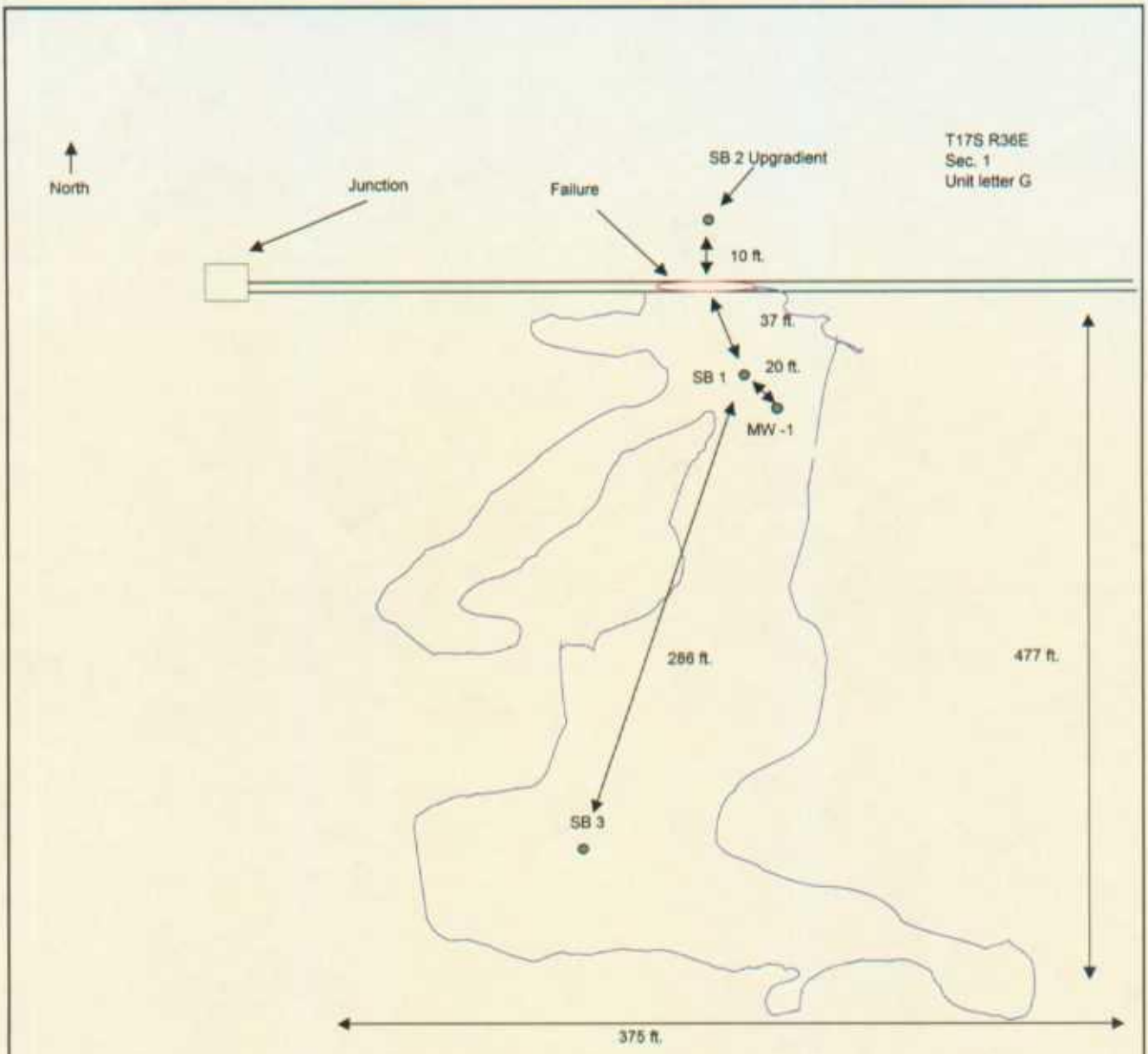
We recommend that ROC:

A. Not remove the thin layer of chloride-impaired soil from the site as stated in the August 31, 2004 letter to NMOCD,

B. Import clean soil to accelerate re-vegetation of the site,

C. Monitor ground water on a quarterly basis for two years as outlined in the October 28, 2004 letter to the NMOCD in order to further verify the veracity of our predictions presented herein.

PLATES



R.T. Hicks Consultants 901 Rio Grande NW Albuquerque, NM	**Rice Operating Company**	**Plate 1**
	Abo Release Site Sketch Map	**March 2005**

Logger:	David Hamilton	**Client:**	**Well ID:**
Driller:	Eades Drilling	ROC	
Drilling Method:	Air Rotary	**Project Name:**	
Start Date:	11/5/2004	Lovington Abo Release Site	**LA MW-1**
End Date:	11/6/2004	**Location:**	
		Section 1, 17S, 36E, Unit 1G	

Depth (feet)	Description	Lithology	Comments	Well Construction	Field data: Depth	Chloride mg/kg	PID
0.0	Surface, 0 - 5 feet		Hard drilling	Cement, 0-3 feet			
2.0	Frac. caliche, sand, clay, 5 - 3 feet, tan						
4.0	Sand and caliche, 3 - 5 feet, tan						
6.0	Very fine grained sand, silt, some caliche, 5 - 10 feet, tan				6.0	1245	6.3
8.0							
10.0	Very fine grained sand, silt, little caliche, 10 - 15 feet, tan				11.0	553	7.3
12.0							
14.0	Indurated caliche, 15 - 17 feet						
16.0	Very fine grained sand, silt, little caliche, 17 - 20 feet				16.0	1307	5.2
18.0							
20.0	Thin caliche layers in sand, 20 - 22 feet				21.0	905	8.2
22.0	Very fine grained sand, silt, 22 - 33 feet, tan with reddish tinge		Samples fell out of spoon, collected with shovel				
24.0							
26.0					26.0	741	1.1
28.0							
30.0					31.0	493	0.8
32.0							
34.0	Very fine grained sand, silt, caliche , 33 -44 feet, light tan. Well indurated caliche layer from 35 to 36 feet.						
36.0					36.0	566	0.8
38.0							
40.0					41.0	126	3.3
42.0							
44.0	Very fine grained sand, silt, 44 - 53 feet, tan			Hydrated bentonite, 3-87 feet			
46.0					46.0	83	2.0
48.0							
50.0					51.0	49	1.0
52.0	Very fine grained sand, silt, some caliche, 53 - 60 feet, tan						
54.0							
56.0							
58.0					61.0	59	2.4
60.0	Very fine grained sand, silt, 60 - 67 feet, tan						
62.0							
64.0							
66.0	Indurated sand, silt, 67 - 68 feet		Hard drilling				
68.0	Very fine grained sand, silt, 68 - 100 feet tan. Slightly redder below 83 feet.				71.0	90	2.9
70.0							
72.0							
74.0							
76.0							
78.0							
80.0					81.0	59	3.7
82.0							
84.0							
86.0							
88.0							
90.0					91.0	55	2.7
92.0							
94.0							
96.0							
98.0			Soil moist at 100 feet				
100.0	Very fine grained sand, silt, 100 - 122 feet			Sand, 87-122 feet			
102.0							
104.0							
106.0							
108.0							
110.0			Hole was drilled with water below 100 feet due to borehole collapse				
112.0							
114.0							
116.0							
118.0							
120.0							
122.0							

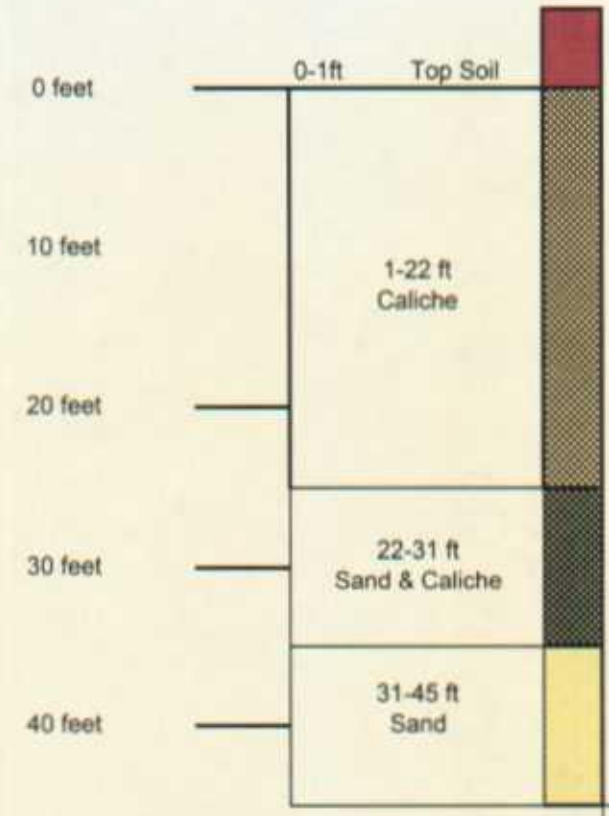
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
505-266-5004

ROC Lovington Abo Site

Monitoring Well Boring

Plate 2

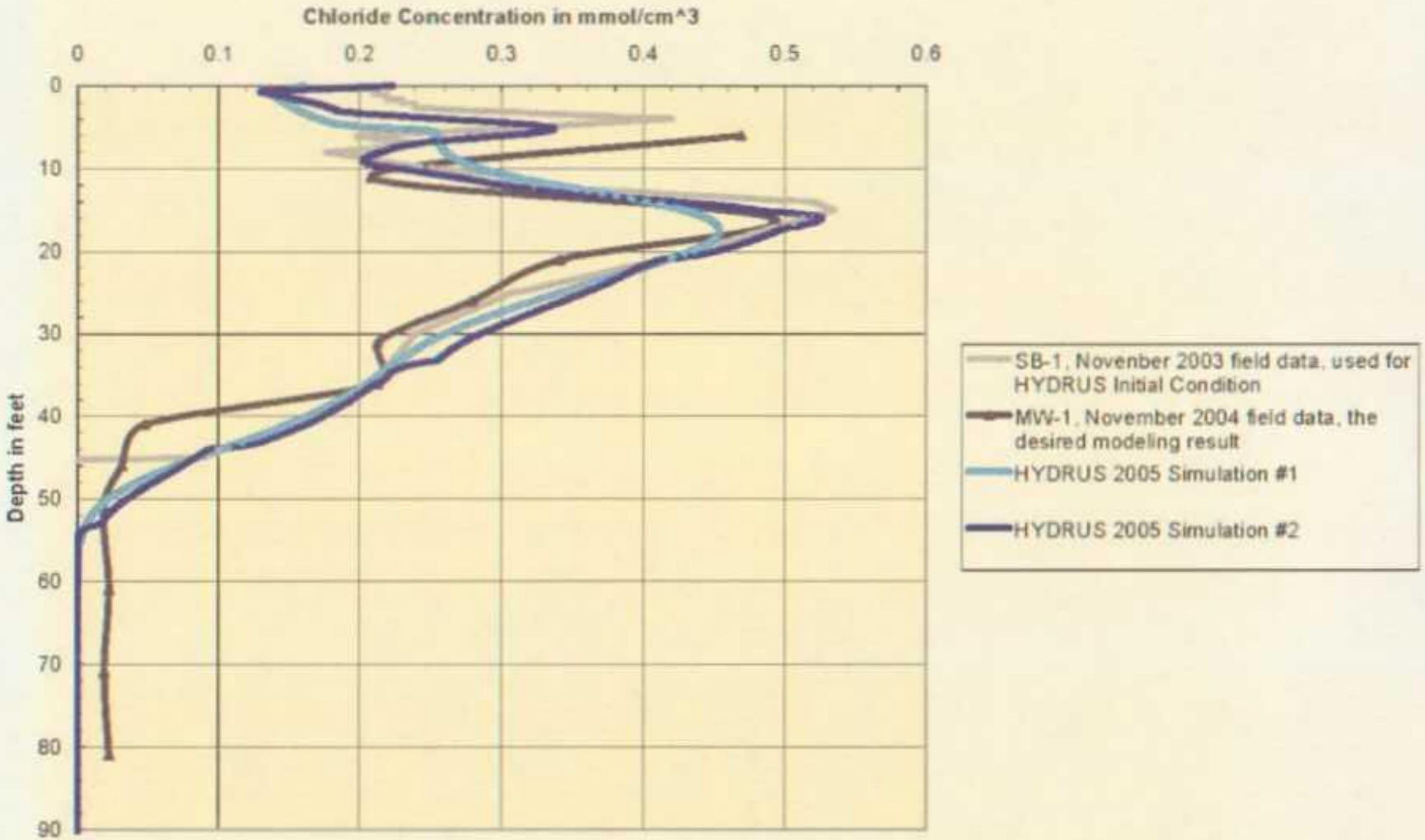
March 2005



Depth	Lithologic Description	Measured Soil Chloride Concentration mg/kg	Bulk Density of Sample kg/m3	Thickness of Column (ft)	Calculated Chloride Mass in Column (kg/m2)
0 feet	0-1ft Top Soil				
	1-22 ft Caliche	525	1858	10	3.23
10 feet					
		1088	1858	11	7.37
20 feet					
	22-31 ft Sand & Caliche	1161	1858	5	3.57
30 feet		636	1858	4	1.57
	31-45 ft Sand	573	1858	7	2.47
40 feet		236	1858	7	1.02
		Calculated Chloride Load			19.22

R.T. Hicks Consultants, Ltd. **901 Rio Grande NW** **Albuquerque, NM**	**RICE** *Operating Company*	Plate 3 Soil Bore #1
	Calculation of Chloride Load, Abo Leak, Lea County, New Mexico	Mar-05

Comparison of HYDRUS 1D Modeling with Field Data



R.T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87104
505.266.5004 Fax: 505.266.0745

Rice Operating Company	Plate 4
Full Length Chloride Concentration Profiles	March 2005

RICE Operating Company

122 West Taylor
Hobbs, NM 88240
Phone: (505) 393-9174
Fax: (505) 397-1471

TO: Wayne Price

FROM: Kristin Farris Pope

FAX NUMBER: (505) 476-3462

DATE: 5-4-05

COMPANY: NMOCD

TOTAL NO. OF PAGE INCLUDING COVER: 5

RE: Abo leak report

NOTES/COMMENTS:

IF YOU DO NOT RECEIVE ALL PAGES INCLUDED, PLEASE CALL THE OFFICE PHONE NUMBER LISTED AT THE TOP OF THIS PAGE-THANK YOU

RICE Operating Company
122 West Taylor • Hobbs, New Mexico 88240
Phone: (505)393-9174 • Fax: (505) 397-1471

October 20, 2003

Paul Sheeley
NMOCD Hobbs Office
1625 N. French Drive
Hobbs, New Mexico

Re: ABO SWD System
UL G-Sec 1 T17S R36E
Lca County, New Mexico

Dear Mr. Paul Sheeley:

Rice Operating Company (ROC) discovered an accidental discharge at the above referenced site the occurred on October 18, 2003. The failure occurred when a 4" poly line spilt at the fusion point. The release consisted of approximately 200 bbls of produced water affecting 30, 818 square feet. 130 bbls were recovered. Landowner, City of Lovington, has been notified. ROC is evaluating the site to determine the remedial plan of action.

ROC requests approval of this C-141 form as an initial report. If you have any questions, please call me at the above number.

Sincerely,

Joe Gatts
Environmental Technician

Enclosed: C-141 Initial Report
Copy of Initial Spill
Generic Spill and Leak Plan

COPY

District I
P.O. Box 1980, Hobbs, NM 88241-1980
District II
811 South First, Artesia, NM 88210
District III
1000 Rio Brazos, Aztec, NM 87410
District IV
2040 South Pacheco, Santa Fe, NM 87505

State of New Mexico
Energy, Minerals & Natural Resources Department
OIL CONSERVATION DIVISION
2040 South Pacheco
Santa Fe, NM 87505
OPERATOR'S MONTHLY REPORT

Form C-141
Originated 2/13/97

Submit 2 copies to Appropriate District Office in accordance with Rule 116 on back side of form

Release Notification and Corrective Action

OPERATOR

☒ Initial Report ☐ Final Report

Name	Contact
Rice Operating Company	Joe Gatts
Address: 122 West Taylor Hobbs, NM 88240	Telephone No.: 505-393-9174
Facility Name: ABO	Facility Type: SWD Disposal Line

Surface Owner	Mineral Owner	Lease No.
City of Lovington		-

LOCATION OF RELEASE

Unit Letter	Section	Township	Range	Feet from the	North/South line	Feet from the	East/West Line	County
G	1	17s	36e					LEA

NATURE OF RELEASE

Type of Release	Volume of Release	Volume Recovered
Produced Water	Approx. 200 bbls	130 bbls
Source of Release	**Date and Hour of Occurrence**	**Date and Hour of Discovery**
Pipeline	Unknown	10/18/03 10:30 am
Was Immediate Notice Given? ☒ Yes ☐ No ☐ Not Required	**If YES, To Whom?** Paul Sheeley	
By Whom? Joe Gatts	**Date and Hour** 10/20/03 11:55 am	
Was a Watercourse Reached? ☐ Yes ☒ No	**If YES, Volume Impacting the Watercourse.**	

If a Watercourse was Impacted, Describe Fully. (Attach Additional Sheets If Necessary)

Describe Cause of Problem and Remedial Action Taken. (Attach Additional Sheets If Necessary)
4" poly split at fuse. Cut out remaining slack and refused.

Describe Area Affected and Cleanup Action Taken. (Attach Additional Sheets If Necessary)
The release consisted of approx. 200 bbls, which affected 30,818 square feet. 130 bbls were recovered.

I hereby certify that the information given above is true and complete to the best of my knowledge and understand that pursuant to NMOCD rules and regulations all operators are required to report and/or file certain release notifications and perform corrective actions for releases which may endanger public health or the environment. The acceptance of a C-141 report by the NMOCD marked as "Final Report" does not relieve the operator of liability should their operations have failed to adequately investigate and remediate contamination that pose a threat to ground water, human health or the environment. In addition, NMOCD acceptance of a C-141 report does not relieve the operator of responsibility for compliance with any other federal, state, or local laws and/or regulations.

Signature: Joe Gatts	OIL CONSERVATION DIVISION	
Printed Name: Joe Gatts	Approved by District Supervisor:	
Title: Environmental Technician	Approval Date:	Expiration Date:
Date: 10/20/03 Phone: 505-393-9174	Conditions of Approval:	Attached ☐

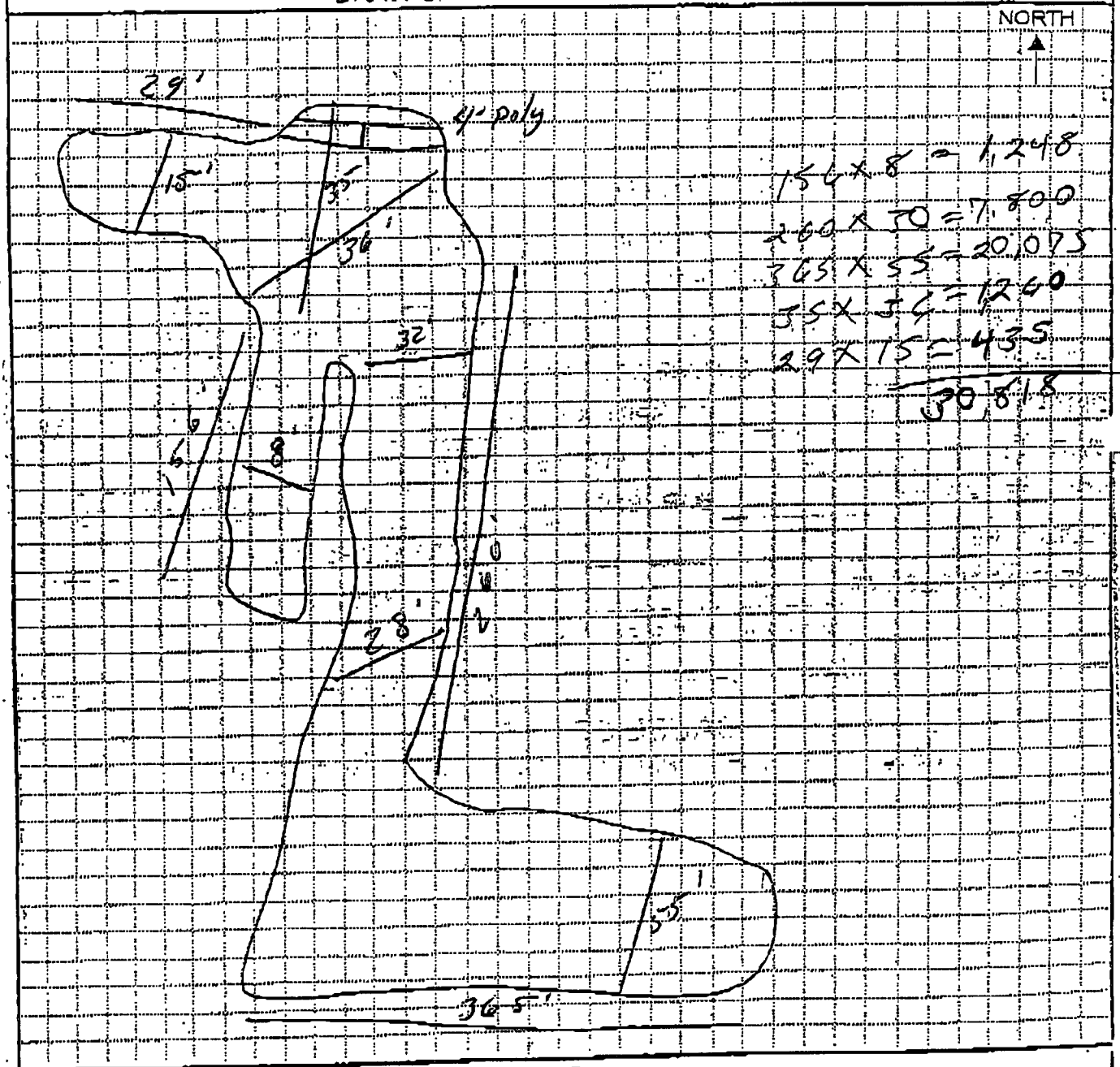
RICE INITIAL SPILL REPORT

IS THIS THE FIRST SPILL AT THIS LOCATION? NO

DESCRIBE AREA AFFECTED AND ON-SITE ACTION TAKEN

PASTURE ✓ ROADWAY _____ OTHER _____

DRAW SKETCH OF AFFECTED AREA



REPORT PREPARED BY Ray Ortega DATE 10 18 03

L. Goodhart ✓ C. Haynes ✓ S. Curtis ___ C. Maxwell ✓
J. Rampone ✓ O. Armendarez ✓ N. Cermona ✓ R. Anderson ___ O. Ojeda ✓
D. Anderson ✓ K. Farris ✓ J. Batts ___
Roy R. ✓

SPILL REPORTING REQUIREMENTS

WEEKDAYS: TURN IN ROC SPILL REPORT SAME DAY OR BY 10:00 AM NEXT DAY
REPORT MUST BE ACCOMPANIED BY DRAWING AND PHOTOS

WEEKENDS: IF SPILL IS OVER 4000 SQUARE FEET, CALL OCD (393-6161) AND REPORT THAT A SPILL HAS BEEN FOUND THAT MAY BE OVER 25 BBLS. COMPLETE ROC SPILL REPORT AS NOTED ABOVE AND TURN IN TO ENVIRONMENTAL TECH.

OCD PHONE NO. 393-6161 TIME CALLED 11:55 AM 10/20/03 DATE [illegible]

NAME OF OCD PERSON NOTIFIED Paul Kautz voicemail

RICE INITIAL SPILL REPORT

SYSTEM ABO TIME & DATE DISCOVERED 10:30 10/18/03

NAME OF PERSON REPORTING LEAK Pure Energy pumper Billy

SECTION 31 TOWNSHIP 17 S RANGE 37 E UNIT LETTER ___

JCT. BOX ___ ON LINE BETWEEN JCT Apache-LA E.O.L. AND JCT B-6 PS1

DISTANCE FROM JCT Apache-LA E.O.L. TO SPILL SITE 100' FEET N (E) S W

SWD WELL ___ PUMP STATION ___

VOLUME OF SPILL 190 BARRELS 30,818 SQUARE FEET AFFECTED

FLUID TYPE PW BARRELS RECOVERED 130 bbls

LIVESTOCK PRESENT NO PICTURES TAKEN Yes

WAS LEAK SITE FENCED NO

Landowner: City of Lovington Notified @ 10/20/03 Spoke to Charles Kelley

CAUSE OF THE LEAK

DESCRIBE CAUSE OF PROBLEM AND HOW IT WAS REPAIRED: 10/22/03
4" Poly line split at fuse cut out
Slant Refuse Poly

IS THE REPAIR: TEMPORARY ___ USED CLAMP ___ PERMANENT ✓

DRAW SPILL SITE ON BACK

P.01

TRANSACTION REPORT

MAY-04-2005 WED 09:59 AM

FOR:

RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
MAY-04	09:58 AM		1'19"	5	RECEIVE	OK		

RICE *Operating Company*

122 West Taylor
Hobbs, NM 88240
Phone: (505) 393-9174
Fax: (505) 397-1471

TO: Wayne Price

FROM: KFP

FAX NUMBER: (505) 476-3462

DATE: 5-4-05

COMPANY: OCD

TOTAL NO. OF PAGE INCLUDING COVER: —

RE: Abo leak

NOTES/COMMENTS:

LAB ANALYSIS

IF YOU DO NOT RECEIVE ALL PAGES INCLUDED. PLEASE CALL THE OFFICE PHONE NUMBER LISTED AT THE TOP OF THIS PAGE-THANK YOU

ENVIRONMENTAL LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Kristin Pope
Rice Operating Co.
122 W. Taylor
Hobbs, NM 88240

Project: ABO-Apache LA Leak
Project Number: None Given
Location: Lovington

Lab Order Number: 5C02003

Report Date: 03/15/05

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-1	5C02003-01	Water	03/01/05 14:10	03/01/05 18:45

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co. 122 W. Taylor Hobbs NM, 88240	Project: ABO-Apache LA Leak Project Number: None Given Project Manager: Kristin Pope	Fax: (505) 397-1471 Reported: 03/15/05 09:54

General Chemistry Parameters by EPA / Standard Methods
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (5C02003-01) Water									
Total Alkalinity	**148**	2.00	mg/L	1	EC50405	03/03/05	03/03/05	EPA 310.2M	
Chloride	**120**	2.50	"	5	EC50903	03/03/05	03/03/05	EPA 300.0	
Sulfate	**91.8**	2.50	"	"	"	"	"	"	
MW-1 (5C02003-01RE1) Water									
Total Dissolved Solids	**532**	5.00	mg/L	1	EC50311	03/11/05	03/11/05	EPA 160.1	O-04, QC-08

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

Total Metals by EPA / Standard Methods
Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (5C02003-01) Water									
Calcium	**85.2**	0.100	mg/L	10	EC50412	03/03/05	03/04/05	EPA 6010B	
Magnesium	**13.5**	0.0100	"	"	"	"	"	"	
Potassium	**5.10**	0.100	"	2	"	"	"	"	
Sodium	**48.3**	0.100	"	10	"	"	"	"	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

Volatile Organic Compounds by EPA Method 8260B

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (5C02003-01) Water									
Benzene	ND	1.00	ug/l	1	EC50703	03/04/05	03/04/05	EPA 8260B	
Toluene	ND	1.00	"	"	"	"	"	"	
Ethylbenzene	ND	1.00	"	"	"	"	"	"	
Xylene (p/m)	ND	1.00	"	"	"	"	"	"	
Xylene (o)	ND	1.00	"	"	"	"	"	"	
Surrogate: Dibromofluoromethane		*112 %*		*68-129*		"	"	"	
Surrogate: 1,2-Dichloroethane-d4		*90.2 %*		*72-132*		"	"	"	
Surrogate: Toluene-d8		*104 %*		*74-118*		"	"	"	
Surrogate: 4-Bromofluorobenzene		*101 %*		*65-140*		"	"	"	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

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 EC50311 - 410.4										
Blank (EC50311-BLK1)				Prepared: 03/02/05 Analyzed: 03/03/05						
Total Dissolved Solids	ND	5.00	mg/L							
Duplicate (EC50311-DUP1)		Source: 5C02003-01		Prepared: 03/02/05 Analyzed: 03/03/05						
Total Dissolved Solids	1150	5.00	mg/L		1080			6.28	20	
Duplicate (EC50311-DUP2)		Source: 5C02003-01RE1		Prepared & Analyzed: 03/11/05						
Total Dissolved Solids	556	5.00	mg/L		532			4.41	20	
Batch EC50405 - General Preparation (WetChem)										
Blank (EC50405-BLK1)				Prepared & Analyzed: 03/03/05						
Total Alkalinity	ND	2.00	mg/L							
Calibration Check (EC50405-CCV1)				Prepared & Analyzed: 03/03/05						
Carbonate Alkalinity	0.0500		mg/L	0.0500		100	80-120			
Duplicate (EC50405-DUP1)		Source: 5C02003-01		Prepared & Analyzed: 03/03/05						
Total Alkalinity	149	2.00	mg/L		148			0.673	20	
Batch EC50903 - General Preparation (WetChem)										
Blank (EC50903-BLK1)				Prepared & Analyzed: 03/03/05						
Chloride	ND	0.500	mg/L							
Sulfate	ND	0.500	"							
LCS (EC50903-BS1)				Prepared & Analyzed: 03/03/05						
Chloride	10.2		mg/L	10.0		102	80-120			
Sulfate	10.5		"	10.0		105	80-120			

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

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 EC50903 - General Preparation (WetChem)										
Calibration Check (EC50903-CCV1)				Prepared & Analyzed: 03/03/05						
Chloride	10.5		mg/L	10.0		105	80-120			
Sulfate	10.8		"	10.0		108	80-120			
Duplicate (EC50903-DUP1)		Source: 5C02010-01		Prepared & Analyzed: 03/03/05						
Sulfate	87.5	2.50	mg/L		87.9			0.456	20	
Chloride	529	10.0	"		577			8.68	20	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

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 EC50412 - 6010B/No Digestion										
Blank (EC50412-BLK1)				Prepared: 03/03/05 Analyzed: 03/04/05						
Calcium	ND	0.0100	mg/L							
Magnesium	ND	0.00100	"							
Potassium	ND	0.0500	"							
Sodium	ND	0.0100	"							
Calibration Check (EC50412-CCV1)				Prepared: 03/03/05 Analyzed: 03/04/05						
Calcium	2.25		mg/L	2.00		112	85-115			
Magnesium	2.30		"	2.00		115	85-115			
Potassium	1.85		"	2.00		92.5	85-115			
Sodium	1.82		"	2.00		91.0	85-115			
Duplicate (EC50412-DUP1)	**Source: 5B25005-01**			Prepared: 03/03/05 Analyzed: 03/04/05						
Calcium	104	0.100	mg/L		99.2			4.72	20	
Magnesium	38.9	0.0100	"		41.0			5.26	20	
Potassium	10.8	0.500	"		11.1			2.74	20	
Sodium	267	1.00	"		252			5.78	20	

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

Volatile Organic Compounds by EPA Method 8260B - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC50703 - EPA 5030C (GCMS)										
Blank (EC50703-BLK1)				Prepared & Analyzed: 03/04/05						
Benzene	ND	1.00	ug/l							
Toluene	ND	1.00	"							
Ethylbenzene	ND	1.00	"							
Xylene (p/m)	ND	1.00	"							
Xylene (o)	ND	1.00	"							
Surrogate: Dibromofluoromethane	*50.5*		"	*50.0*		*101*	*68-129*			
Surrogate: 1,2-Dichloroethane-d4	*43.6*		"	*50.0*		*85.2*	*72-132*			
Surrogate: Toluene-d8	*48.6*		"	*50.0*		*97.2*	*74-118*			
Surrogate: 4-Bromofluorobenzene	*48.1*		"	*50.0*		*96.2*	*65-140*			
LCS (EC50703-BS1)				Prepared & Analyzed: 03/04/05						
Benzene	55.7		ug/l	50.0		111	70-130			
Toluene	56.6		"	50.0		113	70-130			
Ethylbenzene	54.5		"	50.0		109	70-130			
Xylene (p/m)	95.6		"	100		95.6	70-130			
Xylene (o)	56.0		"	50.0		112	70-130			
Surrogate: Dibromofluoromethane	*51.0*		"	*50.0*		*102*	*68-129*			
Surrogate: 1,2-Dichloroethane-d4	*47.6*		"	*50.0*		*95.2*	*72-132*			
Surrogate: Toluene-d8	*50.1*		"	*50.0*		*100*	*74-118*			
Surrogate: 4-Bromofluorobenzene	*50.2*		"	*50.0*		*100*	*65-140*			
Calibration Check (EC50703-CCV1)				Prepared & Analyzed: 03/04/05						
Toluene	54.0		ug/l	50.0		108	70-130			
Ethylbenzene	50.7		"	50.0		101	70-130			
Surrogate: Dibromofluoromethane	*51.1*		"	*50.0*		*102*	*68-129*			
Surrogate: 1,2-Dichloroethane-d4	*44.2*		"	*50.0*		*88.4*	*72-132*			
Surrogate: Toluene-d8	*50.4*		"	*50.0*		*101*	*74-118*			
Surrogate: 4-Bromofluorobenzene	*48.6*		"	*50.0*		*97.2*	*65-140*			

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

Volatile Organic Compounds by EPA Method 8260B - Quality Control

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch EC50703 - EPA 5030C (GCMS)										
Matrix Spike (EC50703-MS1)		**Source: 5C02003-01**		Prepared & Analyzed: 03/04/05						
Benzene	56.9		ug/l	50.0	ND	114	80-120			
Toluene	58.8		"	50.0	ND	118	80-120			
Ethylbenzene	58.3		"	50.0	ND	117	80-120			
Xylene (p/m)	104		"	100	ND	104	80-120			
Xylene (o)	58.7		"	50.0	ND	117	80-120			
Surrogate: Dibromofluoromethane	*51.3*		"	*50.0*		*103*	*68-129*			
Surrogate: 1,2-Dichloroethane-d4	*48.4*		"	*50.0*		*96.8*	*72-132*			
Surrogate: Toluene-d8	*50.3*		"	*50.0*		*101*	*74-118*			
Surrogate: 4-Bromofluorobenzene	*49.7*		"	*50.0*		*99.4*	*65-140*			
Matrix Spike Dup (EC50703-MSD1)		**Source: 5C02003-01**		Prepared & Analyzed: 03/04/05						
Benzene	56.2		ug/l	50.0	ND	112	80-120	1.24	20	
Toluene	58.1		"	50.0	ND	116	80-120	1.20	20	
Ethylbenzene	57.1		"	50.0	ND	114	80-120	2.08	20	
Xylene (p/m)	100		"	100	ND	100	80-120	3.92	20	
Xylene (o)	58.4		"	50.0	ND	117	80-120	0.512	20	
Surrogate: Dibromofluoromethane	*49.2*		"	*50.0*		*98.4*	*68-129*			
Surrogate: 1,2-Dichloroethane-d4	*47.0*		"	*50.0*		*94.0*	*72-132*			
Surrogate: Toluene-d8	*49.2*		"	*50.0*		*98.4*	*74-118*			
Surrogate: 4-Bromofluorobenzene	*48.5*		"	*50.0*		*97.0*	*65-140*			

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	Reported:
Hobbs NM, 88240	Project Manager: Kristin Pope	03/15/05 09:48

Notes and Definitions

QC-08	Sample was originally analyzed within holding time. However, it was determined that positive interferences contributed to the sample results. The sample was rerun with lower volume of sample.
O-04	This sample was analyzed outside the EPA recommended holding time.
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: 3-15-05

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 Pope
Company Name: Rice Operating
Company Address: 122 w Taylor
City/State/Zip: Hobbs, nm 88240
Telephone No: (505) 393-9174 Fax No: (505) 397-1471
Sampler Signature: Jake Ellard

Project Name: ABO - HACKBERRY LA LEAK
Project #:
Project Loc: LOVINGTON
PO #:

LAB # (lab use only) 502003	FIELD CODE	Date Sampled 2005	Time Sampled	No. of Containers	Preservative: Ice	HNO3	HCl	NaOH	H2SO4	None	Other (Specify)	Matrix: Water	Sludge	Soil	Other (specify):	Analyze For: TCLP: TPH: 418.1 8015M 1005 1006	TOTAL: 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 8021B/5030 or TEX 8260	RCI	N.O.R.M.	T105			RUSH TAT (Pre-Schedule)	Standard TAT
-01	MW-1	3/1/2005	14:10	3	X		X					X					X	X					Y			X				

Special Instructions:
Please email analysis to Kristin envleo@leaco.net

Sample Containers Intact? Y N
Temperature Upon Receipt:
Laboratory Comments:
Rec 3.0°C
2 VOA
1 L HPTE

Relinquished by:	Date	Time	Received by:	Date	Time
Jake Vance	3-1-05	14:34	Kristin Pope	3-1-05	1435
Kristin Pope	3-1-05	430pm MST	Received by ELOT: CD Hanna Lab c/c/p	3-1-05	1815 1845

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

Client: Pine Operating

Date/Time: 3/2/05 8:20

Order #: 5C02003

Initials: MR

Sample Receipt Checklist

Temperature of container/cooler?	Yes	No	3.0 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	No	Not Applicable

Other observations:

Variance Documentation:

Contact Person: _____ Date/Time: _____ Contacted by: _____

Regarding:

Corrective Action Taken:

P.01

TRANSACTION REPORT

MAY-04-2005 WED 12:12 PM

FOR:

RECEIVE

DATE	START	SENDER	RX TIME	PAGES	TYPE	NOTE	M#	DP
MAY-04	12:11 PM		1'39"	14	RECEIVE	OK		

Price, Wayne

From: Price, Wayne
Sent: Monday, May 02, 2005 2:58 PM
To: 'Kristin Farris'; Johnson, Larry; Sheeley, Paul; Price, Wayne
Cc: Carolyn Haynes; Randall Hicks; Roy Rascon
Subject: RE: Abo MW in Lovington

OCD has not received the results. Please E-mail ASAP.

-----Original Message-----
From: Kristin Farris [mailto:enviro@leaco.net]
Sent: Tuesday, March 01, 2005 7:50 AM
To: Larry Johnson; Paul Sheeley; Wayne Price
Cc: Carolyn Haynes; Randall Hicks; Roy Rascon
Subject: Abo MW in Lovington

Basin Environmental will re-sample the monitoring well at the Abo Apache 1A leak site in Lovington today at 1:00 pm. NMOCD-Hobbs will split samples. Please contact me if you need directions.

Kristin Farris Pope
Project Scientist
RICE Operating Company
Hobbs, NM 88240
(505) 393-9174

LAW OFFICES

HEIDEL, SAMBERSON, NEWELL, COX & McMAHON

C. GENE SAMBERSON
MICHAEL T. NEWELL
LEWIS C. COX, III
PATRICK B. McMAHON

311 NORTH FIRST STREET
POST OFFICE DRAWER 1599
LOVINGTON, NM 88260
TELEPHONE (505) 396-5303
FAX (505) 396-5305

F.L. HEIDEL
(1913-1985)

April 29, 2005

VIA FACSIMILE/(505) 476-3462

Wayne Price
New Mexico Oil Conservation Division
Environmental Bureau
1220 South St. Francis Blvd.
Santa Fe, NM 87505

Re: Rice/Abo 1G Leak Site

Dear Mr. Price,

Thank you for the opportunity to review Rice's most recent proposal to remediate the Abo 1G leak site. Please be advised that the City of Lovington objects to Rice's plan.

The flowline which had the leak at issue was installed as a result of a grant of easement to Rice by the City. Under the terms of that easement, Rice does not have the right to leave contaminants in the right of way or on adjacent City property. If the OCD grants Rice's proposed plan to leave contaminants in place, the City will view this as a taking and act accordingly.

If you have any questions, please do not hesitate to call.

Sincerely,

HEIDEL, SAMBERSON, NEWELL, COX & McMAHON

By: Pat B McM

Patrick B. McMahon

PBM:cd
pc: Pat Wise, City Manager

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

March 25, 2005

Wayne Price
NMOCD Environmental Bureau
1220 South St. Francis Drive
Santa Fe, New Mexico 87505
Via E-mail and Federal Express

RE: Amended Corrective Action Plan Loving Abo 1G Pipeline Release
Section 1, 17S, 36E, Unit G

Dear Wayne:

On behalf of Rice Operating Company, R.T. Hicks Consultants, Ltd. is pleased to submit the attached Amended Corrective Action Plan for the above-referenced site.

If you have any questions or concerns about the enclosed report, please let us know. Thank you for your time.

Sincerely,
R.T. Hicks Consultants, Ltd.

Katie Lee

Katie Lee
Associate Scientist

Copy: Rice Operating Company

March 2005

Amended Corrective Action Plan

Lovington Abo 1G Release Site

R.T. Hicks Consultants, Ltd.

901 Rio Grande Blvd. NW, Suite F-142, Albuquerque, NM 87104

Price, Wayne

From: Price, Wayne
Sent: Monday, February 21, 2005 11:01 AM
To: 'katie@rthicksconsult.com'; Price, Wayne; Carolyn Doran Haynes (E-mail)
Cc: Kristen at Rice; Randall Hicks; Sheeley, Paul; Johnson, Larry
Subject: RE: NMOCD Case #1R0415

After reviewing the lab QA/QC check-in sheet, it appears the sample bottle was not labeled. Please make arrangements to resample this monitoring well. Provide OCD the results no later than March 21, 2005. In addition, please contact the OCD Hobbs office and make arrangements for them to witness and/or split samples.

-----Original Message-----
From: katie Lee [mailto:katie@rthicksconsult.com]
Sent: Tuesday, December 21, 2004 12:43 PM
To: Wayne Price
Cc: Kristen at Rice; Randall Hicks
Subject: RE: NMOCD Case #1R0415

Dear Mr. Price,

My apologies for the mistake in the NMOCD case number for Lovington Abo. It was marked as #1R0414, when in fact it should have read #1R0415. Attached, the report with the transmittal letter corrected. A hard copy of this report (with the incorrect number) has already been mailed to you. I can fax you the corrected first page, or send it via the post, as seems best to you.

Best regards,

Katie Lee
Associate Scientist
R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW F-142
Albuquerque, NM 87104

Phone: 505-266-5004
Fax: 505-266-0745

-----Original Message-----
From: katie Lee [mailto:katie@rthicksconsult.com]
Sent: Monday, December 20, 2004 3:32 PM
To: Wayne Price
Cc: Kristen at Rice; Randall Hicks
Subject: NMOCD Case #1R0414

Dear Mr. Price:

Attached, please find a transmittal letter and supporting documents for the Rice Operating Company Abo 1G Leak Site, NMOCD Case # 1R0414. If you have any trouble with these documents, questions, comments, etc, please let us know. A paper copy follows via snail mail. Happy holidays!

Best regards,

Katie Lee
Associate Scientist
R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW F-142
Albuquerque, NM 87104

Phone: 505-266-5004
Fax: 505-266-0745

Price, Wayne

From: Price, Wayne
Sent: Monday, February 21, 2005 10:46 AM
To: Patrick B. McMahon (E-mail)
Subject: FW: NMOCD Case #1R0415

Dear Mr. McMahon:

Per your request please find attached a copy of the reports. After reviewing the report OCD has a concern with the sampling QA/QC. We will be asking Rice to re-sample the water.

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Albuquerque, NM 87104

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> **Cc:** Kristen at Rice; Randall Hicks
> **Subject:** NMOCD Case #1R0414
>
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>
> Best regards,
>
> Katie Lee
> Associate Scientist

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW F-142
Albuquerque, NM 87104

Phone: 505-266-5004
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> Katie Lee
> Associate Scientist

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW F-142
Albuquerque, NM 87104

Phone: 505-266-5004
Fax: 505-266-0745

Price, Wayne

From: Patrick McMahon [hsncpbm@leaco.net]
Sent: Monday, February 14, 2005 9:11 AM
To: Price, Wayne
Subject: Rice Abo 1G site

Dear Wayne,
As per our recent conversation, the City of Lovington is very interested in commenting on the Rice Abo 1G site. As of this date, however, we have not recieved copies of the sampling resuts from Rice's installation of their monitor well. Please forward those results to me. Once I have had a chance to review those results I will forward my comments to you.
Thank You
Patrick

Heidel, Samberson, Newell, Cox & McMahon
P.O. Drawer 1599
Lovington, NM 88260
Ph: (505) 396-5303
Fax: (505) 396-5305

Price, Wayne

From: katie Lee [katie@rthicksconsult.com]
Sent: Tuesday, December 21, 2004 12:43 PM
To: Wayne Price
Cc: Kristen at Rice; Randall Hicks
Subject: RE: NMOCD Case #1R0415

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Associate Scientist
R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW F-142
Albuquerque, NM 87104

Phone: 505-266-5004
Fax: 505-266-0745

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Cc: Kristen at Rice; Randall Hicks
Subject: NMOCD Case #1R0414

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Katie Lee
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R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

December 20, 2004

Mr. Wayne Price
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Abo 1G Leak Site:
Section 1, 17S 36E Unit G
NMOCD Case #1R0415

Dear Wayne:

Included with this letter is the well log for our drilling event of November 5th and 6th, 2004. The well log features lithology, drilling notes, well construction, and field chloride and PID data. We have also included laboratory results from soil samples collected during the drilling and a site map with the position of this monitoring well, LA MW-1. In addition, the attached laboratory results of the first ground water sample from this well show no impact to ground water.

Sincerely,
R.T. Hicks Consultants, Ltd.

David Hamilton

David Hamilton
Project Hydrologist

Copy: Kristin Farris Pope

Logger:	David Hamilton	**Client:**	**Well ID:**
Driller:	Eades Drilling	ROC	LA MW-1
Drilling Method:	Air Rotary	**Project Name:**	
Start Date:	11/5/2004	Lovington Abo Release Site	
End Date:	11/6/2004	**Location:**	
		Section 1, 17S, 36E, Unit 1G	

Depth (feet)	Description	Lithology	Comments	Well Construction	Field data: Depth	Field data: Chloride mg/kg	Field data: PID
0.0	Surface, 0 - 5 feet		Hard drilling	Cement, 0-3 feet			
2.0	Frac. caliche, sand, clay, 0 - 3 feet, tan						
4.0	Sand and caliche, 3 - 5 feet, tan						
6.0	Very fine grained sand, silt, some caliche, 5 - 10 feet, tan				6.0	1246	6.3
8.0							
10.0	Very fine grained sand, silt, little caliche, 10 - 15 feet, tan				11.0	553	7.3
12.0							
14.0	Indurated caliche, 15 - 17 feet						
16.0	Very fine grained sand, silt, little caliche, 17 - 20 feet				16.0	1307	5.2
18.0							
20.0	Thin caliche layers in sand, 20 - 22 feet				21.0	905	8.2
22.0	Very fine grained sand, silt, 22 - 33 feet, tan with reddish tinge		Samples felt out of spoon, collected with shovel				
24.0					26.0	741	1.1
26.0							
28.0					31.0	493	0.8
30.0							
32.0							
34.0	Very fine grained sand, silt, caliche , 33 -44 feet, light tan. Well indurated caliche layer from 35 to 36 feet.				36.0	566	0.8
36.0							
38.0					41.0	128	3.3
40.0							
42.0							
44.0	Very fine grained sand, silt, 44 - 53 feet, tan			Hydrated bentonite, 3-67 feet	46.0	83	2.0
46.0							
48.0					51.0	49	1.0
50.0							
52.0	Very fine grained sand, silt, some caliche, 53 - 60 feet, tan						
54.0							
56.0					61.0	59	2.4
58.0							
60.0	Very fine grained sand, silt, 60 - 67 feet, tan						
62.0							
64.0							
66.0	Indurated sand, silt, 67 - 68 feet		Hard drilling				
68.0	Very fine grained sand, silt, 68 - 100 feet tan. Slightly redder below 83 feet.				71.0	50	2.8
70.0							
72.0							
74.0							
76.0							
78.0					81.0	59	3.7
80.0							
82.0							
84.0							
86.0							
88.0					91.0	55	2.7
90.0							
92.0							
94.0							
96.0			Soil moist at 100 feet				
98.0							
100.0	Very fine grained sand, silt, 100 - 122 feet		Hole was drilled with water below 100 feet due to borehole collapse	Sand, 67-122 feet			
102.0							
104.0							
106.0							
108.0							
110.0							
112.0							
114.0							
116.0							
118.0							
120.0							
122.0							

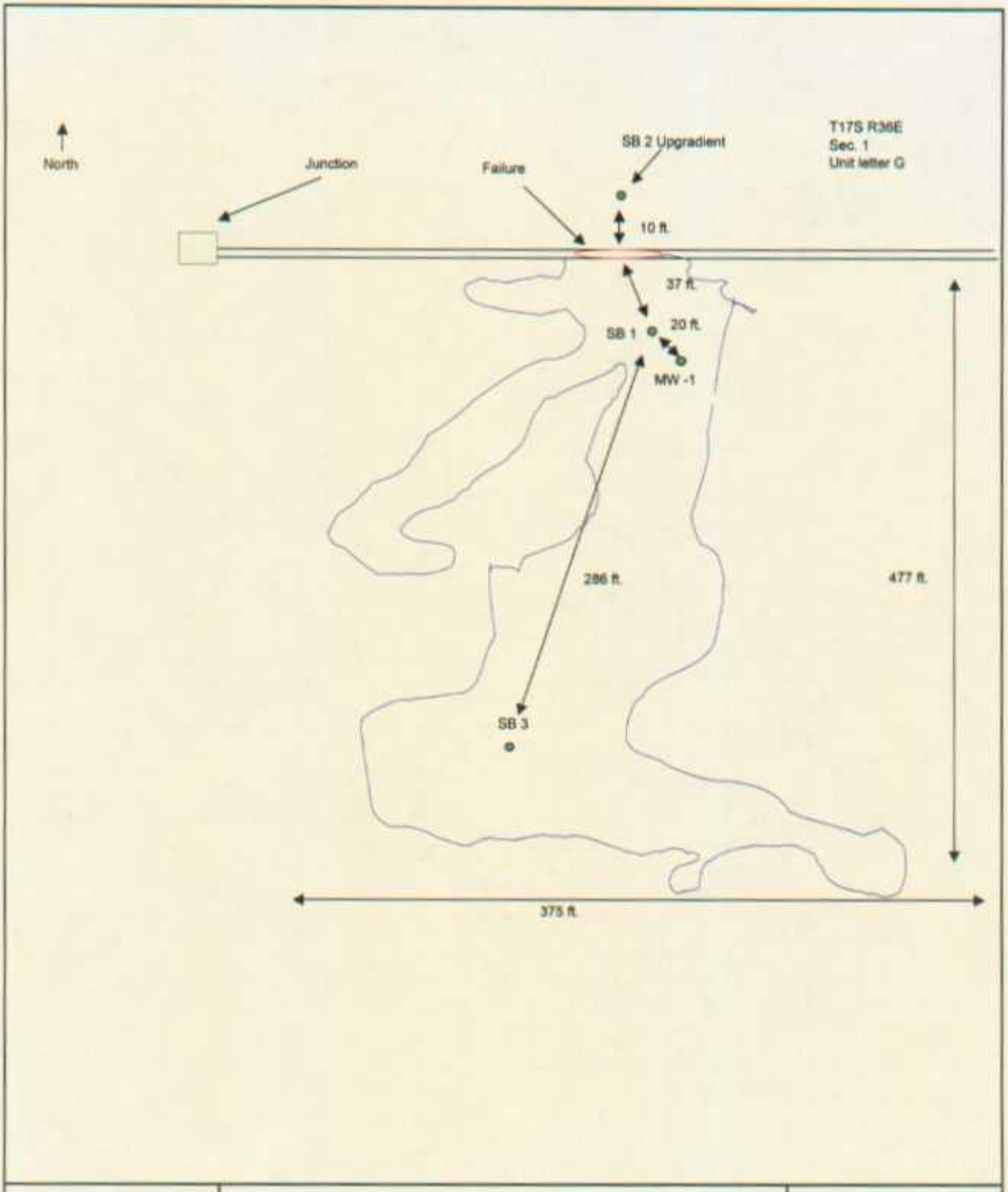
R.T. Hicks Consultants, Ltd
901 Rio Grande Blvd NW Suite F-142
Albuquerque, NM 87104
505-266-5004

ROC Lovington Abo Site

Monitoring Well Boring

Plate 1

Dec. 2004



R.T. Hicks Consultants 901 Rio Grande NW Albuquerque, NM	**Rice Operating Company**	**Plate 2**
	Abo Release Site Sketch Map	**Dec-03**

BASIN ENVIRONMENTAL

FIELD MEASUREMENT/OBSERVATION LOG

PROJECT NAME:	PROJECT NUMBER:	LEAK NUMBER:
Rice Operating Company	ABO Apacke LA Leak	

PROJECT MANAGER:	FIELD TECHNICIAN:	Notes:
Kristin Farris Pope - Rice Operating Company	Rozanne Johnson - Basin Environmental	Water was disposed of at Cooper's Water Station

WELL # /SAMPLE LOCATION	TOTAL WELL DEPTH (feet)	DEPTH TO PRODUCT (feet)	DEPTH TO WATER (feet)	HEIGHT WATER COLUMN (feet)	PSH THICKNESS (feet)	WELL FACTOR 2"=.16 4"=.65 6"=1.5	CALC. WELL VOLUME (gal)	# OF WELL VOLUMES PURGED	TOTAL PURGED (gal)	Temp (°C)	pH	Cond. (µs)	TIME/DATE SAMPLE TAKEN	SAMPLE CHARACTERISTICS (odor, color, sheen)
MW-1	122.6		92.1	30.5		0.16	4.9	3	14.6	16.8	7.78	714	11/24/04 @ 12:30	No Odor / Clear Color

Chain-Of-Custody

I certify that the samples listed above were transferred from _____ to _____

at (location) _____ on (date) _____ at (time) _____

Signatures: _____ (Sampler) _____ (Client or Lab)

ENVIRONMENTAL LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Kristin Pope

Rice Operating Co.

122 W. Taylor

Hobbs, NM 88240

Project: ABO-Apache LA Leak

Project Number: None Given

Location: Lovington

Lab Order Number: 4L06004

Report Date: 12/16/04

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-1	4L06004-01	Water	12/03/04 08:30	12/06/04 10:35

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (4L06004-01) Water									
Benzene	ND	0.00100	mg/L	1	EL40913	12/08/04	12/08/04	EPA 8021B	
Toluene	ND	0.00100	"	"	"	"	"	"	
Ethylbenzene	ND	0.00100	"	"	"	"	"	"	
Xylene (p/m)	ND	0.00100	"	"	"	"	"	"	
Xylene (o)	ND	0.00100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*101 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*96.0 %*	*80-120*		"	"	"	"	

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (4L06004-01) Water									
Total Alkalinity	**142**	2.00	mg/L	1	EL41406	12/10/04	12/10/04	EPA 310.2M	
Chloride	**80.5**	5.00	"	10	EL40916	12/08/04	12/08/04	EPA 300.0	
Total Dissolved Solids	**329**	5.00	"	1	EL40702	12/06/04	12/07/04	EPA 160.1	
Sulfate	**85.7**	5.00	"	10	EL40916	12/08/04	12/08/04	EPA 300.0	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

Total Metals by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (4L06004-01) Water									
Calcium	**60.0**	0.100	mg/L	10	EL41408	12/14/04	12/14/04	EPA 6010B	
Magnesium	**12.9**	0.0100	"	"	"	"	"	"	
Potassium	**2.67**	0.500	"	"	"	"	"	"	
Sodium	**42.4**	0.100	"	"	"	"	"	"	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40913 - EPA 5030C (GC)										
Blank (EL40913-BLK1)				Prepared & Analyzed: 12/08/04						
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	*19.8*		*ug/l*	*20.0*		*99.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*17.4*		*"*	*20.0*		*87.0*	*80-120*			
LCS (EL40913-BS1)				Prepared & Analyzed: 12/08/04						
Benzene	94.3		ug/l	100		94.3	80-120			
Toluene	97.6		"	100		97.6	80-120			
Ethylbenzene	96.2		"	100		96.2	80-120			
Xylene (p/m)	194		"	200		97.0	80-120			
Xylene (o)	99.5		"	100		99.5	80-120			
Surrogate: a,a,a-Trifluorotoluene	*17.8*		*"*	*20.0*		*89.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*22.1*		*"*	*20.0*		*110*	*80-120*			
LCS Dup (EL40913-BSD1)				Prepared & Analyzed: 12/08/04						
Benzene	97.4		ug/l	100		97.4	80-120	3.23	20	
Toluene	100		"	100		100	80-120	2.43	20	
Ethylbenzene	102		"	100		102	80-120	5.85	20	
Xylene (p/m)	202		"	200		101	80-120	4.04	20	
Xylene (o)	103		"	100		103	80-120	3.46	20	
Surrogate: a,a,a-Trifluorotoluene	*18.7*		*"*	*20.0*		*93.5*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*22.2*		*"*	*20.0*		*111*	*80-120*			
Calibration Check (EL40913-CCV1)				Prepared & Analyzed: 12/08/04						
Benzene	97.0		ug/l	100		97.0	80-120			
Toluene	99.1		"	100		99.1	80-120			
Ethylbenzene	101		"	100		101	80-120			
Xylene (p/m)	199		"	200		99.5	80-120			
Xylene (o)	101		"	100		101	80-120			
Surrogate: a,a,a-Trifluorotoluene	*19.4*		*"*	*20.0*		*97.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*21.5*		*"*	*20.0*		*108*	*80-120*			

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40913 - EPA 5030C (GC)										
Matrix Spike (EL40913-MS1)	**Source: 4L06002-01**		Prepared & Analyzed: 12/08/04							
Benzene	102		ug/l	100	ND	102	80-120			
Toluene	102		"	100	ND	102	80-120			
Ethylbenzene	101		"	100	ND	101	80-120			
Xylene (p/m)	203		"	200	ND	102	80-120			
Xylene (o)	111		"	100	ND	111	80-120			
Surrogate: a,a,a-Trifluorotoluene	*18.4*		"	*20.0*		*92.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*19.5*		"	*20.0*		*97.5*	*80-120*			

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40702 - General Preparation (WetChem)										
Blank (EL40702-BLK1)				Prepared: 12/06/04 Analyzed: 12/07/04						
Total Dissolved Solids	ND	5.00	mg/L							
Duplicate (EL40702-DUP1)	**Source: 4L03001-01**			Prepared: 12/06/04 Analyzed: 12/07/04						
Total Dissolved Solids	4120	5.00	mg/L		4030			2.21	20	
Batch EL40916 - General Preparation (WetChem)										
Blank (EL40916-BLK1)				Prepared & Analyzed: 12/08/04						
Chloride	0.00	0.500	mg/L							
Sulfate	0.00	0.500	"							
Blank (EL40916-BLK2)				Prepared & Analyzed: 12/08/04						
Sulfate	0.00	0.500	mg/L							
Chloride	0.00	0.500	"							
LCS (EL40916-BS1)				Prepared & Analyzed: 12/08/04						
Chloride	9.75	0.500	mg/L	10.0		97.5	80-120			
Sulfate	11.7	0.500	"	10.0		117	80-120			
LCS (EL40916-BS2)				Prepared & Analyzed: 12/08/04						
Chloride	9.77	0.500	mg/L	10.0		97.7	80-120			
Sulfate	11.8	0.500	"	10.0		118	80-120			
LCS Dup (EL40916-BSD1)				Prepared & Analyzed: 12/08/04						
Sulfate	11.8	0.500	mg/L	10.0		118	80-120	0.851	20	
Chloride	9.83	0.500	"	10.0		98.3	80-120	0.817	20	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40916 - General Preparation (WetChem)										
LCS Dup (EL40916-BSD2)				Prepared & Analyzed: 12/08/04						
Chloride	9.74	0.500	mg/L	10.0		97.4	80-120	0.308	20	
Sulfate	11.7	0.500	"	10.0		117	80-120	0.851	20	
Calibration Check (EL40916-CCV1)				Prepared & Analyzed: 12/08/04						
Chloride	9.79		mg/L	10.0		97.9	80-120			
Sulfate	11.7		"	10.0		117	80-120			
Calibration Check (EL40916-CCV2)				Prepared & Analyzed: 12/08/04						
Chloride	9.80		mg/L	10.0		98.0	80-120			
Sulfate	11.7		"	10.0		117	80-120			
Duplicate (EL40916-DUP1)		**Source: 4L03001-01**		Prepared & Analyzed: 12/08/04						
Chloride	1570	20.0	mg/L		1330			16.6	20	
Sulfate	809	20.0	"		682			17.0	20	
Duplicate (EL40916-DUP2)		**Source: 4L06003-02**		Prepared & Analyzed: 12/08/04						
Chloride	731	20.0	mg/L		725			0.824	20	
Sulfate	1210	20.0	"		1200			0.830	20	
Batch EL41406 - General Preparation (WetChem)										
Blank (EL41406-BLK1)				Prepared & Analyzed: 12/10/04						
Total Alkalinity	ND	2.00	mg/L							
Duplicate (EL41406-DUP1)		**Source: 4L06003-01**		Prepared & Analyzed: 12/10/04						
Total Alkalinity	161	2.00	mg/L		160			0.623	20	

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL41406 - General Preparation (WetChem)										
Reference (EL41406-SRM1)				Prepared & Analyzed: 12/10/04						
Carbonate Alkalinity	0.0501		mg/L	0.0500		100	80-120			

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL41408 - 6010B/No Digestion										
Blank (EL41408-BLK1)				Prepared & Analyzed: 12/14/04						
Calcium	ND	0.0100	mg/L							
Magnesium	ND	0.00100	"							
Potassium	ND	0.0500	"							
Sodium	ND	0.0100	"							
Calibration Check (EL41408-CCV1)				Prepared & Analyzed: 12/14/04						
Calcium	1.95		mg/L	2.00		97.5	85-115			
Magnesium	2.06		"	2.00		103	85-115			
Potassium	2.18		"	2.00		109	85-115			
Sodium	1.77		"	2.00		88.5	85-115			
Duplicate (EL41408-DUP1)	**Source: 4L03004-01**			Prepared & Analyzed: 12/14/04						
Calcium	120	1.00	mg/L		127			5.67	20	
Magnesium	73.9	0.100	"		75.1			1.61	20	
Potassium	5.29	0.500	"		5.37			1.50	20	
Sodium	102	1.00	"		97.9			4.10	20	

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

Notes and Definitions

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: Celey D. Keene Date: 12/16/2004

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.

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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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 Pope
Company Name: Rice Operating
Company Address: 122 W. Taylor St.
City/State/Zip: Hobbs, NM 88240
Telephone No: (505) 393-9174 Fax No: (505) 397-1471
Sampler Signature:

Project Name: ABO-APACHE LA Leak
Project #:
Project Loc: Lovington
PO #:

LAB # (lab use only)	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Preservative: Ice	Preservative: HNO_3	Preservative: HCl	Preservative: NaOH	Preservative: H_2SO_4	Preservative: None	Preservative: Other (specify)	Matrix: Water	Matrix: Sludge	Matrix: Soil	Matrix: Other (specify)	Analyze For: TCLP: TPH: 418.1 8015M 1005 1006	Analyze For: TOTAL: 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 8021B/5030 or BTEX 8260	RCI	N.O.R.M.	TDS			RUSH TAT (Pre-Schedule)	Standard TAT
4L06004 -01	MW-1	12-3-04	8:30	3	X		X					X					X	X					X			X				X

Special Instructions:
Please email analysis to Kristin enviro@leaco.net

Sample Containers Intact? Y N
Temperature Upon Receipt:
Laboratory Comments:
Ice -3°C

Relinquished by:	Date	Time	Received by:	Date	Time
	12-6-04	9:35			
Relinquished by:	Date	Time	Received by ELOT:	Date	Time
				12-06-04	10:35

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

Client: Rice Operation

Date/Time: 12/6/04 11:58

Order #: 4L06004

Initials: JLH

Sample Receipt Checklist

Temperature of container/cooler?	(Yes)	No	-3 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)	No label on 1 L Poly
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)	No	Not Applicable

Other observations:

_____

_____

_____

Variance Documentation:

Contact Person: - _____ Date/Time: _____ Contacted by: _____

Regarding:

_____

_____

_____

Corrective Action Taken:

_____

_____

_____

_____

_____

_____

_____

_____

ENVIRONMENTAL LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Roy Rascon

Rice Operating Co.

122 W. Taylor

Hobbs, NM 88240

Project: Apache LA Leak MW 1

Project Number: None Given

Location: Abo

Lab Order Number: 4K10011

Report Date: 11/16/04

Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
SB @ 91'	4K10011-01	Soil	11/05/04 11:35	11/10/04 07:50

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Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SB @ 91' (4K10011-01) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EK41501	11/12/04	11/12/04	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*86.5 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*106 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EK41006	11/10/04	11/11/04	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*97.8 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*110 %*	*70-130*		"	"	"	"	

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Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SB @ 91' (4K10011-01) Soil									
Chloride	ND	20.0	mg/kg Wet	2	EK41210	11/10/04	11/11/04	SW 846 9253	
% Moisture	**3.0**		%	1	EK41101	11/10/04	11/11/04	% calculation	

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R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

December 20, 2004

Mr. Wayne Price
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Abo 1G Leak Site:
Section 1, 17S 36E Unit G
NMOCD Case #1R0414

Dear Wayne:

Included with this letter is the well log for our drilling event of November 5th and 6th, 2004. The well log features lithology, drilling notes, well construction, and field chloride and PID data. We have also included laboratory results from soil samples collected during the drilling and a site map with the position of this monitoring well, LA MW-1. In addition, the attached laboratory results of the first ground water sample from this well show no impact to ground water.

Sincerely,
R.T. Hicks Consultants, Ltd.

David Hamilton

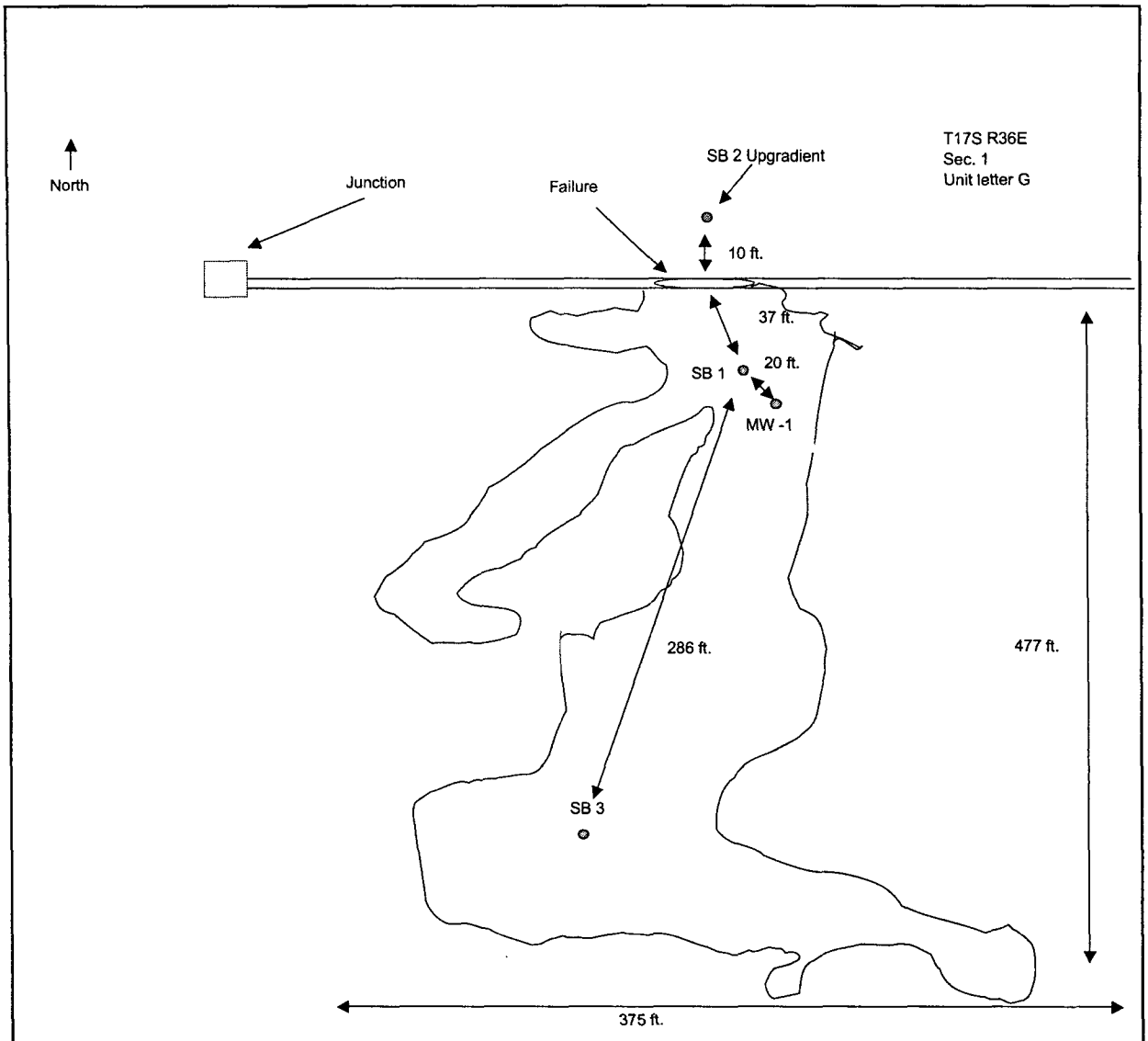
David Hamilton
Project Hydrologist

Copy: Kristin Farris Pope

Logger:	David Hamilton	**Client:**	**Well ID:**
Driller:	Eades Drilling	ROC	LA MW-1
Drilling Method:	Air Rotary	**Project Name:**	
Start Date:	11/5/2004	Lovington Abo Release Site	
End Date:	11/6/2004	**Location:**	
		Section 1, 17S, 36E, Unit 1G	

Depth (feet)	Description	Lithology	Comments	Well Construction	Field data: Depth	Field data: Chloride mg/kg	Field data: PID
0.0	Surface, 0 - .5 feet		Hard drilling	Cement, 0-3 feet			
2.0	Frac. caliche, sand, clay, .5 - 3 feet, tan						
4.0	Sand and caliche, 3 - 5 feet, tan						
6.0	Very fine grained sand, silt, some caliche, 5 - 10 feet, tan				6.0	1245	6.3
8.0							
10.0	Very fine grained sand, silt, little caliche, 10 - 15 feet, tan				11.0	553	7.3
12.0							
14.0	Indurated caliche, 15 - 17 feet						
16.0	Very fine grained sand, silt, little caliche, 17 - 20 feet				16.0	1307	5.2
18.0							
20.0	Thin caliche layers in sand, 20 - 22 feet				21.0	905	8.2
22.0	Very fine grained sand, silt, 22 - 33 feet, tan with reddish tinge						
24.0							
26.0			Samples fell out of spoon, collected with shovel		26.0	741	1.1
28.0							
30.0					31.0	493	0.8
32.0							
34.0	Very fine grained sand, silt, caliche , 33 -44 feet, light tan. Well indurated caliche layer from 35 to 36 feet.						
36.0					36.0	596	0.8
38.0							
40.0					41.0	128	3.3
42.0							
44.0	Very fine grained sand, silt, 44 - 53 feet, tan			Hydrated bentonite, 3-87 feet			
46.0					46.0	83	2.0
48.0							
50.0					51.0	49	1.0
52.0	Very fine grained sand, silt, some caliche, 53 - 60 feet, tan						
54.0							
56.0							
58.0							
60.0	Very fine grained sand, silt, 60 - 67 feet, tan				61.0	59	2.4
62.0							
64.0							
66.0	Indurated sand, silt, 67 - 68 feet		Hard drilling				
68.0	Very fine grained sand, silt, 68 - 100 feet tan. Slightly redder below 83 feet.						
70.0					71.0	50	2.9
72.0							
74.0							
76.0							
78.0							
80.0					81.0	59	3.7
82.0							
84.0							
86.0							
88.0							
90.0					91.0	55	2.7
92.0							
94.0							
96.0			Soil moist at 100 feet				
98.0							
100.0	Very fine grained sand, silt, 100 - 122 feet			Sand, 87-122 feet			
102.0							
104.0							
106.0							
108.0			Hole was drilled with water below 100 feet due to borehole collapse				
110.0							
112.0							
114.0							
116.0							
118.0							
120.0							
122.0							

R.T. Hicks Consultants, Ltd 901 Rio Grande Blvd NW Suite F-142 Albuquerque, NM 87104 505-266-5004	**ROC Lovington Abo Site** **Monitoring Well Boring**	**Plate 1** **Dec. 2004**



R.T. Hicks Consultants 901 Rio Grande NW Albuquerque, NM	**Rice Operating Company**	**Plate 2**
	Abo Release Site Sketch Map	**Dec-03**

BASIN ENVIRONMENTAL

FIELD MEASUREMENT/OBSERVATION LOG

PROJECT NAME:	PROJECT NUMBER:	LEAK NUMBER:
Rice Operating Company	ABO Apacke LA Leak	

PROJECT MANAGER:	FIELD TECHNICIAN:	Notes:
Kristin Farris Pope - Rice Operating Company	Rozanne Johnson - Basin Environmental	Water was disposed of at Cooper's Water Station

WELL # /SAMPLE LOCATION	TOTAL WELL DEPTH (feet)	DEPTH TO PRODUCT (feet)	DEPTH TO WATER (feet)	HEIGHT WATER COLUMN (feet)	PSH THICKNESS (feet)	WELL FACTOR 2"=.16 4"=.65 6"=1.5	CALC. WELL VOLUME (gal)	# OF WELL VOLUMES PURGED	TOTAL PURGED (gal)	Temp (°C)	pH	Cond. (µs)	TIME/DATE SAMPLE TAKEN	SAMPLE CHARACTERISTICS (odor, color, sheen)
MW-1	122.6		92.1	30.5		0.16	4.9	3	14.6	16.8	7.78	714	11/24/04 @ 12:30	No Odor / Clear Color

Chain-Of-Custody

I certify that the samples listed above were transferred from _____ to _____

at (location) _____ on (date) _____ at (time) _____

Signatures: _____ (Sampler) _____ (Client or Lab)

ENVIRONMENTAL LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Kristin Pope

Rice Operating Co.

122 W. Taylor

Hobbs, NM 88240

Project: ABO-Apache LA Leak

Project Number: None Given

Location: Lovington

Lab Order Number: 4L06004

Report Date: 12/16/04

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-1	4L06004-01	Water	12/03/04 08:30	12/06/04 10:35

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (4L06004-01) Water									
Benzene	ND	0.00100	mg/L	1	EL40913	12/08/04	12/08/04	EPA 8021B	
Toluene	ND	0.00100	"	"	"	"	"	"	
Ethylbenzene	ND	0.00100	"	"	"	"	"	"	
Xylene (p/m)	ND	0.00100	"	"	"	"	"	"	
Xylene (o)	ND	0.00100	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*101 %*		*80-120*		"	"	"	
Surrogate: 4-Bromofluorobenzene		*96.0 %*		*80-120*		"	"	"	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (4L06004-01) Water									
Total Alkalinity	**142**	2.00	mg/L	1	EL41406	12/10/04	12/10/04	EPA 310.2M	
Chloride	**80.5**	5.00	"	10	EL40916	12/08/04	12/08/04	EPA 300.0	
Total Dissolved Solids	**329**	5.00	"	1	EL40702	12/06/04	12/07/04	EPA 160.1	
Sulfate	**85.7**	5.00	"	10	EL40916	12/08/04	12/08/04	EPA 300.0	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

Total Metals by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
MW-1 (4L06004-01) Water									
Calcium	**60.0**	0.100	mg/L	10	EL41408	12/14/04	12/14/04	EPA 6010B	
Magnesium	**12.9**	0.0100	"	"	"	"	"	"	
Potassium	**2.67**	0.500	"	"	"	"	"	"	
Sodium	**42.4**	0.100	"	"	"	"	"	"	

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40913 - EPA 5030C (GC)										
Blank (EL40913-BLK1)				Prepared & Analyzed: 12/08/04						
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	*19.8*		*ug/l*	*20.0*		*99.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*17.4*		*"*	*20.0*		*87.0*	*80-120*			
LCS (EL40913-BS1)				Prepared & Analyzed: 12/08/04						
Benzene	94.3		ug/l	100		94.3	80-120			
Toluene	97.6		"	100		97.6	80-120			
Ethylbenzene	96.2		"	100		96.2	80-120			
Xylene (p/m)	194		"	200		97.0	80-120			
Xylene (o)	99.5		"	100		99.5	80-120			
Surrogate: a,a,a-Trifluorotoluene	*17.8*		*"*	*20.0*		*89.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*22.1*		*"*	*20.0*		*110*	*80-120*			
LCS Dup (EL40913-BSD1)				Prepared & Analyzed: 12/08/04						
Benzene	97.4		ug/l	100		97.4	80-120	3.23	20	
Toluene	100		"	100		100	80-120	2.43	20	
Ethylbenzene	102		"	100		102	80-120	5.85	20	
Xylene (p/m)	202		"	200		101	80-120	4.04	20	
Xylene (o)	103		"	100		103	80-120	3.46	20	
Surrogate: a,a,a-Trifluorotoluene	*18.7*		*"*	*20.0*		*93.5*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*22.2*		*"*	*20.0*		*111*	*80-120*			
Calibration Check (EL40913-CCV1)				Prepared & Analyzed: 12/08/04						
Benzene	97.0		ug/l	100		97.0	80-120			
Toluene	99.1		"	100		99.1	80-120			
Ethylbenzene	101		"	100		101	80-120			
Xylene (p/m)	199		"	200		99.5	80-120			
Xylene (o)	101		"	100		101	80-120			
Surrogate: a,a,a-Trifluorotoluene	*19.4*		*"*	*20.0*		*97.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*21.5*		*"*	*20.0*		*108*	*80-120*			

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40913 - EPA 5030C (GC)										
Matrix Spike (EL40913-MS1)	**Source: 4L06002-01**			Prepared & Analyzed: 12/08/04						
Benzene	102		ug/l	100	ND	102	80-120			
Toluene	102		"	100	ND	102	80-120			
Ethylbenzene	101		"	100	ND	101	80-120			
Xylene (p/m)	203		"	200	ND	102	80-120			
Xylene (o)	111		"	100	ND	111	80-120			
Surrogate: a,a,a-Trifluorotoluene	*18.4*		"	*20.0*		*92.0*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*19.5*		"	*20.0*		*97.5*	*80-120*			

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40702 - General Preparation (WetChem)										
Blank (EL40702-BLK1)				Prepared: 12/06/04 Analyzed: 12/07/04						
Total Dissolved Solids	ND	5.00	mg/L							
Duplicate (EL40702-DUP1)	**Source: 4L03001-01**			Prepared: 12/06/04 Analyzed: 12/07/04						
Total Dissolved Solids	4120	5.00	mg/L		4030			2.21	20	
Batch EL40916 - General Preparation (WetChem)										
Blank (EL40916-BLK1)				Prepared & Analyzed: 12/08/04						
Chloride	0.00	0.500	mg/L							
Sulfate	0.00	0.500	"							
Blank (EL40916-BLK2)				Prepared & Analyzed: 12/08/04						
Sulfate	0.00	0.500	mg/L							
Chloride	0.00	0.500	"							
LCS (EL40916-BS1)				Prepared & Analyzed: 12/08/04						
Chloride	9.75	0.500	mg/L	10.0		97.5	80-120			
Sulfate	11.7	0.500	"	10.0		117	80-120			
LCS (EL40916-BS2)				Prepared & Analyzed: 12/08/04						
Chloride	9.77	0.500	mg/L	10.0		97.7	80-120			
Sulfate	11.8	0.500	"	10.0		118	80-120			
LCS Dup (EL40916-BSD1)				Prepared & Analyzed: 12/08/04						
Sulfate	11.8	0.500	mg/L	10.0		118	80-120	0.851	20	
Chloride	9.83	0.500	"	10.0		98.3	80-120	0.817	20	

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL40916 - General Preparation (WetChem)										
LCS Dup (EL40916-BSD2)				Prepared & Analyzed: 12/08/04						
Chloride	9.74	0.500	mg/L	10.0		97.4	80-120	0.308	20	
Sulfate	11.7	0.500	"	10.0		117	80-120	0.851	20	
Calibration Check (EL40916-CCV1)				Prepared & Analyzed: 12/08/04						
Chloride	9.79		mg/L	10.0		97.9	80-120			
Sulfate	11.7		"	10.0		117	80-120			
Calibration Check (EL40916-CCV2)				Prepared & Analyzed: 12/08/04						
Chloride	9.80		mg/L	10.0		98.0	80-120			
Sulfate	11.7		"	10.0		117	80-120			
Duplicate (EL40916-DUP1)	**Source: 4L03001-01**			Prepared & Analyzed: 12/08/04						
Chloride	1570	20.0	mg/L		1330			16.6	20	
Sulfate	809	20.0	"		682			17.0	20	
Duplicate (EL40916-DUP2)	**Source: 4L06003-02**			Prepared & Analyzed: 12/08/04						
Chloride	731	20.0	mg/L		725			0.824	20	
Sulfate	1210	20.0	"		1200			0.830	20	
Batch EL41406 - General Preparation (WetChem)										
Blank (EL41406-BLK1)				Prepared & Analyzed: 12/10/04						
Total Alkalinity	ND	2.00	mg/L							
Duplicate (EL41406-DUP1)	**Source: 4L06003-01**			Prepared & Analyzed: 12/10/04						
Total Alkalinity	161	2.00	mg/L		160			0.623	20	

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Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL41406 - General Preparation (WetChem)										
Reference (EL41406-SRM1)				Prepared & Analyzed: 12/10/04						
Carbonate Alkalinity	0.0501		mg/L	0.0500		100	80-120			

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

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 EL41408 - 6010B/No Digestion										
Blank (EL41408-BLK1)				Prepared & Analyzed: 12/14/04						
Calcium	ND	0.0100	mg/L							
Magnesium	ND	0.00100	"							
Potassium	ND	0.0500	"							
Sodium	ND	0.0100	"							
Calibration Check (EL41408-CCV1)				Prepared & Analyzed: 12/14/04						
Calcium	1.95		mg/L	2.00		97.5	85-115			
Magnesium	2.06		"	2.00		103	85-115			
Potassium	2.18		"	2.00		109	85-115			
Sodium	1.77		"	2.00		88.5	85-115			
Duplicate (EL41408-DUP1)	**Source: 4L03004-01**			Prepared & Analyzed: 12/14/04						
Calcium	120	1.00	mg/L		127			5.67	20	
Magnesium	73.9	0.100	"		75.1			1.61	20	
Potassium	5.29	0.500	"		5.37			1.50	20	
Sodium	102	1.00	"		97.9			4.10	20	

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

Notes and Definitions

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: Celey D Keene Date: 12/16/2004

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.

Rice Operating Co.	Project: ABO-Apache LA Leak	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Kristin Pope	12/16/04 09:21

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

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 Pope
Company Name: Rice Operating
Company Address: 122 W. Taylor St.
City/State/Zip: Hobbs, NM 88240
Telephone No: (505) 393-9174 Fax No: (505) 397-1471
Sampler Signature:

Project Name: ABO-APACHE LA Leak
Project #:
Project Loc: Lovington
PO #:

LAB # (lab use only)	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Preservative: Ice	Preservative: HNO_3	Preservative: HCl	Preservative: NaOH	Preservative: H_2SO_4	Preservative: None	Preservative: Other (Specify)	Matrix: Water	Matrix: Sludge	Matrix: Soil	Matrix: Other (specify)	Analyze For: TCLP: TPH: 418.1 8015M 1005 1006	Analyze For: TOTAL: 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 8021B/5030 or BTEX 8260	PCI	N.O.R.M.	TDS			RUSH TAT (Pre-Schedule)	Standard TAT
406004																														
-01	MW-1	12-3-04	8:30	3	X		X					X					X	X					X			X				X

Special Instructions:
Please email analysis to Kristin enviro@leaco.net

Sample Containers Intact? Y N
Temperature Upon Receipt:
Laboratory Comments:
Ice -3°C

Relinquished by:	Date	Time	Received by:	Date	Time
	12-6-04	9:35			
Relinquished by	Date	Time	Received by ELOT:	Date	Time
				12-06-04	1035

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

Client: Rice Operation

Date/Time: 12/6/04 11:58

Order #: 4L06004

Initials: JLH

Sample Receipt Checklist

Temperature of container/cooler?	(Yes)	No	-3 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)	No label on 1L Poly
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)	No	Not Applicable

Other observations:

_____

_____

_____

Variance Documentation:

Contact Person: - _____ Date/Time: _____ Contacted by: _____

Regarding:

_____

_____

_____

Corrective Action Taken:

_____

_____

_____

_____

_____

_____

_____

_____

ENVIRONMENTAL LAB OF

12600 West I-20 East - Odessa, Texas 79765

Analytical Report

Prepared for:

Roy Rascon

Rice Operating Co.

122 W. Taylor

Hobbs, NM 88240

Project: Apache LA Leak MW 1

Project Number: None Given

Location: Abo

Lab Order Number: 4K10011

Report Date: 11/16/04

Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
SB @ 91'	4K10011-01	Soil	11/05/04 11:35	11/10/04 07:50

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

Organics by GC

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SB @ 91' (4K10011-01) Soil									
Benzene	ND	0.0250	mg/kg dry	25	EK41501	11/12/04	11/12/04	EPA 8021B	
Toluene	ND	0.0250	"	"	"	"	"	"	
Ethylbenzene	ND	0.0250	"	"	"	"	"	"	
Xylene (p/m)	ND	0.0250	"	"	"	"	"	"	
Xylene (o)	ND	0.0250	"	"	"	"	"	"	
Surrogate: a,a,a-Trifluorotoluene		*86.5 %*	*80-120*		"	"	"	"	
Surrogate: 4-Bromofluorobenzene		*106 %*	*80-120*		"	"	"	"	
Gasoline Range Organics C6-C12	ND	10.0	mg/kg dry	1	EK41006	11/10/04	11/11/04	EPA 8015M	
Diesel Range Organics >C12-C35	ND	10.0	"	"	"	"	"	"	
Total Hydrocarbon C6-C35	ND	10.0	"	"	"	"	"	"	
Surrogate: 1-Chlorooctane		*97.8 %*	*70-130*		"	"	"	"	
Surrogate: 1-Chlorooctadecane		*110 %*	*70-130*		"	"	"	"	

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

General Chemistry Parameters by EPA / Standard Methods

Environmental Lab of Texas

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
SB @ 91' (4K10011-01) Soil									
Chloride	ND	20.0	mg/kg Wet	2	EK41210	11/10/04	11/11/04	SW 846 9253	
% Moisture	**3.0**		%	1	EK41101	11/10/04	11/11/04	% calculation	

12600 West I-20 East - Odessa, Texas 79705 - (432) 563-1800 - Fax (432) 563-1713

Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

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 EK41006 - Solvent Extraction (GC)										
Blank (EK41006-BLK1)				Prepared: 11/10/04 Analyzed: 11/11/04						
Gasoline Range Organics C6-C12	ND	10.0	mg/kg wet							
Diesel Range Organics >C12-C35	ND	10.0	"							
Total Hydrocarbon C6-C35	ND	10.0	"							
Surrogate: 1-Chlorooctane	*38.3*		*mg/kg*	*50.0*		*76.6*	*70-130*			
Surrogate: 1-Chlorooctadecane	*44.6*		*"*	*50.0*		*89.2*	*70-130*			
LCS (EK41006-BS1)				Prepared: 11/10/04 Analyzed: 11/11/04						
Gasoline Range Organics C6-C12	422	10.0	mg/kg wet	500		84.4	75-125			
Diesel Range Organics >C12-C35	471	10.0	"	500		94.2	75-125			
Total Hydrocarbon C6-C35	893	10.0	"	1000		89.3	75-125			
Surrogate: 1-Chlorooctane	*46.3*		*mg/kg*	*50.0*		*92.6*	*70-130*			
Surrogate: 1-Chlorooctadecane	*45.6*		*"*	*50.0*		*91.2*	*70-130*			
Calibration Check (EK41006-CCV1)				Prepared: 11/10/04 Analyzed: 11/11/04						
Gasoline Range Organics C6-C12	503		mg/kg	500		101	80-120			
Diesel Range Organics >C12-C35	564		"	500		113	80-120			
Total Hydrocarbon C6-C35	1070		"	1000		107	80-120			
Surrogate: 1-Chlorooctane	*51.2*		*"*	*50.0*		*102*	*70-130*			
Surrogate: 1-Chlorooctadecane	*54.2*		*"*	*50.0*		*108*	*70-130*			
Matrix Spike (EK41006-MS1)	**Source: 4K10009-02**			Prepared: 11/10/04 Analyzed: 11/11/04						
Gasoline Range Organics C6-C12	522	10.0	mg/kg dry	521	ND	100	75-125			
Diesel Range Organics >C12-C35	586	10.0	"	521	ND	112	75-125			
Total Hydrocarbon C6-C35	1110	10.0	"	1040	ND	107	75-125			
Surrogate: 1-Chlorooctane	*55.6*		*mg/kg*	*50.0*		*111*	*70-130*			
Surrogate: 1-Chlorooctadecane	*51.8*		*"*	*50.0*		*104*	*70-130*			
Matrix Spike Dup (EK41006-MSD1)	**Source: 4K10009-02**			Prepared: 11/10/04 Analyzed: 11/11/04						
Gasoline Range Organics C6-C12	538	10.0	mg/kg dry	521	ND	103	75-125	3.02	20	
Diesel Range Organics >C12-C35	595	10.0	"	521	ND	114	75-125	1.52	20	
Total Hydrocarbon C6-C35	1130	10.0	"	1040	ND	109	75-125	1.79	20	
Surrogate: 1-Chlorooctane	*58.2*		*mg/kg*	*50.0*		*116*	*70-130*			
Surrogate: 1-Chlorooctadecane	*59.9*		*"*	*50.0*		*120*	*70-130*			

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Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

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 EK41501 - EPA 5030C (GC)										
Blank (EK41501-BLK1)				Prepared & Analyzed: 11/12/04						
Benzene	ND	0.0250	mg/kg wet							
Toluene	ND	0.0250	"							
Ethylbenzene	ND	0.0250	"							
Xylene (p/m)	ND	0.0250	"							
Xylene (o)	ND	0.0250	"							
Surrogate: a,a,a-Trifluorotoluene	*91.3*		*ug/kg*	*100*		*91.3*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*96.4*		*"*	*100*		*96.4*	*80-120*			
LCS (EK41501-BS1)				Prepared & Analyzed: 11/12/04						
Benzene	95.0		ug/kg	100		95.0	80-120			
Toluene	96.5		"	100		96.5	80-120			
Ethylbenzene	97.7		"	100		97.7	80-120			
Xylene (p/m)	216		"	200		108	80-120			
Xylene (o)	101		"	100		101	80-120			
Surrogate: a,a,a-Trifluorotoluene	*103*		*"*	*100*		*103*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*109*		*"*	*100*		*109*	*80-120*			
Calibration Check (EK41501-CCV1)				Prepared: 11/12/04 Analyzed: 11/15/04						
Benzene	102		ug/kg	100		102	80-120			
Toluene	103		"	100		103	80-120			
Ethylbenzene	109		"	100		109	80-120			
Xylene (p/m)	237		"	200		118	80-120			
Xylene (o)	116		"	100		116	80-120			
Surrogate: a,a,a-Trifluorotoluene	*112*		*"*	*100*		*112*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*119*		*"*	*100*		*119*	*80-120*			
Matrix Spike (EK41501-MS1)	**Source: 4K12001-07**			Prepared & Analyzed: 11/12/04						
Benzene	2760		ug/kg	2500	83.0	107	80-120			
Toluene	2770		"	2500	235	101	80-120			
Ethylbenzene	2720		"	2500	222	99.9	80-120			
Xylene (p/m)	6780		"	5000	1210	111	80-120			
Xylene (o)	4350		"	2500	1730	105	80-120			
Surrogate: a,a,a-Trifluorotoluene	*101*		*"*	*100*		*101*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*111*		*"*	*100*		*111*	*80-120*			

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Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

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 EK41501 - EPA 5030C (GC)										
Matrix Spike Dup (EK41501-MSD1)	**Source: 4K12001-07**			Prepared & Analyzed: 11/12/04						
Benzene	2890		ug/kg	2500	83.0	112	80-120	4.57	20	
Toluene	2900		"	2500	235	107	80-120	5.77	20	
Ethylbenzene	2850		"	2500	222	105	80-120	4.98	20	
Xylene (p/m)	7040		"	5000	1210	117	80-120	5.26	20	
Xylene (o)	4490		"	2500	1730	110	80-120	4.65	20	
Surrogate: a,a,a-Trifluorotoluene	*94.3*		"	*100*		*94.3*	*80-120*			
Surrogate: 4-Bromofluorobenzene	*108*		"	*100*		*108*	*80-120*			

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Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

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 EK41101 - General Preparation (Prep)										
Blank (EK41101-BLK1)				Prepared: 11/10/04 Analyzed: 11/11/04						
% Moisture	0.0		%							
Duplicate (EK41101-DUP1)		**Source: 4K10004-01**		Prepared: 11/10/04 Analyzed: 11/11/04						
% Moisture	7.0		%		7.0			0.00	20	
Batch EK41210 - Water Extraction										
Blank (EK41210-BLK1)				Prepared: 11/10/04 Analyzed: 11/11/04						
Chloride	ND	20.0	mg/kg Wet							
Matrix Spike (EK41210-MS1)		**Source: 4K10010-01**		Prepared: 11/10/04 Analyzed: 11/11/04						
Chloride	1060	20.0	mg/kg Wet	500	510	110	80-120			
Matrix Spike Dup (EK41210-MSD1)		**Source: 4K10010-01**		Prepared: 11/10/04 Analyzed: 11/11/04						
Chloride	1040	20.0	mg/kg Wet	500	510	106	80-120	1.90	20	
Reference (EK41210-SRM1)				Prepared & Analyzed: 11/11/04						
Chloride	5050	10.0	mg/kg Wet	5000		101	80-120			

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Rice Operating Co.	Project: Apache LA Leak MW 1	Fax: (505) 397-1471
122 W. Taylor	Project Number: None Given	**Reported:**
Hobbs NM, 88240	Project Manager: Roy Rascon	11/16/04 14:13

Notes and Definitions

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: 11/16/2004

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, Inc.

12600 West I-20 East
Odessa, Texas 79763
Phone: 915-563-1800
Fax: 915-563-1713

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

Project Manager: Roy Rascon
Company Name: RICE Operating
Company Address: 122 W. Taylor
City/State/Zip: Hobbs, NM 88240
Telephone No: (505) 393-9174
Fax No: (505) 397-1471
Sampler Signature: Israel Juarez

Project Name: Apache CA Coal MW 1
Project #:
Project Loc: ABD
PO #: 500

4410011

LAB # (lab use only)	FIELD CODE	Date Sampled	Time Sampled	No. of Containers	Preservative: Ice	Preservative: HNO_3	Preservative: HCl	Preservative: NaOH	Preservative: H_2SO_4	Preservative: None	Preservative: Other (Specify)	Matrix: Water	Matrix: Sludge	Matrix: Soil	Matrix: Other (specify)	Analyze For: TCLP: ~~TCLP (40) SVOC~~	TCLP: TPH 418.1	TOTAL: TPH TX 1005/1006	TOTAL: TPH 8015M GRO/DRO	TOTAL: Metals: As Ag Ba Cd Cr Pb Hg Se	TOTAL: Volatiles	TOTAL: Semivolatiles	TOTAL: BTEX 8021B/5030									RUSH TAT (Pre-Scheduled)	Standard TAT
-01	SB @ 9'	11/5/04	11:35	1	X									X		X			X				X											

Special Instructions:

Sample Containers Intact? Y N
Temperature Upon Receipt:
Laboratory Comments:
25°C

Relinquished by:	Date	Time	Received by:	Date	Time
	11/9/04	7:25			
Relinquished by: Drop box	Date 11/10/04	Time 7:50	Received by ELOT:	Date 11/10/04	Time 7:50

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

Client: Rice Operating Co.

Date/Time: 11-10-04 @ 1000

Order #: 4K10011

Initials: JMM

Sample Receipt Checklist

Temperature of container/cooler?	(Yes)	No	2.5 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)	No	Not Applicable

Other observations:

_____

_____

_____

Variance Documentation:

Contact Person: - _____ Date/Time: _____ Contacted by: _____

Regarding:

_____

_____

_____

Corrective Action Taken:

_____

_____

_____

_____

_____

_____

_____

_____

Price, Wayne

From: Price, Wayne
Sent: Monday, December 20, 2004 8:31 AM
To: 'Carolyn Doran Haynes'; Price, Wayne; Kristin Farris Pope (E-mail)
Cc: Randall Hicks (E-mail)
Subject: RE: Lovington ABO leak site 1R0414

The case # for this site is 1R0415. NOT 1R0414

-----Original Message-----
From: Carolyn Doran Haynes [mailto:cdhriceswd@leaco.net]
Sent: Wednesday, December 15, 2004 3:09 PM
To: 'Price, Wayne'
Subject: FW: Lovington ABO leak site 1R0414

Dear Mr. Price;

Please review the case number for this site as it has been referred to as 414 and 415 in various communications.

Thank you,

Carolyn Haynes

-----Original Message-----
From: Carolyn Doran Haynes [mailto:cdhriceswd@leaco.net]
Sent: Tuesday, December 14, 2004 4:37 PM
To: 'Price, Wayne'
Cc: R@rthicksconsult.com; 'Kristin Farris'
Subject: FW: Lovington ABO leak site 1R0414

Dear Mr. Price:

You requested further information by today on this work site (as described below in your email).

The plot plan and boring log will be sent via RT Hicks Consultants before the end of the week (December 17). The monitor well has been developed and was sampled November 24th. The samples were sent to Environmental Labs of Texas and ROC is awaiting results. Results will be submitted as soon as received.

Thank you,

Carolyn Haynes

-----Original Message-----
From: Rice Operating [mailto:riceswd@leaco.net]
Sent: Tuesday, December 07, 2004 1:26 PM
To: Haynes, Carolyn Doran
Subject: Fw: Lovington ABO leak site 1R0414

----- Original Message -----
From: "Price, Wayne" <WPrice@state.nm.us>
To: "Carolyn Doran Haynes (E-mail)" <riceswd@leaco.net>; "Kristin Farris Pope (E-mail)" <enviro@leaco.net>
Cc: "Pat Wise (E-mail)" <pwise@lovington-nm.org>; "Patrick B. McMahon (E-mail)" <hsncpbm@leaco.net>
Sent: Tuesday, December 07, 2004 10:13 AM
Subject: Lovington ABO leak site 1R0414

> Please provide a plot plan showing the location of the new monitor well,
> please send boring log and all analytical results by December 14, 2004.
>
> Sincerely:
>
> Wayne Price
> New Mexico Oil Conservation Division
> 1220 S. Saint Francis Drive
> Santa Fe, NM 87505
> 505-476-3487
> fax: 505-476-3462
> E-mail: WPRICE@state.nm.us
>
>

Price, Wayne

From: Carolyn Doran Haynes [cdhriceswd@leaco.net]
Sent: Tuesday, December 14, 2004 3:37 PM
To: 'Price, Wayne'
Cc: R@rthicksconsult.com; 'Kristin Farris'
Subject: FW: Lovington ABO leak site 1R0414

Dear Mr. Price:

You requested further information by today on this work site (as described below in your email).

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Thank you,

Carolyn Haynes

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From: Rice Operating [mailto:riceswd@leaco.net]
Sent: Tuesday, December 07, 2004 1:26 PM
To: Haynes, Carolyn Doran
Subject: Fw: Lovington ABO leak site 1R0414

----- Original Message -----
From: "Price, Wayne" <WPrice@state.nm.us>
To: "Carolyn Doran Haynes (E-mail)" <riceswd@leaco.net>; "Kristin Farris Pope (E-mail)" <enviro@leaco.net>
Cc: "Pat Wise (E-mail)" <pwise@lovington-nm.org>; "Patrick B. McMahon (E-mail)" <hsncpbm@leaco.net>
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> 1220 S. Saint Francis Drive
> Santa Fe, NM 87505
> 505-476-3487
> fax: 505-476-3462
> E-mail: WPRICE@state.nm.us
>
>
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> message. -- This email has been scanned by the MessageLabs Email Security

> System.

>

Price, Wayne

From: Price, Wayne
Sent: Tuesday, December 07, 2004 10:18 AM
To: Price, Wayne
Subject: RE: Lovington ABO leak site 1R0414

Sorry this project is 1R0415 not 414

-----Original Message-----
From: Price, Wayne
Sent: Tuesday, December 07, 2004 10:14 AM
To: Carolyn Doran Haynes (E-mail); Kristin Farris Pope (E-mail)
Cc: Pat Wise (E-mail); Patrick B. McMahon (E-mail)
Subject: Lovington ABO leak site 1R0414

Please provide a plot plan showing the location of the new monitor well, please send boring log and all analytical results by December 14, 2004.

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From: Price, Wayne
Sent: Tuesday, December 07, 2004 10:14 AM
To: Carolyn Doran Haynes (E-mail); Kristin Farris Pope (E-mail)
Cc: Pat Wise (E-mail); Patrick B. McMahon (E-mail)
Subject: Lovington ABO leak site 1R0414

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Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

1R415

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Thursday, November 04, 2004 1:02 PM
To: 'Pat Wise (E-mail)'
Cc: 'Kristin Farris Pope'; david@rthicksconsult.com; 'Sheeley, Paul'; 'Johnson, Larry'; 'Price, Wayne'; 'Patrick B. McMahon (E-mail)'
Subject: RE: Lovington Abo

Mr. Wise

About 5 minutes ago, I was informed that we should have obtained a permit for tomorrow's monitor well installation activity at the Abo-1G site (see attached map). I immediately called your office and spoke with Charles who told me the purpose of the permit process is to make sure the City remains informed about what is going on near your wells.

May I assume that our notification sent to you on 11/1/04 and copies of previous correspondence with the NMOCD will serve as a permit application for this first time? And I promise that for any future activity of R.T. Hicks Consultants on City property we will fill out the appropriate permits.

Thanks for understanding about this lapse on my part. If you have any questions regarding our work at this site, please contact me.

Randy Hicks
505-266-5004

-----Original Message-----
From: Price, Wayne [mailto:WPrice@state.nm.us]
Sent: Thursday, November 04, 2004 11:42 AM
To: 'Randall Hicks'; Price, Wayne; Pat Wise (E-mail); Patrick B. McMahon (E-mail)
Cc: Kristin Farris Pope; david@rthicksconsult.com; Sheeley, Paul; Johnson, Larry
Subject: RE: Lovington Abo

OCD approves of the installation of the monitor well and sampling of the soil and water. OCD will require that the sample of the soil in the boring be conducted every 5 feet to groundwater.

At this time OCD does not approve of the remediation work. OCD will evaluate the monitor well results and soil boring results before we approve the remediation plan. We will also wait on comments from the City of Lovington.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Thursday, October 28, 2004 9:05 AM
To: 'Price, Wayne'
Cc: Kristin Farris Pope; david@rthicksconsult.com

Subject: Lovington Abo
Wayne

Here is our plan for drilling at the Lovington Abo spill

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Price, Wayne
Sent: Thursday, November 04, 2004 11:42 AM
To: 'Randall Hicks'; Price, Wayne; Pat Wise (E-mail); Patrick B. McMahon (E-mail)
Cc: Kristin Farris Pope; david@rthicksconsult.com; Sheeley, Paul; Johnson, Larry
Subject: RE: Lovington Abo

OCD approves of the installation of the monitor well and sampling of the soil and water. OCD will require that the sample of the soil in the boring be conducted every 5 feet to groundwater.

At this time OCD does not approve of the remediation work. OCD will evaluate the monitor well results and soil boring results before we approve the remediation plan. We will also wait on comments from the City of Lovington.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Thursday, October 28, 2004 9:05 AM
To: 'Price, Wayne'
Cc: Kristin Farris Pope; david@rthicksconsult.com
Subject: Lovington Abo

Wayne

Here is our plan for drilling at the Lovington Abo spill

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Randall Hicks [R@rthicksconsult.com]
Sent: Thursday, October 28, 2004 9:05 AM
To: 'Price, Wayne'
Cc: Kristin Farris Pope; david@rthicksconsult.com
Subject: Lovington Abo

Wayne

Here is our plan for drilling at the Lovington Abo spill

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

October 28, 2004

Mr. Wayne Price
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Abo 1G Leak Site:
Section 1, 17S 36E Unit G
Response to NMOCD email and Notification of Field Activities

Dear Wayne:

Rice Operating Company (ROC) intends to move forward with the construction of a ground water monitoring well as we discussed at our meeting last week. Please accept this letter as our notification of field activities, which we will commence on November 4 or 5. You or individuals in the Hobbs District Office may contact Dave Hamilton on his cell phone (505-977-4671) on Wednesday November 3 to determine the start date for this monitoring well.

Comment: Should this be me instead of Andrew?

We intend to perform the following actions to respond to your recent comments on the Corrective Action Plan.

1. We will construct a 2-inch monitoring well with 5 feet of screen above the observed water table and 15 feet of screen within the water table. Because the water levels in the Ogallala Aquifer are generally declining, we are placing more screen in the saturated zone than typically requested by NMOCD. We will locate this well adjacent to SB-1 (see Plate 1 of our August 31, 2004 letter, attached)
2. During the air-rotary boring of this well, we will collect 2.5-foot split spoon samples at five-foot intervals from 5 feet bgs to 50 feet bgs. From 50 feet bgs to the water table (about 77 feet).
3. We will examine the split spoon samples and cuttings and create a lithologic profile of the vadose zone.
4. ROC staff will evaluate the split spoon samples in the field for chloride concentration using the silver nitrate titration method.
5. We will submit two sample splits to a laboratory for analysis of chloride in soil as quality assurance for the field sampling protocol.
6. At least two weeks after completion of the well, ROC will collect a water sample for analysis of chloride and TDS.
7. After completion of the boring/well, ROC will remove the high-chloride, thin soil zone remaining on the caliche sub-strata. ROC will specifically instruct the contractor to avoid removal of the caliche substrata and soil

that shows evidence of re-vegetation. ROC will then import top soil, grade the site to avoid ponding after precipitation events, and seed the area.

8. We will submit a letter report with the results of the vadose zone sampling, the initial water sampling results, documentation of the soil importation/exportation program, and a short discussion that compares the vadose zone chloride results to the previous results from SB-1.

If we find that this proposed vadose zone sampling shows that the migration of chloride is similar to that predicted by the HYDRUS-1D model presented in our June 7, 2004 report, we will conclude that this previously-submitted simulation and prediction is field-verified. We will then recommend closure of the regulatory file for this spill site. We remind NMOCD that the input parameters employed in our June 7, 2004 report were highly conservative. For example, the model in our report does not consider re-vegetation of the site. Establishing a vegetative cap over the site will greatly reduce infiltration and the resultant chloride flux to ground water will be much less than the input value used in our prediction.

Regardless of our conclusion regarding the accuracy of the previously-submitted HYDRUS-1D simulation, ROC will monitor chloride concentration in ground water at the site on a quarterly basis for two years. If chloride concentrations remain consistent with background values, we will plug and abandon this well. If chloride concentrations in ground water are greater than 250 mg/L during the proposed 2-year monitoring program, ROC will discuss the need for additional action with the NMOCD.

We trust this field program will meet with your approval and that any comments by the City of Lovington will be forthcoming prior to the proposed field activities.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall Hicks
Principal

Copy: Kristin Farris Pope

Price, Wayne

From: Price, Wayne
Sent: Thursday, November 04, 2004 11:45 AM
To: Pat Wise (E-mail); Patrick B. McMahon (E-mail); Eddie Seay (E-mail)
Subject: FW: Lovington Abo

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Thursday, October 28, 2004 9:05 AM
To: 'Price, Wayne'
Cc: Kristin Farris Pope; david@rthicksconsult.com
Subject: Lovington Abo

Wayne

Here is our plan for drilling at the Lovington Abo spill

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Price, Wayne
Sent: Friday, October 01, 2004 1:44 PM
To: Patrick B. McMahon (E-mail)
Subject: FW: Rice ABO IG release site

-----Original Message-----
From: Price, Wayne
Sent: Friday, October 01, 2004 1:35 PM
To: Pat Wise (E-mail)
Cc: Carolyn Doran Haynes (E-mail)
Subject: FW: Rice ABO IG release site

E-mail was accidentally sent to wrong E-mail should have gone to Mr. Pat Wise not Pat McCasland

-----Original Message-----
From: Price, Wayne
Sent: Friday, October 01, 2004 11:42 AM
To: Carolyn Doran Haynes (E-mail); Randall Hicks (E-mail); Pat McCasland (E-mail)
Cc: Johnson, Larry; Sheeley, Paul; Olson, William
Subject: FW: Rice ABO IG release site

Dear Ms Haynes, Mr. Randy Hicks, and Mr. Pat Wise:

OCD is in receipt of the revised work plan (attached below) Dated August 31, 2004. The revised plan contains actions that will remove as much of the sterile topsoil as possible, import sufficient topsoil, re-vegetate, add water if necessary and monitor.

OCD supports source removal particular in this case because of the proximity to the City of Lovington fresh water well field. By removing the bulk of the contaminated soil, which still lies near the surface, OCD feels the future impairment of groundwater will be minimal if any. To make sure OCD is protecting the water supply of the City of Lovington we will also require a monitor well to be located in the spill area. If this method fails to protect fresh water then OCD would require additional actions.

I am asking for comments and concurrence so we may proceed ASAP.

-----Original Message-----
From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Friday, October 01, 2004 10:25 AM
To: 'Price, Wayne'
Cc: 'Carolyn Doran Haynes'
Subject:

Wayne

Indeed, this was to be delivered to you on the 30th, when we finished it. I fear that if you do not have a record of it in your email, it slipped through the cracks in my office. I will see if we have a record of it being sent from another machine.

I apologise.

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

Price, Wayne

From: Carolyn Doran Haynes [cdhriceswd@leaco.net]
Sent: Friday, October 01, 2004 7:58 AM
To: 'Price, Wayne'
Subject: FW:

Wayne,

I trusted Randy Hicks to submit this as he stated in this email. Kristin and I considered it submitted. I forwarded your message this morning to Randy and I'm sure he'll get back with you. In fact, we discussed in our team meeting last week whether to call you and see where the revision approval stood. A copy was supposed to go to Pat Wise also, same time it was submitted to you.

I'll get back with you.

Carolyn

From: Randall Hicks [mailto:R@rthicksconsult.com]
Sent: Tuesday, August 31, 2004 4:26 PM
To: 'Carolyn Doran Haynes'; 'Kristin Farris'
Subject:

This is the final – out today at 4:45 pm unless I hear different

Randy Hicks
505-266-5004 - office
505-238-9515 - cell

R. T. HICKS CONSULTANTS, LTD.
901 Rio Grande Blvd NW ▲ Suite F-142 ▲ Albuquerque, NM 87104 ▲ 505.266.5004 ▲ Fax: 505.266-0745

August 31, 2004

Mr. Wayne Price
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Abo 1G Leak Site: Section 1, 17S 36E Unit G

Dear Wayne:

Due to the close proximity of the City of Lovington water supply wells to this release, we prepared the Corrective Action Plan of June 7, 2004 using highly "conservative" input values for the HYDRUS-1D model simulation. Specifically, we employed:

- the highest observed chloride values observed in boreholes
- a 10-foot aquifer thickness rather than the full thickness penetrated by the nearby supply wells,
- the absence of a vegetative cover that would reduce infiltration.

The predicted chloride concentration in an imaginary ground water monitoring well located immediately down gradient from the release site was less than 250 mg/L. We also predicted the potential impact to the closest Lovington water supply wells if the simulated chloride flux from this release actually intercepted ground water. Our predictions suggest the impact to the City of Lovington wells is smaller than the measurement error of most laboratory instruments.

We expected these results. Our modeling study for the American Petroleum Institute examined over 2000 brine release scenarios, many of which were similar to the Abo 1G release. We found that in an arid climate, such as Lovington, these types of releases rarely impair ground water quality. We also knew that many "dig and haul" responses to produced water releases actually cause more environmental damage than they cure. Therefore, we counseled Rice Operating Company (ROC) to examine the science first and then implement a remedy. This remains good advice for brine releases.

August 2004 Field Event

On August 16, 2004, ROC staff obtained shallow soil samples from the release site. Plate 1 shows the location of these samples and the field chloride values. ROC designed this field program to identify areas of residual chloride in shallow soil.

We can see from Figure 1 that recent rainfall has driven some of the chloride mass below the root zone, permitting vegetation. As our work with API and the site-specific modeling demonstrates, the relatively small mass of chloride below the root zone represents no threat to fresh water, human health or the environment. This evidence of natural restoration is good news. Vegetation over this spill site will reduce infiltration of precipitation and reduce the chloride flux to ground water.

Remedy Amendment

Rice Operating Company and Hicks Consultants were surprised and pleased by the rapid natural restoration of the ground surface at this site. However, despite the recent rains, some areas remain barren due to high chloride in soil (See also Plate 1). ROC proposes to accelerate the surface restoration process and establish a vegetative cap over the release. As stated above, a vegetative cove will significantly reduce the infiltration of precipitation and thereby reduce the flux of chloride to ground water, creating a "belt and suspenders" response action.

Figure 1: November 2004 photograph of site

ROC proposes the following actions:

1. Remove as much of sterile topsoil from the site as possible without tearing the underlying caliche.
2. Remove any weeds with seed and till the areas now supporting growth.
3. Import sufficient topsoil to cover the spill site and raise the elevation of the site to prevent any ponding of stormwater.
4. Seed the site with an appropriate mix.
5. Monitor the progress of vegetation growth at the site on a monthly basis and add fresh water to assist the growth if necessary.
6. Provide NMOCD with a brief letter report upon completion of this proposed action.
7. Provide NMOCD with photographic evidence of re-vegetation in 12 months.

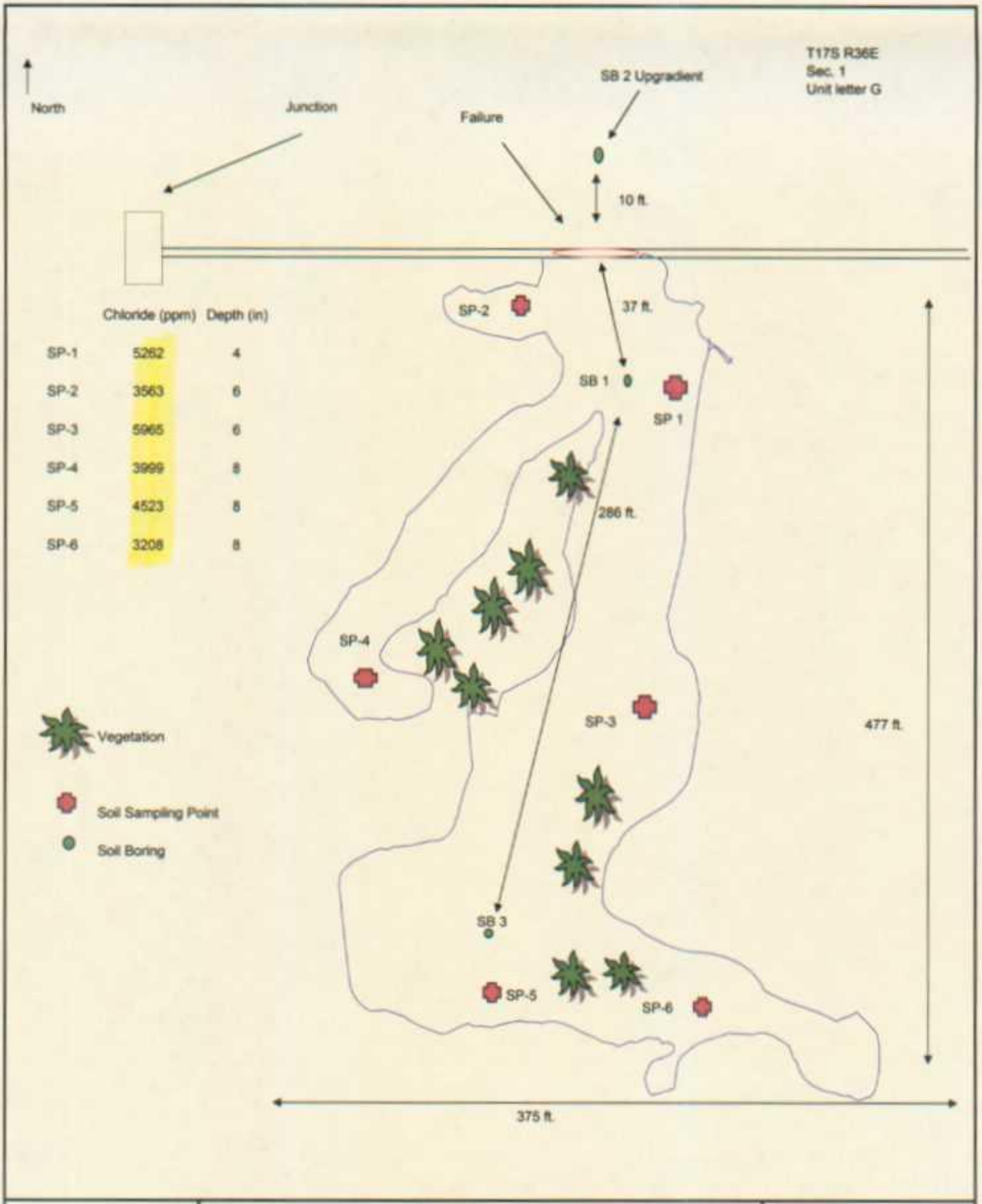
We look forward to NMOCD approval of this supplement to our Corrective Action Plan. Please contact Kristin Pope or me if you have any questions regarding this proposed action.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks

Randall Hicks
Principal

Copy: Kristin Pope, Rice Operating Company



R.T. Hicks Consultants 901 Rio Grande NW Albuquerque, NM	**Rice Operating Company**	**Plate 1**
	Abo Release Site Sketch Map	**Aug-04**

Price, Wayne

From: Price, Wayne
Sent: Thursday, September 30, 2004 4:41 PM
To: Carolyn Doran Haynes (E-mail)
Subject: ABO 1G Release Site OCD case# 1R0415

Carolyn, I received a call from the City of Lovington concerning the status of this site. My last correspondence show that Rice was suppose to submit a plan by Aug 31 where do we stand on this issue?

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

LAW OFFICES

HEIDEL, SAMBERSON, NEWELL, COX & McMAHON

C. GENE SAMBERSON
MICHAEL T. NEWELL
LEWIS C. COX, III
PATRICK B. McMAHON

311 NORTH FIRST STREET
POST OFFICE DRAWER 1599
LOVINGTON, NM 88260
TELEPHONE (505) 396-5303
FAX (505) 396-5305

F.L. HEIDEL
(1913-1985)

August 13, 2004

New Mexico Oil Conservation Division
Wayne Price
P. O. Box 6429
Santa Fe, NM 87504-6429

Re: Rice/Abo 1G Release Site Corrective Action Plan

Dear Mr. Price:

I have reviewed a copy of your August 6, 2004 e-mail to Ms. Carolyn Haynes regarding the above referenced matter. It is my understanding that you have rejected this Plan and requested Ms. Haynes to re-submit. If I am mistaken, please contact me immediately.

The City of Lovington, through its environmental consultant, has reviewed the Plan rejected by you. Despite your rejection, the City would like to make you aware of some of its concerns regarding the Plan. Some of those concerns are as follows:

1. The background soil sample taken by Rice appears to have been taken at a location that has previously been impacted by oilfield contamination. The City's consultant obtained an accurate background soil sample in close proximity to the spill site. Background chloride levels for soils in the area is 64 ppm. I have attached a copy of the analytical result for that background sample.

2. The release occurred in October 2003. As of November 2003, chlorides had migrated to at least 45ft. below ground surface. Considering the delay between the sampling event and the submission of the Plan, the City is concerned about continued migration and the use of stale data. Under the Guidelines, in order to properly evaluate a site an operator is required to determine "depth to groundwater". Rice is required to conduct proper soil borings to a depth that identifies the full extent of chloride contamination and to properly rank this site.

3. The City requests that Rice be required to timely notify the City of any and all sampling events to be conducted at this site in the future.
4. Given the close proximity to groundwater and the fact that the groundwater is used for a public water supply, the City objects to any contaminants being left on site.

In addition, the City requests an opportunity to review and comment upon any Plan resubmitted on behalf of Rice before the OCD makes a decision to accept or reject that Plan.

Thank you for your consideration, if you should have any questions, please do not hesitate to call.

Sincerely,

HEIDEL, SAMBERSON, NEWELL, COX & MCMAHON

By: Patrick B. McMahon

Patrick B. McMahon

PBM:dg
cc: Pat Wise
Eddie Seay

CARDINAL LABORATORIES

PHONE (325) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603
PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR
EDDIE SEAY CONSULTING
ATTN: EDDIE SEAY
601 W. ILLINOIS
HOBBS, NM 88242
FAX TO: (505) 392-6949

Receiving Date: 08/06/04
Reporting Date: 08/09/04
Project Owner: CITY OF LOVINGTON
Project Name: ROC-RICE OP. CO. SPILL ABO
Project Location: S. LOVINGTON, NM

Analysis Date: 08/09/04
Sampling Date: 08/06/04
Sample Type: SOIL
Sample Condition: COOL & INTACT
Sample Received By: GP
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Cl^- (mg/Kg)
H8984-1	L-ROC-1	64
Quality Control		1040
True Value QC		1000
% Recovery		104
Relative Percent Difference		4.0

METHOD: Standard Methods	4500-ClB

Note: Analysis performed on a 1:4 w:v aqueous extract.

Amy Hill
Chemist

8/9/04
Date

Price, Wayne

From: Price, Wayne
Sent: Thursday, August 12, 2004 10:28 AM
To: 'Carolyn Doran Haynes'
Subject: RE: ABO 1G Release Site OCD Case #1R0415

Approved!

-----Original Message-----
From: Carolyn Doran Haynes [mailto:cdhriceswd@leaco.net]
Sent: Thursday, August 12, 2004 10:25 AM
To: 'Price, Wayne'
Cc: 'Randall Hicks'; enviro@leaco.net
Subject: ABO 1G Release Site OCD Case #1R0415

Dear Mr. Price:

Rice Operating Company (ROC) is in receipt of your request to submit a new work plan for the above referenced site. ROC respectfully pleads for an extension of the August 13 deadline to August 31, in order to adequately develop a work plan that addresses the OCD concerns. ROC has discussed this timeline issue with RT Hicks Consultants and they concur that a revised plan can be submitted before August 31.

ROC appreciates any consideration the OCD will afford to extend this deadline.

Thank you,

Carolyn Doran Haynes
Engineering Manager
RICE *Operating Company*
PH: 505-393-9174
FX: 505-397-1471

Price, Wayne

From: Price, Wayne
Sent: Friday, August 06, 2004 3:47 PM
To: Carolyn Doran Haynes (E-mail)
Cc: Pat Wise (E-mail); Randall Hicks (E-mail); Sheeley, Paul; Johnson, Larry
Subject: Rice Operating Co.-Abo 1G Release site OCD Case # 1R0415

Dear Ms. Haynes:

OCD is in receipt of the corrective action plan dated June 07, 2004 submitted by RT Hicks. Please note due to the close proximity to the City of Lovington's fresh water well field OCD feels compelled to deny the plan as submitted. Please re-submit with a plan to remove the salt contaminated soil within some practical limit. Please submit by August 13, 2004. The longer "no action" is performed the deeper the salt will migrate into the vadose zone and a higher potential of groundwater contamination exists. We will not accept a model that allows groundwater contamination and dilution in this area. The model may be used after excavation to demonstrate no further threat exist.

Sincerely:

Wayne Price
New Mexico Oil Conservation Division
1220 S. Saint Francis Drive
Santa Fe, NM 87505
505-476-3487
fax: 505-476-3462
E-mail: WPRICE@state.nm.us

Price, Wayne

From: Katie Lee [katie@rthicksconsult.com]
Sent: Friday, July 30, 2004 11:10 AM
To: Wayne Price
Subject: requested docs

Wayne,

Here is the Lovington Abo G-1 CAP report you requested. I'm hitting a little snag with finding the Vaccuum G-5 report, in that I think we might have it saved under another name. I will try and catch up with Randy after he gets done talking with you and get things straightened out and send along the report you need.

Best regards,

Katie
R.T. Hicks Consultants, Ltd.

ERROR: ioerror
OFFENDING COMMAND: image

STACK:

-dictionary-
-savelevel-

June 7, 2004

Corrective Action Plan

Abo 1G Release Site

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142, Albuquerque, NM

June 7, 2004

Abo 1G Release Site Report

Prepared for:

Rice Operating Company
122 West Taylor
Hobbs, NM 88240

R.T. Hicks Consultants, Ltd.
901 Rio Grande Blvd. NW, Suite F-142, Albuquerque, NM 87104

1.0 BACKGROUND

The Abo 1G Discharge Site is located about 6 miles southeast of the center of Lovington, New Mexico. Plate 1 shows the location of the site relative to Route 18, the Hobbs-Lovington Highway.

On October 18, 2003, Rice Operating Company (ROC) prepared a Release Notification report that estimated the pipeline failure released 190 barrels of produced water and recovered 130 barrels. The pipeline failure released produced water with little or no hydrocarbons. Plate 2 shows the geometry of this release, which affected about 31,000 square feet of range-land. Plate 2 also shows the locations of soil borings used to characterize the release. ROC is also aware that a 10 barrel release near this same location on occurred on June 3, 2003 and this earlier release impacted a 2,400 square foot area near SB-1.

Figure 1 is a photograph of the site in October, 2003 looking south from a caliche road. The line in the foreground ruptured and produced water flowed south.

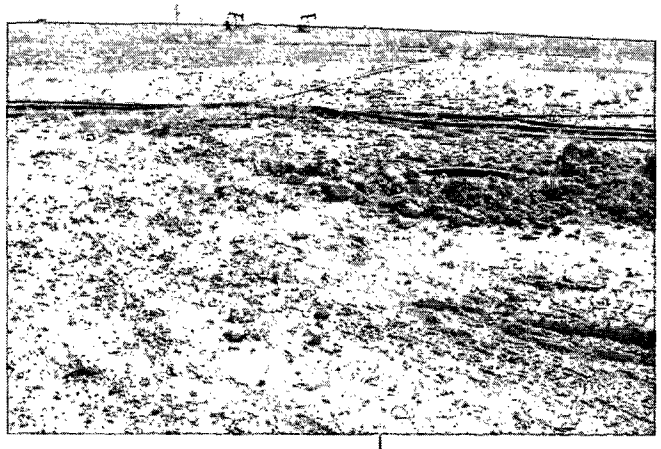


Figure 1. Abo 1G site looking south.

ROC mobilized to the site on November 10, 2003 and drilled three borings as shown on Plate 2. The field procedures employed by ROC were consistent with industry practice and with previously-submitted ROC characterization plans (e.g. junction box plan). Hicks Consultants used the data collected by ROC and obtained additional data from public sources as input to the HYDRUS-1D vadose zone fate and transport model. Hicks Consultants employed the results of the modeling to predict the potential impact to ground water quality as a result of the release and to develop a remedy to protect ground water quality and to restore the ground surface.

2.0 RESULTS OF FIELD PROGRAMS AND INVESTIGATIONS

CHARACTERISTICS OF VADOSE ZONE AND SATURATED ZONE

Next to the pipeline rupture, SB - 01 was drilled to a depth of 45 feet. From field inspection, the site has several inches of sandy soil covering a high-fractured caliche horizon. We examined bore-hole samples and the on-site cuttings log from SB-01 and concluded that the subsurface is composed of 24 feet of thin caliche layers within sands and silts. Interbedded with these caliche-rich sands and silts are silty clays. Below this uppermost 24 feet is 20 feet of sand and silt. The logs for each of these three ROC borings are included in Appendix A.

In well L-1716 , about 1 mile west of the release site, the driller's log reports "water sand" from 45 feet to 70 feet underlain by 7 feet of "calcium sand" before penetrating water bearing units. At well L-5014, approximately 5 miles north of the site, the driller log identifies caliche from 2 to 28 feet below surface. Below this upper strata is sand and sandy clay to a depth of 190 feet. From 190 to 205 feet below surface, the driller reports a clay zone. This 15 feet of clay is underlain by 10 feet of clay and gravel. The driller penetrated the Dockum Group red beds at 215 feet below grade. Monitoring wells in the Lea Refinery, one mile to the northeast, driller's logs report a 4 foot caliche bed overlying more than 100 feet of very fine to fine grained sands. At the Lea Refinery, April, 1996 water levels are 90 feet below grade (H+GCL, 1996). These well logs are also included in Appendix A.

We conclude that the vadose zone is about 90 feet thick and is composed of a caliche-rich upper horizon underlain by sand with minor amounts of silt. The saturated Ogallala Aquifer, which underlies the location, is dominantly sand. The saturated thickness of the aquifer is about 130 feet. The screened interval of wells in the area range from 20 feet to more than 100 feet.

According to the USGS (http://water.usgs.gov/GIS/metadata/usgswrd/ofr98-548.html#Identification_Information), the hydraulic conductivity of the High Plains Aquifer ranges from less

than 25 feet/day to greater than 300 feet per day with an average hydraulic conductivity of 60 feet/day. At this location, where saturated gravel units are restricted to the base of the Ogallala, we estimate the hydraulic conductivity is about 50 feet per day. Geologists who drilled monitoring wells at the Lea Refinery estimated the saturated hydraulic conductivity as ranging from 25-75 feet per day. At the Lea Refinery, the hydraulic gradient is 0.004 feet/foot to the southeast. The resultant ground water flux is probably about 0.2 feet per day.

We have no site specific or regional data on the moisture content of the vadose zone. Such data are generally rare. As described in a later section of this report, we used HYDRUS-1D to simulate an initial water content of the unsaturated zone.

CHLORIDE DISTRIBUTION IN THE VADOSE ZONE

Soil boring SB-2 is uphill from the spill site and we consider this a "background" location. At this soil boring, the chloride near the ground surface is 475 ppm. From 4 feet below grade to the total depth of 15 feet, chloride in this caliche-rich horizon ranges between 230 and 356 ppm (Figure 2). Other workers suggest that "background" chloride concentration in Lea County soil can be less than 100 ppm. At this site, where the caliche dominates the upper vadose zone, the background is about 300 ppm.

Figure 2. Chloride vs. depth in soil boring 2.

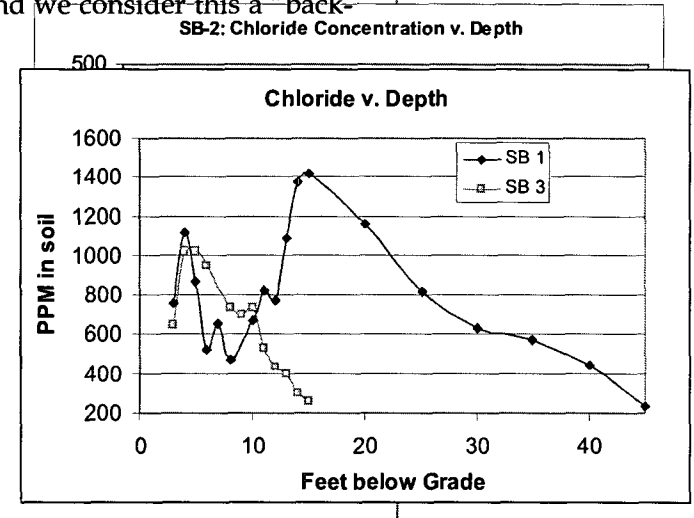


Figure 3. Chloride vs. Depth in soil borings 1 and 3.

The soil borings within the area of the release (#1 and #3) show a decline in chloride concentrations from more than 1000 ppm chloride to background levels at 45 feet and 9 feet below land surface respectively (Figure 3). Because the water table lies about 90 feet below land surface, this observed decrease of chloride concentrations to background suggests that the release did not create saturated conditions between ground surface and ground water.

The pattern for SB-1 shown in Figure 3, which was closest to the pipeline rupture, confirms that the October 2003 release is not the first release at or near this site. An earlier release appears as chloride concentrations above 1000 ppm between 12 and 20 feet below grade and the October release appears as the high chloride between 3 and 6 feet depth. We do not believe that the chloride concentrations between 12 and 20 feet in SB-1 were caused by the 10-barrel release of June 2003.

The data from SB-3 suggests the influence of only the October 2003 release. Data from SB-1 and SB-3 demonstrate that the center of mass from the recent release is at a depth of 4-5 feet below land surface.

Regardless of the source of chloride observed at 12-20 feet below grade in SB-1, we can conclude that these soil boring data show no evidence of imminent ground water impairment. The chloride from the releases remains within the vadose zone. Using these data, and the chloride concentration in the produced water, we can estimate the volume of produced water released at this site.

RELEASE CHARACTERISTICS

ROC provided an analysis of the chloride in the produced water - 19,994 ppm. Because the soil sampling program identified an older spill event at SB-1, we considered the calculated chloride load at SB-3 more representative of the October release. Calculations using the chloride load at SB-3 imply that the spill was 1 in. deep (see Appendix B for these calculations). If 1-inch was the average spill height for the 31,000 square feet of impact (see Plate 2), the total volume of the release would be 440 barrels. However, ROC located SB-3 where the released "pooled", therefore using the chloride load from this boring will probably overestimate the release volume. We suggest that the October event released between 200 and 500 barrels of produced water and 130 barrels were recovered.

Ground water at the Lea Refinery flows toward the southeast. We estimate that the length of the spill parallel to ground water flow is 477 feet.

EVALUATION OF CHLORIDE FLUX FROM THE VADOSE ZONE TO GROUND WATER

We employed the HYDRUS-1D and a simple ground water mixing model to evaluate the potential of residual chloride mass in the vadose zone to materially impair ground water quality at the site. Appendix C presents the background documentation for this modeling approach. We applied the results from the HYDRUS-1D modeling of the migration

of chloride ions from the vadose zone to ground water in our selection of an appropriate remedy for the land surface and underlying vadose zone. This simulation is the "no action" alternative, which predicts chloride flux to ground water in the absence of any action by Rice Operating Company.

DATA FOR SIMULATION MODELING

The HYDRUS-1D and mixing model simulation requires input of 11 parameters. As Table 1 shows, site specific data are required for several of these parameters and other data are available from public sources. The source of most of the data is described in the previous section of this report.

Table 1. Input Parameters for Simulation Modeling

Input Parameter	
1. Vadose Zone Thickness – 77 feet	Appendix A we
2. Vadose Zone Texture – Plate 3	Samples and att
3. Dispersion Length - 1.85 meters	Professional jud
4. Soil Moisture	HYDRUS-1D ini
5. Chloride in release – 19,994 ppm	Samples of prod
6. Height of spill on land surface –1.0 inches	Calculated from location SB-3 an
7. Length of release parallel to ground water flow – 477 ft	Field Measurem
8. Climate – Arid	Pearl Weather S
9. Background Chloride in Ground Water – 100 ppm	Professional jud
10. Ground Water Flux – 6.1 cm/day	Calculated from Refinery Report
11. Aquifer Thickness – 10 feet	NMOCD sugge

The vadose zone profile used for the HYDRUS- composed from the well log and samples of SB from the logs of wells in the area. For the purp we will assume that the ground water is uncon depth of 77 feet below land surface. Some drill this depth to water, however we believe that 9(accurate. The 13-foot difference is probably due to falling water levels in the Ogallala. To be conservative in our approach, we used 77 feet at the thickness of the vadose zone. Plate 3 shows the vadose zone profile (texture) employed in the modeling with the HYDRUS-1D input parameters.

The dispersion length of 1.85 meters is less than 10% of the total length of the HYDRUS-1D model and is consistent with standard modeling protocol.

We installed the profile described above as the initial condition in HYDRUS-1D and ran it with the estimated spill installed as an atmospheric event on day 1 of the simulation. We ran the model for 2 years to create a chloride profile v. depth that we use to "calibrate" the model. Comparison of the solute concentrations computed by HYDRUS-1D with the field measured solute concentrations caused us to simplify the soil profile by using higher hydraulic conductivity in the upper soil profile. The parameters used to model the caliche typically employ a very low saturated hydraulic conductivity. From field inspection, the surface caliche in the area is fractured and filled with fine sands. Because of the stratagraphic location near the ground surface, we believe the caliche at this site has a much higher saturated hydraulic conductivity than that typically used in the HYDRUS-1D model. During intense rainfall events (or produced water spills), water will flow quickly to the subsurface through the fractures via saturated flow. Therefore, we adjusted for this observation and modified the default caliche parameters to behave less like clay and more like sand. Deeper in the vadose zone, fractures become barriers to flow and deeply buried caliche behaves more like clay. From previous modeling experience, the properties of the upper soil profile are the most important in determining flow in the vadose zone. Therefore, adjusting the hydraulic input data for the uppermost vadose zone is relatively important.

The parameters of the lower caliche were also altered to allow the higher hydraulic conductivity. In addition, two intermediate layers were merged using the parameters of the coarser layer. These changes err in favor of ground water protection; they will cause the model to overestimate the flux of chloride from the vadose zone into ground water. After making these adjustments, one can observe the relationship between predicted chloride concentration in soil and actual measurements in Figures 4 and 5.

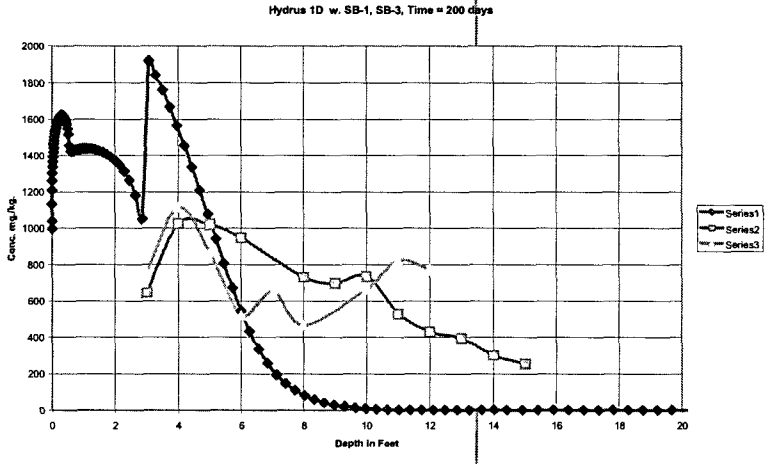


Figure 4. Predicted chloride concentrations in soil at 200 days.

What are important in the examination of these figures are the distribution of the predicted chloride mass in the vadose zone and

the measured distribution of vadose zone chloride. The simulation of the chloride distribution at 200 days after the release (Figure 4) shows a peak chloride concentration at about 3 feet deep and background concentrations (zero ppm in the model) at 10 feet below grade. The simulation at time=730 days provides a better fit between the predicted chloride concentrations and the measured values. The reason for this "time shift" is due how the model uses the meteorological data from Pearl, New Mexico. The meteorological data consists of 47 years of daily data. Day 1 is NOT the day that the October 2003 release occurred, however. Day 1 of the file is about 50 years ago. The measured values will only correlate exactly with the predicted values if rainfall, wind speed and other atmospheric events between the time of the release and the time of the sampling event were exactly the same as the atmospheric file in the model. We maintain that the "match" between the predicted chloride concentrations and the measured concentrations presented in Figure 5 provide adequate verification of our input parameters for the vadose zone texture.

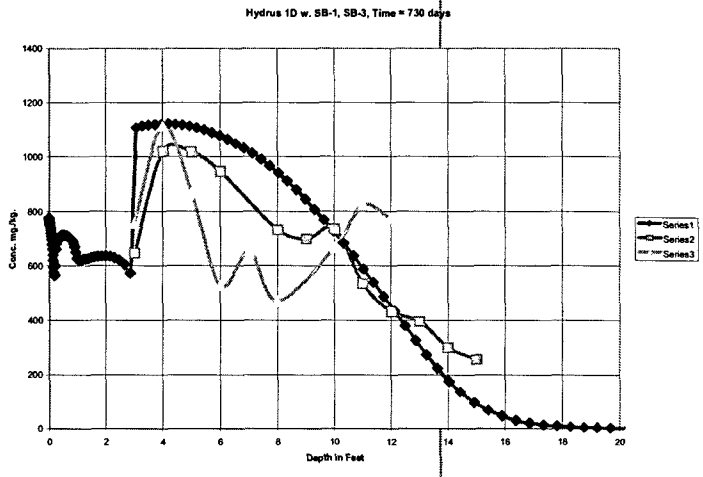


Figure 5. Predicted Chloride concentrations in soil at 730 days.

For the mixing model, the largest dimension of the spill (477 feet) was used for the length of spill parallel to groundwater flow. Climate data from the Pearl Weather Station near the Hobbs, New Mexico airport, approximately 15 miles south of the site, was used. Ground water flux at the Lea refinery is estimated at .4 feet/day to 1.2 feet/ day. (Lea refinery Report) Well logs in Appendix A indicate that 10 feet is a very conservative estimate for the aquifer thickness in that most wells exhibit well screens in excess of 20 feet.

We then ran the HYRDUS-1D model to predict chloride movement through the vadose zone for 71 years. From the output, we found that the center of chloride mass enters the ground water zone between 15 years and 50 years from present.

This flux was then fed into the aquifer mixing model with the resulting output shown in Figure 6. The predicted peak concentration is less than 200 ppm.

In examining Figure 6, it is important to understand that the model assumes that rainfall is distilled water (0 ppm chloride) and that the initial vadose zone water also contains 0 ppm chloride. Attempting to use chloride concentrations other than zero for precipitation and initial soil moisture creates too much complexity in the model. This simplification causes a minor under estimate of the chloride flux to ground water, as described below.

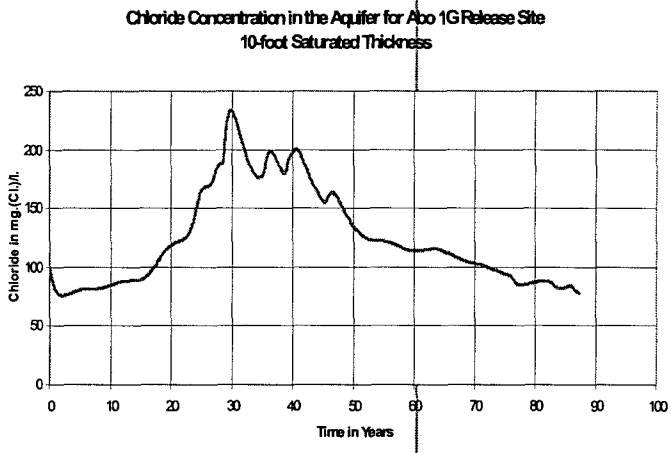


Figure 6. Ground water chloride concentrations in imaginary monitoring well.

In our model, natural precipitation (0 ppm chloride) moves the released chloride through the vadose zone and dilutes the chloride mass (from above) during transport, just as real rainfall dilutes the real spill. Minor dilution of released chloride also occurs as it moves downward and mixes with 0 ppm pore water. Dilution of the release by pore water also occurs in nature. Thus from time zero to slightly more than 3 years, a flux of 0 ppm chloride enters the aquifer from the vadose zone, diluting the 100 ppm chloride ground water to 75 ppm. This decrease in chloride concentration in the mixing model is due to the relatively high flux through the bottom of the sandy soil vadose zone. After 3 years, the chloride mass from the release begins entering ground water raising chloride concentration. The maximum chloride concentration in a 10-foot thick aquifer beneath the site would occur about 30 years after present and would be less than 200 ppm chloride.

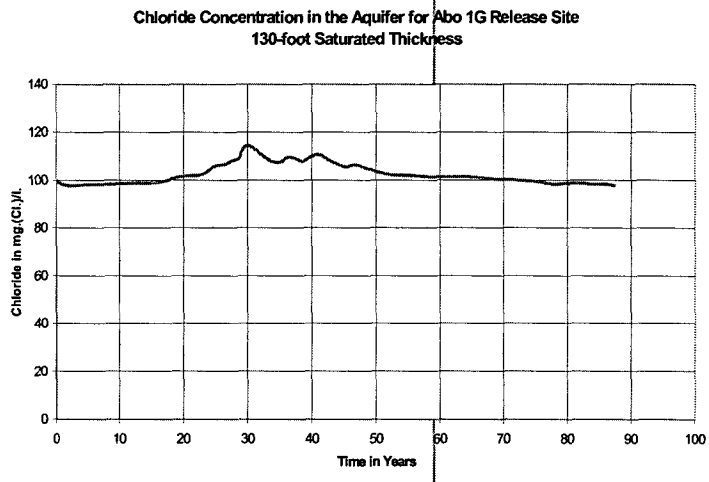
We can confidently conclude that the release(s) that created the chloride load observed in SB-1 will cause minimal impairment of ground water quality at an imaginary well located immediately adjacent to the release. Our predictions show that a well with 20 feet of screened interval located immediately next to the release would observe chloride concentrations less than 150 ppm.

POTENTIAL IMPACT ON CITY OF LOVINGTON WATER SUPPLY WELLS

The water supply wells for the City of Lovington are more than 2000 feet from the release site. These wells do not draw water from only the uppermost 20 feet of the Ogallala Aquifer, but from most or the entire 130-foot thick saturated zone. Let us assume that in the future the City of Lovington or another water user were to install a water supply well at

the edge of the release site. The maximum predicted chloride concentration in this fully-penetrating, fully-screened well (130 feet of screen within the 130-foot saturated zone) is 109 ppm or 9 ppm above the assumed 100 ppm background concentration (see Figure 7).

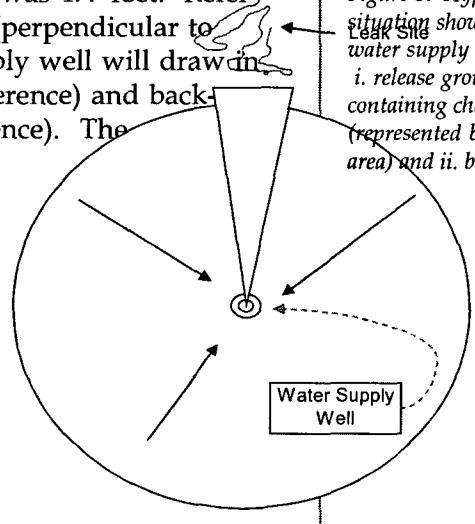
Figure 7. Chloride concentration in imaginary monitoring well with 130 foot saturated thickness



If we wish to predict the potential impact to an existing City of Lovington water supply well that lies 2000 feet from the release site, we must calculate the dilution that will occur as background water is drawn to the well.

For example, let us assume that a City of Lovington supply well creates a cone of depression with a 2000-foot radius and a circumference of 12,560 feet (Figure 8). If we assume this large cone of depression, all of the chloride from the release will eventually be drawn into the well. In our modeling, we assumed that the maximum length of the release parallel to ground water flow was 477 feet. Referring to Plate 2, the maximum width of the release (perpendicular to ground water flow) is 375 feet. Therefore, the supply well will draw in water from the release site (375 feet of the circumference) and background quality water (12,560 feet of the circumference). The site contributes only 3% of the total volume of water pumped by the well. In a simple dilution calculation where 3% of the water drawn into the well will exhibit a chloride concentration of 109 ppm and 97% of the water drawn into the well is background water quality (100 ppm), the resultant concentration in the supply well is 100.27 ppm. In other words, one will not be able to measure the effect of this release on the Lovington water supply wells. Figure 8 shows this hypothetical situation.

Figure 8. Hypothetical situation showing a Lovington water supply well drawing in: i. release ground water containing chloride molecules (represented by the triangular area) and ii. background water.



We conclude that the chloride from this release site will have no impact on the City of Lovington water supply wells.

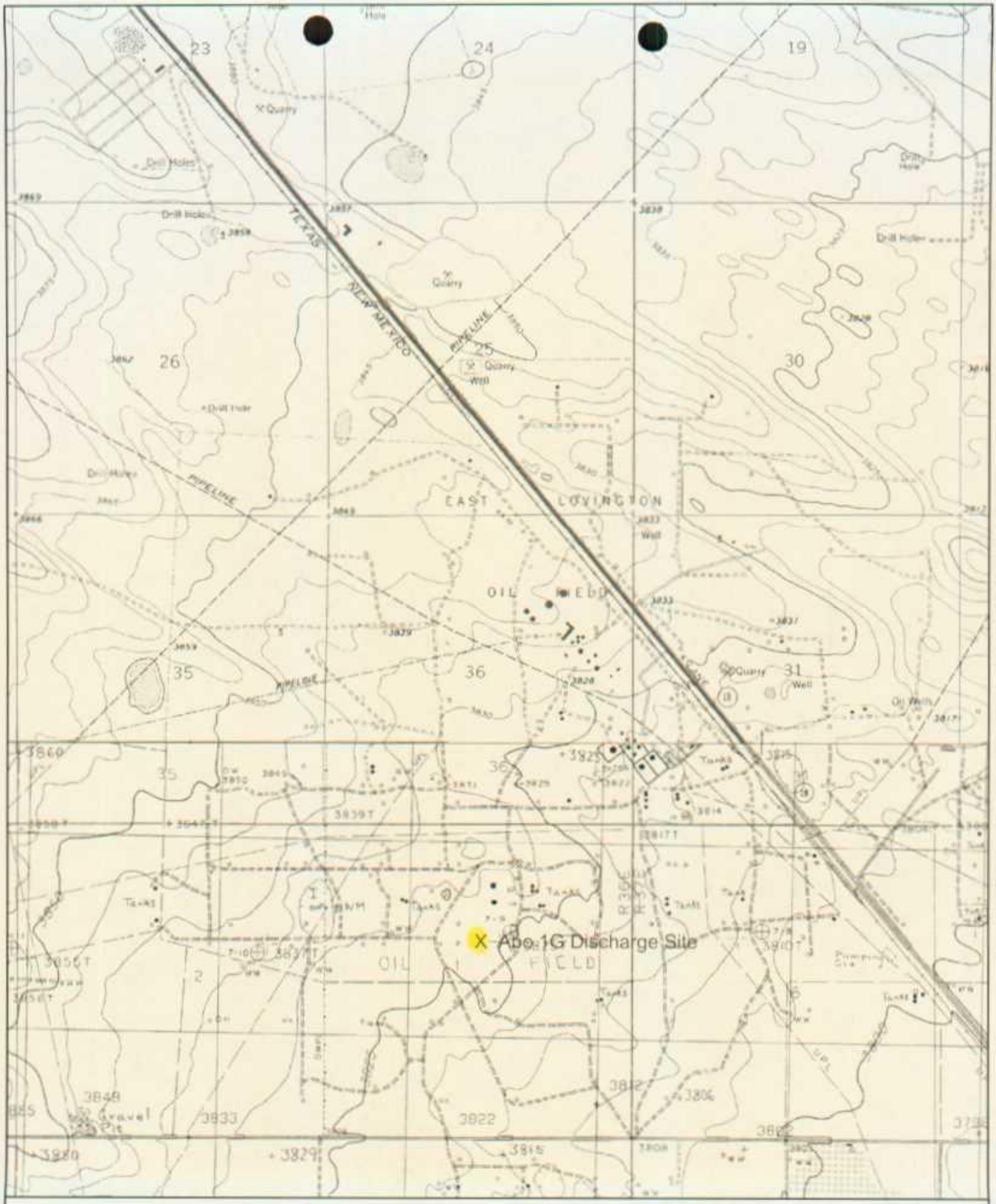
PROPOSED REMEDY

We conclude that the release poses no material threat to ground water quality. Simulations using input parameters that should over-estimate the chloride concentration in ground water show that the release will not cause WQCC Standards to be exceeded at a place of reasonable foreseeable future use.

We recommend closure of the regulatory file.

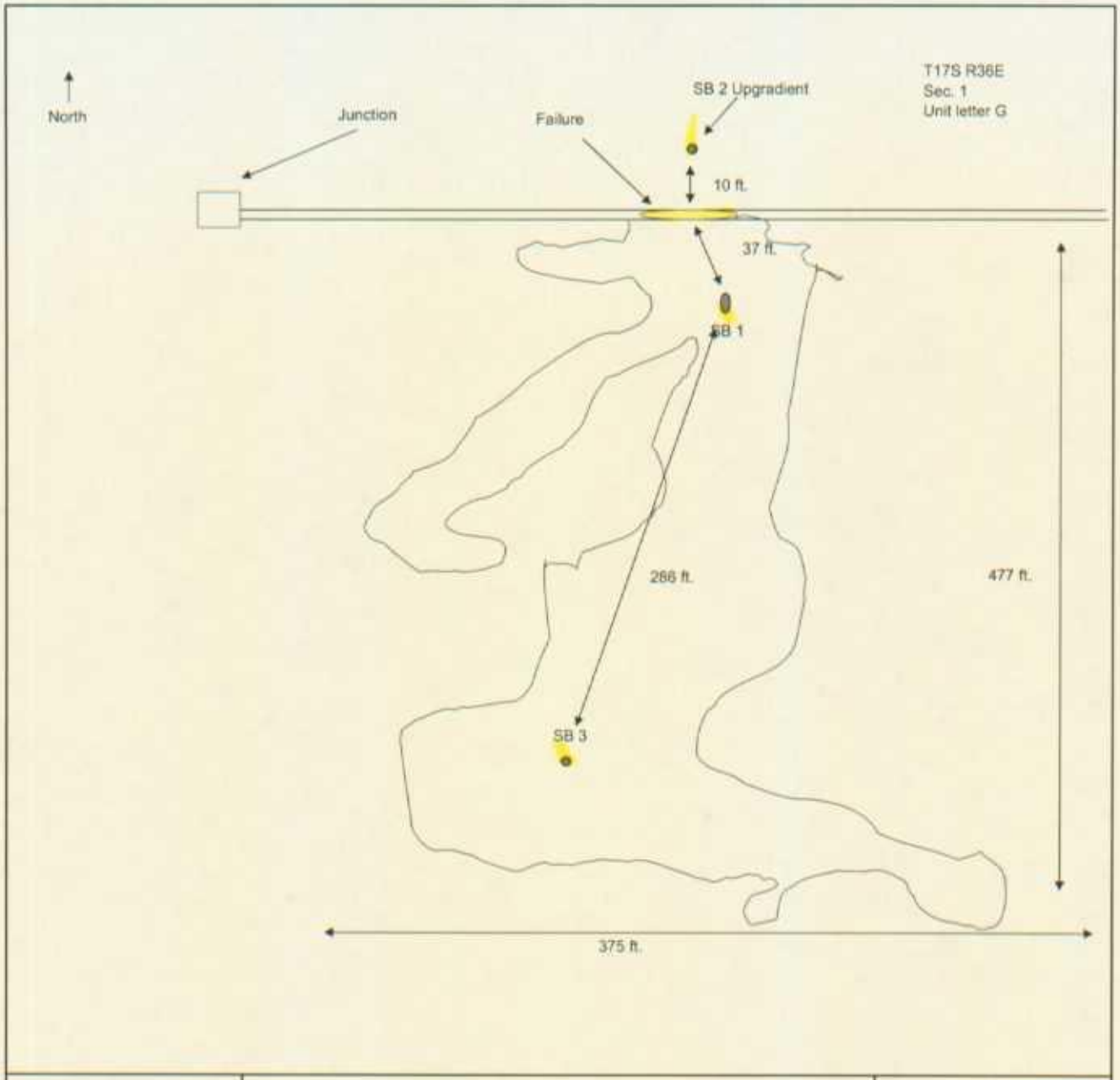
We propose annual inspection of the site and re-seeding when vegetation begins to invade the spill site. Our site visit in April, 2004 showed that the recent heavy rains of the area have permitted some natural re-vegetation of the site.

PLATES



Name: LOVINGTON
Date: 12/18/2003
Scale: 1 inch equals 2000 feet

Location: 032° 52' 53.8" N 103° 18' 23.0" W
Caption: Plate 1: Location Map



R.T. Hicks Consultants 901 Rio Grande NW Albuquerque, NM	**Rice Operating Company**	**Plate 2**
	Abo Release Site Sketch Map	**May-04**

Depth	Lithologic Description	Van Genuchten's parameters as used in adjusted profile	Soil description by USDA soil triangle
0 ft. 3ft.	0-3ft Top Soil	th_r - .065, th_s - .41, alpha - .075, n - 1.89, Ks - 106.1	sandy loam
16 feet	3 -16 ft Clay - very fine sand, caliche	th_r - .078, th_s - .43, alpha - .038, n - 1.58, Ks - 35	fractured caliche, values modified from Jan Hendrick
19 ft	16 - 19 ft.silt - clay, min. caliche	th_r - .089, th_s - .43, alpha - .01, n - 1.23, Ks - 1.68	silty clay loam
22 ft.	19 - 22 ft. clay - silt, min. caliche		
28 ft.	22 - 28 ft Silt - v.f. sand ,some caliche	th_r - .078, th_s - .43, alpha - .038, n - 1.58, Ks - 35	fractured caliche, values modified from Jan Hendrick
32 ft.	28 - 32 ft. silt - very fine sand, caliche		
45 ft.	32 - 45 ft., silt - very fine sand, some clay	th_r - .095, th_s - .41, alpha - .019, n - 1.31, Ks - 6.24	clay loam
70 ft.	45 - 70 ft. vf sand	th_r - .067, th_s - .45, alpha - .02, n - 1.41, Ks - 10.8	silt loam
77 ft. and water, tot	70 - 77 ft. limey sand	th_r - .095, th_s - .41, alpha - .019, n - 1.31, Ks - 6.24	clay loam

R.T. Hicks Consultants, Ltd. 901 Rio Grande, Suite F-142 Albuquerque, NM	RICE Operating Company	Lovington Abo Soil Profile at SB-1
	Lovington Abo Release Site	Apr-04

APPENDIX A

Form WR-23 STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

# 5 in 730-20-13			
DAN 25-41350			

(Plat of 640 acres)

(A) Owner of well Jack Cayton

Street and Number Box 1021

City Lovington State New Mexico

Well was drilled under Permit No. L-2480-1716 and is located in the NW ¼ NW ¼ NE ¼ of Section 2 Twp. 17 S Rge. 36 E

(B) Drilling Contractor Cayton & Porter License No. WD-183

Street and Number Box 1021

City Lovington State New Mexico

Drilling was commenced Sept. 1 19 55

Drilling was completed Sept. 2 19 55

Elevation at top of casing in feet above sea level ..... Total depth of well 145

State whether well is shallow or artesian Shallow Depth to water upon completion 50

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	77	92	15	Water Sand
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor ..... License No. .....

Street and Number ..... City ..... State .....

Tons of Clay used ..... Tons of Roughage used ..... Type of roughage .....

Plugging method used ..... Date Plugged ..... 19 .....

Plugging approved by:

..... Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received SEP 13 1955

OFFICE STATE ENGINEER

File No. L-2480 1716 Use Irrig Location No. 17 36 2

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	1	1		Soil
1	7	6		Rock
7	16	9		Caliche
16	20	4		Boulder
20	26	6		Sand Rock
26	45	19		Sand
45	70	25		Water Sand
70	77	7		Calcium Sand
77	92	15		Quick Sand
92	106	14		Sandy Clay
106	108	2		Sand
108	112	4		Rock
112	134	22		Sandy Clay
134	143	9		Sand
143	145	2		Sandy Clay

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Jack Cleveland
Well Driller

LOG FILED

(This form to be executed in triplicate)

WELL RECORD

Renumbered L-4058
Feb 2
1959

Date of Receipt _____ Permit No. L-455A

Name of permittee, Lovington Municipal Utilities

Street or P.O., _____, City and State Lovington, New Mexico

1. Well location and description: The shallow (shallow or artesian) well is located in ¼, ¼, ¼,

Lot 5 ¼ of Section 4, Township 16, Range 36; Elevation of top of

casing above sea level, 3979 feet; diameter of hole, 16 inches; total depth, 127 feet;

depth to water upon completion, 58 feet; drilling was commenced June 2, 1952,

and completed June 4, 1952; name of drilling contractor Aqua Drilling Co.

Box 1004; Address, Lovington, N.M.; Driller's License No. WD 35

2. Principal Water-bearing Strata:

	Depth in Feet From	To	Thickness	Description of Water-bearing Formation
No. 1	58	59	1	Water Sand
No. 2	69	71	2	Water Sand
No. 3	82	86	4	Quick Sand & Water
No. 4	112	116	4	Water Sand & Shale
No. 5				

3. Casing Record:

Diameter in inches	Pounds per ft.	Threads per inch	Depth of Casing or Liner Top	Depth of Casing or Liner Bottom	Feet of Casing	Type of Shoe	Perforations From	Perforations To

RECEIVED
OCT 27 1952
STATE ENGINEER

4. If above construction replaces old well to be abandoned, give location: ¼, ¼, ¼

of Section _____, Township _____, Range _____; name and address of plugging contractor,

_____

_____

date of plugging _____ 19____; describe how well was plugged: _____

FILED
OCT 20 1952
OFFICE
ROSWELL, NEW MEXICO

FILED
SEP 16 1958
STATE ENGINEER
ROSWELL, NEW MEXICO

5. Log of Well:

Depth in feet From	To	Thickness in feet	Description of Formation
0	2	2	Soil
2	26	24	Caliche & Lime Shale
26	58	32	Sandy Shale
58	59	1	Water Sand
59	69	10	Sand & Shale
69	71	2	Water Sand & Shale
71	82	11	Sand Shale with Streaks of Clay
82	86	4	Quick Sand & Water
86	112	26	Sand & Shale
112	116	4	Tight Water Sand & Clay Shale
116	127	11	Sandy Shale

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Licensed Well Driller

Instructions

This form shall be executed, preferably typewritten, in triplicate and filed with the State Engineer's Office at Roswell, New Mexico, within 10 days after drilling has been completed. Data on water-bearing strata and on all formations encountered should be as complete and accurate as possible.

(This form to be executed in triplicate)

WELL RECORD

Date of Receipt..... Permit No. L-265

Name of permittee, Ernest Mahan

Street or P.O., Box 32, City and State Lovington, N. M.

1. Well location and description: The shallow (shallow or artesian) well is located in NW ¼, NW ¼, SW ¼ of Section 11, Township 16 S, Range 36 E; Elevation of top of casing above sea level, ... feet; diameter of hole, 16 inches; total depth, 120 feet; depth to water upon completion, 45 feet; drilling was commenced Jan. 8, 1948, and completed Jan. 9, 1948; name of drilling contractor Abbott Bros.; Address, Box 637, Hobbs, N. M.; Driller's License No. WD-46

2. Principal Water-bearing Strata:

	Depth in Feet From	To	Thickness	Description of Water-bearing Formation
No. 1	45	120	75	Water sand
No. 2				
No. 3				
No. 4				
No. 5				

3. Casing Record:

Diameter in inches	Pounds per ft.	Threads per inch	Depth of Casing or Liner Top	Depth of Casing or Liner Bottom	Feet of Casing	Type of Shoe	Perforations From	Perforations To
NONE								

4. If above construction replaces old well to be abandoned, give location: ¼, ¼, ¼ of Section, Township, Range; name and address of plugging contractor,

date of plugging, 19; describe how well was plugged:

FILED
JAN 11 1952
OFFICE
ARTESIAN WELL SUPERVISOR
ROSWELL, NEW MEXICO

5. Log of Well:

Depth in feet From	Depth in feet To	Thickness in feet	Description of Formation
0	4	4	Soil
4	35	31	Caliche
35	45	10	Hard shell
45	120	75	Water sand

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Licensed Well Driller

Instructions

This form shall be executed, preferably typewritten, in triplicate and filed with the State Engineer's Office at Roswell, New Mexico, within 10 days after drilling has been completed. Data on water-bearing strata and on all formations encountered should be as complete and accurate as possible.

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Hulda Heidel Owner's Well No. _____
Street or Post Office Address 1018 West Avenue K
City and State Lovington, New Nexico 88260

Well was drilled under Permit No. L-135 enlarged L-135S and is located in the:

a. _____ ¼ _____ ¼ _____ ¼ NW ¼ of Section 11 Township 16S Range 36E N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

c. Lot No. _____ of Block No. _____ of the _____
Subdivision, recorded in Lea County.

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

(B) Drilling Contractor Abbott Bros. License No. WD-46

Address P.O. Box 637, Hobbs, New Mexico 88240

Drilling Began 3/17/77 Completed 3/22/77 Type tools Cable Size of hole 16 in.

Elevation of land surface or _____ at well is _____ ft. Total depth of well 146 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 58 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
58	146	88	Sand	

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
12 3/4"	43	Welded	0	146	146	None	66	146

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

Section 5. PLUGGING RECORD

Plugging Contractor _____
Address _____
Plugging Method _____
Date Well Plugged _____
Plugging approved by: _____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received June 14, 1977

Quad _____ FWL _____ FSL _____

Supplemental

File No. L-135 & L-135-Enlgd-S Use Irr Location No. 16.36.11.

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	2	2	Surface soil
2	26	24	Caliche
26	58	32	Sand-tight
58	112	54	Sand-water
112	128	16	Sand-tight
128	146	18	Sand-water

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Russell Abbott
Driller

H.B

Form WR-23 STATE ENGINEER OFFICE

STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well J.W. Taylor Jr.

Street and Number P.O.

City Hope State New Mex.

Well was drilled under Permit No. Comer Andrews Enlgd. L-135 and is located in the N.E.¼ S.E.¼ N.W.¼ of Section 11 Twp. 16So Rge. 36 E.

(B) Drilling Contractor C.O. Eldredge License No. W.D.79

Street and Number Box 38 379

City Lovington State New Mex.

Drilling was commenced Mar. 14 19 64

Drilling was completed Mar. 16 19 64

Elevation at top of casing in feet above sea level Total depth of well 110 Ft

State whether well is shallow or artesian Shallow Depth to water upon completion 75

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	95	110	15	Small crystlized sand rock & quick sand
2				
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
			Not cased					

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used
		16			2 sacks of drilling mud used to hold quick sand back while cleaning out well

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received STATE ENGINEER OFFICE 1964 MAY 19 AM 8:21

File No. L-135-Enlgd. Use Stk Location No. 16.36.11.131

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
95	110	15	red	small crystalized sand rock

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

C. O. Albaugh

Well Driller

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well City of Lovington Owner's Well No. L-9517

Street or Post Office Address P.O. Box 1268

City and State Lovington, N.M. 88260

Well was drilled under Permit No. L 9517 and is located in the:

a. SESE ¼ NE ¼ SESW ¼ SW ¼ of Section 3 Township 16S Range 36E N.M.P.M.

b. Tract No. _____ of Map No. _____ of the _____

c. Lot No. _____ of Block No. _____ of the _____ Subdivision, recorded in _____ County.

d. X= _____ feet, Y= _____ feet, N.M. Coordinate System _____ Zone in the _____ Grant.

(B) Drilling Contractor Gene Eades License No. WD982

Address Rt. 4 Tahoka, Tx. 79373

Drilling Began 11-27-84 Completed 11-27-84 Type tools Rotary Size of hole 8 in.

Elevation of land surface or _____ at well is _____ ft. Total depth of well 138 ft.

Completed well is ☒ shallow ☐ artesian. Depth to water upon completion of well 66 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
66	138	72	Brown water sand w/ sandstone stringers	30

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5 3/4	160 psi,				134		118	138
5 3/4	Sch, 40 steel	for	pitless	adapter	4			

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

Section 5. PLUGGING RECORD

Plugging Contractor _____

Address _____

Plugging Method _____

Date Well Plugged _____

Plugging approved by: _____

State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received December 10, 1984

Quad _____ FWL _____ FSL _____

File No. L-9517 Use Drinking/Sanitary 16.36.3.33244

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
0	3	3	Top soil
3	15	12	Caliche
15	21	6	Sandy clay
21	40	19	Sandy clay & sandstone
40	65	25	Sand & sandstone
65	66	1	Hard sandstone
66	138	72	Brown water sand

Section 7. REMARKS AND ADDITIONAL INFORMATION

DEC 10 8 22 AM '04

STATE ENGINEER
ROSWELL, NM

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Dane Eaker

Driller

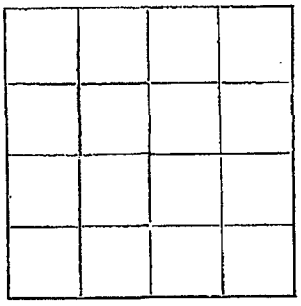
Form WR-23

STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1



(Flat of 640 acres)

(A) Owner of well City of Lovington

Street and Number Box 1268

City Lovington State New Mexico

Well was drilled under Permit No. L - 5356 and is located in the E ½ S ½ ¼ ¼ ¼ of Section 3 Twp. 18 S Rge. 36 E

(B) Drilling Contractor Grady Backus License No. W. D. 322

Street and Number Box 791

City Lovington State New Mexico

Drilling was commenced April 8 19 64

Drilling was completed April 12 19 64

Elevation at top of casing in feet above sea level Shallow Total depth of well 164 Ft. 70 Ft.

State whether well is shallow or artesian Depth to water upon completion

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	70	84	14 Ft.	Sand
2	112	120	10 Ft.	Sand
3	138	146	8 Ft.	Water Sand
4	153	158	5 Ft.	Water Sand
5				

Section 3 RECORD OF CASING

Dia in	Pounds ft	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
12 1/2	30		0	164	164 Ft.		112	164

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received

1964 APR 28 AM 8:37

File No. L-5356 Use Exfl C Location No. 16.36.3.400

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	1	1 ft.		Soil
1	4	3 ft.		Rock
4	18	14 ft.		Caliche
18	62	44 ft.		Sand
62	70	8 ft.		Sand Stone
70	84	14 ft.		Sand
84	98	14 ft.		Sand & Calcum
98	112	14 ft.		Sandy Clay
112	120	8 ft.		Sand
120	138	18 ft.		Sandy Clay
138	146	8 ft.		Water Sand
146	153	7 ft.		Sandy Clay
153	158	5 ft.		Sand
158	164	6 ft.		Sandy Clay

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Mack Barker

Well Driller

Form WR-23 Orig. [illegible] S.E. STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(Plat of 640 acres)

(A) Owner of well City of Lovington

Street and Number

City Lovington State New Mexico

Well was drilled under Permit No. L-3901 and is located in the SW ¼ NW ¼ SE ¼ of Section 10 Twp. 16 S Rge. 36 E

(B) Drilling Contractor Clayton Drlg. Co. License No. WD-183

Street and Number New Mex.

City Lovington State New Mexico

Drilling was commenced June 26 19 58

Drilling was completed June 28 19 58

Elevation at top of casing in feet above sea level Total depth of well 104 ft.

State whether well is shallow or artesian Shallow Depth to water upon completion 66 ft.

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	66	74	8	Water Sand
2	82	90	8	Quick Sand
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
7 in. O.D.	26	8	0	104	104	None	65	100

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used
20	104	8 in.	100 lbs.		Dry Mix

Section 5 PLUGGING RECORD

Name of Plugging Contractor License No.

Street and Number City State

Tons of Clay used Tons of Roughage used Type of roughage

Plugging method used Date Plugged 19

Plugging approved by:

Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received JUL 0 1958

File No. L-3901 Use Dom. Location No. 16.36.10.413

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	2	2		Soil
2	20	18		Caliche
20	28	8		Boulder
28	66	38		Sand
66	74	8		Water Sand
74	82	8		Sandy Clay
82	90	8		Quick Sand
90	104	14		Sand

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

CATTON WATER WELL DRILLING COMPANY
Well Driller

Quarley Barden

3. Dispersion Length of Chloride in the Vadose Zone

The dispersion length describes the amount of mixing a solute such as chloride will undergo in the vadose zone. Dispersion causes dilution of solute concentrations through mixing with ambient vadose water or ground water in a longitudinal direction parallel to water flow as well as in a transverse direction perpendicular to water flow. Systems with larger dispersion lengths produce greater mixing. Soil and aquifer heterogeneity tend to increase dispersion.

The dispersion length is very difficult to measure in the field. Researchers and field personnel rely upon professional judgement and published values (from laboratory or field experiments) to arrive at the dispersion length for a particular site. In general, researchers employ a dispersion length that is 7-10% of the total model length. When modeling a ten meter thick vadose zone, one may set the dispersion length at 10% of ten meters (100 cm).

4. Depth to Ground Water or Vadose Zone Thickness

The vadose zone is the region between the land surface and ground water table, and its thickness is defined by the depth to the ground water table. The vadose zone (also referred to as the unsaturated zone) includes the capillary fringe (pore space completely filled with water, under negative soil water pressure) and the overlying soil and sediment where the pore space is partially filled with water. Because ground water table depth rises and falls due to seasonal fluctuations in precipitation, ground water pumping withdrawals, and other factors, the thickness of the vadose zone is not constant. Like soil texture, the thickness of the vadose zone affects the time required for a release at the ground surface to reach the water table. The thicker the vadose zone, generally, the longer the travel time from ground surface to the water table. A relatively thick vadose zone also has more open pore space to temporarily store released fluid. A thick vadose zone can attenuate the effects of a chloride ion release more effectively than a thin vadose zone.

5. Climate

Precipitation and evaporation affect the water content of the vadose zone (before a release) and exert control over the migration of chloride after a release. In a humid climate regular and gener-

ous precipitation over the annual cycle can create relatively uniform infiltration patterns and a predictable soil water profile. In arid climates, where rainfall occurs in short-duration thunderstorms punctuated by long periods of drought, the infiltration is not uniform and occurs only immediately after large precipitation events. Arid climates exhibit vadose zones with relatively low water contents.

In humid climates with relatively uniform infiltration patterns, one could employ monthly climate data for simulation modeling. In arid climates, daily precipitation and evaporation data are necessary.

6. Chloride Concentration of Release

Chloride concentration in oil field brine water can be 100,000 ppm, or much lower if the producing formation contains fresh water due to infiltration of precipitation over geologic time. One of the easiest input parameters to measure in the oil and gas fields is the chloride concentration of the produced water. The chloride concentration in other types of released fluids can also be measured. The effect of chloride concentration in a released substance is straightforward: the higher the chloride concentration, the greater the environmental threat.

7. Release Volume and Chloride Mass

The volume of the release multiplied by the chloride concentration of the release yields the total mass of chloride released to the environment. The total mass released is a very important input parameter because it determines for a specific site the risk for ground water impairment. In the absence of reliable data on the volume of a release, the total mass of chloride can generally be estimated by a field investigation.

8. Height of Spill

Chloride ion releases occur in bermed areas when produced water storage tanks fail or within the natural terrain due to transmission line leaks and other transportation accidents. Releases may pond in a berm, pit, or natural depression, or can be dispersed over a large area. If the release is contained within a berm, the spill height is equal to or less than the height of the berm. In an open field, the spill height may vary. For a given site the amount of chloride ion infiltration into the soil is a function of the hydrau-

lic head or ponding depth. As the ponding depth increases, so does the hydraulic head, (pressure, at the soil/chloride ion spill interface). Understanding the depth of ponding and the total amount of infiltration per unit area guides the characterization efforts. A large amount of infiltration may require deep drilling for site characterization while a small release may require sampling with a hand shovel.

9. Ground Water Flux

Ground water moves through an aquifer in response to its capacity for transmitting water, or, hydraulic conductivity (m/day), and the driving force caused by a sloping water table (hydraulic gradient). The hydraulic conductivity of aquifers can be measured in the field, and can be found in publications that often provide estimates of this parameter. The hydraulic gradient can be measured in the field by determining the depth to water at three wells of known surface elevation. Multiplication of the hydraulic conductivity by the hydraulic gradient yields the ground water flux, which is the volume of water flowing through a unit area of aquifer over a specified time period (expressed in $m^3/(m^2 * day)$ = m/day). The lower the ground water flux, the higher the probability that a release will cause unacceptable ground water quality impairment.

10. Aquifer Thickness

A thick aquifer contains more water than a thin aquifer. A given amount of chloride that enters from the vadose zone in a thick aquifer will result in a lower chloride concentration than the same amount entering a thin aquifer since aquifers that contain more water can be more effective at diluting contaminates. A thick aquifer that exhibits a large ground water flux may be able to absorb chloride from a large surface release without any severe impact to water quality.

11. Aquifer Ambient Chloride Concentration

Ambient chloride concentrations of ground water will influence whether or not a release causes unacceptable ground water quality impairment. If ground water has a low chloride concentration, even a considerable release may not cause chloride concentrations to exceed the US EPA Secondary Standard of 250 ppm or preclude the use of the water for agricultural needs. A high chloride concentration in ground water increases the risk that a chlo-

ride ion release will render the groundwater unfit for use. Simple field measurements from nearby well water or published data can supply an accurate estimate of the ambient chloride concentration in an aquifer.

1.1 HETEROGENEITY

Heterogeneity, most often caused by the layering of different sediment or soil types within a vadose zone, is more common in nature than not. Heterogeneity affects the distribution of chloride and other solutes through its strong influence on dispersion and hydraulic permeability.

One of the most common simplifying assumptions employed by regulators and guidance manuals is the assumption of homogeneity. However, a clay lens one meter thick found 3 meters below a release in a sandy soil will have a profound effect on the migration of chloride through the vadose zone. Heterogeneity can increase the attenuation of a release and help mitigate the effects on ground water quality.

1.2 RELEASE VOLUME, SPILL HEIGHT, AND CHLORIDE CONCENTRATION OF THE RELEASE

We have found that knowledge of the volume of a release is less important than understanding (1) the chloride load per unit area and (2) the geometry of the release with respect to ground water flow. Because release volume is seldom known with accuracy, we have combined chloride concentration in the release and spill height into a single parameter: chloride load/ unit area. We then used the release volume and spill height to calculate the size of a circular release. As described below, we used the diameter of the release as the length of a release parallel to ground water flow. If an oblong release geometry is oriented parallel to ground water flow, more chloride will enter the aquifer along a specific flow line, yeilding a higher chloride concentration in the down gradient well. If the long axis of the oval release is perpendicular to ground water flow, the impact to a well will be less. By re-arranging and combining these factors, we reduced the total number of factors from 11 to 10.

2.0 MODELING APPROACH

The modeling of chloride ion migration from the soil surface through the vadose zone into a shallow aquifer towards a monitoring well would require a sophisticated three-dimensional model, which takes into account the full coupling between unsaturated flow in the vadose zone and saturated flow in the aquifer. Such an approach is outside the scope of this study since generally acceptable three-dimensional models capable of such simulations are still being developed. Moreover, the computer time necessary to conduct such simulations would have been prohibitive for regulators and oil field personnel.

We used an approach based upon the assumption that flow through the vadose zone is mainly downward. This assumption is reasonable for humid climates where precipitation exceeds evapotranspiration most of the year. It is also reasonable in arid climates when the ground water table is so deep that no upward flow due to capillary rise can be maintained. Under these conditions, it is possible to de-couple the modeling of water flow and chloride transport in the vadose zone from the modeling of water flow and chloride transport in the aquifer. We assume that flow in the vadose zone is one-dimensional downward and flow in the aquifer is one-dimensional horizontal. This assumption allows us to first simulate water flow and chloride transport through the vadose zone using the model HYDRUS-1D. The output from HYDRUS-1D is the downward water flow seeping out of the vadose zone and the downward chloride flux over time. These outputs are used as inputs into the model for the aquifer. In this study, we used two models for the aquifer: MODFLOW and a simple groundwater mixing model. MODFLOW is a standard code for modeling water flow and solute transport through aquifers (Domenico & Schwartz, 1998). Since it takes quite some time to setup a simulation in MODFLOW, we used a validated excel spreadsheet mixing model to generate results more cost effectively.

2.1 VADOSE ZONE MODEL: HYDRUS-1D

2.1.1 Model Overview

HYDRUS-1D (Simunek et. al, 1998) is used to simulate one-dimensional transport of water, heat, and solute movement in variably saturated porous media. The HYDRUS- 1D model was developed by the George E. Brown Jr., Salinity Laboratory, USDA, ARS, Riverside, California and is distributed by the International

Ground Water Modeling Center (IGWMC), Golden, Colorado. A Microsoft Windows™ based Graphics User Interface (GUI) supports HYDRUS-1D.

The HYDRUS-1D model numerically solves the Richards' equation for water flow and Fickian-based advection-dispersion equations for heat and solute transport. The HYDRUS-1D flow equation includes a sink term (a term used to specify water leaving the system) to account for transpiration by plants. The solute transport equation considers advective, dispersive transport in the liquid phase, diffusion in the gaseous phase, nonlinear and non-equilibrium sorption, linear equilibrium reactions between the liquid and gaseous phases, zero-order production, and first-order degradation. The heat transport equation describes conduction as well as convection.

HYDRUS-1D can handle large numbers of soil layers, and uses the van Genuchten-Mualem, Brooks-Corey, Kosugi lognormal, and Durner dual porosity models to describe soil hydraulic properties. When values of soil hydraulic properties are unavailable, HYDRUS-1D can estimate them from a small catalog of values based on major textural classes (e.g., sand, sandy loam, etc.) or neural network based predictions.

The HYDRUS-1D code can simulate a wide range of boundary conditions. These are constant and time-variable pressure heads and fluxes, free drainage, seepage face, and an atmospheric boundary condition. An atmospheric boundary condition can be used to either generate run-off when the precipitation rate exceeds the infiltration capacity of the soil, or store excess water on the land surface allowing the water to infiltrate when precipitation stops. Time-variable conditions can be entered hourly, daily, or any general time interval.

We used HYDRUS-1D for the vadose zone simulations of this research project because we are interested in the vertical transport of water and chloride through the vadose zone. The outputs from HYDRUS-1D are the daily water flow and chloride flux from the vadose zone over the time period of the simulation expressed as cm day^{-1} and mg cm^{-2} day^{-1} respectively. These outputs are used as inputs into the simple mixing model.

2.1.2 Applicability of HYDRUS-1D for Chloride ion Releases

Surface or near surface releases of chloride ion migrate through the vadose zone under variably saturated conditions as a function

Form WR-23 STATE ENGINEER OFFICE

FIELD ENGR. LOG

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

(A) Owner of well City of Lovington

Street and Number P.O. Box 1268

City Lovington State New Mex.

Well was drilled under Permit No. L-5014 and is located on the

___ ¼ ___ ¼ ___ ¼ of Section ___ Twp. ___ Rge. 32E

(B) Drilling Contractor Box 791 License No. ___

Street and Number Lovington New Mex.

City Nov. 27, State 62

Drilling was commenced Dec. 9, 19 62

Drilling was completed 1962 19

(Plat of 640 acres) 216 Ft.

Elevation at top of casing in feet above sea level Unknown Total depth of well 66 Ft.

State whether well is shallow or artesian ___ Depth to water upon completion ___

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
	70	76	6	Sand
1	82	94	12	Quick Sand
2	112	116	4	Sand
3	132	137	5	Sand
4	164	168	4	Sand ?
5	178	190	12	Sand

Section 3 RECORD OF CASING

Dia in.	Pounds per ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
12	3/16 Wall							

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor ___ License No. ___

Street and Number ___ City ___ State ___

Tons of Clay used ___ Tons of Roughage used ___ Type of roughage ___

Plugging method used ___ Date Plugged ___ 19___

Plugging approved by:

___ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

STATE ENGINEER OFFICE
1962 DEC 13 AM 8:11

Date Received √

File No. L-5014 Use Expl. Location No. 16.36.10.240

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	2	2		Soil
2	8	6		Clachie
8	12	4		Bolder
12	28	16		Clichie
28	70	42		Sandy Clay
70	76	6		Water Sand
76	82	6		Sandy Clay
82	94	12		Quick Sand
94	112	18		Sandy Clay
112	116	4		Sand
116	132	16		Sandy Clay
132	137	5		Sand
137	164	27		Sandy Clay
164	168	4		Sand
168	178	10		Sandy Clay
178	190	12		Sand
190	205	15		Clay
205	215	10		Clay & Gravel
215	216	1		Red Bed
				L S Elev
				Depth to K Trc
				Elev of K Trc
				Loc. No.
				Hydro. Survey Field Check

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Grady Backus
Well Driller

SOURCE OF ALTITUDE GIVEN

Interpolated from Topo. Sheet_____

Determined by Inst. Leveling_____

Other_____

L-5014

16.36.10.240

APPENDIX B

Depth	Lithologic Description	Measured Soil Chloride Concentration mg/kg	Bulk Density of Sample kg/m3	Thickness of Column (ft)	Calculated Chloride Mass in Column (kg/m2)
0 feet	0-1ft Top Soil				
	1-22 ft Caliche	525	1858	10	3.23
10 feet					
		1088	1858	11	7.37
20 feet					
	22-31 ft Sand & Caliche	1161	1858	5	3.57
30 feet		636	1858	4	1.57
	31-45 ft Sand	573	1858	7	2.47
40 feet		236	1858	7	1.02
		Calculated Chloride Load			19.22

R.T. Hicks Consultants 901 Rio Grande NW Albuquerque, NM	**RICE** *Operating Company*
	Calculation of Chloride Load, Abo Leak, Lea County, New Mexico
	Soil Bore #1
	Apr-04

Calc. of hydrus cl inputs, C_hyd = a * .003489 mmol/cm^3

CL in mg/kg	Cl in mmol/cm^3	Depth to bndy in ft.	Depth to bndy. In cm.
		1	30.5
525	0.183173	11	335.5
1088	0.379603	22	671
1161	0.405073	27	823.5
636	0.2219	31	945.5
573	0.19992	38	1159
236	0.08234	45	1372.5

Calc. Chloride load in kg./m^2	19.228	
Area of spill in ft^2	30000	
Totlal Cl in kg. (= Cl load * area)	53584.96	
Conc. of the spill mg.(Cl)/liter (from field test)	19994	
Volume of spill in liters (= Total Cl * 1000)/ Conc.)	2680.052	
volume of spill in ft.^3	94.63264	16.85587
height of spill in inches (= vol.of spill / area)	0.037853	Vol. in barrels, assumes a barrel is 42 gal.
Area of spill in m^2	2786.819	

ABO leak

Unit G, Sec. 1, T17S, R36E

Calculation of Lovington Abo Spill Height, SB-1

Calc. Chloride load in kg./m^2	(From calc., see other sheet)	19.228	
Area of spill in ft^2	(Field measurements, ROC)	30818	
Area of spill in m^2		2866.84445	Barrel size 42
Totlal Cl in mg.	(= Cl load * area)	55123685085	
Conc. of the spill mg.(Cl)/cm^3	(from field test)	247.04	theta_v assumed .15
Volume of spill in liters	(= (Total Cl * 1000)/ Conc.)	223136.6786	
volume of spill in ft.^3		7878.956122	Vol. in barrels, assumes a barrel is 42 gal. 1403.392
height of spill in inches	(= vol.of spill / area)	3.067930218	
height of spill in cm.		7.783354922	

Calculated Chloride load at SB-3

Soil Bore #3		Soil density Kg./m^3		Depth in ft.	Cl. in each layer in kg.
Depth bgs (ft	[Cl] ppm				
3	647		1858	3	1.194808711
4	1023		1858	1	0.629721438
5	1018		1858	1	0.626643621
6	947		1858	1	0.582938614
8	733		1858	2	0.902416059
9	700		1858	1	0.430894435
10	736		1858	1	0.45305472
11	533		1858	1	0.328095334
12	432		1858	1	0.265923423
13	396		1858	1	0.243763137
14	301		1858	1	0.185284607
15	256		1858	1	0.15758425
		Total CL. in kg./m^2 for SB-3			6.00112835

Calculation of Lovington Abo Spill Height, SB-3

Calc. Chloride load in kg./m^2	(From calc.)	6.00112835	
Area of spill in ft^2	(Field measurements, ROC)	30818	
Area of spill in m^2		2866.84445	
Totlal Cl in mg.	(= Cl load * area)	17204301503	
Conc. of the spill mg.(Cl)/cm^3	(from field test)	247.04	theta_v assumed .15
Volume of spill in liters	(= Total Cl / Conc.*1000)	69641.7645	
volume of spill in ft.^3		2459.050705	Vol. in barrels, assumes a barrel is 42 gal. 438.0038
height of spill in inches	(= vol.of spill / area)	0.957512118	
height of spill in cm.		2.429213224	

The SB-3 spill data was used in the HYDRUS-1D runs to calibrate the model to the soil. For the long time run with the adjusted soil, the chloride load at SB-1 was installed as the initial condition in the soil profile. This adds the chloride load from the earlier spill to the long time simulation.

APPENDIX C

1.0 FACTORS INFLUENCING THE MIGRATION OF CHLORIDE FROM A RELEASE

Chloride ion migration is controlled by a combination of factors related to the vadose zone, the aquifer and the characteristics of a release. Eleven factors control chloride ion migration. Here we discuss how these factors affect the movement of the chloride ion through the vadose zone and in the aquifer.

1. Vadose Zone Texture

The proportion of sand, silt, and clay in a soil or sediment defines vadose zone texture. Texture affects the flow of water and the transport of dissolved chloride. In the vadose zone, fine-grained layers containing silt and clay, which generally have relatively high moisture content, can often transmit water more quickly than drier coarse-grained units containing sand and gravel. A vadose zone composed of layers of fine-grained and coarse-grained units will often transmit water more slowly than a homogeneous, fine-grained profile. In the unsaturated zone, open fractures do not transmit water.

2. Water Content in the Vadose Zone

The soil moisture content is the volumetric fraction of water in a soil or sediment. Climate and soil texture influence soil moisture contents. Wetter, more humid environments result in higher moisture contents. Fine grained and heterogeneous soils retain water better than coarse-grained, more homogeneous soils. Therefore, the more heterogeneous and finer grained the material, the greater the water content.

The water content of a soil or sediment affects its ability to transmit fluids because the hydraulic conductivity increases with increasing water content. The hydraulic conductivity of a sandy soil with water content of 20% can be 1,000 times greater than the same soil in an arid climate where water content is only 5%. Although chloride ion from a release may migrate much faster in a wet soil profile, the natural water in the soil also dilutes the chloride concentration and provides some mitigation of its effects on ground water quality.

of release volume, topography, and climatic conditions (i.e., precipitation and evapotranspiration). Although other vadose zone models exist that satisfy this criterion, we selected HYDRUS-1D over other models for the following three reasons:

1. It can simulate water and solute transport through heterogeneous porous media: horizons and sediments of varying geology;
2. It can incorporate daily climatic data; and
3. We are familiar with the model.

Dr. Jirka Šimùnek of our team developed the HYDRUS-1D model with his colleagues Dr. van Genuchten and Dr. Sejna; Dr. Jan Hendrickx, another team member, has used the HYDRUS-1D model for many years for evaluation of groundwater recharge and salt movement through the vadose zone.

2.2 SATURATED ZONE MODEL: MIXING MODEL AND MODFLOW

As stated, the objective of this part of this study is to evaluate the impact of choride releases on ground water quality as measured in a well adjacent to and down gradient of the release. The chloride flux leaving the vadose zone, the horizontal flux in the unconfined aquifer, the original chloride concentration in the ground water, and the thickness of the unconfined aquifer also affect the chloride concentration of the aquifer. Since the water flux seeping from the vadose zone and its chloride concentration vary with time, no simple analytical solutions are available for determination of the time-varying chloride concentration in the well.

Therefore, we implemented a simple spreadsheet ground water mixing model for the determination of the chloride concentration in the well. This mixing model uses the output of the HYDRUS-1D model as input. We have to define the aquifer volume, (the mixing compartment underneath the spill) as a first step in the ground water mixing modeling process. Assuming a circular spill area and a unidirectional horizontal flux in the aquifer, the highest impact will occur where the ground water has the longest exposure to the incoming chloride from the vadose zone. This takes place along the diameter of the circular spill. Therefore, the length of the mixing compartment is made equal to the diameter of the spill area, D. The depth of the mixing compartment is the thickness of the aquifer, H. The width, W, of the mixing compartment is taken equal to unity (one) to simplify the calculations.

Now we will develop the relation between the water flux seeping out of the vadose q_v, the chloride concentration in the vadose zone flux , C_v, the horizontal flux in the aquifer underneath the release entering the compartment, $q_{in,}$ the original chloride concentration in the aquifer, C_{in}, the horizontal flux in the aquifer underneath the release leaving the compartment, q_{out}, and the chloride concentration of the aquifer flux leaving the area underneath the chloride ion release, C_{out}. The latter concentration is the one that will be monitored in the down gradient well. We make the following reasonable assumptions to determine C_{out}:

1. Ground water flow is in steady state. The discharge entering into the mixing compartment from the vadose zone, q_vH*D*H*W*, plus the horizontal discharge in the aquifer entering the mixing compartment at its up-gradient side, q_{in}H*H*H*W*, are equal to the discharge leaving the mixing compartment, q_{out}H*H*H*W*.

2. Changes in thickness of the saturated aquifer are small compared to the total thickness of the aquifer H.

3. The thickness of the aquifer, *H*, and its porosity, *n*, are constant.

4. Mixing of the chloride entering the mixing compartment is complete and immediate. This assumption appears invalid from data published in the recent literature (LeBlanc et al., 1991; Zhang et al., 1998). We can use the results of the mixing model as an excellent indicator of the mean chloride concentration in a supply well penetrating the aquifer underlying the release, but not as an indicator of the chloride distribution in the aquifer.

The volume of the mixing compartment, *V*, will be constant under these assumptions, and is equal to:

$$V = D \times H \times W \times n \qquad \textbf{(2-1)}$$

The water balance of the mixing compartment is equal to:

$$q_{in} \times H \times W + q_v \times D \times W = q_{out} \times H \times W \qquad \textbf{(2-2)}$$

We can eliminate variable *W* from Eqs. [2-1] and [2-2] by putting *W*= 1 m.

The chloride balance of this mixing compartment during any time period dt is:

$$[(q_{in} \times C_{in} \times H + q_v \times C_v \times D) - (q_{in} \times H + q_v \times D) \times C_{out}]dt = [D \times H \times n]dC$$

(2-3)

where dC is the change of chloride concentration occurring during time period dt.

Rearranging Eq. [2-3] we obtain the ordinary differential equation:

$$\frac{dC}{dt} = \frac{q_{in} \times C_{in} \times H + q_v \times C_v \times D - (q_{in} \times H \times q_v \times D) \times C_{out}}{H \times D \times n}$$

(2-4)

As soon as chloride from the release enters the ground water, the volume average concentration in the mixing compartment is C_{out} after complete mixing has occurred. Thus the chloride concentration of the water leaving the department, C_{out}, becomes:

$$C = C_{out} \qquad \text{and} \qquad dC = dC_{out}$$

(2-5)

Therefore, we can convert Eq. [2-4] in a forward finite difference expression:

$$\frac{C_{out}^{i+1} - C_{out}^{i}}{t^{i+1} - t^{i}} = \frac{q_{in}^{i} \times C_{in}^{i} \times H + q_v^{i} \times C_v^{i} \times D - (q_{in}^{i} \times H + q_v^{i} \times D) \times C_{out}^{i}}{H \times D \times n}$$

(2-6)

which yields an explicit expression for C_{out}^{i+1},

$$C_{out}^{i+1} = C_{out}^{i} + \frac{[q_{in}^{i} \times C_{in}^{i} \times H + q_v^{i} \times C_v^{i} \times D - (q_{in}^{i} \times H + q_v^{i} \times D) \times C_{out}^{i}] \times [t^{i+1} - t^{i}]}{H \times D \times n}$$

(2-7)

Using the output from HYDRUS-1D: the chloride concentration, C_v^i, of the water, q_v^i, entering the ground water table on day, t^i, we have put into a spreadsheet the mixing model of Eq.

[2-7]. By changing the values for spill diameter, D, ground water flux, q_{in}, original chloride concentration in the aquifer, C_{in}, and the aquifer thickness, H, we have evaluated the effect of these four factors of an unconfined aquifer.

Figure 2-1 *Comparison between MODFLOW and the Mixing Model*

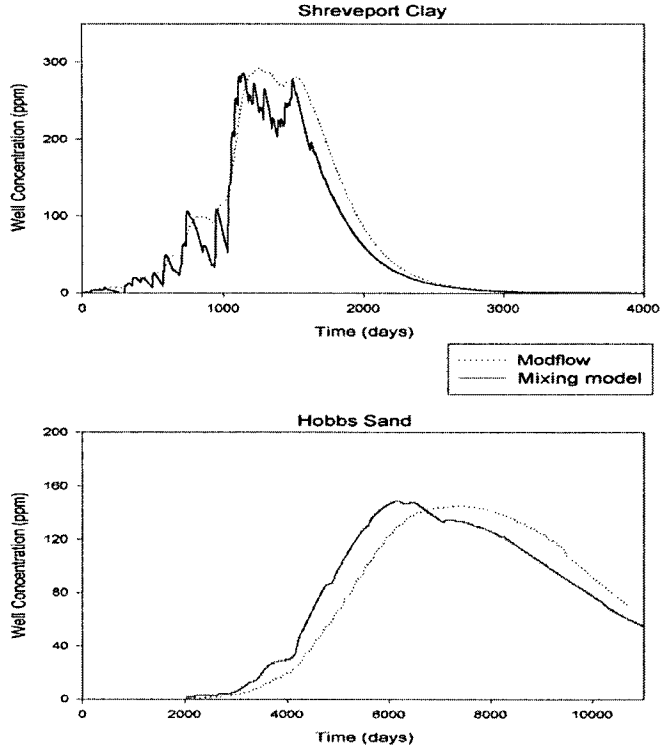


Figure 2-1 presents two comparisons between the chloride concentrations in the well located down gradient of the entry point of the release obtained with the mixing model Eq. [2-7] and those obtained with the model MODFLOW. The two comparisons deal with two complete different sets of environmental and release factors. In Shreveport the vadose zone texture is clay, the dispersion length 0.1 m, release chloride concentration 10,000 ppm, spill height 0.6 m, and aquifer flux 0.05 m/day. In Hobbs, vadose zone texture is sand, dispersion length 2.0 m, release chloride concentration 100,000 ppm, spill height 0.025 m, and aquifer flux 0.004 m/day. The maximum chloride concentrations predicted by the two models is quite similar, although the time of arrival to the maximum concentration is different between the two models. We have conducted

this part of the study using the less expensive mixing model Eq. [2-7]. (Our approach using HYDRUS-1D in combination with MODFLOW and Eq. [2-7] is valid for situations where the vadose zone seepage flux, q_v, is downward. A downward flux in the vadose zone is always found in the profiles with a deep ground water table depth. However, in the profiles with a ground water table depth between **0 – (+/-) 10** m an upward flux from ground water table towards the soil surface does occur as a result of capillary rise. The magnitude of the upward capillary flux depends on soil type and climate.

A large amount of precipitation enables the downward vadose zone flux to dominate the chloride transport in both the sandy and clayey soil in the humid climate of Shreveport. Occasionally in the clayey soil an upward flux is encountered during short periods without rain.

An upward flux is sometimes found in the sanyd soil but is prevalent in the clay soil in the arid climate of Hobbs. For example, when the ground water table depth is 3 m, the average upward flux in a clay profile would be 0.04 cm/day or 13.5 cm/year; this upward capillary flux causes the chloride and soil water from the release to stay in the vadose zone and protects the ground water from impairment. In hydrogeological situations where capillary rise is common, vadose zone water movement towards ground water is sporadic. However, a big storm can push chloride ion into a shallow aquifer very quickly.

There is a strong dynamic interaction between all eleven factors, outlined in section 1.1., when water leaving the vadose zone, q_v, changes direction frequently in response to precipitation events (downward movement) and evapotranspiration (upward movement). In dry climates with shallow ground water (less than 3 m), upward movement of ground water into the vadose zone thnce to the atmosphere is common. The only manner to correctly simulate the interaction between these factors is by employing a two- or three-dimensional model, such as HYDRUS-2D. However, since the main objective of this study is ground water impairment and the effect of capillary rise in diminishing the leaching of chloride to the ground water, and is not the chloride ion concentration in the root zone, we used the mixing model Eq. [2-7] for ground water table depths of 3 m. We used the equation only for downward fluxes and made it inactive when the vadose zone flux q_v, goes upward. It was

initiated again with the next occurrence of a downward flux, q_v, taking the C_{out} value of the previous occurrence of a downward q_v. In this manner a conservative estimate is obtained of the chloride concentration in the monitoring well assuming perfect mixing for shallow groundwater tables.

3.0 SENSITIVITY ANALYSIS OF FACTORS DETERMINING CHLORIDE ION FATE

3.1 PURPOSE

After a brine release, the concentration of chloride in the vadose zone decreases with time and distance traveled through the vadose zone towards ground water because of dilution with ambient soil water. Further dilution occurs in the aquifer after the chloride reaches the ground water. The maximum chloride concentration occurring at a well down gradient from the release will depend on all the factors that affect chloride transport through the vadose zone and shallow aquifer. Understanding these factors is critical for the design and implementation of a site characterization program after a chloride ion release. The degree of ground water quality impairment determines to a large extent the need for a ground water remedy. The purpose of this sensitivity study is to evaluate which of the eleven factors have the greatest effect on prediction of maximum chloride concentration in the well down gradient of the release.

3.2 MODELING SPECIFICS

We needed to optimize our simulation efforts in order to obtain the maximum amount of information from the modeling. Statistics of experimental designs (e.g. Law & Kelton, 2000; Snedecor & Cochran, 1967; Steel & Torrie, 1980) allow us to decide which combination of factors to simulate so that the desired information can be obtained with the lowest possible number of simulations.

The factors used in experimental design statistics are the input variables to our simulation models. The outputs of our simulations are the responses. The responses that we consider in this study are the maximum chloride concentration, C_{max}, occurring in the well and the time at which the maximum chloride concentration reaches the well, T_{max}.

We have opted for a 2^k *factorial design* that requires us to choose two levels of each factor in this study. This design results in a

total of 2^k simulation runs, where k is the number of factors. We chose the two values for each factor so that they represent two opposite conditions such as an arid and a humid climate. The factors can be qualitative like climate or quantitative like depth to ground water. The two input values should not be too extreme or unrealistic. Additionally, the two values should not be too similar or the simulations may not adequately evaluate important aspects of the transport process under consideration. The 11 factors of this sensitivity analysis (see Table 3-1) resulted in 2^{11} or 2,048 different chloride ion release scenarios.

3.2.1 VADOSE ZONE FACTORS

Table 3-1: *Vadose zone, aquifer, and brine release factors determining maximum chloride concentration arriving at a monitoring well down gradient.*

Factor #	Factor Description	Factor Abbreviation	Maximum Chloride Concentration Decrease	Maximum Chloride Concentration Increase
1	Climate	clim	Arid	Humid
2	Soil Texture	soil	Clay	Sand
3	Initial Water Content	wcin	Wet	Dry
4	Chloride Dispersion Length	disp	2.0 m	0.1 m
5	Ground Water Depth	gwl	30 m	3 m
6	Ground Water Flux	qaq	0.05 m/day	0.001 m/day
7	Ambient Aquifer Cl Concentration	cin	0 ppm	100 ppm
8	Aquifer Thickness	thick	30 m	3 m
9	Release Volume	vol	100 barrels	10,000 barrels
10	Release Height	depth	0.025 m	.6m
11	Release Chloride Concentration	clcon	10,000 ppm	100,000 ppm
10*11	Release Chloride Mass	clmass	250 g/m^2	60,000 g/m^2

Climate

We selected the two contrasting climates of Lea County, New Mexico, and Shreveport, Louisiana for the sensitivity analysis. Lea County is located in the arid southwest, and Shreveport is in the humid south. Lea County's annual precipitation and potential evapotranspiration is 14 inches and 59 inches, respectively, while annual precipitation and potential evapotranspiration for Shreveport is 46 inches and 67 inches, respectively. Lea County and Shreveport also differ in how precipitation occurs. In Lea County, the majority of precipitation occurs during the "monsoon" of July-August and much of the remainder of the year resembles drought conditions. Shreveport's precipitation falls throughout the year.

Vadose Zone Texture

We selected sand and clay as contrasting soil textures for the sensitivity analysis. Sand and clay differ not only in grain size but also in their ability to retain and transmit water. Sand has a relatively high-saturated hydraulic conductivity and low water retention; whereas clay has a relatively low saturated hydraulic conductivity and high water retention.

Water Content in Vadose Zone

We hypothesized that higher initial water content in the vadose zone would result in slower chloride ion movement because the initial moisture must be displaced before the chloride ion can move downward through the vadose zone. We used HYDRUS-1D to predict initial water contents for both vadose zone textures in both Lea County and Shreveport. We used these predictions as initial conditions in the sensitivity analysis.

We ran simulations for one hundred years or until we achieved dynamic equilibrium between soil water content and climatic conditions for both the wet and dry initial conditions. To create *wet* conditions, we ran simulations without any vegetation (low evapotranspiration); and ran simulations with vegetation (high evapotranspiration) in *dry* conditions. We used evergreen plants capable of transpiring soil water all year round with a 3 meter (~10 ft) deep root zone. Transpiration of soil water created a drier soil profile than simulations without vegetation.

Dispersion Length of Chloride in Vadose Zone

For the sensitivity analysis, we selected minimum and maximum chloride dispersion lengths of 0.10 m (0.33 ft) and 2.0 m (6.6 ft), respectively. The larger dispersion length will produce greater mixing of chloride ion with ambient soil water in the vadose zone, and it is expected to result in a lower maximum chloride concentration in the well. Conversely, the smaller dispersion length will result in minimal mixing, e.g. minimal attenuation of the release, and larger maximum chloride concentrations. We based our selection of dispersion lengths on values reported in the literature (Gelhar, 1993).

Depth to Ground Water

Deep ground water allows for more storage of chloride ion and more attenuation of the maximum chloride concentration during its downward migration. We selected ground water depths of 3.0 m (9.8 ft) and 30 m (98 ft) for the sensitivity analysis. These depths represent reasonable values for a shallow and deep aquifer, respectively.

3.2.2 AQUIFER FACTORS

Ground Water Flux

Ground water flux represents the rate of ground water movement and effects the ability of an aquifer to dilute chloride and other constituents of a chloride ion release. A large ground water flux produces greater dilution.

We based our selection of minimum and maximum groundwater fluxes on literature values for the Ogalalla aquifer, Southern Lea County, New Mexico (Native and Smith, 1987). We used 0.10 cm/day (0.0033 ft/day) and 5.0 cm/day (0.16 ft/day) as minimum and maximum values, respectively. The maximum flux is lower than some of the ground water fluxes reported in the literature (e.g. 40 cm/day by Zhang et al., 1998) and, thus, is a conservative estimate.

Aquifer Ambient Chloride Concentration

We selected ambient chloride concentrations for ground water of 0 ppm and 100 ppm. One hundred parts per million or less is typical for ground water of the Ogallala aquifer (Nicholson and Clebsch, 1961) and the Carrizo-Wilcox aquifer in Caddo Parish, Louisiana (Rapp, 1992). Although 10-ppm chloride is a more characteristic minimum value for the Ogallala and Carrizo-Wilcox aquifers, we selected 0.0 ppm to create a greater difference between minimum and maximum chloride concentrations of ground water.

Aquifer Thickness

The thicker the aquifer, the more opportunity for mixing (dilution), and the lower the predicted chloride concentration will be in the aquifer. We selected two aquifer thicknesses, 3.0 m (9.8 ft) and 30 m (98 ft). Three meters are approximately equal to the length of most well screens used to monitor the chloride changes. Therefore, an aquifer thickness of 3 meters provides a good estimate of expected chloride concentrations at a monitor well in a thicker aquifer under conditions of limited vertical mixing. Many unconfined, alluvial aquifers are greater than 30 m thick, but we have selected 30 m as the maximum value. A 30 m thick saturated sandy formation with a hydraulic conductivity of at least 0.0005 m/s (140 ft/day) is classified as a good aquifer (Freeze and Cherry, 1979).

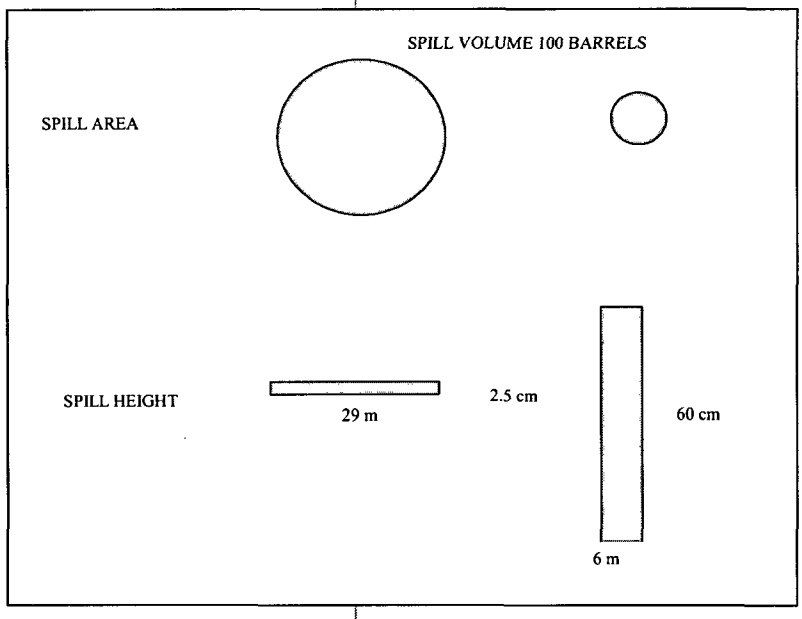
3.2.3 CHLORIDE ION RELEASE FACTORS

Release Volume

We used minimum and maximum release volumes of 100 bbl (16 m^3) and 10,000 bbl (1,600 m^3), respectively. These release volumes are representative of large and very large releases based on the experience of oil and gas industry personnel.

In the one-dimensional HYDRUS-1D model we used only spill height as an input variable. The spill volume was introduced into the mixing model using the diameter of the spill. For example, a 100 barrel release resulting in a chloride ion release of 0.025 m height with circular shape will have a diameter of 29 m while a release of 0.6m height will have a diameter of only 6m (Figure 3-1). Table 3-2 summarizes the four chloride ion release areas evaluated with the mixing model. These four release areas are combinations of the two spill heights (0.025 and 0.6 m) and two release volumes (large: 100 barrels and very large: 10,000 barrels).

Figure 3-1. *Schematic of Two Possible Brine Release Characteristics After a Release of 100 Barrels.*



We represented all spill areas as circles, and then, used the mixing model to evaluate mixing along the diameter of each circular spill (see Table 3-2). The diameter of each circle represents the longest path groundwater must flow beneath each release area, and thus provides a conservative estimate of groundwater quality impairment at a well immediately down gradient of a release.

Table 3-2. *Characteristics of brine releases in this study.*

Volume	Depth		Area		Diameter
Barrels	m^3	m	m^2	acres	m
100	16	0.025	640	0.16	29
		0.6	26.67	0.007	6
10000	1600	0.025	64000	16	285
		0.6	2666.67	0.7	58

Chloride Concentration of Release

We selected chloride concentrations of 10,000 and 100,000 ppm, as the minimum and maximum concentrations for the chloride ion release input parameter in consultation with experienced professionals. These concentrations are representative of most chloride ion releases.

The mixing model does not consider density differences between the density of the chloride ion arriving at the aquifer and the density of the water in the aquifer. These differences (even if small) may cause chloride ion to sink in an aquifer (LeBlanc et al., 1991; Zhang et al., 1998) and would influence the distribution of chloride ion in the aquifer. Since our approach assumes complete mixing in the aquifer, the chloride distribution is not taken into account. Water extracted from a well by bailing or pumping typically would represent a well mixed sample. The

results of the mixing model help to identify environmental and release characteristics that cause groundwater quality impairment and provide a measure of the overall impact of a chloride ion release on an aquifer.

Height of Spill

We selected 0.025 m (1 inch) and 0.6 m (2 ft) as the minimum and maximum spill heights, respectively, of brine water on the land surface, based on observations of oil and gas industry personnel. A 0.6 m (two-foot) height represents a discharge of 1600 m^3 (10,000-bbls) of chloride ion to a 2670 m^2 (0.7 acre) bermed area or large depression. Releases to flat or gently sloped areas are likely to result in initial heights of 0.025m (an inch) or less.

Chloride Mass

Table 3-1 presents a final factor, "Release Chloride Mass". This factor, which is the product of "Release Height" and "Release Chloride Concentration", is the mass of chloride released to the ground surface per unit area. As Table 3-1 shows, a chloride ion release (see Release Chloride Concentration) of 100,000 ppm chloride that ponds to a depth of 0.6 meters (see Release Height) causes a subsurface chloride input of 60,000 grams per square meter (the Release Chloride Mass).

3.3 SIMULATION RESPONSES

The simulations with the HYDRUS-1D code and the mixing model yield large amounts of information about the flow of water and the transport of chloride through the vadose zone and the underlying aquifer. As mentioned above, we have selected two critical response variables for the sensitivity analysis: (i) the maximum chloride concentration in a down gradient monitoring well, C_{max}, and (ii) the time of arrival of the maximum chloride concentration at the monitoring well, T_{max}.

Maximum Chloride Concentration

The maximum chloride concentration defines the center of mass of a release as it migrates through the vadose zone into the aquifer and reaches a well. For this reason, we used the maximum chloride concentration, C_{max}, to identify those factors listed in Table 3-1 that have a significant influence on chloride migration through the vadose zone and the aquifer as the release moves toward the well. Evaluation of C_{max} can also identify the environmental con-

ditions that result in significant attenuation of chloride ion. For example, for those simulations where C_{max} is much less than the original chloride concentration of released chloride ion, environmental factors cause significant chloride ion attenuation. Additionally, an evaluation of C_{max} can be used to identify release scenarios that pose little or no threat to groundwater quality. For instance, simulations that predict a C_{max} less than the EPA Secondary Water Quality Standard of 250-ppm chloride will not cause water quality impairment. On the other hand, when predictions of C_{max} are greater than 250-ppm, ground water quality may be threatened by the release. Thus, the maximum chloride concentration in the well informs us about the risk for ground water impairment and its severity.

Time of Arrival of Maximum Concentration at the Well

Time of arrival of maximum concentration, T_{max}, is the time required for the chloride center of mass to reach the well. It dictates the urgency to implement a field investigation and possible remedy. A relatively rapid response is required if simulations suggest a chloride concentration of 250 ppm or more at a well within a few years. However, when input factors combine to predict that decades or centuries are required for a well to show ground water impairment, an immediate ground water investigation may be of little value.

3.4 STATISTICAL ANALYSIS OF THE RESPONSES AT MONITORING WELL

Following the statistical approach by Law & Kelton (2000) for simulation modeling and analysis, we determined the impact of each factor presented in Table 3-1 on the migration of chloride ion through the vadose zone and aquifer. We did this by inspecting the effect of each factor on the maximum chloride concentration in a down gradient well, C_{max}, and the arrival time of this concentration, T_{max}, at the well.

Table 3-3. *Main effects of the vadose zone, aquifer, and brine release factors on the maximum chloride concentration*

Factor	Effect on Cmax	
	ppm	Relative Effect
Height of Brine Release	4,340	1
Release Chloride Concentration	4,017	0.93
Thickness of Aquifer	3,237	0.75
Soil	2,070	0.48
Aquifer Flux	1,994	0.46
Dispersion Length	1,545	0.36
Climate	1,184	0.27
Ground Water Depth	1,081	0.25
Volume of Brine Release	932	0.21
Ambient Cl Concentration	76	0.02
Initial Water Content of Soil	25	0.01

3.4.1 MAXIMUM CHLORIDE CONCENTRATION

Table 3-3 presents the sensitivity of C_{max} to each of the 11 factors considered in this study (Table 3-1). The factors are sorted according to their impact on C_{max} in Table 3-3. The most important factors are the Height of Chloride ion Release and the Release Chloride Concentration. Changing the Height of Chloride ion Release from 0.025 to 0.6 m while holding all other factors fixed results in an average increase of maximum chloride concentration of 4,340 ppm. Changing the Release Chloride Concentration from 10,000 to 100,000 ppm results in an average increase of 4,017 ppm in maximum chloride concentration in the well. The absolute concentration values depend on the set up of the simulation experiment. We have added the relative effects of each factor in Table 3-3. The factors Height of Chloride ion Release and Release Chloride Concentration have relative effects of 1.00 and 0.93 respectively, much higher than of any other factor. The predicted difference in C_{max} due to the difference in Release Chloride Concentration is 93% of predicted difference for the Height of Chloride ion Release. The predicted difference in C_{max} for the two climate's indices, however, was only 27% of predicted difference for the Height of Chloride ion Release. As Table 3-3 shows, Initial Water Content of Soil exerts the smallest influence on the prediction of C_{max}.

The two most important factors, Height of Chloride ion Release and the Release Chloride Concentration, determine the Mass of Chloride entering the soil surface during a release. If the Height of Chloride ion Release or the Release Chloride Concentration increases, the Mass of Chloride increases and consequently, the maximum chloride concentration increases. Because the Mass of Chloride appears to be the key factor in determining the maximum chloride concentration arriving at a down gradient monitoring well, we repeated the sensitivity analysis using Mass of Chloride instead of Height of Chloride ion Release and Release Chloride Concentration. We eliminated the Initial Water Content of Soil in the second sensitivity analysis since this factor has very little impact on C_{max}.

The results of the second analysis are presented in Table 3-4 and in Figure 3-2. The mean chloride concentration of all 256 scenarios with

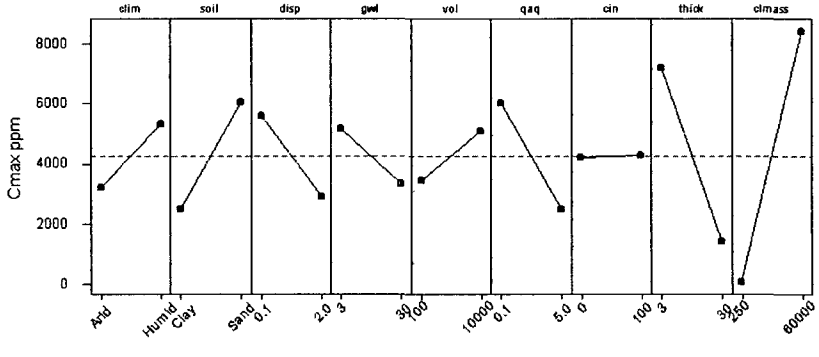


Figure 3-2 *The effect of nine brine release, vadose zone, and aquifer factors*

Mass of Chloride 250 g/m² is 89 ppm and that of all 256 scenarios with Mass of Chloride 60,000 g/m² is 8,446 ppm (See Figure 3-2). The difference between these two values is 8,357 ppm, which is the predicted sensitivity of the maximum chloride concentration for an increase of factors fixed.

Table 3-4. *Main effects and important interactions of the vadose zone, aquifer, and brine release factors on the maximum chloride concentration arriving at the monitoring well C_{max} and the time of arrival of the maximum concentration T_{max}.*

Factor	Effect on C_{max}		Effect on T_{max}	
	ppm	Relative Effect	Years	Relative Effect
Main Effects				
Chloride Mass	8357	1	52	0.46
Aquifer Thickness	5632	0.67	5	0.04
Soil	3560	0.43	106	0.93
Aquifer Flux	3525	0.42	7	0.06
Dispersion Length	2699	0.32	11	0.06
Climate	2099	0.25	114	1
Ground Water Depth	1826	0.22	104	0.91
Volume of Brine Release	1631	0.2	0	0
Ambient Cl Concentration	82	0.01	44	0.39
Interaction Effects				
Chloride Mass x Aquifer Thickness	5573	0.67		
Chloride Mass x Soil	3519	0.42		
Chloride Mass x Aquifer Flux	3509	0.42		
Aquifer Thickness x Aquifer Flux	2529	0.3		
Aquifer Thickness x Soil	2509	0.3		
Soil x Aquifer Flux	1223	0.15		
Soil x Climate			98	0.86
Climate x Depth Ground Water			95	0.83
Soil x Depth Ground Water			90	0.79

The Thickness of Aquifer also has a large impact with a sensitivity of 5,632 ppm for a change from 3 to 30 m. All other factors are less important. For comparison, we have determined the relative impacts of each factor by dividing each affect by the influence of the Mass of Chloride (Table 3-4). The most important factors Mass of Chloride and Thickness of Aquifer with relative affects of 1.00 and 0.67, respectively. The factors Soil, Aquifer Flux, and Dispersion Length have relative affects of 0.43, 0.42, and 0.32, respectively. The factors Climate, Ground Water Depth, and Volume of Chloride ion Release have much less impact with relative affects of 0.25, 0.22, and 0.20. Ambient Chloride Concentration (Relative effect 0.01) has virtually no effect.

We know that the predicted maximum and minimum values of C_{max} for a factor of interest can depend on the values of other factors. Where this is the case, the two factors are said to interact. An Analysis of Variance revealed that six interactions affect the maximum chloride concentration. These are the interactions be-

- Chloride Mass and Thickness of Aquifer,
- Chloride Mass and Vadose zone texture,
- Chloride Mass and Aquifer Flux,

- Thickness of Aquifer and Aquifer Flux,
- Thickness of Aquifer and Vadose zone texture, and
- Vadose Zone Texture and Aquifer Flux.

Table 3-4 shows the relative importance of each interaction and the interactions are presented in Figure 3-3. As shown in Figure 3-3, if Mass of Chloride increases from 250 to 60,000 g/m² above an aquifer with a thickness of 3 m, the maximum chloride concentration at the well increases from 118 to 14,501 ppm. The same increase of Mass of Chloride occurring above an aquifer with a thickness of 30 m causes only a modest chloride increase from 60 to 2,757 ppm. In a sandy vadose zone, C_{max} increases from 110 to 11,985 ppm in response to the different chloride loads to the ground surface. However, different chloride ion releases to a clay result in smaller differences, 68 to 4,906 ppm, but fall within the range of responses in a sandy zone.

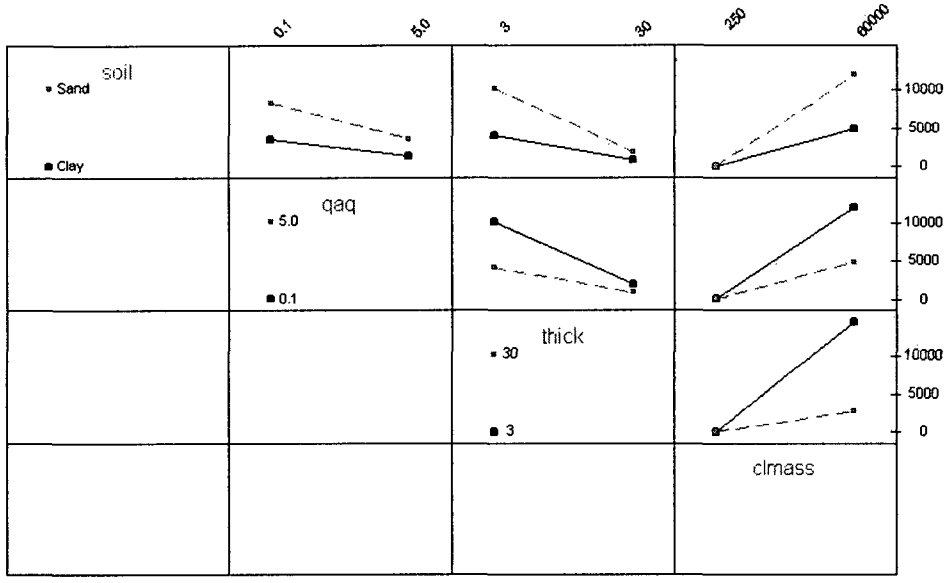


Figure 3-3. *Interaction effects between the factors soil, flux in aquifer, thickness of aquifer, and chloride load on the maximum chloride concentration in a downgradient monitoring well.*

The implication of the results of our sensitivity analysis is that determination of Mass of Chloride per unit surface area and Thickness of Aquifer is critical for the evaluation of ground water impairment. Knowledge of Vadose Zone Texture Conditions, Aquifer Flux, Dispersion length, Climate, Ground Water Depth, and Volume of Chloride ion Release can provide useful additional information, while ambient Chloride Concentration and Initial Water Content of Soil provide little relevant information.

The results of the sensitivity analysis cannot be used to directly evaluate field sites because they are based on the average change of maximum chloride concentration. For each factor, the maximum chloride concentration exhibits a wide range of values as is shown in Table 3-5.

Table 3-5. *Statistics of maximum chloride concentrations (ppm) determined in the sensitivity analysis.*

Main Effect	Level	Mean	Minimum	Maximum
Mass of Chloride	250 g/m2	89	0	303
	60,000 g/m2	8,446	0	46,633
Thickness of Aquifer	30 m	1,429	0	15,354
	3 m	7,195	0	46,633
Soil	Clay	2,487	0	37,233
	Sand	6,047	2	46,633
Aquifer Flux	0.05 m/day	2,505	0	29,779
	0.001 m/day	6,030	0	46,633
Climate	Arid	3,218	0	44,372
	Humid	5,317	0	46,633
Ground Water Depth	30 m	3,354	0	40,758
	3 m	5,181	0	46,633
Volume of Brine Release	100 barrels	3,452	0	41,603
	10,000 barrels	5,083	0	46,633
Dispersion Length	2.0 m	2,918	0	25,653
	0.1 m	5,617	0	46,633
Ambient Cl Concentration	0 ppm	4,226	0	46,593
	100 ppm	4,308	0	46,633

3.4.2 ARRIVAL TIME OF MAXIMUM CHLORIDE CONCENTRATION

We present the effects of the factors on the arrival time of the maximum chloride concentration at the well in Table 3-4. The arrival time strongly depends on climate (relative effect of 1.0 in Table 3-4), vadose zone texture, and depth of ground water. In the arid climate of Lea County, New Mexico, a chloride ion release will require an additional 114 years (40,515 days) for the maximum concentration to arrive at a well than a similar release in the humid climate of Shreveport, Louisiana. The vadose zone texture and ground water table effects are of the same order of magnitude (106 and 104 years respectively). Other factors are less important. Figure 3-4 graphically displays this same information. Our Analysis of Variance identified three important interactions that effect the length of time required

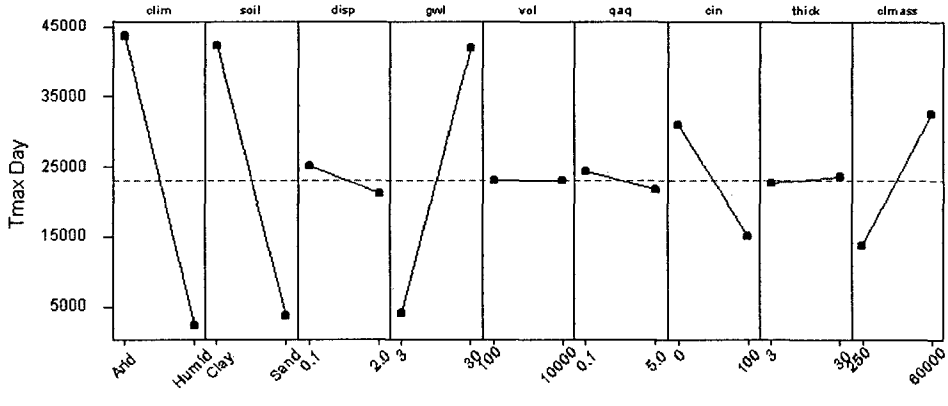


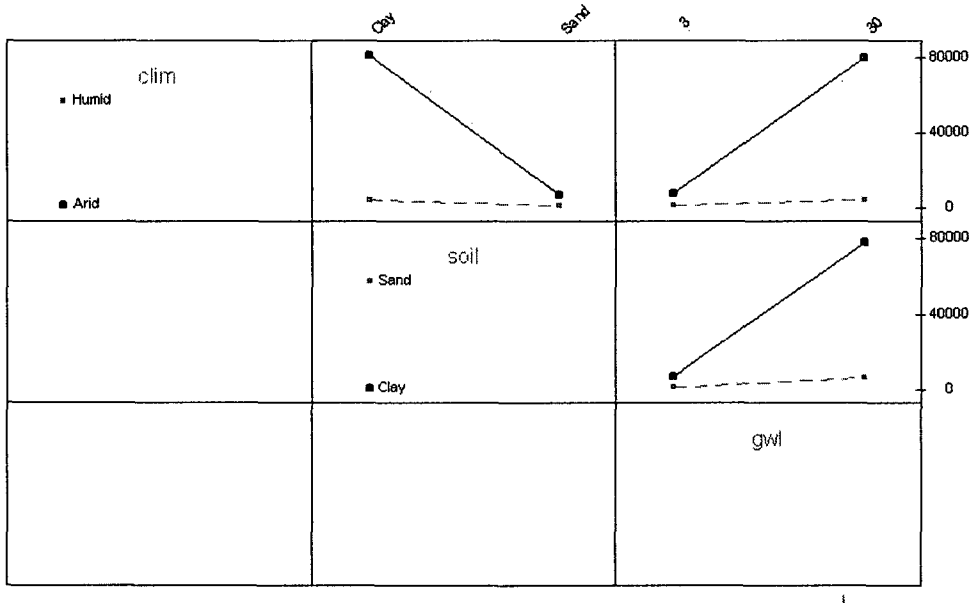
Figure 3-4 *The effect of nine brine release, vadose zone, and aquifer factors on the time when the maximum chloride concentration arrives in a downgradient monitoring well.*

for C_{max} to reach a well:

- Vadose Zone Texture and Climate,
- Climate and Depth to Ground Water, and
- Vadose Zone Texture and Depth to Ground Water.

The lower right section of Figure 3-5 shows that the depth to ground water has little effect on the arrival time of C_{max} if the texture of the vadose zone is sand. In a clay profile, however, the time of arrival is very different: nearly 80,000 days (219 years). This same relationship is expressed with the interaction between Climate and Depth to Ground Water (plotted in the upper right portion of Figure 3-5). In a humid climate, the texture of the vadose zone has little impact on the arrival time of C_{max}. However, in the arid Lea County, a release to a clay profile will require over 200 years longer for C_{max} to reach a well than the same release to a sandy vadose zone would.

Figure 3-5. *Interaction effects between the factors climate, soil, and ground water depth on the time when the maximum chloride concentration arrives in a down gradient monitoring well.*



Price, Wayne

From: Katie Lee [katie@rthicksconsult.com]
Sent: Thursday, January 22, 2004 11:09 AM
To: Wayne Price
Cc: Kristen at Rice; Carolyn Haynes; Randall Hicks
Subject: Lovington Abo

Mr. Price:

Attached please find our submission of a Lovington Abo work plan. If you have any questions or any trouble with this document, please don't hesistate to contact me.

Best regards,

Katie
R.T. Hicks Consultants, Ltd.
505.266.5004

R. T. Hicks Consultants, Ltd.

901 Rio Grande Blvd. NW Suite F-142 Albuquerque, NM 87109 505.266.5004 Fax: 505.266.0745

January 22, 2004

Mr. Wayne Price
New Mexico Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, New Mexico 87505

RE: Abo 1G Leak Site: Section 1, 17S 36E Unit G

Dear Mr. Price:

Rice Operating Company retained Hicks Consultants to address potential environmental concerns at the above referenced site. This submission proposes a scope of work that we believe will best mitigate any threat to human health and the environment and lead to closure of the regulatory file for this site.

Background

The Abo 1G Discharge Site is located about 6 miles southeast of the center of Lovington, New Mexico. Plate 1 shows the location of the site relative to Route 18, the Hobbs-Lovington Highway. The pipeline failure released produced water with little or no hydrocarbons.

Rice Operating Company (ROC) prepared a Release Notification report that summarizes activities to date. Plate 2 shows the geometry of the release and the locations of soil borings used to characterize the release. Soil boring SB2 is uphill from the spill site and we consider this a "background" location. The soil borings within the area of the release (#1 and #3) show a decline in chloride concentrations from more than 1000 ppm chloride to background levels (about 280 ppm) at 45 feet and 15 feet below land surface respectively. Because the water table lies about 80 feet below land surface, this observed decrease of chloride concentrations suggests that the release from did not create saturated conditions between ground surface and ground water.

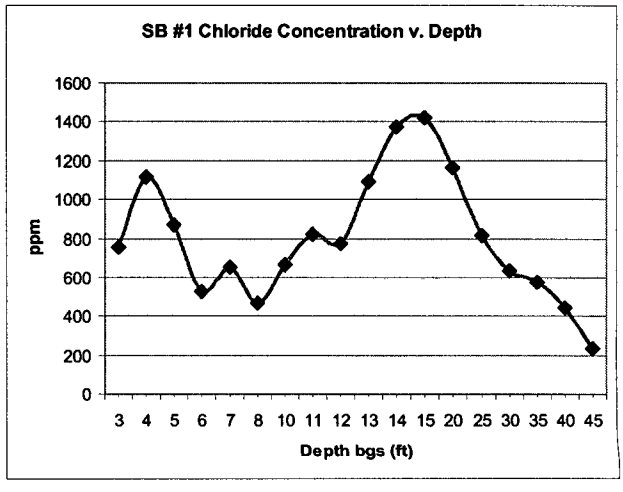


Figure 1 plots the chloride

concentration v. depth for Soil Boring #1. This diagram for Soil Boring #1 shows that the recent release is the second of two releases at or near this site. This data and that from Soil Boring #3 demonstrate that the center of mass from the recent release is at a depth of 4-5 feet below land surface. From 13-20 feet below land surface in Soil Boring #1, a second center of mass exists. As stated earlier, chloride concentrations decline to background levels from 40-45 feet in this boring. ROC confirmed that an earlier release of about 10 barrels did occur in the past near Soil Boring #1.

We conclude that these soil boring data show no evidence of potential ground water impairment. The chloride from the releases remains within the vadose zone. Based upon our experience with other sites, we hypothesize that the chloride will remain in the vadose zone for decades, centuries, or indefinitely. Previous research on the migration and fate of chloride conducted by API suggest that any vertical migration of chloride is so slow that ground water quality cannot be materially impacted by releases of this magnitude. Therefore, we have restricted our proposed activities to reclamation of the surface to its original productive capacity and performing simulation modeling to determine if the residual chloride mass in the vadose zone poses no threat to ground water quality.

1. Evaluate Chloride Flux from the Vadose Zone to Ground Water

We propose to employ HYDRUS1D and a simple ground water mixing model to evaluate the potential of residual chloride mass in the vadose zone to materially impair ground water quality at the site. We will employ predictions of the migration of chloride ion from the vadose zone to ground water then select an appropriate remedy for the land surface and underlying vadose zone. The first simulation is the "no action" alternative, which predicts chloride flux to ground water in the absence of any action by ROC.

For this simulation, we will employ the input parameters to HYDRUS and the mixing model outlined in Table 1. We will assume that vegetation is not present over the release site (no evapotranspiration) and an aquifer thickness of about 35 feet, or whatever value can be justified by examination of the literature and nearby well logs. At other sites, we have found that chloride can be distributed throughout the thickness of the aquifer.

Table 1: Input Parameters for Simulation Modeling

Input Parameter	**Source**
Vadose Zone Thickness – 80 feet	Nearby water supply well logs (Appendix A)
Vadose Zone Texture – caliche and sand	Nearby water supply well logs and on-site borings (Appendix A)
Dispersion Length -	Professional judgment
Soil Moisture - wet	Professional judgment
Vadose Zone Chloride Load – 19 kg/m^2	Appendix B

Length of release perpendicular to ground water flow – 100 meters	Field Measurements (see Plate 2)
Climate	Pearl, NM station (Hobbs)
Background Chloride in Ground Water	City of Lovington water system data
Ground Water Flux	Calculated from regional hydraulic data
Aquifer Thickness	Nearby water supply well logs (Appendix A)

2. Design Remedy and Submit Report

ROC has completed the repair of the pipeline at the site. We do not anticipate additional releases of produced water. Our modeling of similar sites strongly suggests that the relatively small residual chloride loading (19 kg/m^2, Appendix B) in the vadose zone poses a threat to ground water quality. If the modeling described above suggests that a threat does exist, we will use the HYDRUS-1D model predictions to develop a remedy for the vadose zone. If necessary, we will simulate:

1. installation of a low permeability barrier to minimize natural infiltration,

2. surface grading and seeding to eliminate any ponding of precipitation and promote evapotranspiration, thereby minimizing natural infiltration, and

3. a combination of the above potential remedies.

We will select the vadose zone remedy that offers the greatest environmental benefit while causing the least environmental damage.

Once we determine the most appropriate vadose zone remedy, we propose to immediately restore the soil through the addition of fresh water and, if necessary, soil amendments to move the identified chloride mass at the 2-5 foot depth to below the root zone (6-10 feet below land surface). If necessary, we use HYDRUS 1D to simulate this addition of fresh water to determine if any proposed vadose zone remedy might be affected by this soil flushing program. The protocol for the soil restoration program is simple:

1. Sample soils to determine if amendments, such as gypsum, will be necessary to restore soil structure and permeability.

2. If soil amendment is required, we will gently till the surface soil without disturbing the underlying caliche to mix the gypsum with the soil. If amendments are not required, we will forego tilling and the resultant disturbance of the existing soil structure.

3. Then we cover areas of the spill with black plastic to minimize evaporation and apply fresh water to the soil beneath the plastic to flush the chloride from the root zone. When possible, we will irrigate beneath the plastic immediately after precipitation events or immediately before predicted precipitation events. Conducting soil flushing in concert with precipitation events accelerates the process and conserves water.

4. Periodically, we will obtain samples of the soil and underlying material for field chloride analyses. When samples demonstrate that fresh water flushing has moved the chloride to below the root zone, we will remove the plastic and begin the process at another location at the site.

We plan to commence the HYDRUS1D simulations described above immediately. Your approval to move forward with this work plan will speed the implementation of a surface remedy because soil flushing is best conducted in winter when evaporation is low and precipitation is more widespread and easier to predict.

Sincerely,
R.T. Hicks Consultants, Ltd.

Randall T. Hicks
Principal

Copy:
Rice Operating Company