1R - 27

WORKPLANS

Date:

5-24-06

Hansen, Edward J., EMNRD

From: Hack Conder [hconder@riceswd.com]
Sent: Thursday, May 27, 2010 3:11 PM
To: Hansen, Edward J., EMNRD
Cc: Katie Jones
Subject: NMOCD 1R-27 (BD A-27 addendum2)
Attachments: figure eight.jpg

Mr. Hansen

I am requesting a addendum to the Corrective action Plan for NMOCD 1R-27 (BD A-27) dated May 24, 2006. I would like to include in paragraph two under section Recommendation for Corrective Actions the following.

Perform surface water management in three areas identified on attached figure eight(1 to 2 feet burmed areas) .Drill one confirmatory boring between soil bore 5 and soil bore 7 to minimum depth of 30 feet also shown in figure eight . The criteria to delineate in the soil boring is after three consecutive samples showing a decreasing trend of chloride (Samples taken in 5 feet intervals) and the last sample shows chloride < 250 ppm.

If you have any questions or concerns please contact me.

Hack Conder
Environmental Manager
Rice Operating Company
575-393-9174
fax 575-397-1471

RICE OPERATING COMPANY
ROC
SINCE 1955

122 W. Taylor
Hobbs, NM 88240
Phone (575) 393-9174
Fax (575) 397-1471

BD A-27 leak

Legals: UL/A sec. 27 T22S R37E
NMOCD Case #: 1R27
Owner: I. Boyd

- Leak extent
- Surface water management areas
- Current watertight junction box
- Proposed soil bore
- Soil bores

Drawing date: 5-26-2010
Revision date:
Drafted by: Lara Weinheimer

N
W E
S

1R-27

May 24, 2006

1R-27

CORRECTIVE ACTION PLAN
RICE Operating Company
BD A-27 Release Site
T22S-R37E-Section 27, Unit Letter A
Lea County, New Mexico

R. T. Hicks Consultants, Ltd.

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

1R-27

R. T. HICKS CONSULTANTS, LTD.
P. O. Box 7624 ▲ Midland TX 79708 ▲ 432.638.8740 ▲ Fax: 413.403.9968

CERTIFIED MAIL
RETURN RECIEPT NO. 7099 3400 0017 1737 2336

May 24, 2006

Mr. Paul Sheeley
New Mexico Oil Conservation Division
1625 North French Drive
Hobbs, New Mexico 88240

RE: **CORRECTIVE ACTION PLAN**

BD A-27 RELEASE SITE
T22S-R37E-SECTION 27, UNIT LETTER A
LEA COUNTY, NEW MEXICO

Mr. Sheeley:

RICE Operating Company (ROC) retained R.T. Hicks Consultants, Ltd. (Hicks Consultants) to address potential environmental concerns at the above-referenced site. This report proposes a corrective action plan based on the findings of previous investigations. Figure 1 shows the location of the site.

Site History

ROC discovered an accidental discharge at the above-mentioned site that occurred on January 27, 2005. The NMOCD was notified of the release on January 27, 2005. High temperature in the 2-inch PVC line coming from the Santa Rita Battery's heater caused the line to swell and separate from its fittings. The line and fittings were replaced as a permanent repair. The volume of the release was estimated at 800 barrels (bbls). The size of the affected area was approximately 66,400 square feet. By January 28, 2005, ROC recovered 730 bbls for disposal into the BD SWD system. The initial C-141 form was submitted to the OCD Hobbs office on February 7, 2005. An amended Investigation and Characterization Plan (ICP), submitted to the OCD Hobbs District office on July 14, 2005, is attached to this Corrective Action Plan (CAP) with the NMOCD approval. The data and analysis generated by the characterization activities allow us to conclude that the impact of the vadose zone from this release has not and will not cause an exceedence of the 250 mg/l numerical WQCC standard for chlorides in the ground water beneath the site as a result of the identified release. Therefore, ROC respectfully requests closure for the site with respect to ground water.

Concentrations of Constituents of Concern in the Vadose Zone

Results from previous investigations, as reported in the ICP, are depicted in Figures 2 through 5. On August 30-31, 2005, soil samples were collected using an air-rotary drilling rig for further delineation in accordance with the NMOCD-approved ICP. The soil sample locations, as shown on Figure 6, were chosen based on where the highest chloride concentrations were observed from previous investigations and in the lower-lying areas where pooling was evident. The samples were field-tested for chloride content using the titration method in accordance with procedures explained in QP-03 (ICP Appendices).

The results of the soil sampling are summarized in Figure 6. In four borings (B-3, B-4, B-6, and B-8) chloride concentrations in soil were less than 250 mg/kg. Eleven of 41 samples showed chloride concentrations in excess of 250 mg/kg with the maximum field chloride concentration of 906 mg/kg (1490 mg/kg laboratory) from B-5 at a depth of 10-12 feet below ground surface (bgs). The deepest samples showing chloride concentrations greater than 250 mg/kg were obtained at 20 feet from B-1 (344 mg/kg) and B-7 (659 mg/kg). The higher chloride concentrations shown in Figure 6 appear to correspond to the higher gravimetric moisture contents, which is not surprising. The highest gravimetric moisture content of 18.4% occurs in B-7 at 15-17 feet bgs, a soft caliche and fine-grained sand interval. At 30 feet bgs in this same boring, gravimetric moisture declines to 4.8% in a sample of similar lithology.

There were no indications of hydrocarbons in any of the samples based on headspace readings. Lithologic logs of each individual boring are included in Appendix A and photoducumentation of soil boring activities in Appendix B. Copies of the laboratory analytical reports and chains of custody for the most recent soil sampling activities are included in Appendix C.

From chloride and gravimetric moisture content data we conclude that the maximum vertical extent of the release is about 20 feet below ground surface. The lateral extent of the subsurface impact is limited to the area of the junction box (B-1) and extends slightly more than 150 feet north of the junction box (B-5 and B-7). The surface extent of soil impact is larger than the subsurface (e.g. greater than 2 feet deep) impact. Nearby wells show that ground water in this area is at a depth of approximately 50 feet, therefore the thickness of the vadose zone between the water table and the maximum depth of impact is 30 feet.

Chloride Flux from the Vadose Zone to Ground Water

Using all of the site-specific data available, the HYDRUS-1D computer model was used to evaluate the potential of any residual chloride mass in the vadose zone to materially impair groundwater quality at the site. HYDRUS-1D simulates one-dimensional water

flow, heat transport, and the movement of solutes involved in consecutive first-order decay reactions in variably-saturated soils. The HYDRUS-1D simulations employ highly conservative input parameters that can materially over-predict the chloride flux to ground water. A detailed explanation of the procedures and results of the various HYDRUS-1D simulations are included in Appendix D.

In a hypothetical scenario in which *no* vegetation was the variable, a HYDRUS-1D simulation shows a maximum chloride concentration of 251 mg/L in a 10-foot thick aquifer immediately down gradient of the release site in approximately 169 years from now. No further predictions in excess of 250 mg/L occurred beyond 169 years. The above scenario is highly conservative because it simulates the fate and transport of residual chloride without consideration of evapotranspiration by the existing vegetation or re-vegetation of the site, which is proposed as a remedy in this document. Evapotranspiration has a profound impact on the recharge rate, which is the principal source that drives chloride (and other constituents) from the impacted soil to ground water.

Currently, the vegetation within the area of the release consists of about 20% coverage of mesquite. Mesquite is a plant with roots that typically penetrate deep into the vadose zone, well below the root zone of grasses, forbs and small shrubs (about 4-feet).). The existing mesquite will cause evapotranspiration that is not considered in the model prediction described above. Moreover, after the proposed restoration of vegetation, evapotranspiration will increase and materially decrease the recharge rate.

Another highly conservative assumption is the input of a 10-foot thick mixing zone, which results in higher concentrations than a simulation based on the actual aquifer thickness, which is at least 40 feet thick. Many studies show that constituents, such as chloride, that reach ground water from the ground surface will become distributed throughout the thickness of the aquifer within a short transport distance from the release point.

A second simulation that assumes surface grading and seeding of barren areas to deter ponding of precipitation, promote evapotranspiration, and minimize natural infiltration shows that the migration of chloride from the vadose zone to ground water will not cause chloride concentrations in ground water to exceed the 250 mg/l numerical WQCC standard at any time.

Recommendations for Corrective Action

The repair of the line and fittings has minimized the threat of additional impact to the vadose zone. Based on the results from the extensive soil sampling activities and the Hydrus modeling results we have determined that the impact of the vadose zone from this release has not and will not cause an exceedence of the 250 mg/l numerical WQCC standard for chlorides in the ground water beneath the site as a result of the identified release.

Chloride concentrations within the topsoil are very low throughout the area of the release and therefore conducive to natural restoration of the vegetation. In figure 7, areas of the site that have average chloride concentrations within the root zone (0 to 5 feet below ground surface) that are above 750 ppm and 1000 ppm are depicted. We will monitor the site and, as required, conduct efforts to encourage natural re-vegetation of the site. ROC will request closure for this site after the spill area is re-vegetated to approximately 70% of the ground cover observed in adjacent areas not affected by the release. We anticipate that the closure request will be made during or after next year's growing season (August 2007).

Groundwater quality conditions in the area are being addressed in a forthcoming ICP for the Santa Rita EOL site located approximately 400 feet southwest of the BD A-27 release.

We appreciate the opportunity to work with you on this project. Please feel free to call me at 432-638-8740 or Kristin Farris Pope at 505-393-9174, if you have any questions.

Sincerely,

Gilbert J. Van Deventer, REM, PG
R.T. Hicks Consultants, Ltd.

cc: Wayne Price, NMOCD-Santa Fe
Carolyn Haynes, Rice Operating Company-Hobbs
Kristin Pope, Rice Operating Company-Hobbs
Randy Hicks, R. T. Hicks Consultants, Ltd., Albuquerque

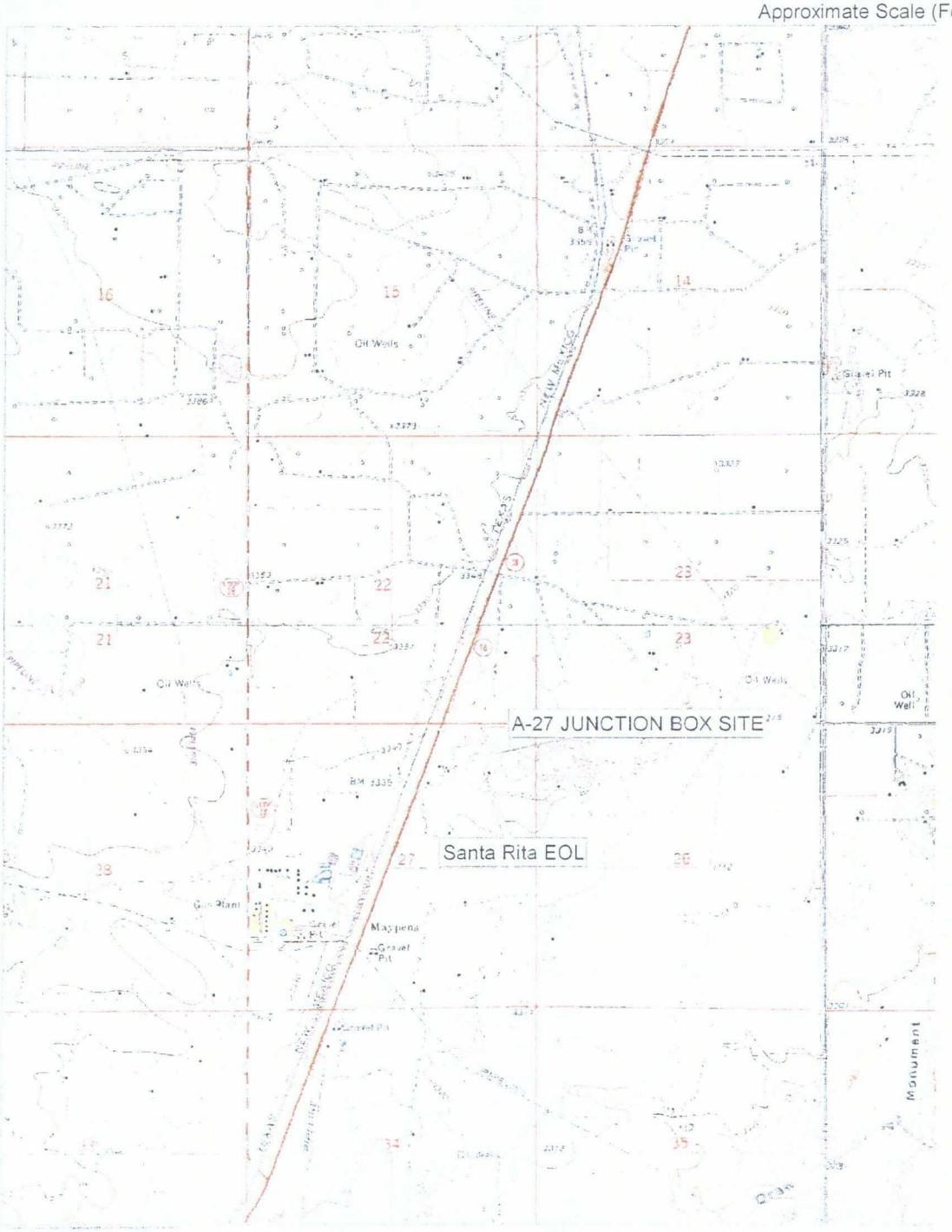
FIGURES

Near Eunice, NM, at the intersection of Hwy 234 and Hwy 18 proceed south 5 miles.
Turn left and continue east ¼ miles. Turn left again and proceed north approximately 700 feet to site.

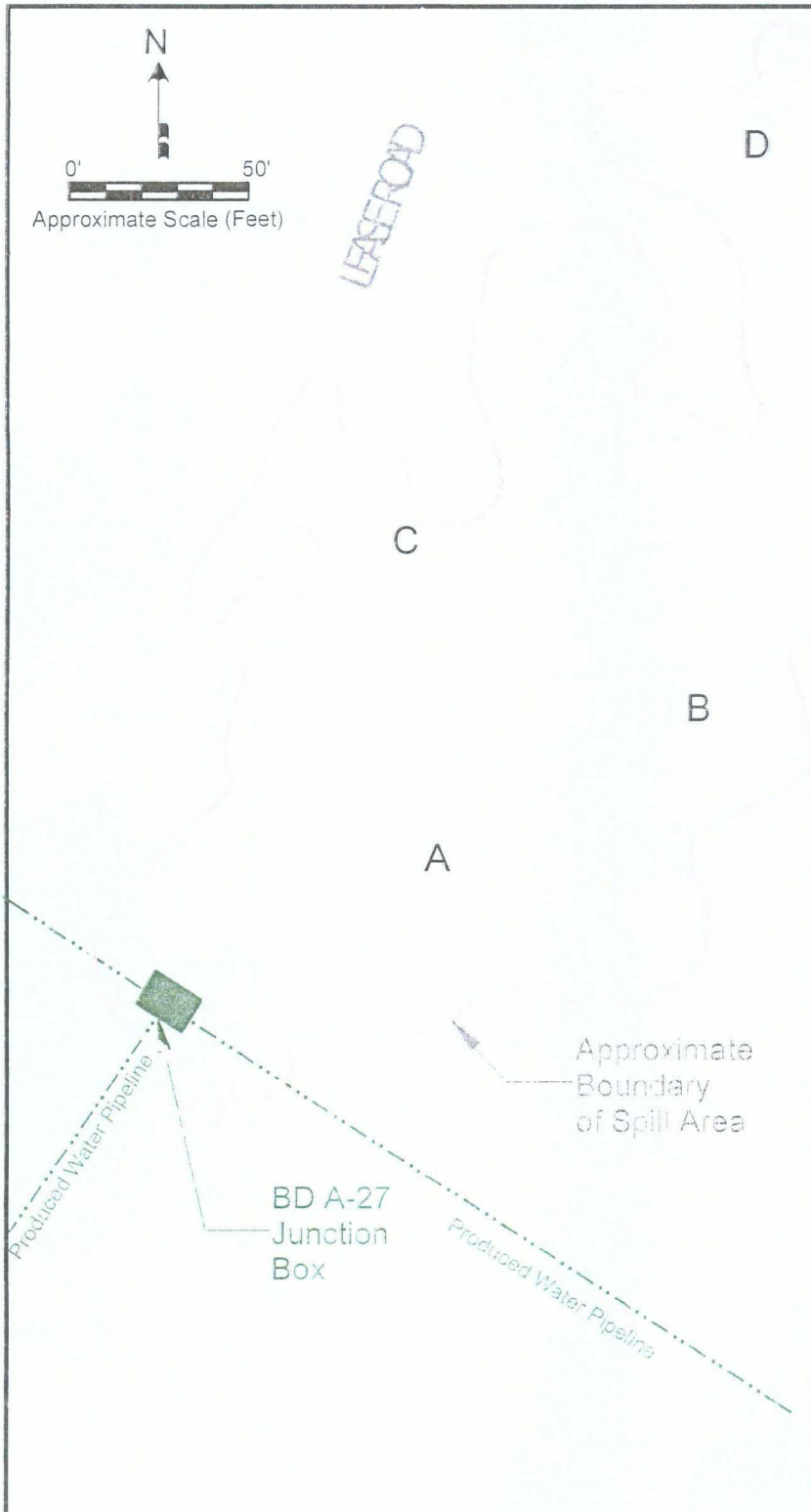
0' 2000'

Approximate Scale (Feet)

N



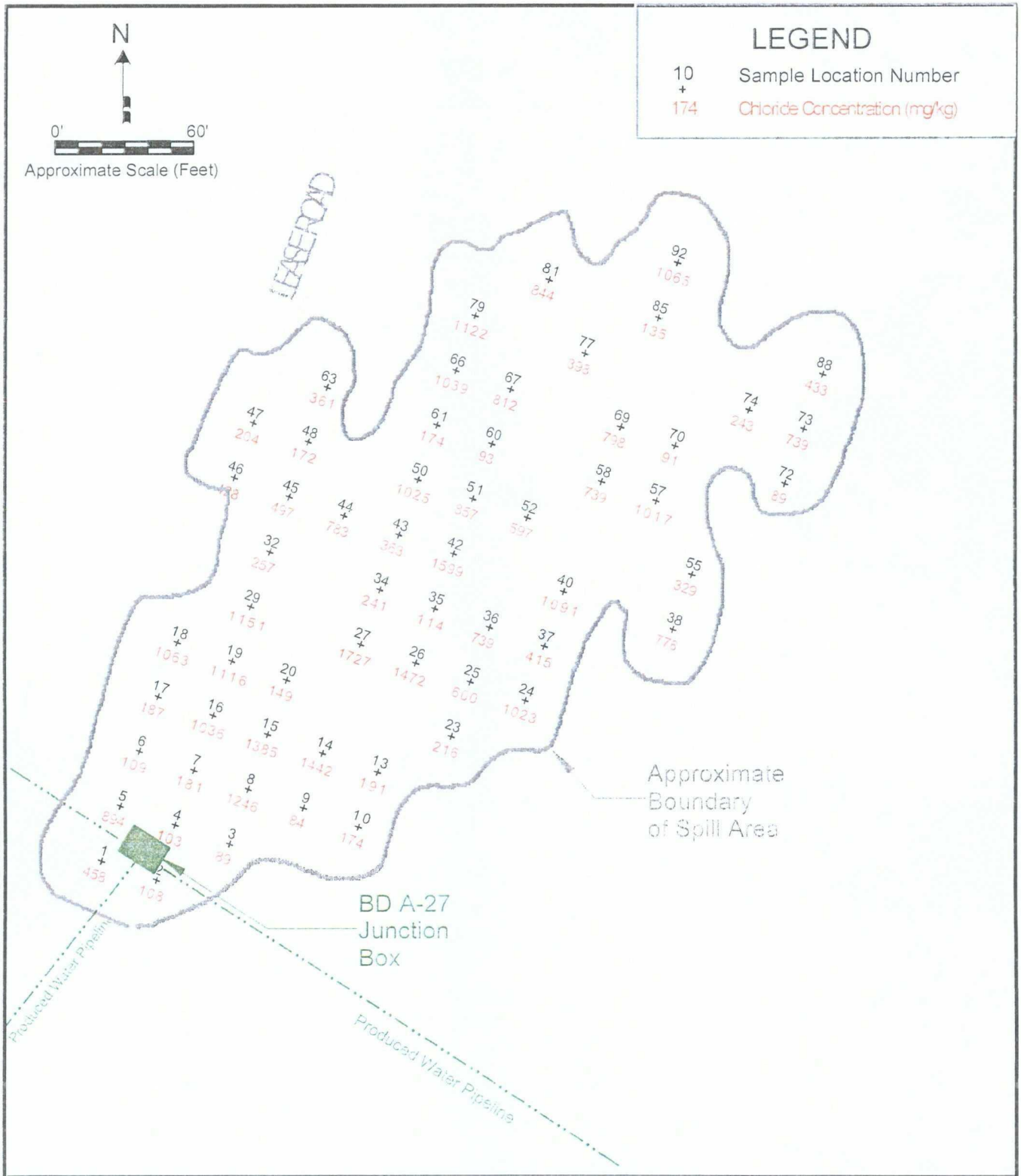
Site: BD A-27 Release Site	FIGURE 1 SITE LOCATION MAP
Date: August 31, 2006	
Author: G. Van Deventer	
Approximate Scale: 1 inch = 2400 feet	



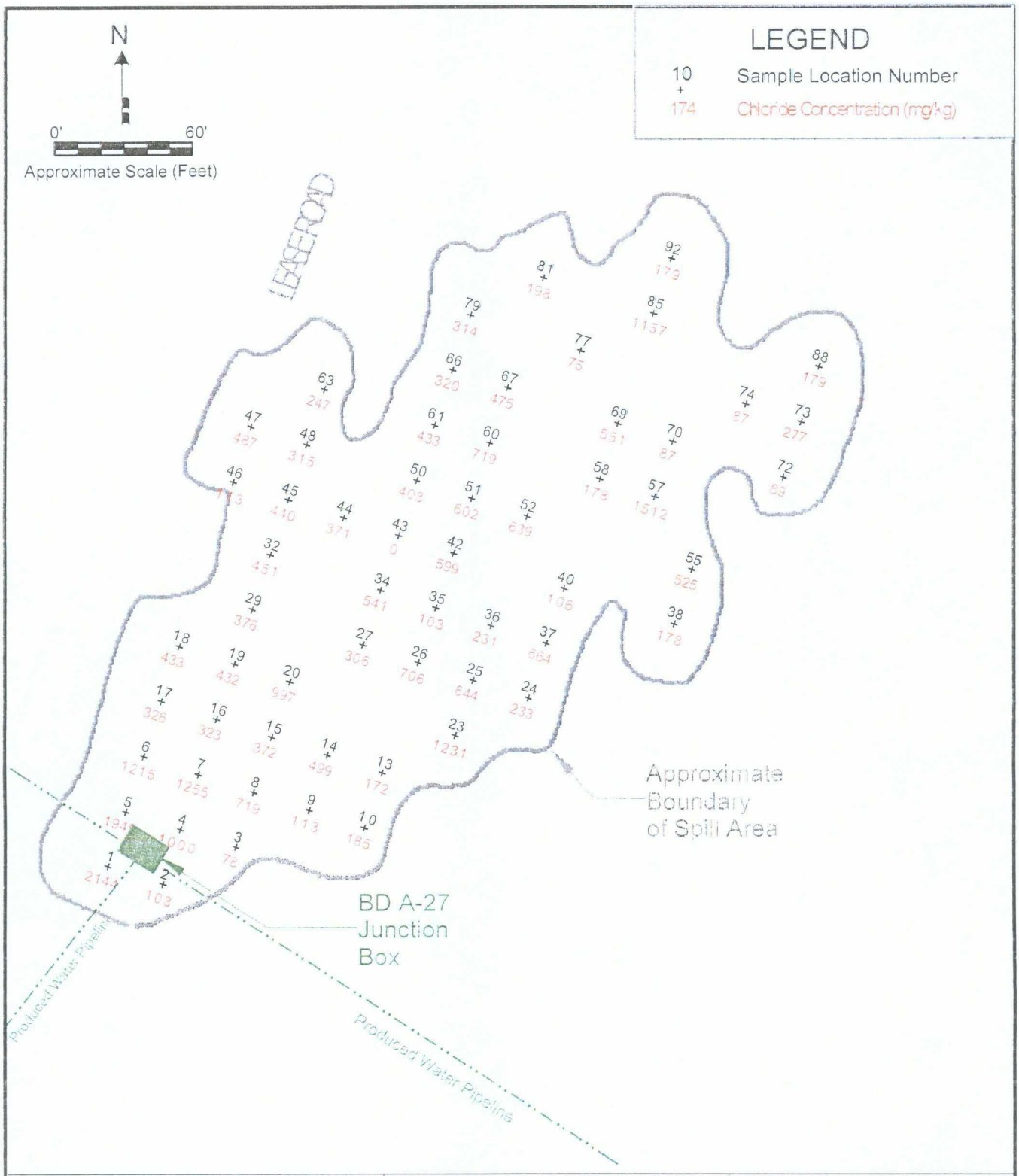
Sample Location	Sample Depth (Ft bgs)	Chloride (ppm)
A	5	1263
	6	243
	8	302
	10	112
B	0	299
	2.3	583
	3	672
	5	172
	7	181
	9	181
C	0	310
	4	994
	6	1336
	8	1569
	10	1396
	12	1678
D	0	144
	4	149
	5	304
	6	448
	7	282
	8	184
	9	183
	10	178

Site: BD A-27 Release Site	
Sampling Dates: 01/31/05 and 02/09/05	
Author: G. Van Deventer	
Approximate Scale: 1 inch = 50 feet	

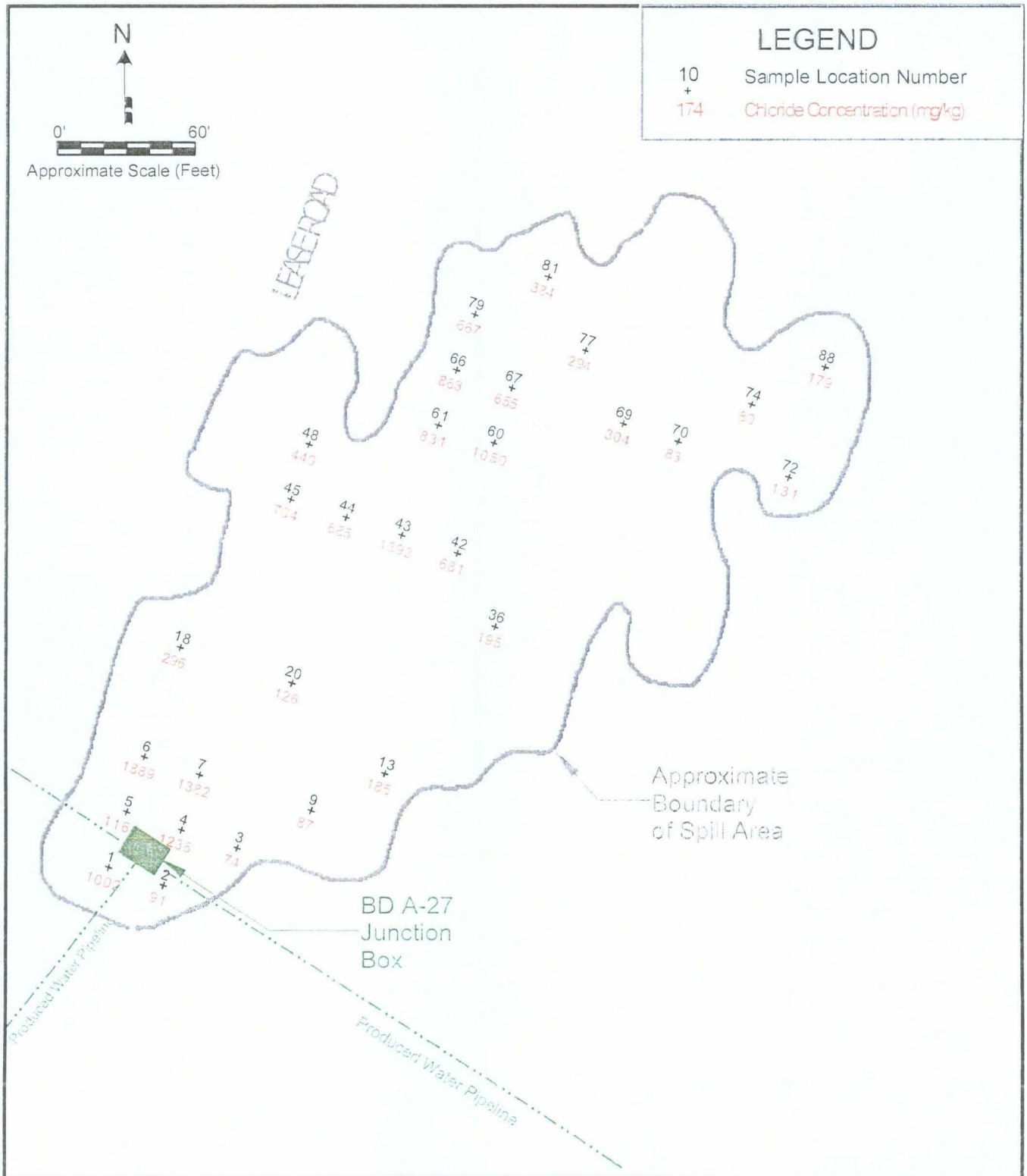
FIGURE 2
PRELIMINARY
SOIL SAMPLE
RESULTS



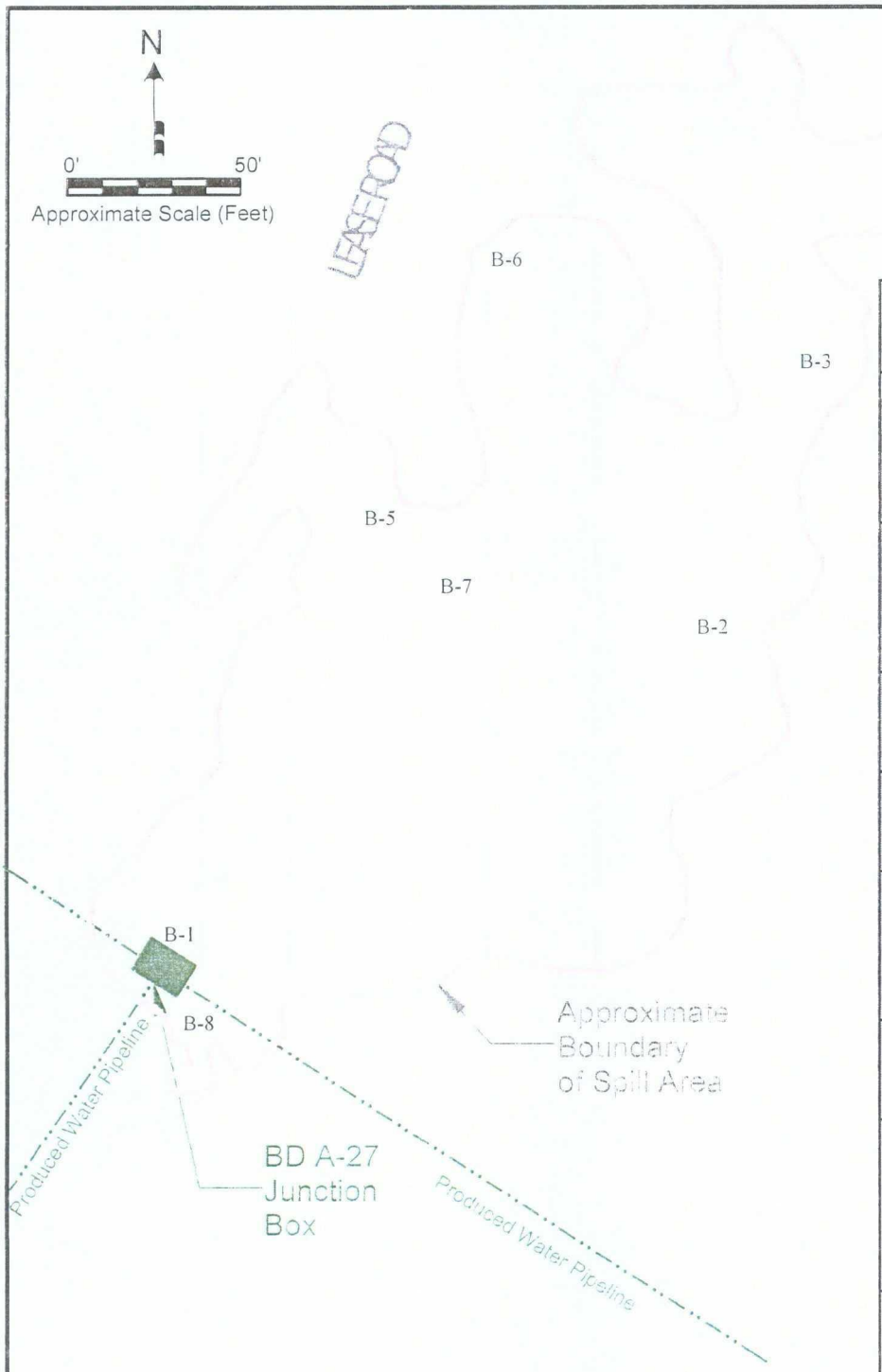
Site: BD A-27 Release Site	FIGURE 3 Chloride Concentrations at Ground Surface
Date: February 17-22, 2005	
Author: G. Van Deventer	
Approximate Scale: 1 inch = 60 feet	



Site: BD A-27 Release Site	FIGURE 4 Chloride Concentrations at 2-3 ft bgs
Date: February 17-22, 2005	
Author: G. Van Deventer	
Approximate Scale: 1 inch = 60 feet	



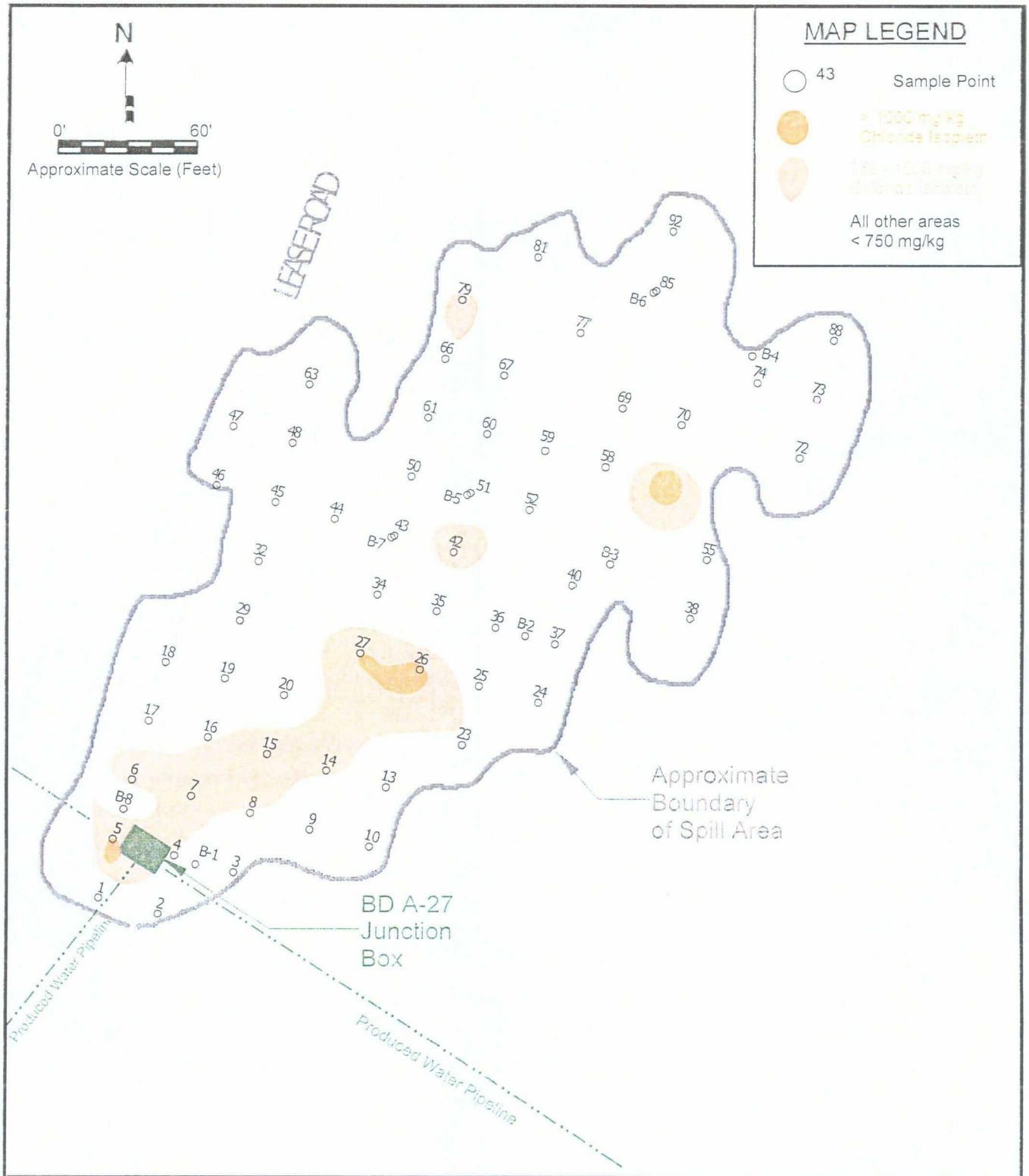
Site: BD A-27 Release Site	FIGURE 5 Chloride Concentrations at 3-4 ft bgs
Date: February 17-22, 2005	
Author: G. Van Deventer	
Approximate Scale: 1 inch = 60 feet	



Sample Location	Sample Depth (Ft bgs)	Chloride (ppm)	Moisture (percent)
B-1	0-2	120	---
	5-7	846 (796)	15.3
	10-12	637	---
	15-17	246	---
	20	344	---
	25-27	230 (178)	8.3
B-2	0-2	179	---
	5-10	175	---
	10-15	259	---
	15-20	239	---
	20-25	142	---
	25-27	230	---
B-3	0-2	218	---
	5-10	121	---
	10-15	93	---
	15-20	168	---
B-4	0-2	224	---
	5-7	219	---
	10-12	198	---
	15-17	79	---
B-5	0-2	208	---
	5-7	814	---
	10-12	906 (1490)	13.6
	15-17	441	---
	20	146	---
	25-27	4.6 (14.7)	3.8
B-6	0-2	102	---
	5-7	80	---
	10-12	123	---
	15-17	115	---
B-7	0-2	151	---
	5-7	759	---
	10-12	591	---
	15-17	864 (1200)	18.4
	20	659	---
	25-27	69	---
	30-32	110 (18.9)	4.8
B-8	0-2	209	---
	5-7	201	---
	10-12	116	---
	15-17	93	---

Values in parentheses indicate lab determined chloride concentrations.

Site: BD A-27 Release Site	FIGURE 6 Soil Boring Chloride Concentration Map
Date: August 30-31, 2005	
Author: G. Van Deventer	
Approximate Scale: 1 inch = 50 feet	



Site: BD A-27 Release Site	FIGURE 7 Average Chloride Concentrations in 5-foot Root Zone
Date: August 31, 2005	
Author: G. Van Deventer	
Approximate Scale: 1 inch = 60 feet	

APPENDIX A

LITHOLOGIC LOGS

Geologist:	Gil Van Deventer	**RICE** *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/30/05	BD A-27 Release Site	
End Date:	08/30/05	Location:	B-1
Notes: Boring located adjacent to north side of junction box.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

Depth (feet)	Sample Interval	Sample Time	Sample Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0-1	0-2	1520	Split Spoon	120	0		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2-4								
5-6	5-7	1530	Split Spoon	846	0	15.3	SM	Light brown (5 YR 6/4), silty clayey fine sand
7-9							CAL/SM	Caliche (soft) with fine-grained sand. Colors vary from very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) to pale yellowish brown (10 YR 6/2). Hard caliche streak at 20 feet. Sand content increases and caliche decreases with depth.
10-11	10-12	1540	Split Spoon	637	0			
12-14								
15-16	15-17	1545	Split Spoon	246	0			
17-19								
20-21	20-22	1555	Split Spoon	344	0			
22-24							SM/CAL	Pale yellowish brown (10 YR 6/2) calcareous fine sand
25-26	25-27	1605	Split Spoon	230	0	8.3		
27-40								Boring terminated at 27 feet.

Geologist:	Gil Van Deventer	**RICE** *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/30/05	BD A-27 Release Site	
End Date:	08/30/05	Location:	B-2
Notes: Boring located approximately 180 feet northeast of junction box.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

Depth (feet)	Sample Interval	Sample Time	Sample Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0 1	0-2	1640	Split Spoon	179	0.1		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2 3 4								
5 6 7 8 9	5-10	1644	Cuttings	175	0.1			
10 11 12 13 14	10-15	1650	Cuttings	259	0.1		CAL/SM	Caliche (soft) with fine-grained sand. Colors vary from very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) to pale yellowish brown (10 YR 6/2).
15 16 17 18 19	15-20	1655	Cuttings	239	0.1			
20 21 22 23 24	20-25	1700	Cuttings	142	0.1		SM/CAL	Pale yellowish brown (10 YR 6/2) calcareous fine sand
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40								Boring terminated at 25 feet.

Geologist:	Gil Van Deventer	**RICE** *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/30/05	BD A-27 Release Site	
End Date:	08/30/05	Location:	B-3
Notes: Boring located approximately 250 feet northeast of junction box.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

Depth (feet)	Sample Interval	Sample Time	Sample Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0-1	0-2	1735	Split Spoon	218	0		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2-4								
5-9	5-10	1740	Cuttings	121	0			
10-14	10-15	1745	Cuttings	93	0		CAL/SM	Caliche (soft) with fine-grained sand. Colors vary from very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) to pale yellowish brown (10 YR 6/2).
15-19	15-20	1750	Cuttings	168	0			
20-40								Boring terminated at 20 feet.

Geologist:	Gil Van Deventer	**RICE** *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/31/05	BD A-27 Release Site	
End Date:	08/31/05	Location:	B-4
Notes: Boring located approximately 300 feet northeast of junction box.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

Depth (feet)	Sample Interval	Sample Time	Sample Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0 1	0-2	0900	Split Spoon	224	0		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2 3 4							CAL/SM	Caliche (soft) with fine-grained sand. Colors vary from very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) to pale yellowish brown (10 YR 6/2). Hard caliche streak at 20 feet.
5 6	5-7	0910	Split Spoon	219	0			
7 8 9								
10 11	10-12	0915	Split Spoon	198	0			
12 13 14								
15 16	15-17	0925	Split Spoon	79	0			
17								Boring terminated at 17 feet.
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40								

Geologist:	Gil Van Deventer	RICE *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/31/05	BD A-27 Release Site	
End Date:	08/31/05	Location:	B-5
Notes: Boring located approximately 140 feet north-northeast of junction box and 25 feet east of road. Surface shows signs of water pooling that has since dried up.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

Depth (feet)	Sample Interval	Time	Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0								
1	0-2	1000	Split Spoon	208	0		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2								
3							SM	Light brown (5 YR 6/4), silty clayey fine sand
4								
5								
6	5-7	1010	Split Spoon	814	0			
7								
8								
9								
10								
11	10-12	1020	Split Spoon	906	1.6	13.6		
12								
13							CAL/SM	Caliche (soft) with fine-grained sand. Colors vary from very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) to pale yellowish brown (10 YR 6/2). Sand content increases and caliche decreases with depth.
14								
15								
16	15-17	1030	Split Spoon	441	6.0			
17								
18								
19								
20								
21	20-22	1040	Split Spoon	146	5.7			
22								
23								
24								
25							SM/CAL	Pale yellowish brown (10 YR 6/2) calcareous fine sand
26	25-27	1055	Split Spoon	98	4.6	3.8		
27								Boring terminated at 27 feet.
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

Geologist:	Gil Van Deventer	RICE *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/31/05	BD A-27 Release Site	
End Date:	08/31/05	Location:	B-6
Notes: Boring located approximately 220 feet north-northeast of junction box and 30 feet east of road.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

Depth (feet)	Sample Interval	Sample Time	Sample Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0								
1	0-2	1125	Split Spoon	102	0		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2								
3							SM	Light brown (5 YR 6/4), silty clayey fine sand
4								
5								
6	5-7	1135	Split Spoon	80	0			
7								
8								
9								Caliche (soft) with fine-grained sand.
10								Colors vary from very pale orange (10 YR 8/2) to grayish orange
11	10-12	1140	Split Spoon	123	0		CAL/SM	(10 YR 7/4) to pale yellowish brown (10 YR 6/2).
12								
13								
14								
15								
16	15-17	1145	Split Spoon	115	0			
17								Boring terminated at 17 feet.
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

Geologist:	Gil Van Deventer	**RICE** *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/31/05	BD A-27 Release Site	
End Date:	08/31/05	Location:	B-7
Notes: Boring located approximately 130 feet north-northeast of junction box and 60 feet east of road. Surface shows signs of water drainage and pooling that has since dried up.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

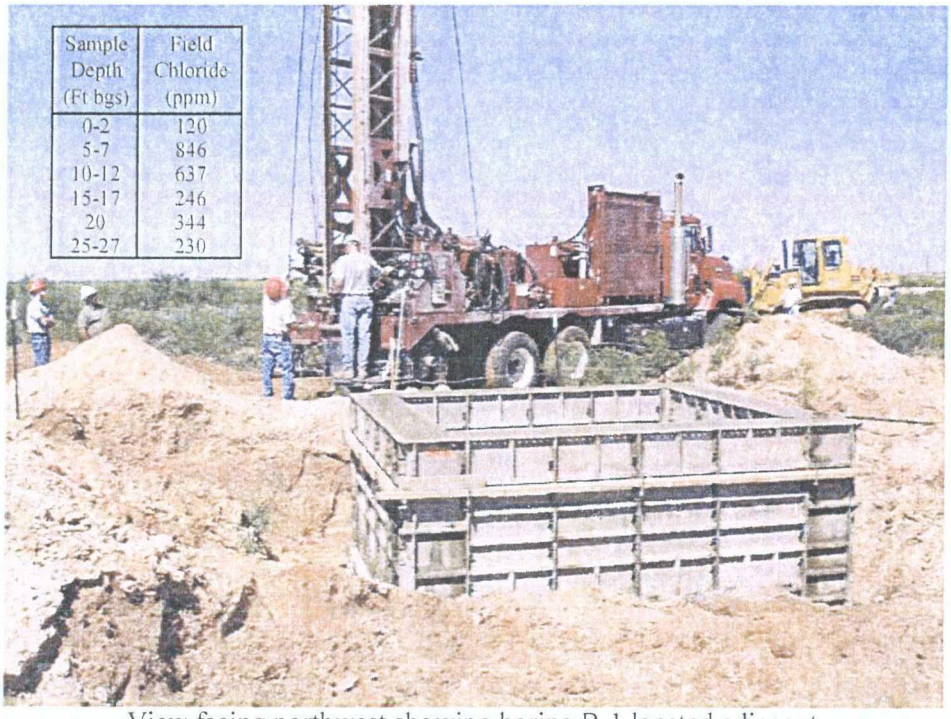
Depth (feet)	Sample Interval	Time	Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0								
1	0-2	1300	Split Spoon	151	0		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2								
3								
4								
5								
6	5-7	1305	Split Spoon	759	0			
7								
8								
9								
10								
11	10-12	1310	Split Spoon	591	0			
12								
13								
14							CAL/SM	Caliche (soft) with fine-grained sand. Colors vary from very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) to pale yellowish brown (10 YR 6/2). Sand content increases and caliche
15								
16	15-17	1315	Split Spoon	854	0	18.4		
17								
18								
19								
20								
21	20-22	1325	Split Spoon	659	0			
22								
23								
24								
25								
26	25-27	1340	Split Spoon	69	0			
27								
28							SM/GP	Pale yellowish brown (10 YR 6/2) calcareous fine sand with large pea size cherty gravel
29								
30								
31	30-32	1355	Split Spoon	110	0	4.8		
32								Boring terminated at 32 feet.
33								
34								
35								
36								
37								
38								
39								
40								

Geologist:	Gil Van Deventer	**RICE** *Operating Company*	Borehole ID:
Driller:	Eades Drilling		
Drilling Method:	Air Rotary	Project Name:	
Start Date:	08/31/05	BD A-27 Release Site	
End Date:	08/31/05	Location:	B-8
Notes: Boring located a few feet southeast of junction box.		BD SWD System	
		unit 'A', Sec. 27, T22S, R37E	
		Lea County, NM	

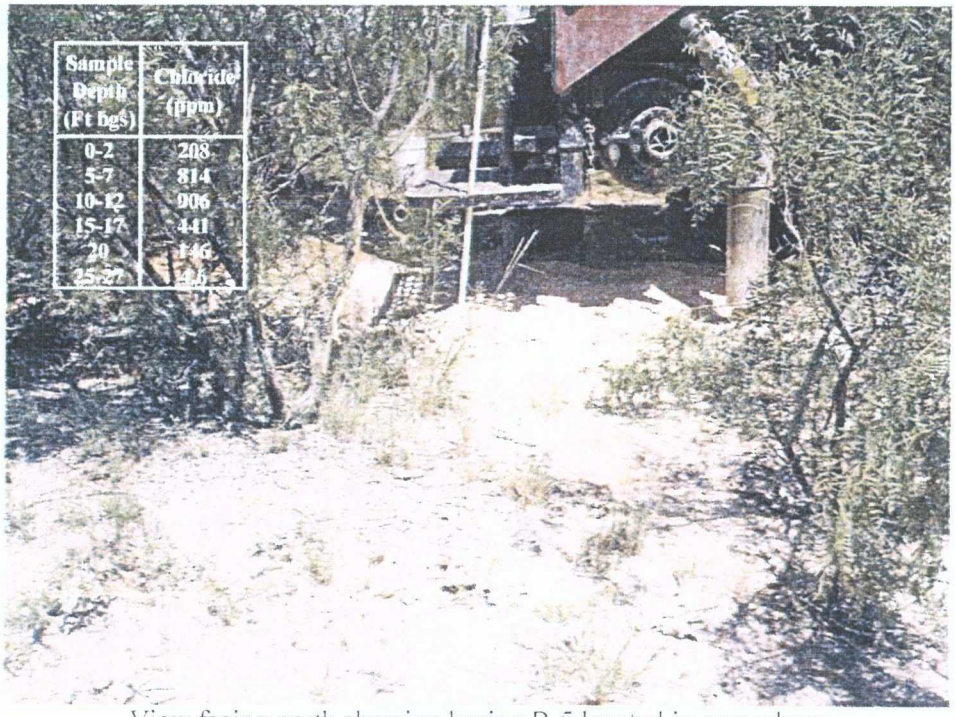
Depth (feet)	Sample Interval	Time	Type	Chloride (ppm)	OVM (ppm)	Moisture (percent)	USCS Symbol	Description: Color, Grain size, Sorting, rounding, Consolidation, Distinguishing Features
0-1	0-2	1425	Split Spoon	209	0		SW	Light brown (5 YR 6/4) sandy loam, dune sand, fine-grained, subrounded grains, unconsolidated, dry
2-4							CAL/SM	Caliche (soft) with fine-grained sand. Colors vary from very pale orange (10 YR 8/2) to grayish orange (10 YR 7/4) to pale yellowish brown (10 YR 6/2).
5-6	5-7	1430	Split Spoon	201	0.1			
7-9								
10-11	10-12	1435	Split Spoon	116	0.1			
12-14								
15-16	15-17	1440	Split Spoon	93	0.1			
17-40								Boring terminated at 17 feet.

APPENDIX B

PHOTODOCUMENTATION

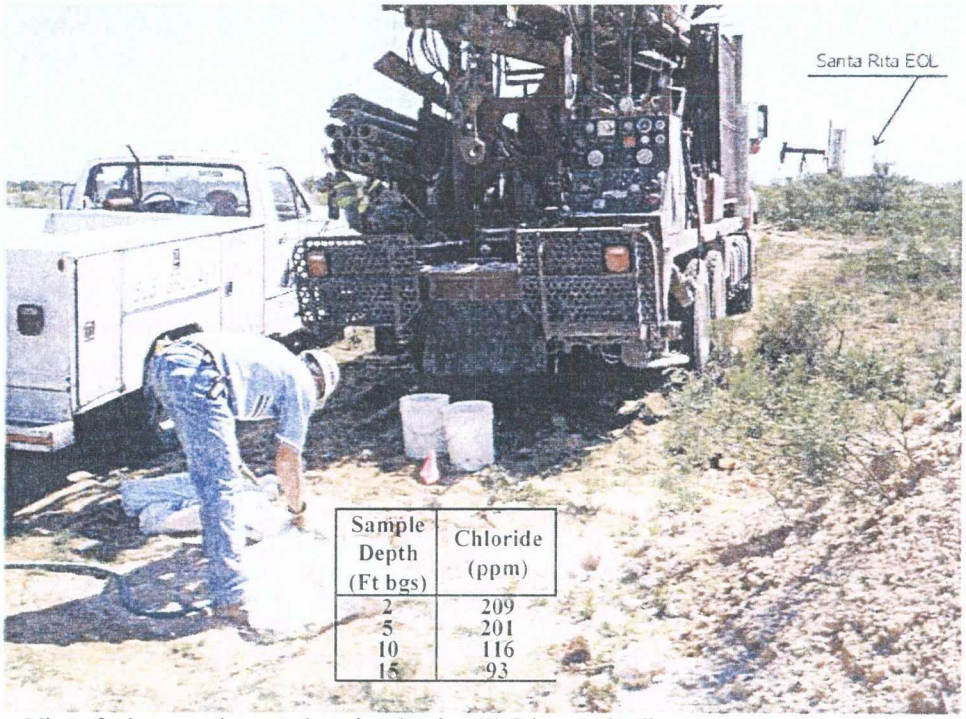


View facing northwest showing boring B-1 located adjacent to the northwest corner of the rebuilt A-27 junction box. (08-30-06)



View facing north showing boring B-5 located in area where pooling and channeling had occurred after initial release (08-31-06)

View facing southwest showing boring B-7 (08-31-06).



View facing southwest showing boring B-8 located adjacent to southeast corner of A-27 junction box. The Santa Rita EOL site is shownlocated in background approximately 400 feet southwest (08-31-06).

APPENDIX C

LABORATORY REPORTS
AND
CHAIN OF CUSTODY DOCUMENTATION

(Included as separate file in Adobe Reader format)

APPENDIX D

HYDRUS-1D
FATE & TRANSPORT
MODELING RESULTS

The HYDRUS-1D computer model was used to evaluate the potential of any residual chloride mass in the vadose zone to materially impair groundwater quality at the site. HYDRUS-1D is used to simulate one-dimensional water flow, heat transport, and the movement of solutes involved in consecutive first-order decay reactions in variably-saturated soils. HYDRUS-1D numerically solves the Richard's equation for water flow and the Fickian-based advection-dispersion equation for heat and solute transportation. 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 ground water mixing model uses the chloride flux from the vadose zone to ground water provided by HYDRUS-1D and instantaneously mixes this chloride and water with the ground water flux of chloride plus water that enters the mixing cell beneath the subject site. We refer the reader to API Publication 4734, Modeling Study of Produced Water Release Scenarios (Hendrickx and others, 2005) for a general description of the techniques employed for this simulation experiment.

A description of the model input parameters are listed below.

Soil Profile - Information for the soil profile (or vadose zone thickness and texture) is based upon the boring logs from the site for the upper vadose zone (32 feet below ground surface (bgs)) and Office of the State Engineer (OSE) well logs from nearby wells for the lower vadose zone. (32 to 51 feet bgs) A vadose zone thickness of 51 feet was used in the modeling based upon recent depth to ground water measurements in the area.

Dispersion lengths - Conservative dispersion lengths were employed based on the recent experience of RT Hicks Consulting with similar soils south of Lovington, New Mexico. Standard practice calls for employing a dispersion length that is 10% of the model length. For each lithologic unit, a dispersion length no greater than 6 % of the unit thickness was employed for that layer in the model. With the more finely grained units, dispersion lengths of 2% were used.

Climate - Weather data used in the predictive modeling was from the Pearl Weather Station (46 years of data), approximately 12 miles northwest of the A-27 site. This is the closest station featuring sufficiently complete weather data for the HYDRUS-1D input files.

HYDRUS-1D can also employ a uniform yearly infiltration rate that will obviously smooth the temporal variations. Because the atmospheric data are of high quality and nearby to the site, we have elected to allow HYDRUS-1D to predict the deep percolation rate and the resultant variable flux to ground water. This choice results in higher peak chloride concentrations in ground water due to temporally variable high fluxes from the vadose zone. As such, this choice is conservative and will over-predict impairment to ground water quality. For simulations of longer time than the weather data spans, the weather data is repeated as an input.

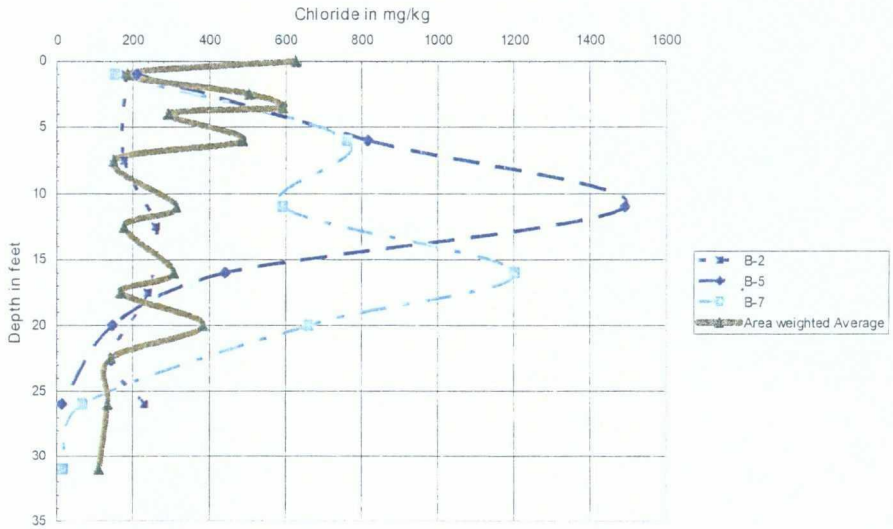
Soil Moisture - Because soils are relatively dry in this climate and vadose zone hydraulic conductivity varies with moisture content, it is important that simulation experiments of different remedial strategies begin with initial "steady state" soil moisture content. The calculation of soil moisture content begins with using professional judgment as an initial input then running sufficient years of weather data through the model to establish a "steady state" moisture content. In this case, establishing the steady state (or initial conditions) without

vegetation creates a "wetter" soil profile than a simulation that assumes a vegetative cover. A wet profile will allow a greater recharge rate and overestimate any chloride flux to ground water as a result. Because only minimal changes in the HYDRUS-1D soil moisture content profile occurred after year 50 of the initial condition calculation, 138 years (3 cycles of the 46 years of weather data) was considered more than sufficient to establish the initial moisture condition. All simulations of chloride movement used soil profiles hydrated in this manner.

Initial Chloride Profile – Field chloride concentrations were obtained at multiple depths from the 8 borings drilled to depths up to 32 feet bgs and the 60 trenches dug to depths up to 4 feet bgs at the A-27 release site. This data was averaged with area weighting to calculate a representative chloride concentration profile for the site (Figure 1). Plotted with the area weighted chloride profile used for the HYDRUS modeling are the chloride profiles from B-5 and B-7 featuring the highest chloride masses. Also included is the chloride profile from B-2 ,which we consider typical of 5 of the 8 boreholes. From the field data, the chloride mass at the site is between 0 and 25 feet bgs. The area-weighted average was installed in the HYDRUS-1D model.

As described in API Publication 4734, the ground water mixing model takes the background chloride concentration in ground water multiplied by the ground water flux to calculate the total mass of ground water chloride entering the ground water mixing cell, which lies below the area of interest . The chloride and water flux from HYDRUS-1D is added to the ground water chloride mass and flux to create a final chloride concentration in ground water at an imaginary monitoring well located at the down gradient edge of the mixing cell (the edge of the release site).

Figure 1
Field Chloride Profiles with Depth, A-27 Site



Influence Distance - The influence distance is defined as the maximal length of the release parallel to groundwater flow direction. From the geometry of the release site, it is less than or equal to 300 feet relative to the published regional groundwater gradient direction to the southeast.

Background Chloride Concentration – A 100 mg/L chloride concentration was used for ground water at this location.

Grain Size - The grain-size analyses for borings B-5 and B-7 are summarized below.

Boring No.	Depth (Ft bgs)	Percentage Passing Sieve Size (microns)				
		4.75	2	0.425	0.18	0.075
B-7	0 - 2	100	100	97	60	19
B-7	5 - 7	100	99	94	65	31.8
B-7	10 - 12	100	98	93	55	17.8
B-5	15 - 17	89	63	74	42	15.8
B-5	20 - 22	67	56	45	28	14

Hydraulic Conductivity - R.T. Hicks Consultants believes that the hydraulic conductivity of the saturated zone at the release site is similar to that observed for the Ogallala Aquifer throughout the general area. McAda (1984) simulated water level declines using a two-dimensional digital model and employed hydraulic conductivity values of 51-75 feet/day (1.9 E-4 to 2.8 E-4 m/s) in the area. More recently, Musharrafieh and Chudnoff (1999) employed values for hydraulic conductivity within this area of interest between 81 and 100 ft/day, for their simulation. According to Freeze and Cherry (1979), these values correspond to clean sand, which agrees with the nearby lithologic descriptions of the saturated zone. For the A-27 site, the saturated hydraulic conductivity of the uppermost-saturated zone is assumed as 75 feet/day.

Groundwater Gradient - In general, ground water flows southeast in the area under a hydraulic gradient of approximately 0.003 ft/ft. This gradient was calculated with data from Nicholson and Clebsch (1961). The resulting ground water flux is 6.8 cm/day.

Aquifer Thickness - A restricted aquifer thickness of 10 feet was employed in the mixing model as a conservative measure to cause over-estimation of chloride concentration in an imaginary receptor well.

For all variables for which field data did not exist, assumptions conservative of ground water quality were made. A summary of the input parameters and a description of the source information used in the HYDRUS-1D model for this application are provided in Table y below.

Vegetation was allowed at the site

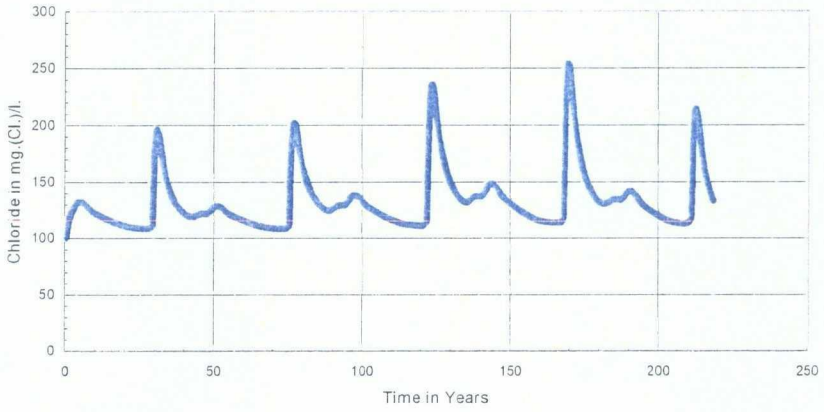
Table 1: Input Data for Simulation Experiment

Input Parameter	Source
Vadose Zone Thickness - 51 feet	Recent depth to water measurements in area
Vadose Zone Texture	Sieve analysis, borehole lithologic logs, and NMOSE well logs
Dispersion Length - <6% of model length	Professional judgement
Climate	Pearl Weather Station Data, 46 years
Soil Moisture	HYDRUS-1D initial condition simulation
Initial soil chloride concentration profile	From ROC Field Measurements
Length of release parallel to ground water flow - 300 feet	Field Estimate
Background Chloride in Ground Water - 100 ppm	Conservative assumption
Ground Water Flux - 6.8 cm/day	Calculated from published data
Aquifer Thickness - 10-feet	Conservative assumption

Results of Modeling

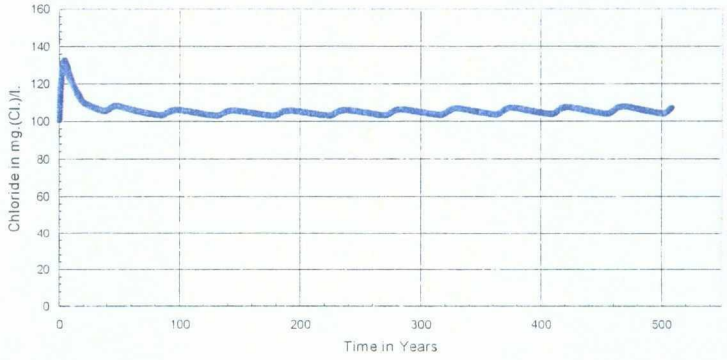
With no vegetation allowed at the site, Figure 2 shows chloride concentration in a 10-foot thick aquifer immediately down gradient of the release site. Peak chloride concentration in the aquifer is 251 mg/L approximately 169 years from now. Of note is that inspection of the HYDRUS-1D output files reveals that peak chloride concentration entering ground water from the vadose zone occurs between years 154 and 167 years from now, earlier than peak chloride concentration in ground water. The peak chloride concentration in ground water is a result of a high vadose zone flux to the aquifer produced by earlier intense rainfall events. Four earlier peak chloride concentrations are results of the repeated weather data.

Figure 2
Chloride Concentration in the 10 foot Thick Aquifer at the A-27 Release Site, no Vegetation



With vegetation allowed to root in the upper 3 feet of the vadose zone, recharge to ground water is reduced due to evapotranspiration. The resultant chloride concentration in a 10-foot thick aquifer immediately down gradient of the release site is shown in Figure 3. Initially, the model predicts an increase in ground water chloride concentration. This is due to drainage "wet" initial condition established by the 138-year simulation described earlier. After about 20 years, the moisture and the attendant chloride in the lower vadose zone have drained and the vegetation establishes a new "steady state" with a material lower recharge rate. In the simulation, transpiration from vegetation reduces recharge, the soil profile becomes drier with resultant decreases in hydraulic conductivity and solute flux to ground water.

Figure 3
Chloride Concentration in the 10 Foot Thick Aquifer at the A-27 Release Site with Vegetation



Examination of HYDRUS -1D output files reveals peak chloride concentration within the vadose zone is about 8 meters below ground surface about 500 years from now. Due to the difficulty of continuing to run the model for more than 1000 years to allow the peak chloride concentration

to enter ground water, we elected to estimate the maximum chloride concentration in ground water by multiplying the HYDRUS-1D vadose zone flux to the mixing model by the scaling factor necessary to equal that of the peak chloride concentration higher in the vadose zone ((2850mg/L)/(1560 mg/L) = 1.83). In this manner, the effect of the peak vadose zone chloride concentration could be examined.

This examination is highly conservative because it ignores additional chloride dispersion that is created as the center of chloride mass migrates through the entire thickness of the vadose zone. Allowance for dispersion would lower the peak vadose zone chloride concentration.

The result of this calculation is a peak chloride concentration in ground water of less than 115mg/L.

Initial C-141 Form

District I
1625 N. French Dr., Hobbs, NM 88240
District II
1301 W. Grand Avenue, Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources

Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-141
Revised October 10, 2003

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 of Company: Rice Operating Company	Contact: Bryan Clay
Address: 122 W. Taylor Hobbs, New Mexico	Telephone No.: 505-393-9174
Facility Name: BD	Facility Type: SWD Gathering Line

Surface Owner: Irwin Boyd	Mineral Owner	Lease No.

LOCATION OF RELEASE

Unit Letter	Section	Township	Range	Feet from the	North/South Line	Feet from the	East/West Line	County
A	27	22S	37E					Lea

Latitude: 32*22.19 N Longitude: 103*08.63 W

NATURE OF RELEASE

Type of Release: Produced Water	Volume of Release: 800 bbls	Volume Recovered: 730 bbls
Source of Release: Pipeline	Date and Hour of Occurrence: 1-27-05	Date and Hour of Discovery: 1-27-05 @ 3:30 p.m.
Was Immediate Notice Given? ☒ Yes ☐ No ☐ Not Required	If YES, To Whom? Gary Wink	
By Whom? Bryan Clay	Date and Hour: 1-27-05 @ 4:49 p.m.	
Was a Watercourse Reached? ☐ Yes ☒ No	If YES, Volume Impacting the Watercourse.	

If a Watercourse was Impacted, Describe Fully.*

Describe Cause of Problem and Remedial Action Taken.*
High temperature in the 2-inch pvc line, caused the line to swell and separate from its fittings. The released freestanding fluid was picked up and hauled to a nearby disposal station.

Describe Area Affected and Cleanup Action Taken.*
The affected area was approximately 66,400 square feet mainly in pastureland. ROC will be submitting a NEW MEXICO Generic Spill and Leak Remediation Work Plan with this C-141 Form.

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, surface 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:	OIL CONSERVATION DIVISION	
Printed Name: Bryan Clay	Approved by District Supervisor:	
Title: Environmental Technician	Approval Date:	Expiration Date:
E-mail Address: bcriceswd@leaco.net	Conditions of Approval:	Attached ☐
Date: February 7, 2005 Phone: 505-393-9174		

* Attach Additional Sheets If Necessary

Investigation & Characterization Plan - Amendment (July 11, 2005)

(Attached as separate Adobe Reader file)