## **AP - 018**

## REPORTS

# 3/20/2000

Hydrogeology and Groundwater in the Vicinity of the Osborn Ranch, Jal, New Mexico Sections 12 and 13, T25S, R36E Sections 7 and 18, T25S, R37E

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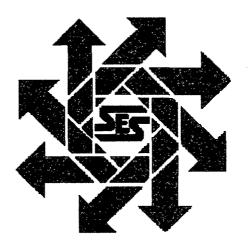
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March 20, 2000



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## HYDROGEOLOGY AND GROUNDWATER IN THE VICINITY OF THE OSBORN RANCH, JAL, NEW MEXICO

#### **1.0 Introduction**

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Concerns over possible surface and subsurface damage as a result of oilfield production operations on the Rocky Top Ranch owned by Clay and Jeri Osborn of Jal, New Mexico, has led to soils and groundwater investigations conducted by Safety and Environmental Solutions, Inc. (SESI), of Hobbs, New Mexico, on behalf of the Osborn's, and by Cornerstone Environmental Resources, Inc. (CERI), of Dallas, Texas, on behalf of the current oilfield operator, Bristol Resources Corporation. Several reports on soils investigation and one previous report on groundwater sampling have been prepared by the involved parties. These reports are not reviewed in this report but are cited where necessary. The list of previous reports may be found with other references in Section 8.0 (References).

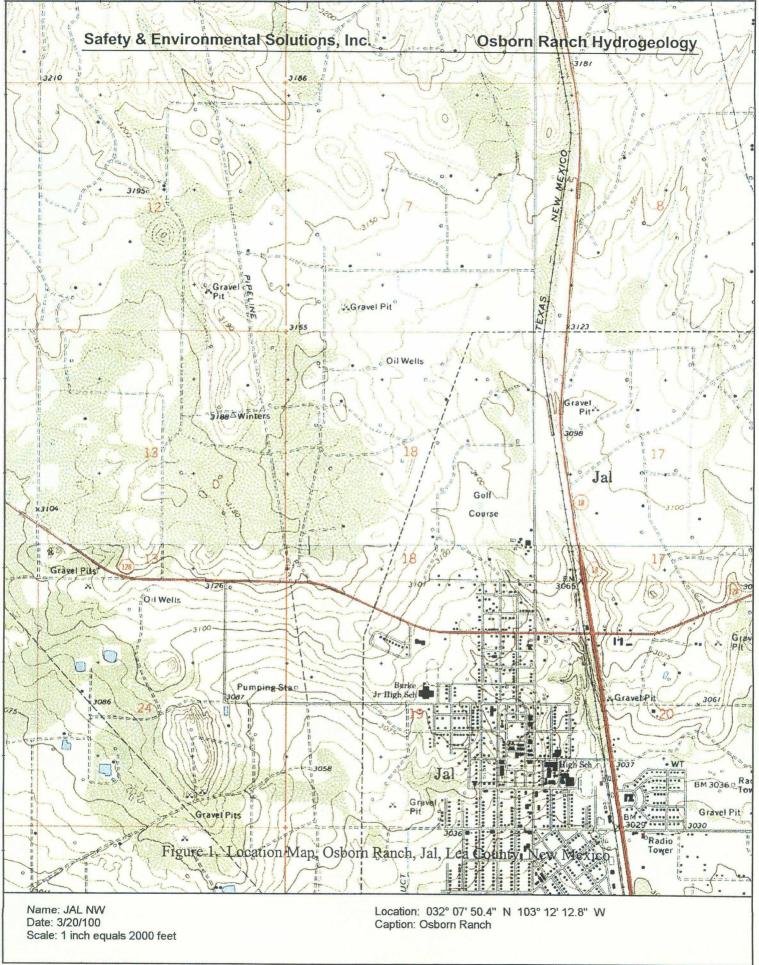
The purpose of the current investigation is to determine existing groundwater conditions in the vicinity of the main ranch residences currently occupied by the Osborn family and their guests. This includes delineation of groundwater flow and water quality. The investigation was begun as a result of increases during the past several years in chlorides and total dissolved solids (TDS) in groundwater used for domestic purposes. A key purpose of the investigation was to determine if groundwater movement was from areas of oilfield activities and if water quality had been impacted by spills, leaks, and/or disposal of oilfield produced water.

Bristol Resources is the current operator of oilfield properties known as the South Langley Jal Unit located in Sections 7 and 18 of Township 25 South, Range 37 East (T25S, R37E). Bristol is the successor to several other operators who have produced oil from the area for over 50 years. Bristol and/or previous operators have had spills, leaks, and/or disposed of oilfield wastes during this period. Prior to regulation by the New Mexico Oil Conservation Division of produced water disposal in the 1950's and 1960's, produced water was commonly placed in unlined evaporation pits. Subsequent to banning of this practice, disposal occurs into OCD-permitted injection wells. However, notwithstanding the banning of surface disposal, flow lines, storage tanks, and/or the injection wells themselves are subject to leaks, overflows, and downhole failures. Some current waste management problems that have occurred at the Bristol locations are documented in the CERI and SESI reports listed in Section 8 (References).

#### 2.0 Geography

#### 2.1 Location

The Osborn Rocky Top Ranch is located in Sections 11 (SE/4), 12 and 13 of T25S, R36E, and Sections 1 (SW/4), 7 and 18 of T25S, R37E, Lea County, New Mexico (Figure 1). The ranch headquarters where the Osborn residence is located is in the NE/4 of Section 18, immediately north of the Jal Country Club. The community of Jal is approximately one mile south of the



ranch residence. The five Osborn water wells are located within several hundred feet of the ranch buildings. Water wells are also located at the Jal Country Club. Several of the country club wells are used to supply water for sale to local oil operators for use in drilling or other oilfield activities. The county club uses treated wastewater effluent from Jal to irrigate the greens and fairways. The application of the effluent is permitted under a groundwater discharge plan approved by the New Mexico Environment Department (NMED).

#### 2.2 Topographic Setting

The Osborn ranch is located in southern Lea County on a topographic feature called the Eunice Plain (Nicholson and Clebsch, 1961). The elevation of the area is approximately 3,100 feet above Mean Sea Level. The Eunice Plain consists mostly of a hard caliche surface overlain in most areas by reddish-brown dune sand from several inches to several feet thick. The Plain has a general and gentle southeast slope toward Monument Draw. In some areas the underlying surface consists of alluvial sediments consisting of calcareous silt in buried channels or Quaternary lake basins. Vegetation consists of shin oak, mesquite and a variety of grasses.

#### 2.3 Climate

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The climate of southern Lea County is characterized by low annual rainfall, low humidity, and high average annual temperature (Nicholson and Clebsch, 1961). The climate is classified as marginal between semiarid and arid. Precipitation near Jal averages about 9 inches per year and is highly variable both areally and seasonally, although maximum values are usually recorded in the summer months. The average monthly temperature ranges from a low of about 45°F to 81°F with an average of about 62°F. Maximums commonly exceed 100°F in summer. In addition to heat and dryness, the other characteristic weather feature in the area is wind. Windy conditions occur throughout the year, but are most common and most intense in springtime. Gusts during this season are commonly powerful enough to damage structures, move sand, and generate large volumes of blowing dust.

## 3.0 Geology

The geology of the area has extensively described by Nicholson and Clebsch (1961) in their report on "Geology and Ground-water Conditions in Southern Lea County." Others in the profession have published numerous papers related to geological conditions important for the exploration and development of the oil and natural gas resources of the region. Only the near-surface geology relevant for this report is reviewed here

Southern Lea County includes parts of the Delaware and Permian Basins. Rocks of the Paleozoic Era (Ordovician through Permian periods) are located at depth and contain oil and gas deposits along with highly mineralized oil-field waters. Unconformably overlying these are Mesozoic Era rocks of the Triassic period. The Triassic rocks are in turn unconformably overlain by rocks of the Cenozoic Tertiary and Quaternary periods, which include the Ogallala Formation and recent alluvium.

The Triassic rocks are composed of red and green claystones, red siltstones, shale and sandstones (generally minor). The rocks yield small quantities of water from the sandstones, but the water

has a high sulfate content. The upper surface of the Triassic rocks has been eroded producing channels and depressions which have been filled by the younger Ogallala and alluvial sediments. These structural features provide a variety of pathways for movement of fluids atop the Triassic rocks.

The Cenozoic Ogallala and alluvial formations generally have much coarser sediments, although fine grained silts and clays are found both in the Ogallala and in alluvial lake deposits. The Ogallala formation ranges up to about 300 feet in thickness and is mainly a calcareous, unconsolidated sand, but it also contains clay, silt, and gravel. Beds of mixed clay and gravel are commonly found at the base of the formation. In most locations the Ogallala formation is capped with a thick layer of dense caliche which ranges in thickness from a few feet to greater than 60 feet. At the surface, the caliche is well cemented and hard, but is softer and more porous at increasing depth where it grades into the underlying sands.

The alluvium has been deposited in topographically low areas where the Ogallala has been stripped away or where erosion channels have been scoured into the Triassic rocks or Ogallala formation and later buried. The alluvium is generally less than 100 feet thick. At the surface it is usually a calcareous silt, but in some locations a cover of reddish-brown dune sand is found. Nicholson and Clebsch (1961) state that up to 80 percent of the area of southern Lea County has a surface cover of the fine to medium sand with thickness ranging from a veneer of several inches up to 30 feet.

At the Osborn ranch, the Ogallala formation outcrops to the north and west of the ranch headquarters, while alluvial sediments with some surficial sand are present in the area of the residences. Surface drainage is by means of a relatively undefined drainage system that trends from the north and northwest to the south. Alluvial material is present at the surface in the vicinity of the drainages. At the community of Jal and further to the south, all surface sediments are alluvial in nature.

## 4.0 Groundwater

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#### 4.1 Reported Occurrence of Groundwater

Nicholson and Clebsch (1961) document relatively thin zones of water saturation in the alluvial sediments immediately north of Jal in the vicinity of the Osborn ranch. Thickness of saturated sediments was estimated at about 20 feet. Water in a well just east of the ranch was reported at a depth of about 63 feet during pumping in 1953; no depth of well was given. No other wells in the vicinity of the ranch were reported in the 1961 report. However, several wells in Jal which were completed in Triassic rocks have a reported saturated thickness of 200 to 300 feet.

#### 4.2 Current Groundwater Investigation

A detailed groundwater investigation was conducted in the vicinity of the Osborn ranch beginning on February 22, 2000. Previously, water levels at several wells in the vicinity of the ranch residences and at the Bristol-installed monitor well had been measured in December 1999, but a detailed groundwater map had not been produced due to the small number of measured 1. S. C.

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water levels, a lack of surveyed casing elevations, and due to the pumping drawdown in the main ranch house well. Although groundwater movement was anticipated generally to be from northwest to southeast, the lack of accurate measurements prevented knowledgeable assumptions as to the possible source(s) of the increasing chloride and total dissolved solids concentrations in the ranch wells.

A trip to the ranch was made on February 22 and locations of wells possibly suitable for measuring water level elevations and/or groundwater sampling were noted. The Jal Country Club was visited and Mr. Harrell Butler from the City of Jal showed the locations of wells used for production of water for sale and the locations of other wells on the property. As a result of that trip, John W. West Surveying Company of Hobbs was contacted to survey the wells and to generate a map showing well locations and casing elevations. On February 29, 2000, SESI staff technicians measured water level elevations and total depth in all the wells identified as suitable for study. The City of Jal shut down it's pumping wells for a minimum of twelve hours to allow recovery of water levels prior to measurement of static water levels. Water quality sampling was performed as described in Section 5.2.

#### 4.3 Groundwater Occurrence and Movement

Information collected during the late February investigation was organized and tabulated for the purpose of drawing groundwater elevation maps. Table 1 lists the wells used in the study while Table 2 provides a summary of water level elevations and total depth. Water levels measured both in December 1999 and February 2000 are included in the table.

Water level elevations range from a high of 3,078.47 feet above MSL at well #6 (the north water well in Section 7), to 3,047.32 feet at well #8 (Jal Country Club Monitor Well 3) which is an elevation difference of 31 feet over a distance of about one mile. The average saturated thickness of the sediments ranges from 20 to 40 feet (assuming that the water supply wells completely penetrate to the bottom of the saturated zone). However, one unused country club well (#10) measured less than one foot of water in the casing; the probe may have encountered an obstruction before reaching total depth. Another well (#13) at the country club and used for pumping water for sale had a saturated thickness of 81.4 feet. The completion details of this well are unknown, but it may have been drilled partially into the Triassic rocks beneath the Ogallala or alluvial surface sediments unless a buried channel or depression was encountered. The two oilfield-related monitor wells installed in the past few years (#4, #7) have between 11 and 13 feet of saturated thickness.

The water level elevation data for both December 1999 and February 2000 was plotted on two maps and water level elevation contours drawn (Figures 2 and 3). Figure 2 shows groundwater on December 15, 1999, moving from the vicinity of Bristol line leak and Monitor Well 4 directly toward the Osborn pumping well (at that time the Main House Well, #2). Therefore, any contaminants present in the groundwater will also migrate toward well #2. The groundwater gradient (outside the area of the pumping cone of depression) is 1 foot per 325 feet, or 0.003 feet per foot. No monitor wells are located to the north or east of the spill site, so no further delineation of groundwater movement is currently possible at this location.

Table 1.List of Water and Monitor Wells in the Vicinity of the Osborn Ranch, Jal, Lea<br/>County, New Mexico

Well Name	Map ID	State Engineer Information	Comment
Front House Windmill	#1	NE, SE, NE, NE Sec. 18, T25S, R37E	Owner's well #4
Front House Well	#5	NE, SE, NE, NE Sec. 18, T25S, R37E	Owner's well #5
Main House Well	#2	SE, SW, NE, NE Sec. 18, T25S, R37E	Owner's well #1 (also, Jal CC Monitor well 11)
Back House Windmill	#3	SE, SW, NE, NE Sec. 18, T25S, R37E	Owner's well #2
West Water Well	#14	SW, SW, NE, NE Sec. 18, T25S, R37E	Owner's well #3
Bristle Resources Well	#4		Monitor well
North (Section 7) Water Well	#6	NW, NE, SW, SW Sec. 7, T25S, R37E	Unused, owner's well #6
SW (TX-NM pipeline) Well	#7		Monitor well
Jal Country Club MW-3	#8	*	Production & monitor well
Jal Country Club MW-4	#9	*	Production & monitor well
Jal Country Club NE MW	#10	*	Unused well
Jal Country Club NW MW	#11	*	Unused well
Jal Country Club Windmill	#12	*	Monitor well #18, plugged
Jal Country Club MW-2	#13	*	Production & monitor well
Jal Country Club Center MW	#15	*	Unused well
Section 13 Water Well		SW, SE, SE, SW Sec. 13, T25S, R36E	Unused, owner's well #7

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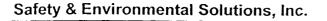
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Table 2.	Water Level Elevations and Total Depth of Wells in the Vicinity of the Osborn Ranch,
	Jal, Lea County, New Mexico

ID and Name	Casing Elevation (feet)	Date	Depth to Water (feet)	Water Level Elevation (feet)	Measured Total Depth (feet)
#1, Front House Windmill	3,095.92	12-15-99 02-29-00	43.58 52.05	3,052.34 3,043.87	65.19 (?) 69.01
#2, Main House Well	3,095.32	12-15-99 02-29-00	45.66 42.33	3,049.66 3,052.99	86.45
#3, Back House Windmill	3,101.64	12-15-99 02-29-00	49.44 48.50	3,052.20 3,053.14	74.80 75.60
#4, Bristol Monitor Well	3,105.99	12-15-99 02-29-00	51.14 51.03	3,054.85 3,054.96	62.37
#5, Front House Well	3,096.47	12-15-99 02-29-00	43.96 44.92	3,052.51 3,051.55	66.16
#6, North (Sec. 7) Water Well	3,133.90	02-29-00	55.43	3,078.47	78.74
#7, SW (TX-NM) Mon. Well	3,126.02	02-29-00	64.08	3,061.94	77.36
#8, Jal CC Monitor Well 3	3,091.47	02-29-00	44.15	3,047.32	78.22
#9, Jal CC Monitor Well 4	3,094.64	02-29-00 03-02-00	42.19 45.58	3,052.45 3,049.06	80.19
#10, Jal CC NE Monitor Well	3,092.74	02-29-00	43.13	3,049.61	43.76 (?)
#11, Jal CC NW Monitor Well	3,103.56	02-29-00	52.18	3,051.38	98.91
#12, Jal CC Windmill (MW-18)	3,103.56	02-29-00	Plugged		
#13, Jal CC Monitor Well 2	3,082.29	02-29-00	33.68	3,048.61	115.05
#14, West Water Well	3,101.38	12-15-99 02-29-00	48.98 48.34	3,052.40 3,053.04	61.37
#15, Jal CC Center Monitor Well	3,093.91	02-29-00 03-02-00	40.79 40.84	3,053.12 3,053.07	69.99 



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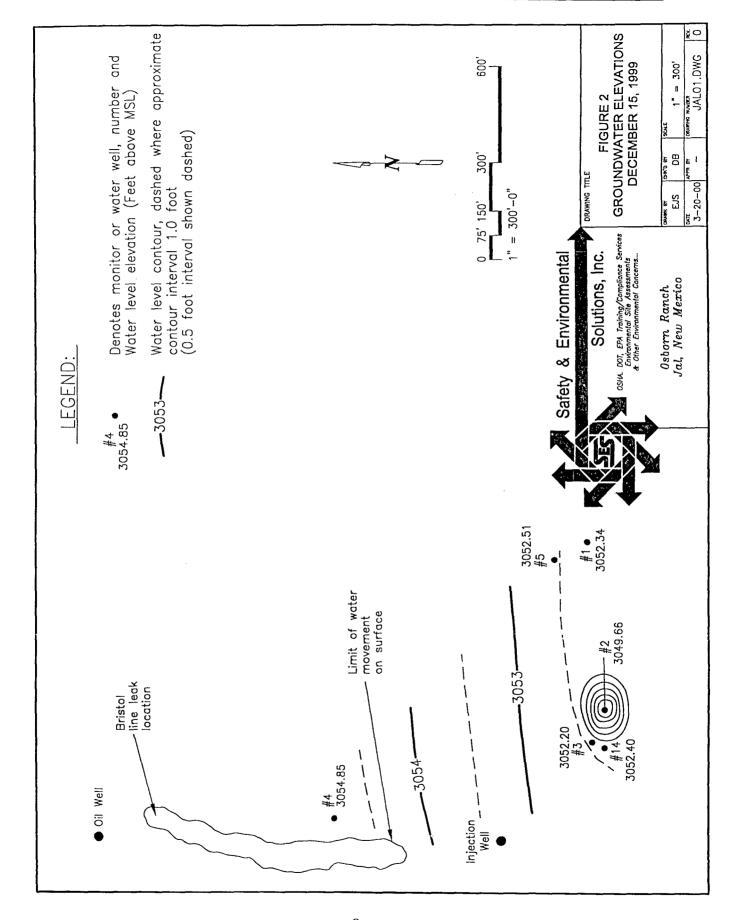
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Figure 3. Groundwater Elevations, February 29, 2000, Osborn Ranch, Jal, Lea County, New Mexico

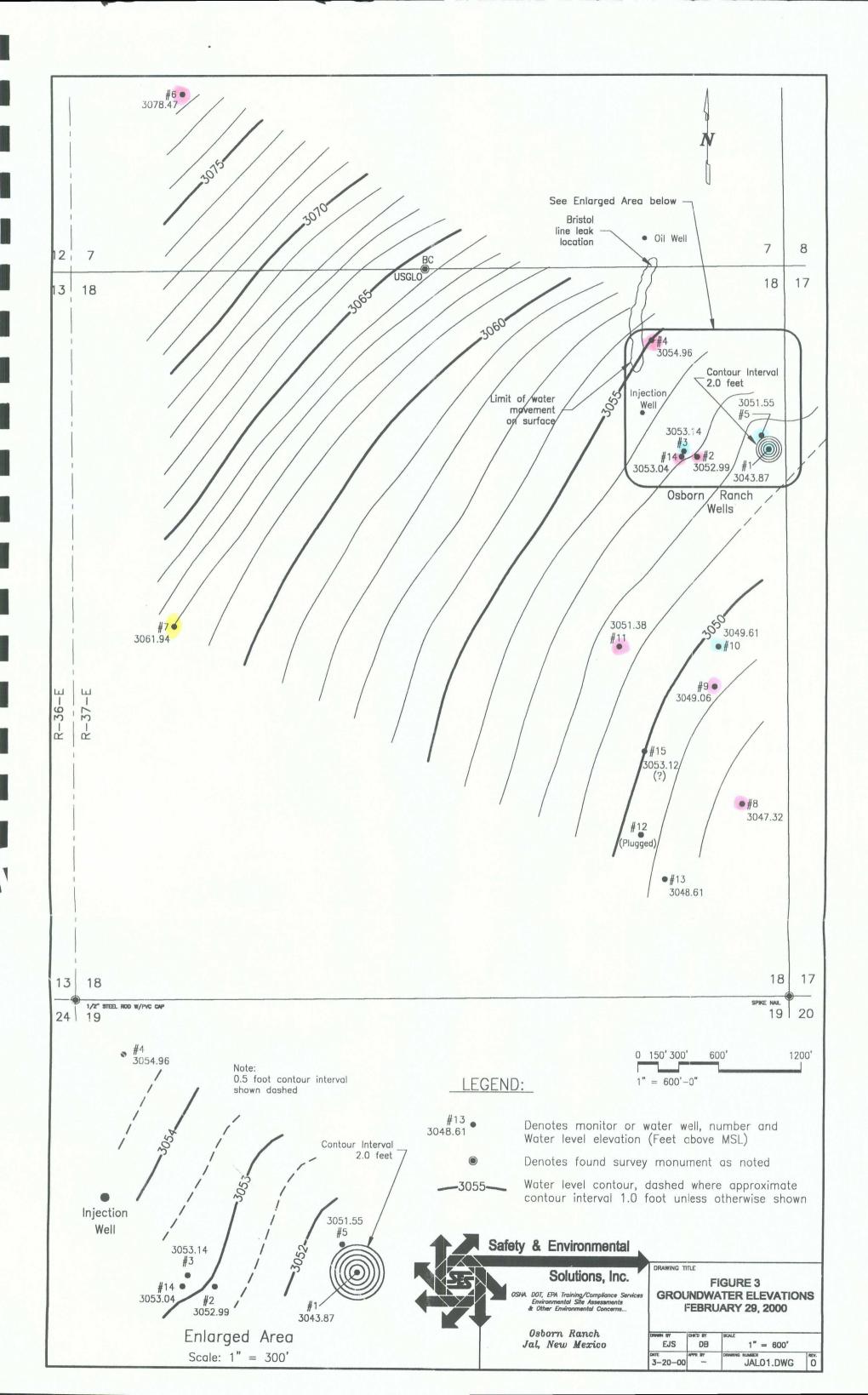


Figure 3 provides an overview of groundwater movement in the vicinity of the ranch and the Jal Country Club on February 29, 2000. Groundwater movement is generally from northwest to southeast. The gradient is about twice as steep in the northwest (0.007 ft/ft) and flattens in the vicinity of the ranch and country club (0.003 ft/ft). No evidence is seen of a pumping cone of depression at the country club, although the wells have been shut in only for about 12 hours. Also, no evidence of groundwater movement from the vicinity of the country club wells toward the Osborn Ranch was seen.

The Osborn's are currently pumping well #1 due to the increased levels of chloride and TDS in well #2. The direction of movement from the vicinity of the Bristol line leak is generally towards well #1, although the movement is not as direct as was movement in December to well #2. However, a plume of contaminated water located between wells #4 and #2 will now move toward well #1 as result of the cessation of pumping of well #2 and commencement of pumping of well #1.

#### 5.0 Water Quality

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#### 5.1 Reported Water Quality

The quality of groundwater in southern Lea County is quite variable due of a number of natural and man-caused factors. In areas where oilfield produced water has not impacted groundwater, water from the Ogallala and from alluvium produced from weathering of the Ogallala is moderately high in calcium plus magnesium, low in sodium plus potassium, moderately low in sulfate and chloride, and moderately high in TDS (Nicholson and Clebsch, 1961). Groundwater from Triassic rocks shows a wide range in calcium and magnesium concentrations, is high in sodium and moderately high in sulfate, and moderately low in chloride. However, in the Triassic rocks both sulfate and chloride can show a wide range in concentration, and TDS is typically somewhat higher than in Ogallala waters.

Where natural groundwater has been impacted by discharges of saline produced water from oilfield operations, increases of sodium, chloride and TDS can be expected with lessor increases in calcium, magnesium and sulfate. A significant increase in inorganic constituents from produced water can make the water non potable for domestic use, including gardening. Nicholson and Clebsch (1961) discuss instances of brine contamination of potable water, and present some criteria for identification of impacted water. However, their proposed identification methods, utilizing ratios of chloride and sulfate may be overly conservative in that virtually all of the waters tested for this report would have failed. This would suggest that brine has contaminated all the wells in the vicinity of the ranch which is not believed to be the case. A more accepted procedure is the use of the Piper Trilinear Diagram which displays the inorganic components graphically so that water analyses can be examined visually for evidence of mixing of natural water with oilfield produced water. The use of this method to evaluate water quality will be discussed in more detail in Section 5.3.

In addition to the inorganic constituents, organic contaminants such as benzene, toluene, ethylbenzene and xylenes (BTEX) are present in oilfield produced water. Improper disposal of waters containing these contaminants can make an otherwise potable water unacceptable due to

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taste, odor, or elevated health risk from toxic or cancer-causing chemicals. The EPA and the state of New Mexico have developed drinking water and groundwater standards for the occurrence of these contaminants in water supplies.

During the time that the Jal Country Club has been applying treated city wastewater effluent at the golf course, the NMED has required monitoring of chlorides, nitrates and TDS at several locations, including the Osborn Main House well (#2). A review of information collected shows recently elevated values of chloride and TDS at the Osborn well #2 (Table 3). The. Chloride and TDS data show an increase since 1996 with the increase accelerating during 1998 and 1999 (Figure 4).

Date	Chloride (mg/L)	TDS (mg/L)
05/23/96	172	992
11/21/96	176	714
05/27/97	182	938
11/05/97	241	1,250
05/11/98	218	1,100
11/30/98	292	1,280
05/17/99	319	1,580
11/22/99	419	1,570
12/15/99	432	1,782

Table 3. Chloride and Total Dissolved Solids (TDS) Measured at Osborn Main House Well,<br/>Osborn Ranch, Jal, Lea County, New Mexico

#### 5.2 Current Water Quality Investigation

SESI began collection of water quality data from wells in the vicinity of the Osborn Ranch on December 15, 1999. Previously, Cornerstone Environmental Resources had collected a limited amount of data in July 1999 for inclusion in the groundwater sampling portion of their Phase II environmental assessment report. Although key constituents were sampled, a complete set of major chemical cations and anions in water must be analyzed so that a mixing study can be performed using the Piper diagrams.

Additional water wells were sampled beginning on February 22 and continuing through March 14, 2000. For wells which were not regularly pumped or sampled, at least three casing volumes of water were removed prior to sampling. Following standard sampling protocol, water electrical conductivity and pH were monitored during pumping until stable. Samples were also obtained of the wastewater effluent applied at the Jal County Club, of water sold by the Jal County Club for

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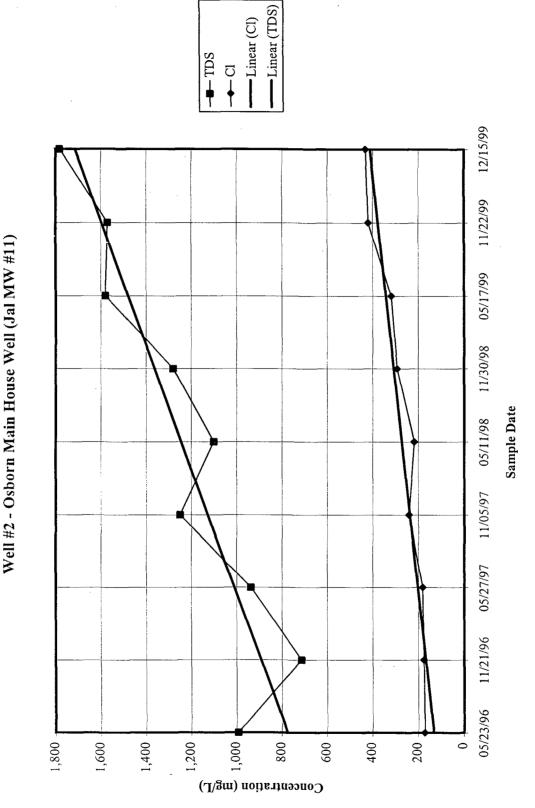
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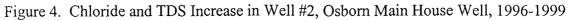
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oilfield use, and of produced water slated for injection well disposal and similar to that which leaked from the surface flow lines. Samples collected were placed on ice and transported to one of two analytical laboratories for analysis. A chain-of-custody form was used to list samples and to have the laboratory acknowledge receipt of the samples.

#### 5.3 Results of the Water Quality Investigation

The results of the current water quality investigation are presented in Table 4. The table shows obvious elevated levels of inorganic constituents at several locations. These locations include water from the Osborn's Main House well (#2), the West Water well (#14), the Bristol monitor well (#4), the north (Section 7) monitor well (#6), the Jal Country Club monitor wells 3 and 4 (#8 and #9), and the Jal Country Club water tanks. A sample of produced water (taken from the injection pump located near the Bristol monitor well) was obtained from Mr. Clay Osborn.

In addition to analysis of inorganic constituents, samples were tested for BTEX hydrocarbons. Those tested include the five water and windmills in the vicinity of the ranch residences (well ID #1, 2, 3, 5, and 14), the North Water well (#6), the SW (TX-NM) monitor well (#7) and the Jal Country Club water sale tanks. All samples tested less than 0.002 mg/L for benzene, toluene and ethylbenzene. All samples tested less than 0.006 mg/L for xylene. These values are at the method detection level for these constituents.

Although a simple comparison of the inorganic analytical results might appear sufficient to determine if the produced water is the source of elevated chloride and other constituents in the monitor wells, a more scientific method is necessary because of the various combinations of constituents that are possible. For example, a water sample might be high in chloride implying brine contamination from produced water. However, instead of sodium the cation might be calcium which is not characteristic of produced water, but could be from other oilfield chemicals.

The Piper Trilinear Diagram requires an analysis of major cations and anions for use in the diagram. The diagram utilizes two equilateral triangles in the left and right corners with a diamond-shaped field in between the triangles (Figure 5). One of the triangles contains cation concentrations (in milliequivalents per liter) and the other anion concentrations. Cation concentrations are proportionally represented by calcium, magnesium, sodium plus potassium while anion concentrations are represented by chloride, sulfate, and carbonate plus bicarbonate. Once plotted in their respective triangles, the points are extended into the central diamond-shaped field where they provide general information on the makeup of the water.

The most important feature of the Piper Diagram is the ability to graphically view the water composition and make conclusions regarding the source(s) of the water sample. The method is especially good at determining whether a water sample is a mixture of two independent waters, or whether it is from a third source. For a water sample to be a mixture of two other sources, it must plot along or close to a straight line in each of the three fields, unless a chemical or ion exchange reaction is occurring.

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Jal, Lea County, NM

Sample	Well	Sample	Sodium	Calcium	Magnesium	Potassium	Chloride	Sulfate	Carbonate	Bicarbon-	Nitrate	TDS
Location	ID	Date	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	ate (mg/L)	(mg/L)	(mg/L)
Front House		12/15/99	116	64	27	4.3	125	171	0.0	215	2.6	780
Windmill		12/17/99	110	67	22	4.5	133	146	0.0	200		872
Front House Well	2	12/15/99	94	85	50	6.4	158	243	0.0	190	7.1	918
Main House Well	2	07/21/99 12/15/99 03/03/00	122 213 98	 162 225	61 47 67	6.0 6.7 3.4	342 432 420	304 282 320	 0.0 0.0	 205 201	 7.5 9.3	 1,782 1,500
Back House	ę	12/15/99	81	73	9.3	4.4	121	83	0.0	176	1.2	484
Windmill		12/17/99	89	52	19	4.4	133	92	0.0	151		623
West Water Well	14	07/21/99 12/15/99 03/03/00	405 186 154	 114 150	135 47 44	13.0 6.0 3.4	687 295 270	1,440 364 460	 0.0 0.0	 116 173	 5.1 6.7	 1,502 1,300
Bristol Monitor Well	4	07/21/99 02/29/00 03/03/00	125 85 125	 147 164	41 50 58	6.0 9.7 6.7	348 380 410	154 111 150	 0.0 0.0	 146 158	 1.2 3.1	 915 1,200
North (Sec. 7)	9	12/30/99	396	195	67	7.6	857	257	0.0	195	0.7	2,300
Monitor Well		03/14/00	203	193	68	5.2	770	250	0.0	84	<1.0	1,700
SW (TX-NM)	7	01/06/00	125	134	54	6.9	210	274	0.0	312	1.4	1,419
Monitor Well		03/14/00	76	208	62	1.7	200	420	0.0	362	3.5	1,200
Note: 1. Analys	is on 7/	21/99 samp	oled by Co	rnerstone E	Analysis on 7/21/99 sampled by Cornerstone Environmental Resources, Inc., for Bristol Resources. All other analyses sampled by SESI	Resources, I	nc., for Bris	tol Resour	rces. All oth	her analyses	sampled b	y SESI

Safety & Environmental Solutions, Inc.

EPA drinking water standards – Chloride 250 mg/L, Sulfate 250 mg/L, Nitrate 10 mg/L, TDS 500 mg/L NM Water Quality Commission Groundwater Standards – Chloride 250 mg/L, Sulfate 600 mg/L, Nitrate 10 mg/L, TDS 1,000 mg/L

Analysis on //21/99 sampled by Cornerstone Environmental Resources, Inc., for Bristol Resources. All other analyses TDS - Total dissolved solids by method of evaporation and weight of residue - ~ ~ ~ +

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Constituents in W	(luded)	
Quality of Inorganic	ounty, NM (conc	
Water	Jal, Lea Co	
Table 4.		

Sample	Well	Sample	Sodium		Magnesium	Potassium	Chloride		Carbonate Bicarbon-	Bicarbon-	Nitrate	SUL
Location	ID	Date	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	ate (mg/L)	(mg/L)	(mg/L)
Jal CC MW-3	8	02/22/00	386	337	143	16	668	1,085	0.0	268	5.5	2,650
Jal CC MW-4	6	02/22/00	369	257	131	12	296	948	0.0	210	5.5	2,080
NE CC MW	10	02/29/00	62	LL	21	6.2	152	111	0.0	156	1.7	623
NW CC Monitor Well	11	02/29/00 03/14/00	95 85	43 54	62 57	12.2 7.8	332 400	3.9 5.2	0.0	137 121	0.2 <1.0	788 710
Jal CC Effluent	ŀ	02/22/00	231	91	61	24	188	468	115	83	1	1,153
Jal CC Tanks	t I	01/12/00 02/22/00	579 	180 	59 	10.6 	667 	796 	0.0	239 	 5.3	2,260
Produced Water	I T	07/21/00 03/03/00	15,700 11,490	 1,125	3,170 3,127	404 557	27,000 30,000	4,590 4,500	 0.0	1,008	 <1.0	 59,000
Note:	, i						· · · · · · · · · · · · · · · · · · ·			,		

Analysis on 7/21/99 sampled by Cornerstone Environmental Resources, Inc., for Bristol Resources. All other analyses sampled by SESI TDS - Total dissolved solids by method of evaporation and weight of residue -. .. .. 4

EPA drinking water standards – Chloride 250 mg/L, Sulfate 250 mg/L, Nitrate 10 mg/L, TDS 500 mg/L

NM Water Quality Commission Groundwater Standards - Chloride 250 mg/L, Sulfate 600 mg/L, Nitrate 10 mg/L, TDS 1,000 mg/L

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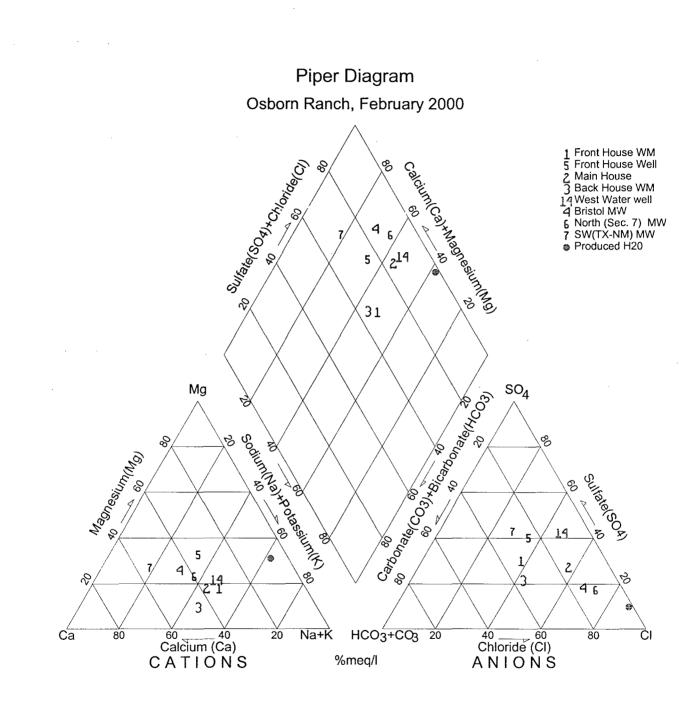


Figure 5. Piper Trilinear Diagram, February 2000, Osborn Ranch, Jal, New Mexico

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Figure 5 shows the relationship of the several well water samples taken in the vicinity of the Osborn Ranch house plus samples from other monitor wells on the property and from produced water prior to downhole injection. In this instance the anion composition of the Main House water well (#2) falls between that of produced water and water from the Front House well (#5). Water from the Bristol monitor well (#4) is even closer to the anionic composition of produced water. Waters from the front and back windmills (#1 and #3) show a lessor impact from produced water chlorides and they retain much of their carbonate-bicarbonate composition.

In the cation triangle, sodium-calcium ion exchange reactions complicate interpretation, but the sodium plus potassium percentage in well #2 is higher than that in #5. Well #4 shows a lower percentage of sodium plus potassium in the water which may be the result of the sodium from the produced water replacing calcium and magnesium in the sediments and releasing these two constituents to the groundwater. The windmill waters (#1, #3) have a moderate amount of calcium and a lessor amount of magnesium than the other samples

In the diamond center, water from the Main House well (#2) is located between the produced water and water from the Front House well (#5). Water from the two windmills (#1, #3) retains its calcium carbonate-bicarbonate composition while the Bristol water shows the result of high chlorides and the exchange of sodium in the produced water for calcium and magnesium present in the sediments.

Water in the North (Section 7) well (#6) and in the Southwest (TX-NM) well (#7) are unrelated. Although both wells are located on the western edge of the study area, #6 has been severely impacted by chlorides from produced water while #7 has been impacted very little if at all. For many years oilfield tank batteries have been located upgradient from the North well (#6). Although located near oilfield production and installed to detect and monitor groundwater impacts from a hydrocarbon release, the Southwest well (#7) contains less than 30 percent chlorides (vs. 70 percent for #6), and greater than 50 percent calcium (versus 40 percent for #6)

The conclusions to be drawn from the examination of the Piper Diagram are 1) that the water in the Main House Well (#2) is a mixture of native groundwater and oilfield produced water, and 2) that elevated levels of chloride in the Bristol monitor well is due to mixing of native groundwater with produced water although some sodium in the water in the vicinity of the well has been exchanged on the calcareous sediments for calcium which is dissolved in the water.

#### 6.0 Discussion

In their discussion of brine contamination of shallow groundwater in southern Lea County, Nicholson and Clebsch (1961, p.104) point out that under some circumstances a mixture of brine and fresh water can be pumped by water wells. Although the brine might move very near a producing well, it still may not be pumped by the well for several reasons. The well may not extend to the base of the aquifer or low permeability beds may retard water movement into the well. The pumping schedule and rate of pumping may not be sufficient to draw the produced water into the well except after prolonged and heavy pumping; contamination might appear less intense in samples collected during short pumping cycles. Also, samples taken only

intermittently from monitor wells receiving little pumping can mask effects of contamination which might appear with heavier and more frequent use.

Several of these points have applicability at the Osborn ranch. First, it appears that the Main House well (#2) supplied most of the water in the area of the ranch houses prior to the time that chloride and dissolved solids concentrations accelerated upward in 1996. Lessor pumping of that well in the future may well reduce the amount of brine captured by the cone of depression. Wells pumped to a lessor extent, especially the two windmills, show lower concentration impacts of the produced water. Secondly, the two monitor wells having shallow completions (Bristol #4 with 11 feet of saturation and the Southwest (TX-NM) #7 with 13 feet of saturation) show markedly different concentrations of constituents. The Bristol well especially shows impacts of produced water even though it is not completed in a deep zone and has not been heavily pumped. This could indicate that contamination has migrated from the surface to the upper portion of the aquifer versus contamination flowing at the base of the aquifer in channels and along the top of Triassic redbed surface.

## 7.0 Conclusions

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- 1. As a result of the study, groundwater movement in the vicinity of the Osborn Ranch is from the north and northwest to the south and southeast. Movement was in a more southerly direction in December 1999 than in February 2000, with the slight change in direction likely due a change in pumping locations from the Main House well to the Front House windmill.
- 2. The groundwater movement is from the general location of oil and gas production operations on the ranch. Mapping of groundwater contours in December 1999 indicate groundwater movement from the vicinity of a surface leak of oil and gas produced water (i.e. wastewater); a monitor well (#4) placed intermediate between the leak and the pumping wells at the ranch shows chloride contamination consistent with a release of produced water. Use of the Piper Trilinear Diagram shows the water in the Main House well to be a mixture of the produced water and native water.
- 3. Based on data from the shallow monitor well (Bristol, #4) discussed in Section 6.0, above, it is very likely that contamination of the shallow subsurface water zone resulted from one or more leaks in the produced water lines. Since other oil and gas-related sources are in the area (e.g. an injection well, production wells, tanks and tank batteries) and may have potentially contributed to the groundwater contamination, the degree of contribution from the line leak can not be ascertained without additional investigation.
- 4. Due to the south and southeasterly direction of groundwater movement and the contamination of groundwater by oilfield operations (either past or present) as determined by analysis of the groundwater, there is a likelihood that the water wells in the vicinity of the ranch residences will continue to show increased salt concentrations resulting in a decrease in quality of the potable water available to the ranch owners and residents.

#### 8.0 References

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## APPENDIX COPIES OF WATER ANALYSES

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298

6701 Aberdeen Avenue, Suite 9 4725 Ripley Avenue, Suite A Lubbock, Texas 79424 800 • 378 • 1296 El Paso, Texas 79922 888 • 588 • 3443 E-Mail: lab@traceanalysis.com

806•794•1296 FAX 806•794•1298 915•585•3443 FAX 915•585•4944

## **Analytical and Quality Control Report**

Bob Allen Safety & Environmental Solutions Inc. P. O. Box 1613 Hobbs, NM 88240

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Report Date: 3/9/00

Order ID Number: A00030309

Project Number: N/A Project Name: Osburn Ranch Project Location: Jal, NM

Enclosed are the Analytical Results and Quality Control Data Reports for the following samples submitted to TraceAnalysis, Inc. for analysis:

Sample Number	Sample Description	Matrix	Date Taken	Time Taken	Date Received
141693	Produced Water	Water	3/3/00	7:00	3/3/00
141694	Monitor Well #4	Water	3/3/00	7:00	3/3/00
141695	West Water Well #14	Water	3/3/00	7:00	3/3/00
141696	Main House Well #2	Water	3/3/00	7:00	3/3/00

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 7 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

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Hydroxide Alkalinity

#### **Analytical Results Report**

		Analytical	Date	Date		Pren	00	
Result	Dilution	Method	Prepared	Analyzed	Analyst	Batch #	Batch #	RDL
<1.0	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
<1.0	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
827	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
827	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
1125	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
3127	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
557	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
11490	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
* 30,000	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.5
<1.0	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.2
* 4500	1	E 300.0	3/2/00	3/4/00	JS	PB01066	OC01291	0.5
	<1.0 <1.0 827 827 1125 3127 557 11490 * 30,000 <1.0	<1.0 1 827 1 827 1 1125 1 3127 1 557 1 11490 1 * 30,000 1 <1.0 1	<1.0 1 E 310.1 <1.0 1 E 310.1 827 1 E 310.1 827 1 E 310.1 827 1 E 310.1 1125 1 E 200.7 3127 1 E 200.7 557 1 E 200.7 11490 1 E 200.7 * 30,000 1 E 300.0 <1.0 1 E 300.0	Result Dilution         Method         Prepared           <1.0	Result Dilution         Method         Prepared         Analyzed           <1.0	Result Dilution         Method         Prepared         Analyzed         Analyst           <1.0	Result Dilution         Method         Prepared         Analyzed         Analyst         Batch #           <1.0	Result Dilution         Method         Prepared         Analyzed         Analyst         Batch #         Batch #           <1.0

\* Sulfate - Sulfate was re-ran on IC030600.sch (PB01099; QC01326). ICV %IA = 96; CCV %IA = 98; Matrix spikes RPD = 2; Matrix spikes %EA = 98.

Sample Number:141694Description:Monitor Well #4									
Param	Decult	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
······································		Dilution	Methou	riepareu	Analyzeu	Analyst	Batch #	Batch #	
Alkalinity (mg/L as CaCo3)	<1.0	- 1	E 310.1	3/6/00	3/6/00	10	<b>DD01000</b>	0.001214	
Hydroxide Alkalinity		-				JS	PB01089	QC01314	1
Carbonate Alkalinity	<1.0	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Bicarbonate Alkalinity	130	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	I
Total Alkalinity	130	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Dissolved Metals (mg/L)									
Dissolved Calcium	164	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Magnesium	58	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Potassium	6.7	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Sodium	125	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Ion Chromatography (IC) (mg/L)									
CL	410	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.5
Fluoride	2.1	1	E 300.0	3/2/00	3/4/00	JS	PB01066	OC01291	0.2
Nitrate-N	3.1	1	E 300.0	3/2/00	3/4/00	JS	PB01066	OC01291	0.2
Sulfate	150	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.5
Sample Number: 141695				· · · · · · · · · · · · · · · · · · ·			<u></u>	×	
Description: West Water Well #14									
			Analytical	Date	Date		Prep	QC	
Param	Result	Dilution	Method	Prepared	Analyzed	Analyst	Batch #	Batch #	RDL

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Report Date: 3/9/00	Orde	r ID N	umber: A00	030309			Page	Number:	3 of 7
N/A	Osbi	ım Rai	nch					Ja	I, NM
Carbonate Alkalinity	<1.0	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Bicarbonate Alkalinity	142	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Total Alkalinity	142	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Dissolved Metals (mg/L)									
Dissolved Calcium	150	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Magnesium	44	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Potassium	3.4	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Sodium	154	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Ion Chromatography (IC) (mg/L)									
CL	270	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.5
Fluoride	2.2	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.2
Nitrate-N	6.7	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.2
Sulfate	460	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.5

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141696 Sample Number: Main House Well #2

Description: Main House Well #2 Param		Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Alkalinity (mg/L as CaCo3)	· · · · · ·			<u> </u>					
Hydroxide Alkalinity	<1.0	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Carbonate Alkalinity	<1.0	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Bicarbonate Alkalinity	165	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Total Alkalinity	165	1	E 310.1	3/6/00	3/6/00	JS	PB01089	QC01314	1
Dissolved Metals (mg/L)									
Dissolved Calcium	225	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Magnesium	67	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Potassium	3.4	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Dissolved Sodium	98	1	E 200.7	3/7/00	3/7/00	RR	PB01161	QC01328	0.5
Ion Chromatography (IC) (mg/L)									
CL	420	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.5
Fluoride	2.3	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.2
Nitrate-N	9.3	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.2
Sulfate	320	1	E 300.0	3/2/00	3/4/00	JS	PB01066	QC01291	0.5

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## Quality Control Report Method Blanks

Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
Hydroxide Alkalinity (mg/L as CaCo3)		<1.0	1	3/6/00	PB01089	QC01314
Carbonate Alkalinity (mg/L as CaCo3)		<1.0	1	3/6/00	PB01089	QC01314
Bicarbonate Alkalinity (mg/L as CaCo3)		<2.0	1	3/6/00	PB01089	QC01314
Total Alkalinity (mg/L as CaCo3)		<2.0	1	3/6/00	PB01089	QC01314

Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
Dissolved Calcium (mg/L)		<.5	0.5	3/7/00	PB01161	QC01328
Dissolved Magnesium (mg/L)		<.5	0.5	3/7/00	PB01161	QC01328
Dissolved Potassium (mg/L)		<.5	0.5	3/7/00	PB01161	QC01328
Dissolved Sodium (mg/L)		<.5	0.5	3/7/00	PB01161	QC01328

Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
CL (mg/L)		<0.5	0.5	3/4/00	PB01066	QC01291
Fluoride (mg/L)		<0.2	0.2	3/4/00	PB01066	QC01291
Nitrate-N (mg/L)		< 0.2	0.2	3/4/00	PB01066	QC01291
Sulfate (mg/L)		<0.5	0.5	3/4/00	PB01066	QC01291

## Quality Control Report Matrix Spike and Matrix Duplicate Spike

Standard	Param	Sample Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
MS	CL (mg/L)	420	1	125	526.03	85		80 - 120	0 - 20	QC01291
MS	Fluoride (mg/L)	2.3	1	25	28.39	104		80 - 120	0 - 20	QC01291
MS	Nitrate-N (mg/L)	9.3	1	50	56.82	95		80 - 120	0 - 20	QC01291
MS	Sulfate (mg/L)	320	1	125	436.35	93		80 - 120	0 - 20	QC01291
MSD	CL (mg/L)	420	1	125	532.63	90	6	80 - 120	0 - 20	QC01291
MSD	Fluoride (mg/L)	2.3	1	25	27.85	102	2	80 - 120	0 - 20	QC01291
MSD	Nitrate-N (mg/L)	9.3	1	50	56.00	93	2	80 - 120	0 - 20	QC01291
MSD	Sulfate (mg/L)	320	1	125	440.58	96	4	80 - 120	0 - 20	QC01291

Standard	Param	Sample Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
MS	Dissolved Calcium (mg/L)	1125	1	1000	2196	107		75 - 125	0 - 20	QC01328
MS	Dissolved Magnesium (mg/L)	3127	1	1000	4112	99		75 - 125	0 - 20	QC01328
MS	Dissolved Potassium (mg/L)	557	1	1000	1721	116		75 - 125	0 - 20	QC01328
MS	Dissolved Sodium (mg/L)	11490	1	1000	12410	92		75 - 125	0 - 20	QC01328
MSD	Dissolved Calcium (mg/L)	1125	1	1000	2165	104	3	75 - 125	0 - 20	QC01328
MSD	Dissolved Magnesium (mg/L)	3127	1	1000	4037	91	8	75 - 125	0 - 20	QC01328
MSD	Dissolved Potassium (mg/L)	557	1	1000	1747	119	2	75 - 125	0 - 20	QC01328
MSD	Dissolved Sodium (mg/L)	11490	1	1000	12620	113	20	75 - 125	0 - 20	QC01328

## Quality Control Report Duplicates

Standard	Param	Flag	Duplicate Result	Sample Result	Dilution	RPD	RPD Limit	QC Batch #
Duplicate	Hydroxide Alkalinity (mg/L as CaCo		<1.0	<1.0	1	0	0 - 20	QC01314
Duplicate	Carbonate Alkalinity (mg/L as CaCo		<1.0	<1.0	1	0	0 - 20	QC01314
Duplicate	Bicarbonate Alkalinity (mg/L as CaC		47	49	1	4	0 - 20	QC01314
Duplicate	Total Alkalinity (mg/L as CaCo3)		47	49	1	4	0 - 20	QC01314

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## Quality Control Report Lab Control Spikes and Duplicate Spike

	Param	Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	QC Batch #
LCS	Dissolved Calcium (mg/L)	<.5	1	1000	980	98		75 - 125	0 - 20	QC01328
LCS	Dissolved Magnesium (mg/L)	<.5	1	1000	999	100		75 - 125	0 - 20	QC01328
LCS	Dissolved Potassium (mg/L)	<.5	1	1000	999	100		75 - 125	0 - 20	QC01328
LCS	Dissolved Sodium (mg/L)	<.5	1	1000	976	98		75 - 125	0 - 20	QC01328
LCSD	Dissolved Calcium (mg/L)	<.5	1	1000	984	98	0	75 - 125	0 - 20	QC01328
LCSD	Dissolved Magnesium (mg/L)	<.5	1	1000	944	94	6	75 - 125	0 - 20	QC01328
LCSD	Dissolved Potassium (mg/L)	<.5	1	1000	1003	100	0	75 - 125	0 - 20	QC01328
LCSD	Dissolved Sodium (mg/L)	<.5	1	1000	983	98	1	75 - 125	0 - 20	QC01328

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## Quality Control Report Continuing Calibration Verification Standard

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Hydroxide Alkalinity (mg/L as CaCo3)		0	<1.0	0	80 - 120	3/6/00	QC01314
ICV	Carbonate Alkalinity (mg/L as CaCo3)		0	208	0	80 - 120	3/6/00	QC01314
ICV	Bicarbonate Alkalinity (mg/L as CaCo3)	)	0	20	0	80 - 120	3/6/00	QC01314
ICV	Total Alkalinity (mg/L as CaCo3)		236	228	97	80 - 120	3/6/00	QC01314
CCV 1	Hydroxide Alkalinity (mg/L as CaCo3)		0	<1.0	0	80 - 120	3/6/00	QC01314
CCV 1	Carbonate Alkalinity (mg/L as CaCo3)		0	214	0	80 - 120	3/6/00	QC01314
CCV 1	Bicarbonate Alkalinity (mg/L as CaCo3)	)	0	15	0	80 - 120	3/6/00	QC01314
CCV 1	Total Alkalinity (mg/L as CaCo3)		236	229	. 97	80 - 120	3/6/00	QC01314
Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Dissolved Calcium (mg/L)		20	20.9	105	75 - 125	3/7/00	QC01328
ICV	Dissolved Magnesium (mg/L)		20	20.2	101	75 - 125	3/7/00	QC01328
ICV	Dissolved Potassium (mg/L)		20	21.1	106	75 - 125	3/7/00	QC01328
ICV	Dissolved Sodium (mg/L)		20	20.6	103	75 - 125	3/7/00	QC01328
CCV 1	Dissolved Calcium (mg/L)		1	21	2100	75 - 125	3/7/00	QC01328
CCV 1	Dissolved Magnesium (mg/L)		20	20.4	102	75 - 125	3/7/00	QC01328
CCV 1	Dissolved Potassium (mg/L)		20	20.5	102	75 - 125	3/7/00	QC01328
CCV 1	Dissolved Sodium (mg/L)		20	20.3	102	75 - 125	3/7/00	QC01328
Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	CL (mg/L)		12.5	11.46	92	80 - 120	3/4/00	QC01291
ICV	Fluoride (mg/L)		2.5	2.53	101	80 - 120	3/4/00	QC01291
ICV	Nitrate-N (mg/L)		5	4.63	93	80 - 120	3/4/00	QC01291
ICV	Sulfate (mg/L)		12.5	12.26	98	80 - 120	3/4/00	QC01291
CCV 1	CL (mg/L)		12.5	11.40	91	80 - 120	3/4/00	QC01291
CCV 1	Fluoride (mg/L)		2.5	2.53	101	80 - 120	3/4/00	QC01291
CCV 1	Nitrate-N (mg/L)		5	4.61	92	80 - 120	3/4/00	QC01291
CCV 1	Sulfate (mg/L)		12.5	11.88	95	80 - 120	3/4/00	QC01291

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6701 Aberdeen Avenue, Suite 9 4725 Ripley Avenue, Suite A Lubbock, Texas 79424 800•378•1296 El Paso, Texas 79922 888•588•3443 E-Mail: lab@traceanalysis.com 806•794•1296 FAX 806 915•585•3443 FAX 915

FAX 806•794•1298 FAX 915•585•4944

### Analytical and Quality Control Report

Bob Allen Safety & Environmental Solutions Inc. P. O. Box 1613 Hobbs, NM 88240

212.20

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Report Date: 3/15/00

Project Number:	N/A
Project Name:	Osburn Ranch
Project Location:	Jal, NM

Order ID Number: A00030309

Enclosed are the Analytical Results and Quality Control Data Reports for the following samples submitted to TraceAnalysis, Inc. for analysis:

Sample Number	Sample Description	Matrix	Date Taken	Time Taken	Date Received
141693	Produced Water	Water	3/3/00	7:00	3/3/00
141694	Monitor Well #4	Water	3/3/00	7:00	3/3/00
141695	West Water Well #14	Water	3/3/00	7:00	3/3/00
141696	Main House Well #2	Water	3/3/00	7:00	3/3/00

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 3 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

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## **Analytical Results Report**

•	141693 Produced Water	Deput	Dilution	Analytical Method	Date	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Conductivity (uMHC	)S/cm)	Kesuit	Dilution	Method	Prepared	Analyzeu	Anaryst	Batch #	Batch #	
Specific Conductan	· · · · · · · · · · · · · · · · · · ·	80000	1	SM 2510B	3/13/00	3/13/00	MD	PB01215	QC01464	
TDS (mg/L) Total Dissolved Sol	ids	59000	1	E 160.1	3/14/00	3/15/00	MD	PB01259	QC01519	10
•	141694 Monitor Well #4	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Conductivity (uMHC Specific Conductant	,	1700	1	SM 2510B	3/13/00	3/13/00	MD	PB01215	QC01464	
TDS (mg/L) Total Dissolved Sol	ids	1200	1	E 160.1	3/14/00	3/15/00	MD	PB01259	QC01519	10
	141695 West Water Well #14	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Conductivity (uMHC Specific Conductant	,	1800	· 1	SM 2510B	3/13/00	3/13/00	MD	PB01215	QC01464	
TDS (mg/L) Total Dissolved Sol	ids	1300	1	E 160.1	3/14/00	3/15/00	MD	PB01259	QC01519	10
•	141696 Main House Well #2	Result	Dilution	Analytical Method	Date Prepared	Date Analyzed	Analyst	Prep Batch #	QC Batch #	RDL
Conductivity (uMHO Specific Conductand		2100	1	SM 2510B	3/13/00	3/13/00	MD	PB01215	QC01464	
TDS (mg/L) Total Dissolved Soli		1500	1	E 160.1	3/14/00	3/15/00	MD		QC01519	10

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#### Quality Control Report Method Blanks

Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
Specific Conductance (uMHOS/cm)		6.0		3/13/00	PB01215	QC01464
Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #

## Quality Control Report Duplicates

Standard	Param		Flag	Duplicate Result	Sample Result	Dilution	RPD	RPD Limit	QC Batch #
Duplicate	Specific Conductance	(uMHOS/cm)		3062	3100	1	1	0 - 20	QC01464
Standard	Param		Flag	Duplicate Result	Sample Result	Dilution	RPD	RPD Limit	QC Batch #
Duplicate	Total Dissolved Solids	(mg/L)		591	590	1	0	0 - 20	QC01519

## Quality Control Report Continuing Calibration Verification Standard

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Specific Conductance (uMHOS/cm)		1413	1308	93	80 - 120	3/13/00	QC01464
CCV 1	Specific Conductance (uMHOS/cm)		1413	1337	95	80 - 120	3/13/00	QC01464
Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
Standard ICV	Param Total Dissolved Solids (mg/L)	Flag	TRUE	Found	Percent	Recovery		•



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PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: DAVID BOYER 703 E. CLINTON, SUITE #103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 02/22/00 Reporting Date: 02/28/00 Project Number: NOT GIVEN Project Name: OSBORN RANCH Project Location: JAL Sampling Date: 02/22/00 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: AH Analyzed By: AH

	Na	Ca	Mg	K Conductivity	T-Alkalinity
LAB NUMBER SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L) (u mhos/cm)	(mgCaCO <sub>3</sub> /L)

ANAL 1010 D	ATE:	02/28/00	02/23/00	02/23/00	02/23/00	02/23/00	02/23/00
H4661-1	JAL CC EFFLUENT	231	91	61	24	1818	260
H4661-3	JAL CC MW-3	386	337	143	16	4497	220
H4661-4	JAL CC MW-4	369	257	131	12	3806	172
Quality Contr	ol	NR	52	53	4.89	1392	NR
True Value Q		NR	50	50	5.00	1413	NR
% Recovery	nn 1 , 1 1 1 <sub>4</sub> , n, 1	NR	104	106	98	98.5	NR
	ent Difference	NR	7.7	7.5	NR	0.2	NR
METHODS:		SM	3500-Ca-D	3500-Mg E	8049	120.1	310.1
		CI_	SO4	CO3	HCO3	рН	TDS
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(s.u.)	(mg/L)
ANALYSIS D	ATE:	02/23/00	02/23/00	02/23/00	02/23/00	02/23/00	02/23/00
H4661-1	JAL CC EFFLUENT	188					
14001-1		100	468	115	83	8.75	
	JAL CC MW-3	668	468 1085	115 0	83 268	8.75	1153
H4661-3 H4661-4		······					1153 2650 2080
H4661-3 H4661-4	JAL CC MW-3 JAL CC MW-4	668 596	1085 948	0	268 210	7.25 7.29	1153 2650 2080
H4661-3 H4661-4 Quality Contro	JAL CC MW-3 JAL CC MW-4	668 596 960	1085 948 53.2	0 0 NR	268 210 971	7.25 7.29 7.01	1153 2650 2080 NR
H4661-3 H4661-4 Quality Contro True Value Q	JAL CC MW-3 JAL CC MW-4	668 596	1085 948 53.2 50.0	0 0 NR NR	268 210 971 1000	7.25 7.29 7.01 7.01	1153 2650 2080 NR NR
H4661-3 H4661-4 Quality Contro True Value Q % Recovery	JAL CC MW-3 JAL CC MW-4	668 596 960 1000	1085 948 53.2	0 0 NR	268 210 971	7.25 7.29 7.01	1153 2650 2080

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PLEAS AGENT ANALOG 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 client for 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 thirty (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.



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PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: DAVID BOYER 703 E. CLINTON, SUITE #103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 02/22/00 Reporting Date: 03/02/00 Project Number: NOT GIVEN Project Name: OSBORN RANCH Project Location: JAL Sampling Date: 02/22/00 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: AH Analyzed By: AH

LAB NUMBER SAMPLE ID	TKN (mg/L)	NO <sub>3</sub> -N (mg/L)	NO <sub>2</sub> -N (mg/L)
ANALYSIS DATE: KAN	03/02/00	02/23/00	02/23/00
H4661-2 NORTH POND Jal CC Tank	-	5.25	0.07
H4661-3 JAL CC MW-3	-	5.51	0.06
H4661-4 JAL CC MW-4	• ·	5.46	0.06
H4661-5 OSBORN FISH POND	1.30	3.61	0.12
Quality Control	2.45	3.09	0.23
True Value QC	2.50	3.00	0.25
% Recovery	98	103	92
Relative Percent Difference	4.0	6.1	13.0
METHODS: EPA 600/4-79-020	351.3	352.1	354.1

10 A Date

PLEA**BLAGET Name** 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 client for 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 thirty (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.

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	and, Hobt	ט רמא (טטי	OL TH	ny: S	KRIST	s:			#		PRES. SA	В 🖉 отнек: Ice / соог				: ×	//				ntract or tort, shall be limite g and received by Cardinal ons, loss of use, or loss of	claim is based upon any o			CHECKED BY: (Initials)
The search of the	ast		BIR		Attn:	Address	city:	State:	Phone #:	Fax #:	ЪЧ	studee отнек: регле stude	1								based in contract of the inwriting and rest interruptions, loss interruptions, loss	ther such		(Lab Staff)	/
		1		1613	241						MATRIX	NASTEWATER Soil Oil		×							for any claim arteing whether based in contract or tort, shall be fimited to the amourt paid by the clerit for the I be deemed walved unless made in writing and received by Cardnal within 30 days after completion of the applicable uding without similation, business interruptions, loss of use, or loss of profils incurred by clerit, its subsidance,	Received BV:	-	Received BV:	Sample Condition Cool Intact
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5 2 4 No. 2	DRATO ood, Abile		どう	CC.	State:////Zip:	$\mathcal{N}$	Ø	Project Owner:	Ranc	,		D	FF/1/ent	S.M.	Acon Station	0-5	4.0	1 Brick			l ctient's exclusive ren er cause whatsoever nsequental clamages,	Dates	Time	Date:	
	ARDINAL LABORATORIES, INC. 2111 Beechwood, Abilene, TX 79603	1-010 10	411	Mon	Sta	051	423	Proj	444	/H/		Sample I.D.	100 1	Vott Pc	ec Ain	CC MU	CC MUL	325.54			Liability and Damages. Cardnare liability and client's exclusive remedy ms including those for negligence and any other cause whatsoever shal ext shat Cardnai be liable for incidential or consequential damages, inclu	out of or related to the performation of the contract of the c			:le One) - Other:
きょう	2111 2111	5	1	7072	295	27 '	M	(	0.51	" N	×		161		J.Z	B Val	H Jal	ES CERT			Leblity and Damages. Carr s including those for neglig rd shall Cardinal be liable for	ing out of or relat	49		(Circ Bus
3.0.2	A.	Company Name:	Project Manager:	ess: 705	NOG	M	52	ct #:	Project Name:	Project Location:	FOR LAB USE ONLY	LAB I.D.	HULAL-0	10101 - 201	HUGEL-B	10101 - BQ	1 - 2 0	(10) - 10 (2)				smiates or successors artsing out of a Sampler Relinduished	A Bar	Relinquished BV;	Delivered Bv: (Circle One) Sampler - UPS - Bus - Other:
	C	Com	Proje	Address:	CITY:	Phone #:	Fax #:	Project #:	Proje	Proje	о С	•	HU		HH	뭔	Hulle	+1446			PLEASE NOTE: analyses. All clai service. In no ev	Sam	V	Relin	Sam Del

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

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PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: DEE WHATLEY 703 E. CLINTON, STE 103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 02/29/00 Reporting Date: 03/02/00 Project Number: NOT GIVEN Project Name: OSBURN RANCH Project Location: JAL, NM Sampling Date: 02/29/00 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: AH Analyzed By: AH

	Na	Ca	Mg	K Conductivity	T-Alkalinity
LAB NUMBER SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L) (u mhos/cm)	(mgCaCO <sub>3</sub> /L)

Cl <sup></sup> (mg/L ANALYSIS DATE: 03/01/00 H4683-1 WELL #4 380 H4683-4 WELL #10 152 H4683-5 WELL #11 332 Quality Control 1000	147 77 43 52 50 104 7.7 3500-Ca-D SO <sub>4</sub>	50 21 62 53 50 106 7.5 3500-Mg E	03/01/00 9.7 6.2 12.2 4.89 5 98 2.2 8049 HCO <sub>3</sub>	03/01/00 1621 952 1251 1392 1413 98.5 0.2 120.1	128 112 NR NR NR 310.1
H4683-4       WELL #10       75         H4683-5       WELL #11       95         Quality Control       NF         True Value QC       NF         % Accuracy       NF         Relative Percent Difference       NF         METHODS:       SM         CI <sup>-</sup> (mg/L         ANALYSIS DATE:       03/01/00         H4683-1       WELL #10         H4683-5       WELL #11         332       Quality Control         Quality Control       1000	77 43 52 50 104 7.7 3500-Ca-D SO <sub>4</sub>	21 62 53 50 106 7.5 3500-Mg E	6.2 12.2 4.89 5 98 2.2 8049	952 1251 1392 1413 98.5 0.2 120.1	
H4683-5       WELL #11       98         Quality Control       NF         True Value QC       NF         % Accuracy       NF         Relative Percent Difference       NF         METHODS:       SM         CI <sup>-</sup> (mg/L         ANALYSIS DATE:       03/01/00         H4683-1       WELL #4       380         H4683-5       WELL #11       332         Quality Control       1000	43 52 50 104 7.7 3500-Ca-D SO <sub>4</sub>	62 53 50 106 7.5 3500-Mg E	12.2 4.89 5 98 2.2 8049	1251 1392 1413 98.5 0.2 120.1	112 NR NR NR 310.1
Quality Control       NF         True Value QC       NF         % Accuracy       NF         Relative Percent Difference       NF         METHODS:       SM         Cl <sup></sup> (mg/L         ANALYSIS DATE:       03/01/00         H4683-1       WELL #4       380         H4683-5       WELL #11       332         Quality Control       1000	52 50 104 7.7 3500-Ca-D SO4	53 50 106 7.5 3500-Mg E	4.89 5 98 2.2 8049	1392 1413 98.5 0.2 120.1	NR NR NR NR 310.1
True Value QC       NF         % Accuracy       NF         Relative Percent Difference       NF         METHODS:       SM         Cl <sup>-</sup> (mg/L         ANALYSIS DATE:       03/01/00         H4683-1       WELL #4       380         H4683-5       WELL #10       152         Quality Control       1000       1000	50 104 7.7 3500-Ca-D SO4	50 106 7.5 3500-Mg E	5 98 2.2 8049	1413 98.5 0.2 120.1	NR NR NR 310.1
% Accuracy       NF         Relative Percent Difference       NF         METHODS:       SM         CI <sup></sup> (mg/L         ANALYSIS DATE:       03/01/00         H4683-1       WELL #4       380         H4683-4       WELL #10       152         H4683-5       WELL #11       332         Quality Control       1000	104 7.7 I3500-Ca-D SO4	106 7.5 3500-Мg Е	98 2.2 8049	98.5 0.2 120.1	NR NR 310.1
Relative Percent Difference       NF         METHODS:       SM         CI <sup>-</sup> (mg/L         ANALYSIS DATE:       03/01/00         H4683-1       WELL #4       380         H4683-4       WELL #10       152         H4683-5       WELL #11       332         Quality Control       1000	7.7  3500-Ca-D SO4	7.5 β500-Mg E	2.2 8049	0.2	NR 310.1
METHODS: SM CI <sup></sup> (mg/L ANALYSIS DATE: 03/01/00 H4683-1 WELL #4 380 H4683-4 WELL #10 152 H4683-5 WELL #11 332 Quality Control 1000	I3500-Ca-D SO₄	β500-Mg E	8049	120.1	310.1
Cl <sup></sup> (mg/L ANALYSIS DATE: 03/01/00 H4683-1 WELL #4 380 H4683-4 WELL #10 152 H4683-5 WELL #11 332 Quality Control 1000	SO4	· · · · · · · · ·			
(mg/L ANALYSIS DATE: 03/01/00 H4683-1 WELL #4 380 H4683-4 WELL #10 152 H4683-5 WELL #11 332 Quality Control 1000	•	CO3	HCO	.,	
ANALYSIS DATE:       03/01/00         H4683-1       WELL #4       380         H4683-4       WELL #10       152         H4683-5       WELL #11       332         Quality Control       1000			1003	pН	TDS
H4683-1         WELL #4         380           H4683-4         WELL #10         152           H4683-5         WELL #11         332           Quality Control         1000	(mg/L)	(mg/L)	(mg/L)	(s.u.)	(mg/L)
H4683-4         WELL #10         152           H4683-5         WELL #11         332           Quality Control         1000	03/02/00	03/01/00	03/01/00	03/01/00	03/03/00
H4683-5 WELL #11 332 Quality Control 1000	111	0	146	7.27	915
Quality Control 1000	111	0	156	7.59	623
	3.87	0	137	7.90	788
	53.17	NR	971	7.02	NR
True Value QC 1000		NR	1000	7.00	NR
% Accuracy 100	50.00	NR	97	100	NR
Relative Percent Difference 4.0				0	NR
METHODS: SM4500-CI-E	106		-	V	

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PLEASE JACKING 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 client for 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 thirty (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.



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PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: DEE WHATLEY 703 E. CLINTON, STE 103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 02/29/00 Reporting Date: 03/01/00 Project Number: NOT GIVEN Project Name: OSBURN RANCH Project Location: JAL, NM Sampling Date: 02/29/00 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: AH Analyzed By: AH

LAB NUMBER	SAMPLE ID	NO <sub>3</sub> -N (mg/L)	NO <sub>2</sub> -N (mg/L)
ANALYSIS DA	re:	03/01/00	03/01/00
H4683-1	WELL #4 BRISTOL	1.18	0.02
H4683-2	WELL #6 SEC. 7 WW	0.65	0.02
H4683-3	WELL #7 TNM	1.37	0.02
H4683-4	WELL #10 JCC	1.71	0.03
H4683-5	WELL #11 JCC	0.21	0.02
Quality Control		3.08	0.23
True Value QC		3.00	0.25

METHOD: EPA 600/4-79-020, 352.1, 354.1

**Relative Percent Difference** 

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% Recovery

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PLEASE ACCESSION Divition 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 client for 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 thirty (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.

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ARDI	ARDINAL LABORATORIES, INC. 2111 Beechwood, Abilene, TX 79603	A TORIE , Abilene, T)		101 East Marl	Marland,	and, Hobbs, NM	NM 88240	~		ι.			ć			
Company Namo	(915) 673-7001 Fax (915) 673-7020	Fax (915) 6		(505) 393-232	-2326 Fa	6 Fax (505) 393-2476	93-2476			V N V	I SIST IVA	LSAUDAd	Trage	5		
Project Manager:	$\sum_{i=1}^{n} \frac{1}{i} \frac{1}{i}$	st feel		8	BHL TO	Po	#:						-			
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Phone #: 397	- 05/0			Ade	Address:			v0.	21		<u> </u>					
Fax #: 353	- 4388			City:	×			N								
Project #:	Project Owner:	Owner:		State:	te:	:diZ		}	4		. <u> </u>			• <u> </u>		
Project Name:	Schurn K	GXICK		μĂ	Phone #:			A	N		<u> </u>					
Project Location:				Fax	Fax #:											
FOR LAB USE ONLY			MATRIX	1	PRES.	SAMPLING	DN.	<i>5/</i>	P							
LAB I.D.	Sample I.D.	B OR (C)OMP.	gatawoni gatawa		1000			roto:	521521	<u> </u>						
H4683-1	1.11#4 4 B.		ା୦୫୭ - ଅ୦୫୭	סדא <u>פ</u> צרחם סור		DATE 22900	TIME 3 40	2	NS							
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PLEASE NOTE: Liablity and Damages. Cardinal's fiablity and client's exclusive remedy for any claim artsing whether based in contract or tot, shall be fimited to the amount paid by the client for the analyses. All claims including those for negigence and any other cause whalloedeen shall be deemed walved unless made in writing and received by Cardinal within 30 days after completion of the applicable analyses. All claims including those for negigence and any other cause whalloedeen shall be deemed walved unless made in writing and received by Cardinal within 30 days after completion of the applicable service. In no event shall Cardinal be fable for incidental or consequental damages, incideng without finitation, business interruptions, loss of uses or fosts incurred by client, its subsidiants,	ages. Cardinal's liablify and client s for negligence and any other cau be liable for incidental or consequ	's exclusive remedy for use whatsoever shall be ental damages, includin	any claim arteing whether based in contract deemed waived unless made in writing and g without limitation, business interruptions, k	ether based in co ss made in writir usiness interrupt	ontract or tort, st og and received ions, loss of use	hall be limited to the by Cardinal withir t, or loss of profit	or tort, stall be limited to the amount paid by the client for the eceived by Cardnal within 30 days after completion of the a; ss of use, or loss of profils incurred by client, its subsidaries	the client for the mpletion of the a t, its subsidiaries	pplicable s,	22.2	Terms and Conditions: Interest will be charged on 30 days past due at the rate of 24% per annum from and all costs of collections, including attorney's fees	ions: Interest will the rate of 24% ections, including	Terma and Conditions: Interest will be charged on at accounts more than 30 days past due at the rate of 24% per annum from the original date of invoice and all costs of collections, including attorney's fees.	l accounts more the original date of	an mvoice,	_
efficience or excessions articing out of or natived to the performance of services hirewards by Cardinal, regardass of whether such claim is based upon any of the above stated reasons or otherwise. Sampler Relinquished: Date: D	of or related to the performance c	Date: Date: Date:	Received	of whether such By:	claim is based	upon any of the a	Phone Read	Phone Result Diversions of otherwise.		D No Additional Fax #:	Fax #:					
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† Cardinal cannot accept verbal changes. Please fax written changes to 915-673-7020.



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PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BETH ALDRICH 703 E. CLINTON, SUITE #103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 12/15/99 Reporting Date: 12/17/99 Project Owner: NOT GIVEN Project Name: OSBORN RANCH Project Location: JAL, NM

Sampling Date: 12/15/99 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: GP Analyzed By: BC

				ETHYL	TOTAL
		BENZENE	TOLUENE	BENZENE	XYLENES
LAB NO.	SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L)
ANALYSIS	DATE	12/16/99	12/16/99	12/16/99	12/16/99
H4514-1	WEST WATER WELL	<0.002	<0.002	<0.002	<0.006
H4514-2	HOUSE WELL	< 0.002	< 0.002	< 0.002	< 0.006
H4514-3	FRONT HOUSE WELL	< 0.002	< 0.002	< 0.002	<0.006
H4514-4	FR. HOUSE WINDMILL	<0.002	<0.002	< 0.002	<0.006
H4514-5	BACK HOUSE WINDMILL	<0.002	<0.002	< 0.002	< 0.006
Quality Cor	ntrol	0.092	0.104	0.100	0.307
True Value	QC	0.100	0.100	0.100	0.300
% Recover	У	91.8	104	99.8	102
Relative Pe	ercent Difference	3.4	3.1	0.7	1.6

METHOD: EPA SW-846 8260

#### H4514A.XLS

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 client for 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 thirty (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 porformance of services hereunder by CardInal, regardless of whether such claim is based upon any of the above-stated reasons or otherwise.



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ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BETH ALDRICH 703 E. CLINTON, SUITE #103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 12/15/99 Reporting Date: 12/17/99 Project Owner: NOT GIVEN Project Name: OSBORN RANCH Project Location: JAL, NM Sampling Date: 12/15/99 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: GP Analyzed By: GP

		Na	Ca	Mg	K	Conductivity	NO3-N
LAB NUMBER	SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(umhos/cm)	(mg/L)
ANALYSIS DAT	E:	12/17/99	12/16/99	12/16/99	12/16/99	12/17/99	12/16/99
H4514-1	WEST WATER WELL	186	114	47	6.0	2328	5.08
H4514-2	HOUSE WELL	213	162	47	6.7	2508	7.47
H4514-3	FRONT HOUSE WELL	94	85	50	6.4	1570	7.14
H4514-4	FR. HOUSE WINDMILL	116	64	27	4.3	1305	2.63
H4514-5	BACK. HOUSE WINDMILL	81	73	9.3	4.4	929	1.22
Quality Control		NR	80	49	4.96	1392	3.19
True Value QC		NR	80	50	5.00	1413	3.00
% Accuracy		NR	100	98	99	99	106
<b>Relative Percen</b>	t Difference	NR	0	2.0	0	0.2	5.6
METHODS:		SM	3500-Ca-D	3500-Mg E	8049	120.1	353.3

		CI	SO4	CO3	HCO <sub>3</sub>	pН	TDS
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(s.u.)	(mg/L)
ANALYSIS D	ATE:	12/14/99	12/17/99	12/16/99	12/16/99	12/17/99	12/16/99
H4514-1	WEST WATER WELL	295	364	0	116	7.81	1502
H4514-2	HOUSE WELL	432	282	0	205	7.73	1782
H4514-3	FRONT HOUSE WELL	158	243	0	190	7.78	918
H4514-4	FR. HOUSE WINDMILL	125	171	0	215	7.80	780
H4514-5	BACK. HOUSE WINDMILL	121	. 83	0	176	7.68	484
Quality Contr	ol	1010	48.63	NR	971	7.07	NR
True Value Q	С	1000	50.00	NR	1000	7.00	NR
% Accuracy		101	97	NR	97	101	NR
<b>Relative Perc</b>	ent Difference	2.0	2.9	NR	-	0.6	NR
METHODS:	S	M4500-CI-B	375.4	310.1	310.1	150.1	160.1

Gayle A/Potter, Chemist

12/17/99 Date

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ARI	ARDINAL LABORATORIES, INC. 2111 Beechwood, Abilene, TX 79603 (915) 673-7001 Fax (915) 673-7020	2 <i>A TORIE</i> 4, Abilene, T 1 Fax (915) 6		101 East Marland, Hobbs, NM  882 (505) 393-2326 Fax (505) 393-2476	and, Hobb 6 Fax (505	rland, Hobbs, NM 88240 326 Fax (505) 393-2476						Page	of		1
Company Name:	SEST		1	ŗ	•				ANA	ANALYSIS	REQUEST	L			
Project Manager:				BILI	TO	PO #:									
Address: 703 E.	. CLINTON, #103	)3		Compar	any: SAME	£								. <b></b>	
city: HOBBS	State:	state: NM ZIp: 88240	240	Attn:	-			101	<u> </u>				- <u></u>		
Phone #: (505)	397-0510			Address:	51			uf.						- <u>.</u>	<u> </u>
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Project Name:	Isbern RAM	4		Phone #:			 	Ū.		, <del>-</del> ,					
Project Location:	74/		-	Fax #:			<u> </u>	4							
FOR LAB USE ONLY			MATRIX	а.	RES. SAN	SAMPLING						<u> </u>			
LAB I.D.	Sample I.D.	AB OR (C)OMP.	AJIOWATER STEWATER		ובא: ג כססר		XƏLƏ	2++×+! N 20[4/1							
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Sampler Relinquished	territoria de la comparate de la compa comparate de la comparate de comparate de la comparate	Date:	Received By			Phone F Fax Res	Phone Result: D Yes		D No Additional Fax #: D No	Fax #:					r;
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PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BETH ALDRICH 703 E. CLINTON, SUITE #103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 12/17/99 Reporting Date: 12/20/99 Project Owner: NOT GIVEN Project Name: OSBORN RANCH Project Location: JAL, NM Sampling Date: 12/17/99 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: GP Analyzed By: AH

		Na	Ca	Mg	K Conductivity	T-Alkalinity
LAB NO.	SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L) (u mhos/cm)	(mgCaCO <sub>3</sub> /L)

ANALYSIS DATE:	12/20/99	12/20/99	12/20/99	12/20/99	12/20/99	12/20/99
H4523-1 BACK HOUSE WINDMILL	89	52	19	4.39	928	124
H4523-2 FRONT HOUSE WINDMILL	110	67	22	4.45	1306	164
Quality Control	NR	80	49	4.96	1392	NR
True Value QC	NR	80	50	5.00	1413	NR
% Accuracy	NR	100	98	99	99	NR
Relative Percent Difference	NR	0	2.0	0	0.2	NR
		- <u> </u>				
METHODS:	SM	3500-Ca-D	3500-Mg E	8049	120.1	310.1
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	CI_	SO₄	CO3	HCO <sub>3</sub>	pH	TDS
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(s.u.)	(mg/L)
ANALYSIS DATE:	12/20/99	12/20/99	12/20/99	12/20/99	12/20/99	12/20/99
H4523-1 BACK HOUSE WINDMILL	133	92	0	151	7.51	623
H4523-2 FRONT HOUSE WINDMILL	133	146	0	200	7.60	872
Quality Control	1041	48.63	NR	971	7.07	NR
True Value QC	1000	50.00	NR	1000	7.00	NR
	104	97	NR	97	101	NR
% Accuracy	104					
% Accuracy Relative Percent Difference	3.0	2.9	NR	-	0	NR

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PLE 444 5273: Xat Sty 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 client for 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 thirty (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.

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ARD	ARDINAL LABORATORIES, INC. 2111 Beechwood, Abilene, TX 79603 (915) 673-7001 Fax (915) 673-7020	RIES, ne, TX - 15) 673	1000 1-7020	-	101 East Marla (505) 393-2326		d, Hol Fax (5	ınd, Hobbs, NM  882 Fax (505) 393-2476	88240 2476	-					ጟ	Page	of		
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Project Manager:					8	BILL	OL	PO #:											
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e#: (50	397-0510				Adr	Address:													
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Project #:	Project Owner:				State:	te:		Zip:		5 U									
ame:	OSBORN RANCH				Ph	Phone #:				<i>îu</i>									
Project Location:	f				Fax #:	( #:		•		F,									
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LAB I.D.	Sample I.D.	(G) RAB OR (C) OMP.	ROUNDWATER ASTEWATER	ס:ר פסור	DTHER : SLUDGE	ICE \ COOF VCID:		DATE	TIME	S MOLT									
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ALC: NO.

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BETH ALDRICH 703 E. CLINTON, STE 103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 12/30/99 Reporting Date: 01/03/00 Project Owner: CLAY OSBORN Project Name: OSBORN RANCH Project Location: NORTH WATER WELL Sampling Date: 12/30/99 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: AH Analyzed By: BC

LAB NO.	SAMPLE ID	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL BENZENE (mg/L)	TOTAL XYLENES (mg/L)
ANALYSIS	DATE	12/30/99	12/30/99	12/30/99	12/30/99
H4547-1	N. WATER WELL	<0.002	<0.002	<0.002	<0.006
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	·····			· · · · · · · · · · · · · · · · · · ·	
					-
·	,				
Quality Conf		0.090	0.103	0.101	0.309
True Value (		0.100	0.100	0.100	0.300
% Recovery	· ·	89.7	103	101	103
<b>Relative</b> Per	rcent Difference	0.5	3.0	2.4	2.8

METHOD: EPA SW-846 8260

Date

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PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BETH ALDRICH 703 E. CLINTON, STE 103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 12/30/99 Reporting Date: 01/03/00 Project Owner: CLAY OSBORN Project Name: OSBORN RANCH Project Location: NORTH WATER WELL Sampling Date: 12/30/99 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: AH Analyzed By: AH

	Na	Ca	Mg	K Conductivity	T-Alkalinity
LAB NUMBER SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L) (u mhos/cm)	(mgCaCO <sub>3</sub> /L)

ANALYSIS DA	ATE:	12/30/99	12/30/99	12/30/99	12/30/99	12/30/99	12/30/99
H4547-1	N. WATER WELL	396	195	67	7.64	3450	160
Quality Contro		NR	79.97	48.70	4.96	1443	NR
True Value Q0	5	NR	80.00	50.00	5.00	1413	NR
% Accuracy		NR	99	97	99	102	NR
<b>Relative</b> Perce	ent Difference	NR	-		0	0.4	NR
METHODS:	·····		3500-Ca-D	3500-Mg E	8049	120.1	310.1
		, CI_	SO₄	CO3	HCO <sub>3</sub>	pН	TDS
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(s.u.)	(mg/L)
ANALYSIS DA	ATE:	12/30/99	12/30/99	12/30/99	12/30/99	12/30/99	12/31/99
H4547-1	N. WATER WELL	857	257	0	195	7.10	2300
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Quality Contro	ol	919	48.63	NR	971	7.03	NF
True Value Q		1000	50.00	NR	1000	7.00	NR
% Accuracy	·····	91	97	NR	97	100	NR
Relative Perce	ent Difference	1.3	2.9	NR		0	•
			375.4				

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01/03/00 Date

PLE 491 5017: Weight and Demages. 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 client for 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 thirty (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.

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Company Name: C	1			ANALYSIS REQUEST
		BILL TO PO#	#	
Address: 703 E.	CLJINTON, #103	Company: SAME		
clty: HOBBS	{	Attn:	57	
Phone #: (505)	397-0510	Address:	Nye	
Fax#: (505) 3	393 <u>-</u> 4388	City:	2.1 /	
	Project Owner: //	άρη State: Zlp:	N f	
Project Name:	Osburn Ravich	Phone #:	7	
Project Location:	rtt 1/67	Fax #:	7	
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ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BETH ALDRICH 703 E. CLINTON, STE 103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 01/06/00 Reporting Date: 01/10/00 Project Number: NOT GIVEN Project Name: OSBORN RANCH Project Location: JAL, NM Sampling Date: 01/06/00 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: AH Analyzed By: AH

	Na	Ca	Mg	K Conductivity	T-Alkalinity
LAB NUMBER SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L) (u mhos/cm)	(mgCaCO <sub>3</sub> /L)

ANALYSIS D	ATE:	01/07/00	01/07/00	01/07/00	01/07/00	01/07/00	01/07/00
H4557-1	SOUTHWEST MW	125	134	54	6.93	2006	272
H4557-2	GOLF COURSE TANKS	504	218	58	8.06	4133	212
	·						
Quality Contr		NR	79.97	48.70	4.96	1443	NR
True Value Q	C	NR	80.00	50.00	5.00	1413	NR
% Accuracy		NR	100	97	99	102	NR
Relative Perc	ent Difference	NR	-	-	0	0.4	NR
METHODS:		SM	3500-Ca-D	3500-Mg E	8049	120.1	310.1
	· · · · ·		 SO₄	CO3	HCO3	pН	TDS
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(s.u.)	(mg/L)
ANALYSIS DATE:		01/07/00	01/07/00	01/07/00	01/07/00	01/07/00	01/07/00
H4557-1	SOUTHWEST MW	210	274	0	312	7.14	1419
H4557-2	GOLF COURSE TANKS	610	786	0	259	7.23	5170
Quality Contr		919	48.63	NR	971	7.02	NR
True Value Q		1000	50.00	NR	1000	7.00	NR
% Accuracy		91	97	NR	97	100	NR
Relative Perc	ent Difference	1.3	2.9	NR	~	0	, NR
METHODS:		SM4500-CI-B	375.4	310.1	310.1	150.1	160.1

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PLEASE HETE Wahintroond 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 client for analyses. All claims, including thuse for negligence and any other cause whatsoever shall be deemed waived unless made in writing and received by CardInal within thinty (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.



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ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BETH ALDRICH 703 E. CLINTON, STE 103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 01/06/00 Reporting Date: 01/08/00 Project Number: NOT GIVEN Project Name: OSBORN RANCH Project Location: JAL, NM Sampling Date: 01/06/00
 Sample Type: GROUNDWATER
 Sample Condition: COOL & INTACT
 Sample Received By: AH
 Analyzed By: BC

LAB NO.	SAMPLE ID	BENZENE (mg/L)	TOLUENE (mg/L)	ETHYL BENZENE (mg/L)	TOTAL XYLENES (mg/L)
ANALYSIS	DATE	01/06/00	01/06/00	01/06/00	01/06/00
H4557-1	SOUTHWEST MW	<0.002	< 0.002	< 0.002	< 0.006
H4557-2	GOLF COURSE TANKS	<0.002	<0.002	<0.002	< 0.006
Quality Cor	itrol	0.087	0.100	0.097	0.298
True Value	QC	0.100	0.100	0.100	0.300
% Recover	У У	87.3	99.9	96.6	99.5
<b>Relative</b> Pe	ercent Difference	1.3	3.2	4.5	5.1

METHOD: EPA SW 846-8021B, 5030, 5021 Gas Chromatography

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Project Manager:			BIH	UL TO	PO #:								
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city: HOBBS	State: NM ZIp:	88240	Attn:								_		
Phone#: (505) 397-0510	0510		Add	Address:								6	<u> </u>
Fax#: (505) 393-4388	388		City:										
Project #:	Project Owner:		State:	e:	Zlp:		5 0.						
Project Name: USKUR	en Ranch		Pho	Phone #:			ĸn						
Project Location:			Fax #:	:#			Ŧ.						
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PHONE (915) 673-7001 • 2111 BEECHWOOD • ABILENE, TX 79603

PHONE (505) 393-2326 • 101 E. MARLAND • HOBBS, NM 88240

ANALYTICAL RESULTS FOR SAFETY & ENVIRONMENTAL SOLUTIONS, INC. ATTN: BOB ALLEN 703 E. CLINTON, SUITE #103 HOBBS, NM 88240 FAX TO: (505) 393-4388

Receiving Date: 01/12/00 Reporting Date: 01/14/00 Project Number: NOT GIVEN Project Name: OSBORN Project Location: NOT GIVEN

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Sampling Date: 01/12/00 Sample Type: GROUNDWATER Sample Condition: COOL & INTACT Sample Received By: GP Analyzed By: AH

	Na	Ca	Mg	K Conductivity	T-Alkalinity
LAB NUMBER SAMPLE ID	(mg/L)	(mg/L)	(mg/L)	(mg/L) (u mhos/cm)	(mgCaCO <sub>3</sub> /L)

ANALYSIS D	ATE:	01/14/00	01/13/00	01/13/00	01/13/00	01/13/00	01/13/00
H4573-1	COUNTRY CLUB TANKS	579	180	59	10.6	3290	196
Quality Contro		NR	80.0	48,7	5.00	1392	NR
True Value Q		NR	80.0	50.0	5.00	1413	NR
% Recovery		NR	100	97.4	100	98.5	NR
<b>Relative Perc</b>	ent Difference	NR	0	0.6	0.8	0.2	NR

METHODS:		SM3	500-Ca-Dβ	500-Mg E	8049	120.1	310.1
	,	CI (mg/L)	SO <sub>4</sub> (mg/L)	CO <sub>3</sub> (mg/L)	HCO <sub>3</sub> (mg/L)	рН (s.u.)	TDS (mg/L)

ANALYSIS I	DATE:	01/13/00	01/13/00	01/13/00	01/13/00	01/13/00	01/13/00
H4573-1	COUNTRY CLUB TANKS	667	796	0	239	6.98	2260
	· · · · · · · · · · · · · · · · · · ·					· · ·	
Quality Con	itrol	1010	48.63	NR	971	7.03	NR
True Value	QC	1000	50.00	NR	1000	7.00	NR
% Recovery	/	101	97.3	NR	97.1	100	NR
Relative Per	rcent Difference	10.0	2.9	NR	3.0	0.1	
METHODS:		SM4500-CI-B	375.4	310.1	310.1	150.1	160.1

Gayle A. Potter, Chemist

01/14/2000 Date

PLEAF 1973 Straight 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 client for analyses. All claims, including linose for negligence and any other cause whatsoever shall be deemed waived unless made in writing and received by Cardinal within thirty (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, affliates 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.

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17 Mar'00 6:28PM; Job 29; Page 2/11 5701 Aberdeen Avenue, Suite D Lubbock, Texas /9424 800+376+1796 806+794=1295 FAX 806+794+1298 4725 Hipley Avenue, Suite A FI Paso, Texas 79927 H68+588+3443 915=585+3443 1AX 915=585=4944 F-Mail, lob@traceanalysis.cum Analytical and Quality Control Report

7941298;

# David Boyer Safety & Environmental Solutions Inc.

Report Date: 3/17/00

P. O. Box 1613 Hobbs, NM 88240

Project Number: N/A Project Name: Osburn Rauch Jal, NM Project Location:

DRAFT

Order ID Number: A00031502

Enclosed are the Analytical Results and Quality Control Data Reports for the following samples submitted to TraceAnalysis, Inc. for analysis:

Sample Number	Sample Description	Маших	Date Takon	Time Taken	Date Received
142562	Nonb West C.C. Well #11	Water	3/14/00	10:40	3/15/00
142563	MW #6 Sec. 7 Well	Water	3/14/00	11:00	3/15/00
142564	MW #7 Tex New Mex	Water	3/14/00	11:20	3/15/00

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

This report consists of a total of 8 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

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	3/17/00	Order ID Number: A00031502	Page Number. 2 of 8
N/A		Osburn Ranch	Jal, NM

### **Analytical Results Report**

Sample Number: 142562 Description. North West C.C. Well #11

Param		Dilution	Anniytical Method	Date Prepared	Date Analyzed	Analysi	Prep Batch #	QC Barch #	RDL
Alkalinity (mg/L as Ca('03)									
Hydroxide Alkalimity	<1.0	1	E 310.1	3/17/00	3/17/00	38	PB01307		1
Curbonate Alkalinity	<1.0	1	E 310.1	3/17/00	3/17/00	JŞ.		QC01576	i
Bicarbonate Alkalinity	99	1	E 310.1	3/17/00	3/17/00	1S	PB01307		1
foul Alkalinhy	<del>99</del>	L	E 310.1	3/17/00	3/17/00	JS	<b>FUR1307</b>	QC01576	1
Conductivity (uMHOS/cm)						_			
Specific Conductance	1300	1	SM 2510B	00/17/10	3/17/00	15	PB01309	QC01578	
Dissolved Metals (mg/L)									
Dissolved Calcium	54	1	E 200.7	3/17/00	3/17/00	RR		QC01572	
Dissolved Magnesium	57	1	1: 200.7	3/17/00	3/17/00	RR		OC01172	1
Dissolved Potassium	7.8	1	E 200.7	3/17/00	3/17/00	RR	-	QC01572	
Dissolved Sodium	R5	k	F. 200.7	3/17/00	3/17/00	RR	PH01312	QC01572	
Ion Chromatography (IC) (mg/L)									
¢1.	+ 400	1	E 300.0	3/15/00	3/15/00	JS		QC01573	0
Fluoride	0.82	3	E 300.0	3/15/00	3/15/00	3C		QCU1573	0 (
Nitrate-N	~1.0	1	E 300.0	3/15/00	3/15/00	35		QC:01573	Q.:
Sultare	5.2	1	E 300.0	3/15/00	3/15/00	38		QC01573	0.
* CL - Chloride re-ran on 1C031600 sch(PR 97	:01305; Q(	201574)	icv %IA - 9	6; CCV *4	IA = 96; Ma	uix spikes	KPD - 0; N	dauin spikes	%£A
TDS (mg/L)									
Total Dissolved Solida	710	1	E 169.1	3/15/00	3/16/00	MD	PB01287	QC01552	1
Sample Number: 142563						_			
Description: MW #6 Sec. 7 Well			Analytical	Duic	Date		Prep	QC	
l'aram	Result	Dilution		Prepared	Analyzed	Analyst	Batch #	Balch #	RD
Alkalinity (mg/l. as CuCo3)	·····								
Hydroxide Alkalinity	<10	1	Б 310.1	3/17/00	3/17/00	JS	PB01307	QC01576	
Carbonute Alkalinity	~1.0	1	E 310.1	3/17/00	3/17/00	JS	PR01307	QC01576	
Bicarbunate Alkalinity	69	1	E 310 1	3/17/00	3/17/00	JS	PB01307	QC01576	
Total Alkalinity	69	1	E 310.1	3/17/00	3/17/00	12	PB01307	QC311576	
Conductivity (uMHOS/cm)					_				
Specific Conductance	3000	1	SM 2510B	3/17/00	3/17/00	JS	PB01309	QC01578	

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MAR-17-2000 16:39

Dissolved Metals (ing/L)

Dissolved Potassium

ion Chromutography (IC) (mg/L)

Dissolved Sodium

C1. Flunride

Mitrate-N

Sulfate

Dissolved Calcium Dissolved Magnesium

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Report Date: 3/17/00 N/A		ler ID Nu burn Ra <mark>n</mark>	mber: A00 ch	031502			Page	Number: 3 Jal	3 of 8 I, NM
• CL. • Chloride re-ran on IC031600.sch(PB0 97.	01305: QC	01574)	ICV 151A - 9	6; CCV %I	A = 96: Mat	rix spikes	RPD = 0; M	latrix spikes	%ЕЛ
TDS (mg/L) Total Dissolved Solids	1700	ł	E 160.3	3/15/00	3/16/00	MD	PB01287	QC01552	10
Sample Number: 142564 Description: MW #7 Tex New Mex. Param		Dilution	Analytical Method	Dars Prepared	Date Anolyzed	Analysi	Prep Batch #	QC Batch #	RD
Alkalinity (mg/L as CaCo.3)									
Hydroxide Alkalinity	<1.0	1	E 310.1	3/17/00	3/17/00	12		QC01576	
Carbonate Alkalinity	<1.0	1	E 340.4	3/17/00	3/17/00	15	PB01307	•	
Ricarbunate Alkalinity	297	1	E 310.1	3/17/00	3/17/00	JS		QC01576	
Total Alkaliaity	297	1	E 310.1	3/17/00	3/17/00	JS	PB01307	QC01576	
Conductivity (uMHON/cm)									
Specific Conductance	)700	L	SM 2510B	3/17/00	3/17/00	JS	PB01309	ÚC01378	
Dissolved Metals (mg/L)									
Dissolved Calcium	208	1	E 200.7	3/17/00	3/17/00	RR	PB01312	QC01572	
Dissolved Magnosium	62	1	E 200.7	3/17/00	3/17/00	RR	PB01312	QC01572	
Dissolved Potassium	1.7	}	E 200.7	3/17/00	3/17/00	RR	PB01312	QC01572	
Dissolved Sodium	76	ĩ	F. 2(8).7	3/17/00	3/17/00	RR	rB01312	QC01572	
Ion Chromatography (IC) (my/L)									
CL.	200	1	E 300.0	3/15/00	3/15/00	IS	PB01304	QC01573	ø
Fluando	2.7	F	E 300.0	3/15/00	3/15/00	JS	PR01304	QC01573	0.
Nitrate-N	35	1	E 300 0	3/15/00	3/15/00	JS	PB01304	QC01573	0
Sulfare Sulfate	• 420		E 300.0	3/15/00	3/15/00	IS		QC01573	0
• Suifate - Sulate te-ran on IC031600 sch(1 %EA = 103	4501305:	QC01574	). ICV %IA)	• 102; CCV	% <b>i∧ =</b> 101	; Maina y	oikes RPD =	3; Muleix sy	pikes
TDS (mg/L)									
Total Dissulved Solids	1200	1	E 160 I	3/15/00	3/16/00	MD	PB01287	ÚC01552	I

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Report Date.	3/17/00		Order 1D Number:	A00031502	Page Nur	iber: 4 of 8
N/A			Osburn Ranch			Jal, NM

	Qu	*	ntrol Repo d Blanks	rt		
Param	Flag	Blank Result	Reporting Limit	Date Analyzeci	Prep Batch #	
Hydroxide Alkalinity (mg/L as CaCo3)		<1.0	1	3/17/00	PB01307	
Carbonate Alkalinity (mg/L as CaCo3)		<1.0	1	3/17/00	PB01307	
Bicarbonate Alkaliaity (mg/L as CaCo3)		<4.0	1	3/17/00	PB01307	
Total Alkalinity (mg/L as CaCo3)		<4.0	1	3/17/00	PB01307	
Param	Flag	Biank Result	Reporting Limit	Date Analyzed	Prep Batch #	
Specific Conductance (uMHOS/cm)		4.3		3/17/00	PB01309	
f'aram	Fiag	Biank Result	Reporting Limit	Date Analyzed	Prop Batch #	
Dissolved Calcium (mg/L)		<1.0	1	3/17/00	PB01312	• •••
Dassolved Magnesium (ing/L)		<}.0	1	3/17/00	P801312	
Dissolved Potassium (mg/L)		<1.0	1	3/17/00	PB01312	
Dissolved Sodium (mg/L)		<1.0	1	3/17/00	PB01312	
					,,,,,,,	

Param	Fing	Blank Result	Reporting Limit	Date Analyzeti	Pr <del>ep</del> Batch #	QC Batch #
CL (mg/l.)		×0.5	0.5	3/15/00	PB01304	QC01573
Fluoride (mg/L)		<0.2	0.2	3/15/00	PB01304	QC01573
Nitrate-N (mg/L)		<0.2	0.2	3/15/00	PB01304	QC01573
Sulfate (mg/L)		<0.5	0.5	3/15/00	PB01304	QC01573
Param	Flag	Blank Result	Reporting Limit	Date Analyzed	Prep Batch #	QC Batch #
Total Dissolved Solids (mg/L)	1,0 •• •• ••	<10	10	3/16/00	PB01287	QC01552

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N/A		Osburn Ranch	Jal. NM

## Quality Control Report Matrix Spike and Matrix Duplicate Spike

Sundard	Param	Sample Result	Dil.	Spike Amount Added	Matrix Spike Result	% Kec	RFD	% Rec. Limit	RPD Limit	QC Batch #
MS	Dissolved Calcium (mg/L)	54	ł	1000	1029	98		75 - 125		QC01572
MS	Dissolved Magnesium (mg/l.)	57	1	1009	1040	98		75 - 125	-	QC01572
MS	Dissolved Potassium (mg/L)	7.8	1	1000	1146	114		75 - 125	•	QC01572
MS	Dissolved Sodium (mg/L)	85	1	1000	1167	108		75 - 125	-	QC01572
MSD	Dissolved Calcium (mg/L)	54	1	1000	1043	99	1	-	0 - 20	QC01572
MSD	Dissolved Magnesium (mg/L)	57	ł	1000	1054	100	1	•	0 - 20	QC01572
MSD	Dissolved Potassium (mg/L)	7.8	1	1000	1159	115	١	<b>-</b> 1	0 - 20	QC01572
MSD	Dissolved Sodium (mg/L)	85	1	1900	1182	110	1	-	0 - 20	QC01572

Standard	Param	Sample Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RPD Limit	OC Batch #
MS	CL (mg/L)	39000	ł	12500	49281.40	82		80 - 120	-	QC311573
MS	Nitrate-N (mg/L)	<10	t	5000	5148 66	103		80 - 120	-	QC01573
MS	Sulfate (mg/L)	6000	1	12500	19468.07	108		80 - 120	-	QC01573
MSD	CL (mg/L)	39000	1	12500	49406.98	83	1	-	0 - 20	QC01573
MSD	Nitrate-N (mg/L)	<10	1	5000	5185.49	104	J	-	0 - 20	QC01573
MSD	Sulfate (mg/L)	6000	ł	12500	19303.78	106	1	-	0 - 20	QC01573

## Quality Control Report Duplicates

Standard	Param	Flag	Duplicate Result	Sample Result	Dilution	KPD	RPD Limit	QC Batch #
Duplicate	Hydroxide Alkalinity (mg/Las CaCo		<1.0	<1.0	i	0	0 - 20	QC01576
	Carbonate Alkalinity (mg/L as CaCo		~1.0	<1.0	1	٥	0 - 20	QC01576
•	Bicarbonate Alkalinity (mg/L as CaC		44	46	1	4	0 - 20	QC01576
•	Total Alkalinity (mg/l. as CaCo3)		44	46	1	4	0 - 20	QC01576

Standard	Param		Flag	Duplicate Result	Sample Result	Dilution	RPD	RPD Limit	QC Batch #
Duplicate	Specific Conductance	(uMHOS/cin)		103613	100008	1	4	0 - 20	QC01578

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Report Dat	re: 3/17/00	Order ID Osbum I	Number: A0 Ranch	0031502			Page Nur	nber: 6 of 8 Jal, NM
Standard	Param	Flag	Duplicate Result	Sample Result	Dilution	RPD	RPD Limit	QC Satch #
Duplicate	Total Dissolved Solids (mg/L)		1214	1200	1	1	0 - 20	QC01552

## Quality Control Report Lab Control Spikes and Duplicate Spike

	Param	Blank Result	Dil	Spike Amount Added	Matrix Spike Kesuk	% Rec.	RPD	% Rec Limit	RPD Limit	QC Batch #
LCS	Dissolved Calcium (mg/L)	<1.0	J	1000	986	99		75 - 125	-	QC:01572
LCS	Dissolved Magnesium (mg/L)	<1.0	1	1000	988	<del>99</del>		75 - 125	-	QC01572
LCS	Dissolved Potassium (mg/L)	<1.0	i	1000	1087	109		75 - 125	•	QC01572
LCS	Dissolved Sodium (mg/L)	<1.0	1	1000	1044	104		75 - 125		QC01572
LCSD	Dissolved Calcium (mg/L)	<1.0	1	1000	982	98	o		0 - 20	QC01572
LCSD	Dissolved Magnesium (mg/L)	<1.0	1	1000	984	98	0	-	0 - 20	QC01572
LCSD	Dissolved Potassium (mg/1.)	s).0	1	1000	1100	110	5	-	0 - 20	QC01572
LCSD	Dissolved Sodium (mg/L)	~1.0	1	1000	1042	104	4	•	0 - 20	QC01572

Param			Blank Result	Dil.	Spike Amount Added	Matrix Spike Result	% Rec.	RPD	% Rec. Limit	RP1) Limit	QC Batch #
	e (mg/L) nk spikes used because Pr	n re-running t	<0.2 he fluorid	l c on the	2.5 Anniple that	2.51 I I spiked.	100		80 - 120	-	QC01573
LCSD Fluorid * Fluoride - Bla	e (mg/L) nk spikes used because I'r	• n re-running t	<0.2 be fluorid	ן contha	2.5 : sumple that	2.67 t I spiked	107	б	-	0 - 20	QC01573

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N/A		Osburn Ranch		Jal, NM
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# Quality Control Report Continuing Calibration Verification Standard

Standard	Param Fla	я£	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
CV	Hydroxide Alkalinity (mg/L as CaCo3)		0	<1.0	0	80 - 120	3/17/00	QC01576
icv	Carbonate Alkalinity (mg/L as CaCo3)		0	240	Ø	80 - 120	3/17/00	QC01576
IÇ V	Bicarbonate Alkalinity (mg/L as CaCo3)		0	4	0	80 - 120	3/17/00	QC01576
СV	Total Alkalinity (mg/L as CaCo3)		236	244	103	80 - 120	3/17/00	QC01576
CVB	Hydroxide Alkalinity (mg/L as CaCo3)		0	<1.0	0	80 - 120	3/17/00	QC01576
CCV I	Carbonate Alkalinity (mg/L as CaCo3)		0	228	0	80 - 120	3/17/00	QC01576
CCV 1	Bicarbonate Alkalinity (mg/l. as CaCo3)		Ø	10	0	80 - 120	3/17/00	QC01576
CCV ‡	Total Alkalinity (mg/L as CaCo3)		236	238	101	80 - 120	3/17/00	QC01576
···	- I*	·	CCVs TRUE	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Barch #
Standard	an a	ag	Conc.	1381	98	80 • 120	3/17/00	QC01578
ICV	Specific Conductance (uMHOS/cm)		1413		•• —			
CCV I	Specific Conductance (uMHOS/cm)		1413	1362	76	80 - 120	3/17/00	QC01578
····· · ·			CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch ≢
Standard	the second se	lag	20	21	105	75 - 125	3/17/00	QC01572
ICV	Dissolved Calcium (mg/l.)		20	21	105	75 - 125	3/17/00	QC01572
ICV	Dissolved Magnesium (mg/L)		20	18	90	<b>75</b> - 125	3/17/00	QC01572
ICV	Dissolved Potassium (mg/L)		20	18	90	75 - 125	3/17/00	QC01572
ICV	Dissolved Sodium (mg/L)							
CCV 1	Dissofved Calcium (mg/L)		20	21	105	75 - 125	3/17/00	QC01572
CCV I	Dissolved Magnesium (mg/L)		20	21	105	75 - 125	3/17/00	QC01572
CCV I	Dissolved Potassium (mg/L)		20	19	95	75 - 125	3/17/00	OC01572
CCVT	Dissolved Sodium (mg/I.)		20	18	90	75 - 125	3/17/00	QC01572
Standard	Param F	lag	CCV <sub>N</sub> TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch
ICV	CL (mg/L)		12.5	11.89	95	80 - 120	3/15/00	QC01573
ICV	Fluoride (mg/1.)		2.5	2.59	104	80 - 120	3/15/00	QC01573
ICV	Nitrate-N (mg/L)		5	4.75	95	80 - 120	3/15/00	QC01573
ICV	Sulfate (mg/L)		12.5	13.01	104	80 - 120	3/15/00	QC01573
CCV 1	CL (mg/L)		12.5	11.93	95	80 - 120	3/15/00	QC01573
CCV I	Fluoride (mg/L)		2.5	2.53	101	80 - 120	3/15/00	QC01573
CCV I	Nitrate-N (mg/L)		5	4,86	97	80 - 120	3/15/00	QC01573
CCV I	Sulfate (mg/L)		12.5	12.59	101	80 - 120	3/15/00	QC01573

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## Quality Control Report Continuing Calibration Verification Standard

Standard	Param	Flag	CCVs TRUE Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed	QC Batch #
ICV	Tutal Dissolved Solids (mg/l.)		1000	9 <b>99</b>	100	80 - 120	3/16/00	QC01552
CCV F	Total Dissolved Solids (mg/L)		1000	976	98	80 - 120	3/16/00	QC01552

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	С Ш	pMHOs/cm	1300	3000	1700	Fotal	Anions	n međil.	13.42	20.36	20.72		meets to be 0.55-0.77	meeds to be 0 55-0 77	needs to be 0.55-0 77-
	ШS	۳qq	210	1700	1269	Total	Carlons	in meqli.	11 26	24.19	18.63	TDS/Anion	C:53	35	13. C
	Fluoride	Wad	C.82	1.1	27		Fluoride	in meq'l.	0.0431048	0022004	0.142128	TDSICat	0.83	0.70	0.64
	Witrale	udd	0	6	35		A FLAN	in megh	e	D	0.246885	TDSAEC	p 55	0.57	¢71
;	Chionde	는 10	004	770	200		Chloride	n megit.	62.11	21 72	564				
	Sulfale	m8d	5.2	250	420		Suitate	in met/L	3.11	12.2	8.74		1132	3900	1970
	Alkelindy	udu	00:66	69.00	287.00		Abustinity	in med/L	1 86	1 38	5 94		8	ŝ	9
	Potaseium	anqq	9.4	5.2	1.7		Polassium	an mequ.	020	013	2.64		0211	00/2	0251
	Sodium	Шđđ	8	203	٤		Sodium	n meq.L	3.70	C9.9	3.31		e futer		e butta
	Magnesium	uudd	67	60	62		Magnesium	in meq.	26.1	2 60	5 10	ECUMION	1341 54288	2636.4504	2071.5393
3/17/00	Catcium	mod	x	197	902		Calcium	in meq.	2.69	6163	10.36	EC/Celion	1128214	2418 9958	1883 0665
DATE:	Sample #		142562	142563	142554		Sampte #		142562	142563	142.964		142562	142565	142364

EC/Cetion	ECONION					TDSAEC	TUSICat	TDS/Anion	
	1241 54286	e futer	1170	8	11 22	p 55	0,83	C:53	meeds to be 0.5
418 9968	2836.4504		2700	ŝ	3305	C 57	0.70	6.62	needs to be 0.5
BBC (0065	2071.5393	45.42s	1520	.9	1870	120	0.64	30	needs to be C.S.

2641568 MAR-17-2000 16:44 Apr-12-96 07:33A P.01 SPTICTAL HANDLING CRAIN-OF-CURTORY RECORD AND ANALYSIS REQUEST PIOH AARA XIX X X A000 21502 EVED TO # DAUGUE MUT A VI AN A \$1/E-902 VAT 2203 হব। SUNNER & SUN 40 THUP IN THE TRADET XXX 0420 092970938 υų TOLP Samy Volume TCLP Volume TOLP MANY AD AD BA CA CI PS HIS SA Test Meters Ag As Bu Cd Cr Pt High Ste HdL ¥ 38TH XBT8 STALLUS 794 2296 - Lunecoch, Texas 79424 794 2296 - Buz (806) 794 2298 2 (400) 378 1296 Style (0) N 1. 1 1201 SAMPTING 3844 લુ 2 2 3140 11 (22) JAP-430 מוש-נען (זהן) יווייי PREJECTIVATIVE, METEROD 00.01 Į ž **RNON** 6701 Aburdem Awaon Tel (1004) 794 3296 201  $\times \times \times$ EONH Ĩ Ĭ Osborn лэн Clintan 300018 ) ALTER ¥₩ 9ng-zhul- LAN-9 7105 **TraceAnalysis**, Inc **AATAW** \*\* Contract line UNOUR/HUNDA 202 # COHTAINERS -1 RU. MIX 1/2502 RODAN WELL C. WELL #. 1mm1 THINK AMOUT ļ 5-14-0 HELD DOOE TI MUN Sec. É ä J Mul 44 14 142562-64 il parte **LUB USE**Ì 3 3 ONLY Ş

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