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REPORTS

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Supplemental Expert Report of Hicks Consultants Regarding Robert A. McCasland et. al. v. Mewbourne Oil Company

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FIGURES

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1.0 Executive Summary

This report describes the investigation by R.T. Hicks Consultants Ltd. (Hicks Consultants) into an area we call the McCasland Windmill Site. Hicks Consultants was retained in 1998 to investigate the cause of atypical chloride concentrations in groundwater near the site.

Located in Lea County, New Mexico, this windmill is adjacent to Conoco Federal #2, a plugged and abandoned oil well formerly operated by Mark Production. The law firm of Hinkle, Hensley, Shanor & Martin, L.L.P., retained Hicks Consultants on behalf of Mewbourne Oil Company, the successor corporate name of Mark Production. The owner of the surface land on which Conoco Federal #2 is located is Robert McCasland and a partnership of McCasland family members. Hereafter, we refer to the owners as the McCasland Ranch. The Federal government has leased mineral rights for the land to Mewbourne.

In 1989, McCasland Ranch drilled a windmill-driven water supply well about 35 feet from Conoco Federal #2. In January 1998, at the request of McCasland Ranch, New Mexico Oil Conservation Division (NMOCD) representatives examined the water supply well and reported that the well exhibited chloride concentrations that were higher than typical Ogallala groundwater. On January 21, 1998, NMOCD first notified Mewbourne Oil Company of the chloride in groundwater. At this time, they requested additional information and investigations. It is Mewbourne's belief that the rationale for NMOCD's requirements is the proximity of Mewbourne's activities to the subject windmill.

In their notification, NMOCD did not present any technical information indicating that any activities of Mewbourne caused the observed chloride in groundwater. In March 1998, Mewbourne obtained water samples from the well and found that calcium and chloride concentrations did appear unusually high. In June 1998, NMOCD required Mewbourne to conduct an investigation to determine if oil field operations had caused the chloride in groundwater. Hicks Consultants investigated the area of the McCasland Ranch water supply well to respond to NMOCD requests.

Our investigation showed:

1. The McCasland water supply well (henceforth called the McCasland windmill well) near Conoco Federal #2, three monitor wells installed by experts for McCasland Ranch, and monitor well Mew A, installed by Hicks Consultants, draw water from a thin sand and/or gravel zone near the base of the Ogallala Formation.

2. The drillers log for the McCasland windmill well shows that this well also draws water from an "anhydrite" formation.

3. The saturated thickness of the water-bearing zone near the McCasland windmill well is only 10-15 feet, which is less than most Ogallala supply wells.

4. Mewbourne files and NMOCD files show that December 28, 1970 is the spud date for Conoco Federal #2.

5. On March 1, 1974, the Conoco Federal #2 was plugged and abandoned by Mark Production Company. We understand that Mark Production followed applicable U.S. Geological Survey rules and standard industry practice in plugging and abandoning the well.

6. The water chemistry of the McCasland windmill well, the associated water storage tank (henceforth called the McCasland water storage tank), and monitor well MW-3 near the McCasland windmill are very similar. The chemistry of these three wells differs from the chemistry of typical Ogallala groundwater and water produced from oil wells in Lea County.

7. The water chemistry of monitor well Mew A, MW-1, MW-2, and several nearby windmills are very similar. The chemistry of these wells are similar to typical Ogallala groundwater and all analyzed constituents are below the maximum concentrations established by the Water Quality Control Commission Regulations.

8. Field tests conducted in August 1999 demonstrate that, after four hours of pumping, the McCasland windmill well delivered water that showed 50% less dissolved solids than water of the McCasland water storage tank.

9. In 1999, Hicks Consultants observed water flowing from the McCasland water storage tank into the McCasland windmill well. Although a check valve had been installed between the storage tank and the well, the valve was permitting water to leak into the well.

10. The water storage tank at the McCasland windmill well is a former oil field storage tank. The tank has a fixed roof, minimizing water loss through evaporation.

11. The chemistry of the McCasland windmill well is consistent with a mixture of typical Ogallala groundwater and the 1999 sample of water stored in the McCasland storage tank.

12. Soil samples from the area near Conoco Federal #2 exhibit chloride concentrations below 20 mg/kg. We observed no evidence that the area north of Conoco Federal #2 was actually used as a reserve pit.

13. In June 2000, NMOCD provided comments on the Hicks Consultants report of September 1999. In August 2000, Hicks Consultants responded to the NMOCD comments and then met with NMOCD on August 31, 2000. At this meeting, NMOCD agreed that sustained pumping of the McCasland windmill well might be the best and quickest way to improve the quality of the water and return the well to service.

14. In a letter dated November 15, 2000 to Mr. Robert McCasland, NMOCD recommended disposal of the water in the storage tank, repair of the check valve, sustained pumping of the windmill and monitoring the results of pumping.

15. Because we found no evidence that McCasland Ranch conducted the program requested by NMOCD, we performed the test in March, 2001. While pumping the McCasland windmill well at 1.0 to 1.7 gallons per minute (gpm) for approximately 2 days, we measured the specific conductance (SC) of pumped groundwater. We pumped approximately 3000 gallons from the windmill. We observed little variability of groundwater SC over time. Analyses of samples from this program also reveal a chemistry profile similar to past analyses.

16. Specific conductance of water derived from Mew A, MW-1, and MW-2 is consistent with typical Ogallala groundwater. Chemical analyses are also consistent with typical Ogallala groundwater.

17. Specific conductance of the McCasland windmill well is 480% higher than the SC of Mew A, MW-1, and MW-2 and 150% higher than the SC of MW-3. Chemical analyses reveal this same relationship.

18. Specific conductance of water in the McCasland water storage tank is 760% higher than the SC of typical unimpaired Ogallala groundwater, 240% higher than MW-3, and 160% higher than the McCasland windmill well. Analytical results show this same relationship.

19. During a field program in March 2001, we observed water leaking from the base of the windmill water storage tank. At this time, the water storage tank was nearly empty. In August 1999, the tank had contained six to eight feet of water.

20. In 1999, we measured groundwater elevations in the area of the McCasland windmill well. We found that groundwater flowed southeast at a gradient of 0.004.

21. With installation of monitoring wells by consultants to McCasland Ranch in Spring 2001, we determined that groundwater at the windmill site flows to the east northeast. The measured hydraulic gradient is 0.003.

22. After drilling and well development, monitoring well Mew A continually produced 20 gallons/minute of water.

23. In our analysis of an aquifer test conducted by HydroGeologic Services, Inc. in January 2001, we calculated a hydraulic conductivity of 0.3. This value is 10 times less than the average hydraulic conductivity for the Ogallala as reported in the literature. This low value, however, is consistent with the observed difference in sustainable pumping rates (25 gpm for Mew A vs. 1 gpm for MW-2).

24. Steady state simulation modeling of two different scenarios using MODFLOW modeling environment predicts that the observed chloride in groundwater impacts could not be caused by a casing leak at Conoco Federal #2.

Based on these findings, we conclude:

A. The plugged and abandoned Conoco Federal #2 oil well is not releasing oil field-produced water to the Ogallala Formation. The chemistry of the water observed in the McCasland windmill well and MW-3 could not be produced by mixing produced water with Ogallala ground water at this location.

B. If there were elevated chloride concentrations in soil, that would indicate a release of produced water from the reserve pit during the 1971-1974 productive life of Conoco Federal #2. Soil samples within and adjacent to the possible reserve pit area did not detect elevated chloride content. Trained individuals found no evidence of stressed vegetation or other indications of chloride disposal and/ or spills. Soil near Conoco Federal #2 is not the source of calcium chloride observed in the McCasland windmill well.

C. There is no evidence (soil samples, production records, etc.) to support a conclusion that activity of Mewbourne or Mark Production caused the observed chloride in groundwater at the McCasland windmill well.

D. Activities of Mewbourne up-gradient (northwest) of monitor well Mew A have not caused chloride in Ogallala groundwater.

E. The cause of the chloride in groundwater at the windmill site cannot be determined with existing data. The cause may be natural or man-made. But no evidence shows that activities of Mark Production or Mewbourne contributed to the observed elevated levels of chloride in the McCasland windmill well.

F. If the chloride was caused by man, it will naturally dissipate over time and will not affect other wells. If the chloride is a result of nature, individuals should not construct wells in similar lithologies (e.g. anhydrite or gypsum).

G. Mewbourne should not be required to conduct remediation, additional investigation or inquiry at this site.

H. NMOCD or McCasland Ranch should monitor the site and restrict additional water supply development at the location of Conoco Federal #2.

2.0 Introduction

Mewbourne Oil operates oil wells adjacent to the well commonly known as Conoco Federal #2, which was plugged and abandoned by Mark Production in 1974. Mewbourne Oil (Mewbourne) is the successor corporate name of Mark Production. The owner of the surface land on which Conoco Federal #2 is located is McCasland Ranch. Mewbourne operated the Conoco Federal #2 as a lessee under a lease with the Federal government which owns the mineral estate. Conoco Federal #2 is in Section 30, T20S, R39E (1980 FEL 660 FSL) in Lea County, New Mexico. Plate 1 shows the location of the well relative to Hobbs, New Mexico. Plate 2 displays the oil field road network and access to the site.

In 1989, McCasland Ranch installed a windmill-driven water supply well about 35 feet from Conoco Federal #2 (referred to hereafter as the McCasland windmill well). The cover of this report and Figure 1 show the well site of Conoco Federal #2 and the McCasland windmill well.

Figure 1: Photograph of Conoco Federal #2 (foreground) relative to the McCasland windmill well and water storage tank.

3.0 Pre-Investigation Review of Published Data and Past Practices

In order to properly design the investigation, Hicks Consultants conducted a literature search to obtain information on the geology and hydrogeology in southern Lea County, near the McCasland windmill site. We obtained well logs from the Office of the State Engineer (OSE) for water wells within five miles of the McCasland windmill site (the Site). We examined Mewbourne files as well as information at the Hobbs office of the NMOCD for additional information regarding drilling, production, and plugging of Conoco Federal #2.

3.1 Physical Setting

Plate 3 is a topographic map presenting the locations of the McCasland windmill site and the nearby water supply wells. Plate 4, a groundwater map of southern Lea County, shows that the McCasland windmill well is near the boundary (shown as a dashed line) between Triassic rocks and saturated Tertiary and Quaternary rocks. West of the boundary, the Tertiary Ogallala Formation, which is the principal aquifer of the area, is unsaturated (dry). Plate 4 also presents depth to water and total depths of nearby wells. As this plate shows, wells within the area mapped as Ogallala suggest a saturated thickness (difference between depth to water and total well depth) ranging from 2 feet to 125 feet, with both extremes occurring near the boundary. The 1988 driller's log of the McCasland windmill well identifies the base of the Ogallala at 88 feet. We have included all relevant drilling logs in this report as Appendix A.

The log for the McCasland windmill well shows anhydrite ($CaSO_4$) from 70 to 88 feet below land surface. Gypsum ($CaSO_4 - 2H_2O$) is a more common sulfate mineral that is often confused with anhydrite. Of nine water wells within a five-mile radius of the site, well logs show that only one other well encountered anhydrite (see Appendix A). This well is located in Section 24, T20S, R38E, approximately two miles northwest of the site, and is labeled in the log as McCasland Well No. 3. In this well log, the recorded anhydrite layer lies between 54 and 58 feet.

3.2 History of Conoco Federal #2

We investigated available records from Conoco Federal #2 for any indications of a potential source of chloride or calcium to the surrounding aquifer. Mewbourne files and NMOCD files show that December 28, 1970 is the spud date for Conoco Federal #2. The drilling log from December 1970 refers to the use of 200 sacks of regular 2% CaCl at a depth of 1,663 feet below grade. Calcium chloride is typically used at low concentrations such as this to accelerate the curing of cement grout used in setting well casing. This description of the 200 sacks of 2% calcium chloride is the only written indication that such material was used at the site.

The drilling records also describe the 1971 stimulation program for Conoco Federal #2. On January 21, 1971, a contractor injected 17,500 gallons of acid (probably hydrochloric acid) into the Conoco Federal #2. The acid strength ranged from 3% to 20%. Over 14 days, in January and February 1971, the well produced 92 barrels of oil and 349 barrels of formation water. On February 24, 1971, the contractor injected 2000 gallons of 15% acid into the Conoco Federal #2. Well records indicate that the water and oil recovered from subsequent swabbing flowed into a test tank.

On March 1, 1974, the Conoco Federal #2 was plugged and abandoned by Mark Production Company. Mewbourne personnel report that Mark Production followed applicable U.S. Geological Survey procedures and standard industry practice in plugging and abandoning the well. Plugs were set at depths of 6,000 feet, 4,100 feet, 3,000 feet, and 1,710 feet below grade, and at the surface. We saw no evidence from the abandonment record to suggest that the well casing may be leaking or otherwise impairing the surrounding aquifer. Roy C. Williamson, Jr., P.E. reached the same conclusion in his written expert report.

Finally, we asked several Mewbourne employees if they had any information or recollection regarding the location of the reserve pit, drilling methods, etc. While no current employees were present when the well was drilled or plugged in the early 1970s, several suggested that the layout of the caliche pad strongly suggested the existence of a reserve pit due north of the well. The Mewbourne employees also stated that the water storage tank used to store water pumped from the McCasland windmill well appeared to have been formerly used for oil field operations. Mr. McCasland confirmed that the water storage tank was formerly used as an oil field tank.

4.0 Field Investigations and NMOCD Review

Hicks Consultants carried out three field investigations of the study area: a groundwater sampling in September 1998, a monitor well drilling and sampling program in July and August 1999, and a well sampling program in March 2001. In January 2001, HydroGeologic Services installed three monitor wells near the McCasland windmill, performed a pumping test, and obtained groundwater samples. We understand that Mr. Gregory Bybee of ECD and Mr. Eddie Seay supervised a windmill inspection, pumping, and sampling program in November 2000.

4.1 September 1998 Groundwater Sampling

On September 1, 1998, under the direct supervision of Mr. Randall Hicks, Ms. Melissa Snodgrass of Hicks Consultants examined the area surrounding the site with Mr. Jerry Elgin of Mewbourne. Ms. Snodgrass visited the four water wells shown on Plate 3 (which include the McCasland windmill well) and collected water samples from three of them.

Assaigai Analytical Laboratories received samples from this first field program on September 2, 1998. The laboratory analyzed each sample for major cations and anions, and calculated the ion balance for all three wells. Table 1 summarizes the results from these analyses as well as analyses from all field programs. The chain- of-custody forms and copies of the original certificates of analysis are included in this report as Appendix B; in these forms, the McCasland windmill well is labeled Fed #2.

MCCASLAND WINDMILL WELL: The well installation includes the well, the windmill used for pumping, a water storage tank, and a water trough into which the storage tank discharges. During our investigation, the water trough exhibited a thick salt crust along the water surface and feathery yellow algae along the tank surfaces. Hicks Consultants collected a water sample from the standpipe of this windmill (see Table 2 for sample results).

MEW #2 & MEW #3: The water well labeled MEW #2 on the chain of custody form is approximately two miles north of the Site (also see Plate 3). Another water supply well, MEW #3, is located 1.5 miles north of the Site. Mr. Elgin stated that livestock used water from these two wells. Our field investigation showed that water troughs at both of these wells contained green algae, tadpoles, and other aquatic species. The edges of the tanks contained only a thin layer of salt encrustation. Livestock were near both tanks. Because the wind during the site visit was not sufficient to cause the windmills to pump, water samples could not be collected from the wells themselves. Hicks Consultants collected a water sample from the MEW #2 water trough. No sample was taken from MEW #3.

MEW #4: The fourth water well, MEW #4, is approximately two miles northwest of the Site. We believe this is the well referred to in the well logs (Appendix A) as McCasland No. 3—it is within a quarter mile of the location given on the well log and no other wells are nearby. Our investigation revealed that the water trough of this well contained some green algae; salt encrustation was considerably less than in the water trough at the McCasland windmill well, though greater than in MEW #2 and MEW #3. Site evidence suggests that livestock drink from this well. Because the windmill was not pumping during the site visit, Hicks Consultants collected a water sample from the MEW #4 water trough.

According to analysis of samples taken during Hicks Consultants' September 1998 sampling event, the McCasland windmill well exhibited a laboratory conductivity of 7,800 μmhos/cm, with a cation content dominated by calcium and chloride. The water from MEW #2 showed a conductivity of 1,160 μmhos/cm. Carbonate was the highest anion concentration, at 275 mg/L; the cations calcium and sodium were each approximately 100 mg/L. In MEW #4, calcium and sulfate were the dominant cations and anions, respectively. The specific conductance of MEW #4 was 3,700 μmhos/cm.

4.2 July/August 1999 Monitor Well Drilling and Soil Sampling Program

On July 29, 1999, Mr. Corky Glenn of Glenn's Water Well Service obtained water levels from the four wells shown on Plate 3. Table 2 presents the results of this survey. As Table 2 indicates, we obtained surface elevation data from the U.S. Geological Survey topographic map.

Plate 5 shows the potentiometric surface derived from water level measurements. Although the well casing elevations are not surveyed, the flat terrain permits an estimate of the well head elevation to within 2–4 feet. The relatively steep hydraulic gradient (steep relative to the land surface), and large distance between wells permits an accurate estimate of the direction of groundwater flow, despite the margin of error associated with obtaining casing elevations from the topographic map. This map shows the regional groundwater flow is from the northwest to the southeast at a gradient of 0.004, similar to that presented in Plate 4.

Figure 2: Photograph of the dune field southeast of the McCaslnad windmill well.

The March 9, 1999, investigation plan proposed one monitor well down-gradient from the Site to determine the extent of chloride in groundwater. The presence of an extensive sand dune field south and east of the Site limited access to potential drilling locations southeast (the presumed down-gradient direction) of the Site (see Figure 2). Along the predicted southeast flow path, one feasible well location was within the original oil well pad, about 120 feet from the McCasland windmill well. The other location was more than 4,000 feet southeast, along a service road that transverses the dune field. Because we hypothesized that the source of calcium chloride may be associated with the drilling operations (e.g., a former reserve pit), drilling a potential conduit between groundwater and the potential source was not prudent. We eliminated a location on the well pad from further consideration. The second location was simply too far from the potential source area.

Due to the logistical constraints of constructing a monitor well directly southeast, we requested a modification of our approved investigation plan (August 11, 1999). We proposed a monitor well location 100 feet south and 600 feet east of the McCasland windmill, adjacent to a caliche service road. The NMOCD approved the proposed modification.

Mr. Hicks and Eades Well Drilling Service mobilized to the site to begin drilling on August 16, 1999. A representative of McCasland Ranch was present to observe drilling activities. Drill cuttings became relatively moist (68 feet below grade), causing Eades to convert from air drilling to water drilling. Eades used about two gallons of a polymer-based drilling fluid to condition the water. Drilling stopped at 91 feet, after penetration of the Triassic Dockum Group, or "Red Beds."

As the well log shows (Appendix A), the unsaturated zone extends from ground surface to 73 feet. Light brown to reddish brown sand with minor clay and caliche characterize the unsaturated zone. The 15-foot thick zone of saturation lies between the water table (73 feet) and the top of the "Red Beds" (Triassic Dockum Group) at 88 feet below grade. The saturated zone is dominantly sandy gravel, a typical lithology found at the base of the Ogallala Formation. We observed abundant white clay in drill cuttings from the uppermost three feet of the Dockum Group (88–91 feet below grade). At 91 feet below grade, the drilling fluid changed from clear to deep red and the cuttings showed red claystone.

After circulation of clear water from the water truck to remove cuttings, Eades completed the well with 20 feet of well screen (91–71 feet below grade) as shown in Appendix A. Eades developed the well by pumping for 35 minutes at 15–20 gpm. Produced water, which discharged to the mud pit, was completely clear and free of silt or clay after five minutes of pumping. After 13 minutes of pumping, specific conductance stabilized at 876 micro-seimens/meter (compensated for temperature). The temperature of the discharged water dropped from nearly 25 degrees C to a relatively constant 20 degrees C at the end of pumping.

We obtained groundwater samples from the development pump at the end of pumping. The McCasland Ranch representative also obtained samples. Table 2 shows the results of the analyses from Assaigai Analytical Laboratory. Appendix B contains copies of the original certificates of analyses and the chain-of-custody forms for this event.

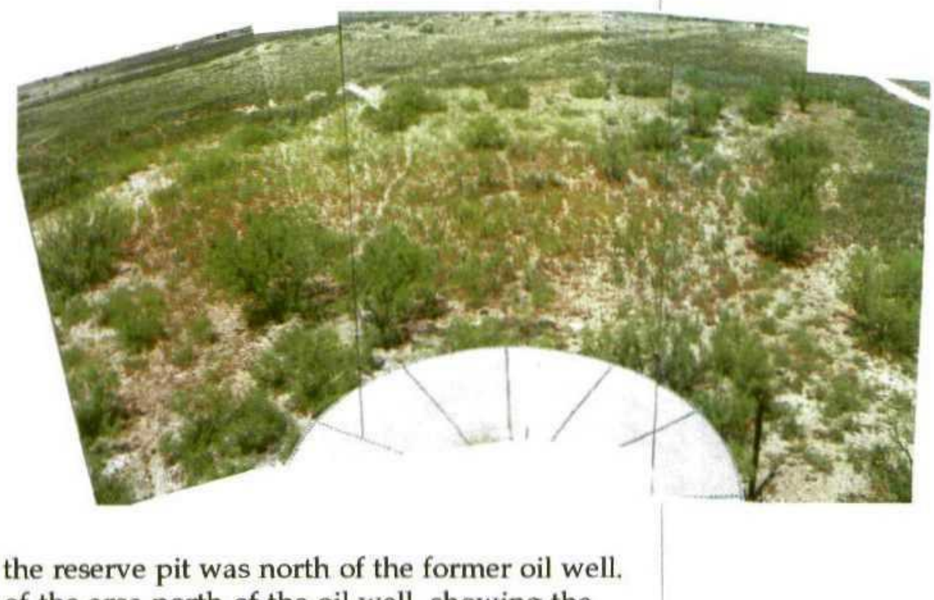
The approved investigation plan also called for sampling of the McCasland windmill well and three other nearby (up-gradient) water supply wells. Because the field conductance of the newly-drilled monitor well suggested water chemistry similar to the three up-gradient windmill wells, we elected to forego additional sampling of these three wells. We did obtain water samples from the McCasland windmill well and its associated water storage tank.

At 1:30 p.m., we switched the windmill from standby to active operation. After breaking the connection between the windmill and storage tank, we noted that water from the tank flowed back toward the well casing when the windmill ceased pumping. We separated the flow pipe to permit the windmill to pump without causing additional backflow from the tank to the well casing (see Figure 3). At 4:22 p.m., we obtained a sample of the backflow discharge from the water storage tank. At or about this same time, the representative of McCasland Ranch obtained a sample of the backflow and a sample from the McCasland windmill well. The windmill pumped about 20 gallons per hour during the afternoon. About 5 p.m., the windmill pumped relatively continuously, discharging about 1 gpm. We sampled the windmill discharge at 5:15 p.m. Table 2 also presents these analytical results.

Figure 3: Photograph of backflow from the storage tank

To determine if past oil exploration or production activities had resulted in a spill or release of calcium chloride or other oilfield material near Conoco Federal #2, the investigation plan required soil sampling within the suspected reserve pit and other locations where oilfield material may have been stored/disposed. The layout of the caliche pad relative to Conoco Federal #2 suggested that the reserve pit was north of the former oil well. Figure 4 is a photomosaic of the area north of the oil well, showing the observed changes in vegetation that suggests a former reserve pit in this

Figure 4: Photomosaic of the area north of Conoco Federal #2



location. Using a backhoe, we excavated three test holes within the suspected reserve pit and one test excavation on the caliche pad. Mewbourne employees suggested that materials might have been stored west of the well during drilling, stimulation, workover, or plugging operations.

Plate 6 shows the locations of the test excavations relative to Conoco Federal #2, the caliche pad and the McCasland windmill. In Test Pit #1, the backhoe encountered cured grout and one bag of hardened cement and clean, dry eolian sand. The excavation, which was about 9 feet deep, 3 feet wide and 12 feet long, encountered no evidence of drilling mud, plastic liners, or salt. We did not find any material that suggested this area was used for disposal of waste. Using the backhoe, we obtained two samples from this excavation: one from the bottom of the excavation (9 feet) and one from the side of the excavation at 5 feet.

We excavated Test Pit #2 in a similar manner. The area surrounding Test Pit #2 exhibited less plant growth than the remainder of the disturbed area north of Conoco Federal #2. We hypothesized that salt disposal may have hindered plant growth. In this excavation, we encountered only clean, dry eolian sand, without any evidence of calcium chloride. We did not find any material to suggest that this area was used for disposal of waste. Using the backhoe, we obtained two samples from this excavation: one from the bottom of the excavation (9 feet) and one from the side of the excavation at 5 feet.

Along the western edge of the disturbed area, we found old wire rope and other material at the surface that suggested past disposal of exploration and production waste. However, when we excavated Test Pit #3 through this debris, we penetrated only clean, dry, eolian sand. We did not find any material that suggested this area was used for disposal of waste. Using the backhoe, we obtained two samples from this excavation: one from the bottom of the excavation (7 feet) and one from the side of the excavation at 5 feet.

On the caliche drill pad, west of Conoco Federal #2, we selected an area of limited vegetation for Test Pit #4. Here, we hypothesized that calcium chloride spills and/or disposal may have limited plant growth. Again, we encountered only clean, dry eolian sand below the caliche pad. We did not find any material to suggest that this area was used for disposal of waste. Using the backhoe, we obtained two samples from this excavation: one from the bottom of the excavation (7 feet) and one from the side of the excavation at 5 feet.

Although the McCasland Ranch representative did not elect to split samples from the test excavations, he observed the entire soil sampling program.

On August 18, 1999, we mixed about 500 grams of each sample with about 500 grams of distilled water. After stirring the mixture and waiting about five minutes, we decanted the fluid and measured its specific conductance. The table below presents the results of this screening analysis.

Soil Conductance at Conoco Federal #2

Sample Location	Depth	Conductivity uS/cm	Notes
Test Pit #1	5 ft	18.1	Submitted to Laboratory
	9 ft	6.6	
Test Pit #2	5 ft	13.5	
	9 ft	20.7	Submitted to Laboratory
Test Pit #3	5 ft	13	
	7 ft	18.2	Submitted to Laboratory
Test Pit #4	5 ft	13.4	
	7 ft	28	Submitted to Laboratory
Distilled Water	NA	3.1	

We submitted the four samples showing the highest conductance to the laboratory for analysis of major cations and anions. The results of the laboratory analyses are in Table 3.

For the Mew A monitor well sample, we requested analyses for volatile organic compounds—calcium, sodium, chloride, sulfate, carbonate, and total dissolved solids (TDS). For samples from the McCasland windmill well, water storage tank, and soil samples, we requested only the aforementioned cations and anions.

On September 3, 1999, Hicks Consultants submitted a report on the above referenced activities to NMOCD. All of the data presented in the 1999 report is reproduced herein.

4.4 June 2000 NMOCD Comments and August 2000 Hicks Consultants Response

In a letter dated June 16, 2000, NMOCD provided comments on the Hicks Consultants report of September 1999. In August 2000, Hicks Consultants responded to the NMOCD comments and then met with NMOCD on August 31, 2000. At this meeting, NMOCD agreed that sustained pumping of the McCasland windmill well might be the best and quickest way to improve the quality of the water and return the well to service.

In a letter dated November 15, 2000 to Mr. Robert McCasland, NMOCD recommended disposal of the water in the storage tank, repair of the check valve, sustained pumping of the windmill, and monitoring the results of pumping. To date, NMOCD has not requested further investigation of the site by Mewbourne.

4.5 November 2000 Sampling and Windmill Inspection Program of ECD and Eddie Seay

We understand that in November 2000, on behalf of McCasland Ranch, Mr. Bybee and Mr. Seay oversaw windmill inspection activities and sampling at the McCasland windmill site. Mr. Bill Olson of NMOCD participated in some of these activities. During this program, some of which is described in the ECD report (Appendix C), Messrs. Bybee and Olson obtained water samples from the windmill. These analyses are presented in Table 1.

4.6 January 2001 Monitor Well Drilling Sampling Program of HydroGeologic Services

In January 2001, on behalf of McCasland Ranch, HydroGeologic Services (HGS) constructed three monitor wells at the McCasland windmill site, obtained water samples from these wells, conducted a pumping test of MW-2, and measured the depth to groundwater. Appendix C contains their report.

4.7 March 2001 Field Program

The objective of Hicks Consultants' March 2001 field programs was (1) to verify results and data presented in HGS's February 2001 report and (2) to implement the program NMOCD requested in their November 15, 2000 letter to Mr. Robert McCasland. At the time of our investigation, Mr. McCasland had not reported to the NMOCD any results or submitted a workplan for the requested program.

PUMPING AND SAMPLING THE MCCASLAND WINDMILL WELL: On March 27, 2001, we initiated pumping of the McCasland windmill well by placing an electrically powered submersible pump into the well. We pumped the well at 1.0 to 1.7 gallons per minute (gpm) for approximately 2 days. The well was able to continually produce water at this rate. However, higher flowrates resulted in complete drawdown and would have subsequently damaged the pump. Therefore, we attempted to maintain the pumping rate at about 1.0 gpm. The total volume of groundwater pumped from the well was approximately 3,000 gallons.

While pumping, we discharged groundwater produced from the McCasland well into a nearby stock tank. To prevent overflow of the stock tank, we contracted with Kelly Maclaskey Oilfield Services to remove and dispose of water in the stock tank.

During the pumping period, we collected four groundwater samples from the well. We collected these samples at 13:05 and 14:20 on 03/27, 17:40 on 03/28 and 15:30 on 03/29. We submitted these samples to Assaigai Analytical Laboratories for analysis of cations, anions, and TDS. Table 1 presents the results of these analyses.

In addition to the samples, we continually monitored the conductance of groundwater produced from the well. Groundwater conductance showed little variability. The average groundwater conductance was 3,902 mmhos/cm with a standard deviation of 258 mmhos/cm.

MONITORING WELL, STORAGE TANK AND PRODUCED WATER SAMPLING: During the March 2001 field program, we collected groundwater samples and measured groundwater conductance at the following monitoring wells: MW1, MW2, MW3, and Mew A. We also collected a water sample from the storage tank used to hold water produced by the windmill and a composite sample of produced water from nearby oil wells. The water sample of the storage tank was collected from its base by loosening a flow valve.

The monitoring wells produced water at a rate of about 1-2 gpm. This pumping rate agrees with the HGS test pumping of January 2001.

Like the water samples of the windmill, we submitted all water samples to Assaigai Analytical Laboratories for analysis of major cations, anions, and TDS. Table 1 presents the results of the analyses.

The McCasland water storage tank was nearly empty during the March 2001 site visit. In 1999, Hicks Consultants noted that the storage tank contained approximately 6-8 feet of standing water. ECD, in their undated report titled "Estimated Cost of Cleanup of Groundwater McCasland Ranch", indicated that the tank water level was about 4-6 feet from the tank base ("several feet above the level of the valve") on November 28, 2000. Our inspection of the storage tank in 2001 revealed leakage from the tank in several locations. We estimate the leakage rate at approximately 20-100 milliliters per minute (less than 0.25 gallons per hour). This leakage may have caused the loss of the 6-8 feet of standing water observed in 1999 and/or the loss of the 4-6 feet of water noted by ECD.

Before sampling or pumping, we measured depth to water in all monitoring wells and the McCasland windmill well. Table 3 presents the results of our depth to water survey and provides previously recorded depth to water measurements. The table shows that the HGS depth to water measurements, presumably collected soon after well drilling, are less than those obtained by Hicks Consultants for MW-1 and MW-2, but more (indicating a deeper water level) than our measurement of MW-3. Table 3 shows the depth to groundwater from the different field programs. Plate 7 displays the water table map from our depth data and the HGS well casing survey data.

5.0 Supplemental Investigation and Data Evaluation

5.1 May 2, 2001 Tank Inspection and Soil Inspection

Previous reports of Hicks Consultants hypothesized that residual oilfield waste in the water storage tank could be the source of observed chloride and calcium in groundwater. During past discussions with NMOCD, NMOCD maintained that previous soil excavations simply looked for the reserve pit (the presumed source of chloride) in the wrong location. This field program's purpose was collecting data to support or discount these hypotheses. The tank investigation did not reveal residual oilfield waste. We did observe a thin (0.01-inch) scale deposit throughout much of the lower portion of the tank. We excavated two test pits with a backhoe to determine if the former reserve pit was located south, rather than north, of Conoco Federal #2. In two test pits, the locations of which are displayed on Plate 6, we found no evidence of waste disposal, or accidental spill residuum. Both test pits revealed dry eolian sand, similar to that observed in previous soil excavations.

5.2 Evaluation of HGS Aquifer Test

We performed an independent analysis of the HGS aquifer test data. The RGE data were collected at MW-2 as the well was pumped and then allowed to recover. We analyzed the recovery data from the aquifer test using a standard method for the determination of aquifer transmissivity which is the product of hydraulic conductivity and aquifer thickness. The method is described in Physical and Chemical Hydrogeology by Domenico and Schwartz (1998).

Our analysis determined a horizontal hydraulic conductivity of the saturated unit near MW-2 of 0.3 feet per day (feet/day). Rio Grande Environment's (RGE) analysis of the pump test data provided a horizontal hydraulic conductivity of 0.87 feet/day. These evaluations using different approaches show excellent agreement. Appendix D presents our independent analysis of the data.

5.3 Aquifer Simulation Modeling

We used numerical modeling to evaluate the impacts of two possible chloride release scenarios in the area of the McCasland windmill. The scenarios were:

(1) An ongoing brine release from the annulus of Conoco Federal #2. We simulated the leak as an injection well. For this simulation, we used a flow domain constructed from data collected by HGS and RGE,

(2) A brine release as above, but with a flow domain based on water level measurements collected by Hicks Consultants in March 2001, and the hydraulic conductivity determined from our analysis of HGS pump test data.

We employed the modeling environment Visual MODFLOW to perform the simulations, using MODFLOW to simulate groundwater flow and MT3DMS to simulate the transport of chloride. Waterloo Hydrogeologic manufactures visual MODFLOW. Appendix E contains information that describes some of the capabilities of the modeling environment as well as documentation about MODFLOW and MT3DMS.

Scenario 1: Casing Leak with HGS and RGE Data

For this scenario, we created a model domain similar to the one used by RGE to analyze the pump test data collected by HGS. Our only modification was to enlarge the modeling area in order to better assess the transport of chloride. We employed aquifer parameters determined by RGE and the hydraulic gradient and flow direction determined by HGS.

We used a horizontal area of 992-feet by 480-feet with the 992-foot side of the rectangle domain aligned parallel to the direction of groundwater flow. The aquifer consisted of 4 horizontal layers each 15-feet thick. We used finer-grid spacing (Äx=Äy=2ft) near the windmill and coarser-grid (Äx=Äy=16ft) spacing near the domain boundaries. The total simulation time was 30 years (10950 days).

The boundaries of the model consisted of an impermeable aquifer bottom, "no flow" boundaries to the north and south, and specified head boundaries to the east and west. A "no flow " boundary is a term of art used to signify that groundwater flows parallel to this boundary, but will not cross it. We selected values for the specified head boundaries that created a hydraulic gradient equal to that measured by HGS, 0.05 feet/foot. These values were 59.9 feet for the west specified head boundary and 10.3 feet for the east specified head boundary.

We used a recharge rate of 0.4 inches per year (in/yr). This recharge rate represents a regional average for the Ogallala aquifer in Lea County, NM (Nicholson and Clebsch, 1961). We assigned this recharge a chloride concentration of 127 mg/l, which we calculated by averaging chloride analysis of MW-1 and MW-2. We believe the water chemistry of MW-1 and MW-2 represents background water quality typically encountered in this region of the Ogallala aquifer.

We also assigned a concentration of 127 mg/l as the initial chloride concentration of the model domain. We defined the western (up gradient) boundary as a specified concentration and assigned it a concentration of 127-mg/l chloride to account for background chloride in groundwater that flows into the model domain.

To simulate a casing leak at the Conoco Federal #2, we used the injection well feature of the model with an injection rate of 0.001 gallons per minute (gpm) and a chloride concentration of 120,000 mg/l. The release was located in the upper-most model layer at an interval of 10 to 15 feet below the water table. The injection rate was determined by trial-and-error. We began with a release rate of 0.1 gpm and decreased the release rate until the injection well stopped creating a measurable groundwater mound around the injection well. A groundwater mound is a region of aquifer where groundwater elevations are significantly greater than surrounding groundwater elevations. Site data show no evidence of water table mounding near the Conoco Federal #2. The 0.001 gpm rate is the maximum possible rate justified by field data. The source concentration was based on an analysis of a composite sample of brine from three nearby oil and gas wells. These wells were the Carter 1, 2, and 3 (see Table 1).

We used the following values determined by RGE for the aquifer characteristics: horizontal hydraulic conductivity of 0.87 feet per day (feet/day), vertical hydraulic conductivity of 0.48 feet/day, storativity of 0.0001, and specific yield of 0.16.

We used a value of 8 feet as the longitudinal dispersivity (A_L) of the aquifer. This value is an average for sand and alluvial aquifers that we calculated from a dispersivity value compiled by Gelhar (1992).

Visual MODFLOW's default settings were used to calculate the transverse horizontal dispersivity (a_{TH}) and vertical transverse dispersivity (a_{TV}). The default settings calculate these parameters acquiring to the following relationships:

$$a_{TH} = 0.1 * a_L$$
$$a_{TV} = 0.01 * a_L$$

Plate 8 shows the predicted distribution of chloride in groundwater along a west to east cross-section after a 30-year release at Conoco Federal #2. The cross-section passes through the McCasland Windmill. Blue, vertical contours are groundwater equipotential lines and represent water table elevation. Green contours represent chloride concentration in mg/l. Arrows indicate the direction of groundwater flow.

The model predicts that chloride from a casing leak at Conoco Federal #2 would not cause concentrations above 130-mg/l chloride at the windmill well.

Note that the steep hydraulic gradient (0.05 feet/feet) causes the eastern portions of the upper model layers to go "dry." The dry cells are colored brown in plate 8. This is a function not of the model, but of the unrealistically steep gradient presented in the HGS report.

Scenario 2: Casing Leak with Hicks Consultants' Data

This simulation differs from scenario 1 in that we used aquifer properties, a hydraulic gradient, and a groundwater flow direction determined by Hicks Consultants rather than HGS and RGE.

For this simulation, we created a model domain with the same horizontal dimensions (992-feet by 480-feet), same release source (injection well), same simulation time (30 years), similar grid spacing, and same recharge condition (0.4 in/yr) as scenario 1. In addition, we also used a background chloride concentration of 127 mg/l to define the constant concentration of the west boundary, the chloride content of recharge water, and the initial chloride concentration of the flow domain.

Rather than use four horizontal layers like scenario 1, we used a single layer with a thickness of 21 feet. This thickness represents the average saturated thickness of the Ogallala aquifer in the area of the McCasland Windmill well (see HGS boring logs for MW-1 - MW-3). We used a single layer because all monitoring wells are screened over the entire saturated thickness of the aquifer. Given the thin saturated thickness and small hydraulic gradient (0.005 feet/foot), we determined from our field data that groundwater flow at the site is primarily horizontal. We measured a hydraulic gradient of 0.005 feet/foot in March 2001.

Like Scenario 1, the boundaries of the model consisted of an impermeable aquifer bottom, no flow boundaries to the north and south, and specified head boundaries to the east and west. We specified the head of the west boundary at 23.3 feet and the head of the east boundary at 18.3 feet in order to define our measured hydraulic gradient of 0.005 feet/foot.

We introduced aquifer heterogeneity by using a smaller hydraulic conductivity value near the McCasland windmill well and a higher hydraulic conductivity in areas distal to the windmill well. Near the windmill well, hydraulic conductivity was assigned a value of 0.3 feet/ day, the value calculated in our analysis of the recovery data. For the area several hundred feet from the windmill well, we employed a hydraulic conductivity of 3.0 feet/day. Field data support this conductivity contrast. Mew A located 630 feet east of the windmill well can sustain a 20 gpm pumping rate, whereas the McCasland windmill well, MW-1, MW-2, and MW-3 produce only 1 gpm. We attribute this water yielding difference to aquifer heterogeneity and, therefore, included it in this simulation. The hydraulic conductivity of 3.0 feet/day is the lowest value we found in published reports on the Ogallala aquifer (Nativ and Smith, 1987).

Other values of aquifer characteristics were a specific yield of 0.13 and longitudinal dispersivity of 8 feet. The longitudinal dispersivity was calculated as described in Scenario 1 as were the horizontal and vertical transverse dispersivities. The value of the specific yield represents a median value for the Ogallala aquifer in eastern New Mexico and west Texas (Nativ and Smith, 1987).

Plate 9 presents the results of this simulation. The plate is in plan view. Red contours represent chloride concentration in mg/l, blue contours are water table elevation, and arrows show the direction of groundwater flow. Using the more realistic hydraulic gradient, the model predicts about 130 mg/l chloride at the windmill, and 127 mg/l chloride at MW-3. The model also predicts that Mew A will show chloride concentrations above background. The simulation does not agree with field conditions, which show 775 mg/l and 1564 mg/l chloride at MW-3 and McCasland windmill well, respectively and background chloride levels at Mew A.

Results of this simulation demonstrate that a casing leak from Conoco Federal #2 could not cause the observed impairment at the windmill well.

5.4 Literature Research of Bromine and Chlorine in Groundwater

Because of concern due to salination of groundwater, many researchers have studied the intrusion of chloride in groundwater. We searched the World Wide Web and the University of New Mexico Libraries for research on the subjects of salt-water impairment and determination of chloride sources. Many investigations have relied upon ratios of stable cations and anions such as chloride and bromide to determine the origin of salt-water intrusion into fresh water supplies. Dr. Alan Dutton of the Bureau of Economic Geology at the University of Texas at Austin has conducted several studies pertaining to the origin of brine into groundwater. Two of Dr. Dutton's studies seem particularly relevant to the McCasland windmill well issue.

The first study, "Identification of Sources and Mechanisms of Salt-Water Pollution Affecting Ground-Water Quality: A Case Study, West Texas," (1990) discusses methods to identify different sources of chloride intrusion to shallow ground water (less than 400 feet below ground surface). This study states that ratios of several types of ions such as Br/Cl can be used to distinguish between salt water intrusion from dissolution of halite (natural sodium chloride in the ground), and salt water intrusion from oil and gas production in the eastern Midland Basin. The authors state that differentiation of chloride sources using such ratios is clearest when the Total Dissolved Solids are above 10,000 mg/l. In the 1990 paper, the authors site a study written by Richter and Kreitler (1986) that states : "Whether these ionic ratios can be used to distinguish between salt-water sources where salinity is less than 5,000 mg/l has not been determined."

We telephoned Dr. Dutton in Austin to discuss the matter further. Dr. Dutton stated that he believed that using Cl/Br ratios of water below 10,000 TDS was probably not valid in part due to analytical instrumentation accuracy errors for bromine at concentrations that are around 1-4 parts per million. We also conducted email correspondence with Dr. Kenneth Rainwater of Texas Technological University in

Lubbock. Dr. Rainwater, a professor and researcher at Texas Tech University, stated that the bromine concentrations in groundwater at Texas Tech are normally between 1-4 parts per million.

Another study, "Origin, distribution, and movement of brine in the Permian Basin (U.S.A.): A model for displacement of connate brine," (Dutton, 1993) is a discussion of different types of naturally occurring brines in the Permian Basin. The introduction of the paper includes discussion of Ca-Cl brine, defined by a low Na/Cl (<.8) molal ratio and a Ca/SO_4+HCO_3 equivalent ratio much greater than 1. The body of the paper states that most areas in the Permian Basin, including the Midland Basin, are indicative of Na-Cl brines. However, the Permian Basin in the southeastern portion of New Mexico, known as the Delaware Basin, is an area where Ca-Cl brine is not uncommon. The paper then states that Cl/ Br weight ratios are low in Ca-Cl brine. We calculated the molal ratio of Carter #1,2,3 (oil wells near the McCasland windmill). The molal ratio is approximately 0.55, well below 0.8. We also calculated the Ca/SO_4+HCO_3 ratio; that ratio is 16, well above 1. Therefore, we believe that the McCasland windmill well is in an area of naturally occurring Ca-Cl brine. This type of oilfield brine (produced water) exhibits a Cl/Br ratio close to that of natural groundwater.

Finally, we examined the chloride and bromine concentrations of natural groundwater near White Sands National Monument. Here gypsum ($CaSO_4 \cdot 2H_2O$), a mineral similar to anhydrite, is common. Chemical data from the U.S. Geological Survey Water-Resources Investigations Report 93-4192 are shown in Table 1. Chloride concentration exceeds 1,000 mg/l in most wells and bromide ranges from 0.31 to 21.0 mg/l. The average Cl/Br ratio of these data is greater than 2000.

6.0 Discussion of Plantiff's Hypotheses Regarding the Source of Chloride

6.1 Hydrogeology of the Ogallala Formation

The lithologic logs of monitor well Mew A, MW-1, MW-2, and MW-3 suggest that the principal water-bearing zone is a coarse-grained sand and gravel unit at the base of the Ogallala Formation. This saturated, coarse-grained basal unit is typical of the Ogallala Formation (Nicholson and Clebsch, 1961). We observed no evidence of evaporites (e.g. anhydrite or gypsum) in these logs.

Nevertheless, the driller's log for the McCasland windmill well describes "anhydrite" as the dominant lithology of the saturated zone. One other nearby windmill (Mew 4 on Plate 3 and State Engineer File L-10,044 #3 in Appendix A) also describes "anhydrite" within the saturated zone. Evaporites like anhydrite or gypsum are described as "common as a secondary mineral" (Nicholson and Clebsch, 1961) in the Chinle Formation (red beds) which underlie the Ogallala. The driller's log for windmill well Mew 4 (see Plate 3) also describes anhydrite in the saturated zone. These data suggest that the McCasland windmill well and, perhaps Mew 4, may penetrate a portion of the Chinle Formation that contains gypsum and other evaporite minerals. These evaporite minerals could contribute chloride, sodium, calcium, and other constituents to groundwater. Such an occurrence would be uncommon, but not unique.

Mew A, a 4-inch well similar to MW-2 and the McCasland windmill well, produced 15-20 gpm for more than 30 minutes without significant water level drawdown. Although the lithology of the HGS wells (MW-1, MW-2 and MW-3) appear similar to that encountered in Mew A, perhaps the area near the windmill well is finer-grained due to the presence of evaporite minerals such as anhydrite. The relatively uniform water production characteristics of all wells in the area near the McCasland windmill suggest a lower hydraulic conductivity than the area near Mew A. An earlier hypothesis regarding poor well development techniques at the windmill site causing the observed poor production from the monitor wells and windmill no longer appears valid. Pumping 700 gallons of water from MW-2 during the pumping test should have been sufficient to fully develop the well, and the pumping test data represent the condition of the aquifer, not the efficiency of the wells.

Plate 5 shows the potentiometric surface derived from August 1999 water level measurements in four windmills and in the monitor well Mew A. These data support a regional groundwater flow direction from the northwest to the southeast at a gradient of 0.004, similar to that reported by Nicholson and Clebsch (1961).

At the McCasland windmill site, we observed a slightly different groundwater flow direction and a minor difference of hydraulic gradient. The groundwater flow direction is east-northeast at a gradient of 0.003. Our observations, presented in Plate 7, represent the potentiometric surface at the McCasland windmill site during the time of our study. Periodically, climatic conditions, such as drought, could cause groundwater at the McCasland windmill site to flow east-southeast, similar to the observed regional flowpath. Conversely, a low permeability zone near the McCasland windmill could cause perturbations in the flow direction. At the windmill site, groundwater may always flow east-northeast.

This groundwater flow direction, away from the windmill, does not support the plaintiff's hypothesis that a casing leak contributes chloride to the windmill water.

Natural evaporite minerals, such as gypsum, can cause high concentrations of chloride in groundwater. This relationship is observed near White Sands National Monument. Evaporite minerals at the windmill site may be the cause of the observed chloride in groundwater.

6.2 Groundwater, Produced Water, and Storage Tank Chemistry

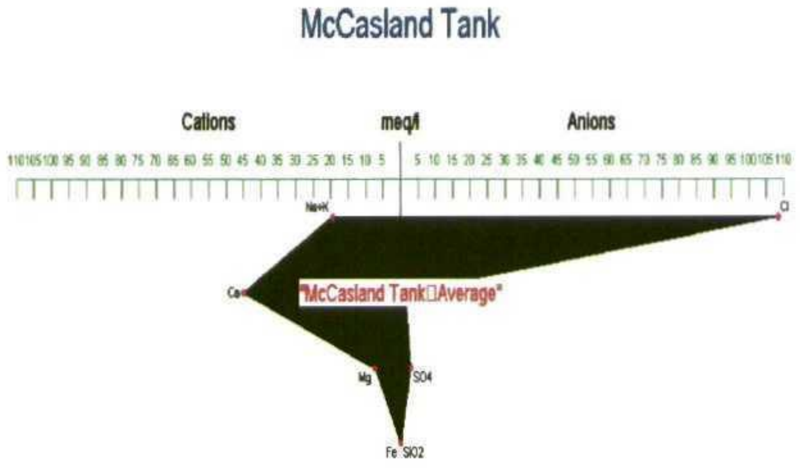
Analytical results from the August 1999 investigation of the McCasland windmill well differ from the results of the August 1998 sampling event, as well as from the results obtained by Mewbourne in its March 1998 investigation (see Table 1). Although 1999 analyses show the water to be still dominated by calcium chloride, the total dissolved solids analysis is 50% less than the results from March 1998. The concentration of other cations and anions in analyses from the 1999 investigations are also significantly lower than the result from the 1998 analysis.

However, the August 1999 laboratory analysis of the McCasland water storage tank (McCasland Tank in Table 1) is very similar to the 1998 analyses of the McCasland windmill well. The calcium, chloride, sodium, and sulfate concentrations are about 25% higher in the 1999 analysis of the water storage tank than in the 1998 analyses of the windmill well. In contrast, the sulfate and magnesium concentrations of the water storage tank (1999) are essentially the same as the 1998 analyses of the windmill well. The analyses and our observation of a leaking check valve between the storage tank and windmill well suggest that the 1998 samples from the McCasland windmill well were a mixture of water from the Ogallala and backflow from the well's water storage tank.

The observed higher TDS of the water in the storage tank than the water pumped from the McCasland windmill well may be explained if residual oilfield material, calcium chloride, cattle salt licks, or other occult material was once in the adjacent storage tank. An alternate explanation is evaporation of water from the storage tank over a ten-year period and the consequential increase in salinity of the stored water. We understand that the windmill has not been used very much since the well was originally drilled. Evaporation could cause the TDS to increase in the storage tank. However, we observed the storage tank leaking on two occasions: at our March 2001 field program and the May 2001 field program. We also observed patches on the tank suggesting past leakage. If leakage from the tank occurred in the past, combined with periodic pumping to re-fill the storage tank, then concentration of salt in the tank due to evaporation is less likely.

Despite the difference in TDS, the "chemical signature" of the tank water is essentially the same as the water derived from the windmill. Figures 5 and 6 are Stiff diagrams that display the chemical constituents in water from the tank and the windmill. The similar shape of the diagram indicates that the waters exhibit similar chemical "signatures." The elongated triangle on the upper right of the figures show that both waters are dominated by the chloride anion. The left side of the figures show that calcium is the dominant cation. The cations sodium and magnesium are also present in these samples. The anions sulfate and bicarbonate are present in low concentrations.

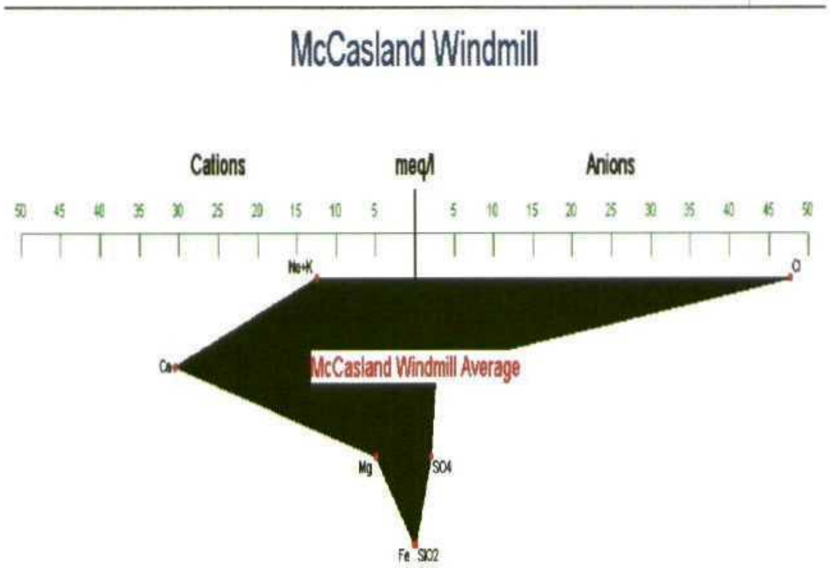
Figure 5:
Stiff Diagram of the water from the McCasland Storage Tank



MW-3 presents the same general composition as the windmill and storage tank.

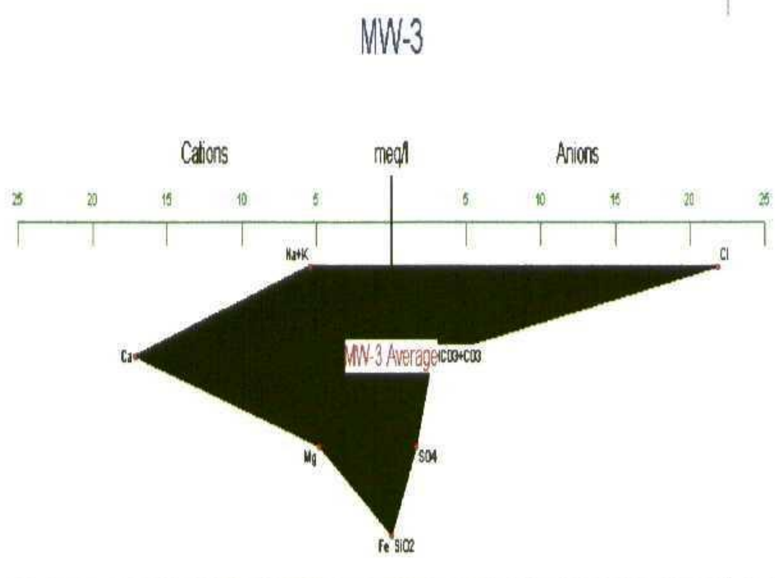
Mew A exhibits chemistry similar to the up-gradient monitoring wells MW-1 and MW-2 and the windmill Mew #2 (see Table 2). These four wells exhibit chemistry similar to nearby Ogallala water wells. Plate 10 is a Piper tri-linear diagram that displays the chemical "signature" in a manner somewhat different from the Stiff diagrams but using the same chemical concepts. Plate 10 plots all samples shown in Table 1. In this plate, Ogallala water contains nearly equal amounts of sodium, calcium, chloride and bicarbonate. Thus these waters plot near the middle of the cation and anion triangles at the bottom of the plate. As a result of this "balanced" chemistry, these waters plot in the center of the uppermost diamond of the Plate. Figure 8 is a Stiff diagram

Figure 6:
Stiff Diagram of the water from the McCasland Windmill



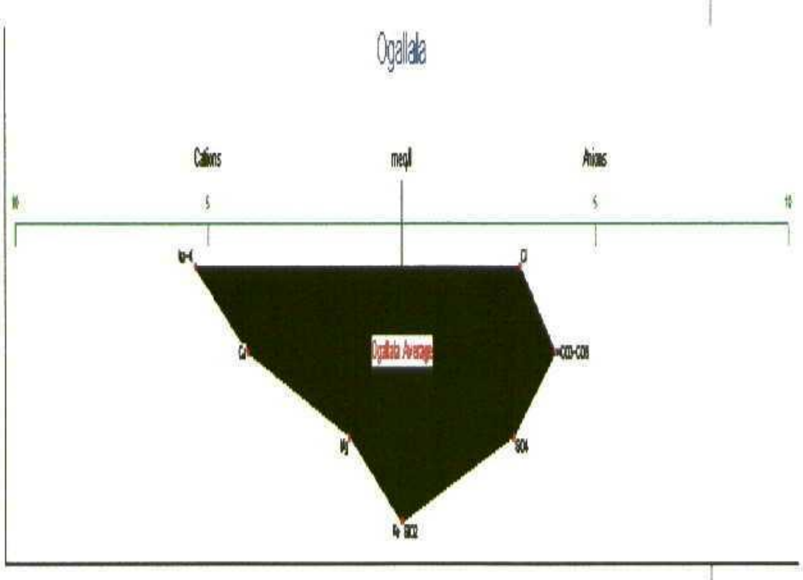
showing the chemical composition of these low-chloride Ogallala well samples.

Figure 7: Stiff Diagram of the water from MW-3



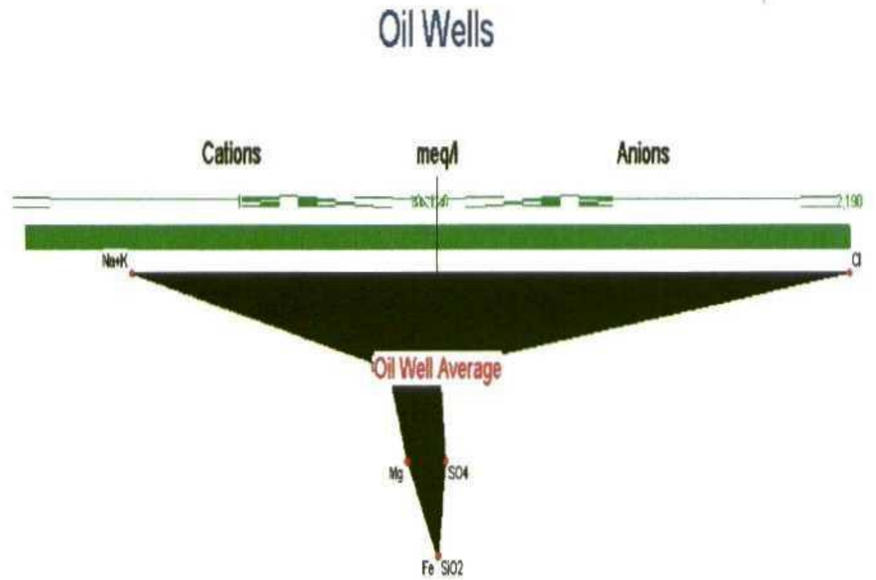
Note how the chemistry signatures of these water samples differs from MW-3, the McCasland windmill well, the associated storage tank, and MW-3. The dominance of calcium and chloride cause the samples from these three wells to plot at the top of the diamond in Plate 10. Mew 4, a windmill north of the McCasland windmill site plots between the more typical Ogallala wells and the three wells discussed above.

Figure 8: Stiff Diagram of the unimpaired water from the Ogallala Aquifer



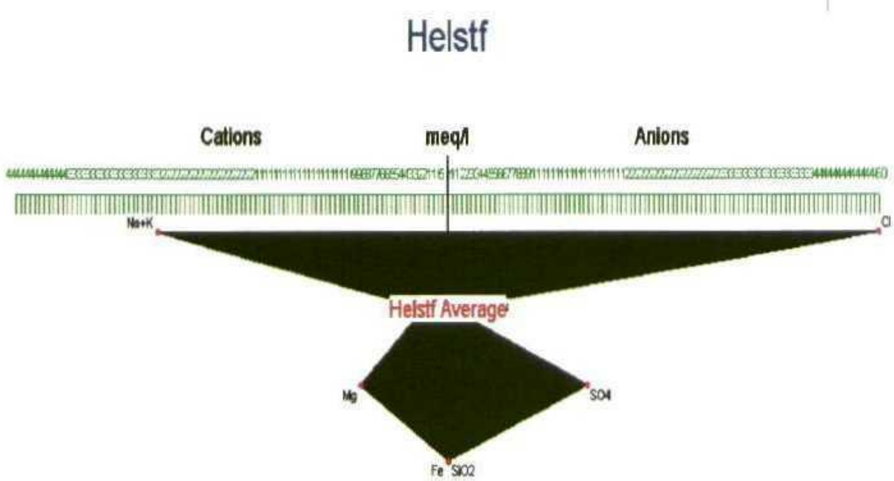
Hicks Consultants compared the water chemistry of the water wells discussed above with produced water from oil production wells in southern Lea County. The locations and ion concentrations for all these wells are displayed in Table 1. Figure 9 shows that produced water in this area is dominated by sodium and chloride. Calcium and carbonate are present in equal amounts, but significantly less than sodium or chloride. On Plate 10, these samples are concentrated on the right-hand corner of the diamond. As mentioned earlier, bromine is not exceptionally concentrated in produced water of this particular chemical signature.

Figure 9: Stiff Diagram of the water from an Oil well in Lea County



Samples of shallow groundwater near White Sands National Monument exhibit a unique chemical signature (Figure 10). Sodium and chloride are the dominant cation and anion, respectively, while sulfate and magnesium are secondary. This chemistry of groundwater in this evaporative basin is highly variable (see Table 1). Despite the variability in chemical composition, the chloride/bromide ratio of the samples is greater than 2000. On Plate 10, these samples plot between "first and second base" of the diamond.

Figure 10: Stiff Diagram of the groundwater from White Sands National Monument



According to Groundwater Hydrology (D. Todd, Wiley 1980) one can use a Piper Tri-linear diagram to verify the composition ("signature") of a mixture of two waters:

> Simple mixtures of two source waters can be identified;
> for example, an analysis of any mixture of two waters will plot on a straight line AB on the diagram, where A and B are the positions of the analyses of the two component waters.

Ogallala groundwater mixed with sodium chloride-rich produced water from a casing leak would plot between the Ogallala and produced water groupings. As Plate 10 illustrates, the McCasland windmill well does not plot on a line between these two groupings. This evaluation further demonstrates that observed chloride in groundwater at the McCasland windmill well is not the result of a casing leak or other release of oil field-produced water. In fact, the water in MEW 4, MW-3, and the McCasland windmill is more similar to the natural groundwater near White Sands Missile Range than a mixture of Ogallala and produced water.

6.3 Lithology and Chemistry of the Soil Zone at the McCasland Windmill Site Well Pad

Despite the observed difference between the vegetation due north of Conoco Federal #2 and the surrounding countryside (see Figure 4), there was no evidence of drilling mud and/or oil field waste. Obviously, the area north of Conoco Federal #2 was disturbed by oil field operations and minor amounts of debris (cement, wire rope, etc.) were placed in the pit. The chemical analyses of soil, which show chloride values below 20 mg/kg, do not suggest disposal of any material such as calcium chloride.

We also excavated three additional observations trenches: adjacent to the windmill well, adjacent to Conoco Federal #2, and adjacent to the watering trough. Our examination of the subsurface found natural eolian sand with no evidence of waste disposal or releases. These data suggest that:

- disposal of bentonite drilling mud did not occur near Conoco Federal #2;
- disposal of calcium chloride did not occur near Conoco Federal #2; and material in soil near Conoco Federal #2 is not the source of the calcium chloride observed in the McCasland windmill well.

6.4 Modeling Results

The modeling results do not support the hypothesis that an ongoing hypothetical casing leak from Conoco Federal #2 is the source of chloride at the site. Using two different flow domains (HGS and Hicks Consultants), the model did not predict sufficient up gradient migrations of chloride to account for the concentration observed in the windmill well.

7.0 Conclusions

We evaluated the plaintiff's hypothesis to explain the observed chemistry of the McCasland windmill well. Hicks Consultants has:

- sampled surface soil
- sampled groundwater
- drilled, sampled and measured water levels in monitor wells
- conducted a pumping test
- performed simulation modeling of flow domains
- examined the historical practices used by Mark Production
- examined the storage tank
- sampled and measured water levels at nearby windmills

Throughout the course of a three-year investigation, a significant volume of data are available to test these hypothesis. We have summarized all of these data in this report.

No hydrogeologic data or modeling support the hypothesis that a casing leak from Conoco Federal # 2 is releasing brine and attendant chloride to groundwater.. Groundwater flows from Conoco Federal #2 to the east, away from the McCasland windmill. Any chloride released from the well would migrate east and not "uphill" to the windmill.

No groundwater chemistry data support this hypothesis. The sodium/ calcium ratio of the windmill water is significantly different from that of the subsurface brine that would originate from a casing leak. The tri-linear diagram demonstrates that a mixture of produced water of the area and normal Ogallala water (i.e. Mew A) of the area would not produce the chemistry we observe in the McCasland windmill. The bromine concentration of the windmill and MW-3 is within the range of natural Ogallala groundwater. Additionally, Bein and Dutton, (1993) and Richter, Dutton and Kreitler (1990) state that using bromine/ chloride ion ratios to determine the source of salinity is not valid for the observed conditions near the McCasland windmill well. This area of the Permian Basin contains Halite Ca-Cl brines (as discussed earlier). Therefore, we conclude that a casing leak has not impaired the McCasland windmill well water quality.

The size of the chloride-rich groundwater zone is very small. Excellent quality Ogallala groundwater exists only 50 feet west (up gradient) of the McCasland windmill well in MW-1 and MW-2. Excellent quality Ogallala groundwater exists 600 feet down gradient (east) of the McCasland Windmill well in Mew A. Chloride concentration in MW-3, which is about 100 feet south (cross-gradient) from the McCasland windmill well, is 33% of the chloride concentration observed in the windmill. Assuming this chloride concentration gradient is relatively uniform to the south, then chloride concentration in groundwater would meet New Mexico groundwater standards within 240 feet south of the windmill well. We conclude the size of the chloride-rich groundwater zone is less than 480 feet (north-south) by 500 feet (east-west).

No evidence supports a conclusion that activity of Mark Production or Mewbourne Oil caused the observed chloride in groundwater at the McCasland windmill site. We found no evidence of high chloride concentrations in soil from samples taken throughout the area surrounding Conoco Federal #2. We found no evidence of historical practices that suggest disposal of chloride-rich material by Mark Production. Monitoring well data demonstrate that Mewbourne's activities up gradient from the McCasland windmill site have not impaired groundwater quality.

We conclude that the cause of the chloride-rich groundwater zone at the McCasland windmill site cannot be determined with existing data. The cause may be natural or man-made.

If the calcium and chloride in groundwater at the site is a result of natural gypsum or anhydrite in the saturated zone, as the preponderance of existing data suggest, then mechanical means cannot "restore" groundwater quality. The observed groundwater quality is natural. The New Mexico Oil Conservation Division cannot require a remedy or any regulatory action under this condition.

If an unknown man-made source caused the chloride-rich groundwater zone, the New Mexico Oil Conservation Division has the regulatory authority to require a responsible party to implement a remedy. However, available data do not permit identification of the responsible party. In fact, the preponderance of data suggests the chloride is a natural phenomenon. Because our investigations conducted to date fully satisfy all regulatory obligations of Mewbourne in this matter, the NMOCD or other parties must perform additional investigation to confirm the exact cause of the chloride in groundwater. Drilling a boring/well near the windmill may determine if the chloride is natural or man-made. This boring/well, chemical analyses and professional labor for this effort would cost about $5,000. If the boring/well suggests that the chloride is man-made, collecting the additional evidence to identify a responsible party would cost about $15,000. This second effort involves historical research, additional borings/wells, chemical analyses, etc.

Given the small zone of chloride-rich groundwater at the McCasland windmill site, we conclude that the neither the New Mexico Oil Conservation Division nor other parties would implement a $20,000 program to identify the source of the impacted zone.

If a subsequent investigation suggests that man caused the chloride-rich zone of groundwater and additional investigation clearly identified a responsible party, then the New Mexico Oil Conservation Division would permit a monitored natural attenuation remedy at the site. The cost of implementing this approach at the site is a $200.00 to $300.00 per year monitoring program for 10-20 years. Installation of a pumping system in MW-1 or MW-2 to supply sufficient high-quality water to permit increased cattle grazing would be part of this remedy. The total present value cost of this effective remedy is about $5,000.

We conclude that the New Mexico Oil Conservation Division would not require installation of a reverse osmosis, pump-and-treat groundwater remedy as suggested by ECD.

We conclude that the investigations conducted to date fully satisfy the regulatory obligations of Mewbourne in this matter. Mewbourne should not conduct additional investigation or inquiry at this site. Mewbourne should not implement any groundwater restoration program at this site.

8.0 References

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TABLES

Well #	Date	Source	Ca	Fe	Mg	K	Si	Na	Zn	Cl	F	Nitrate	Nitrite	Phosphorus	Ortho P.
Carter 1, 2, 3 Production Wells	4/3/01	Hicks Sampling 2001	8630	1.37	3590	1700	4.3	44800	ND	125000	ND	127			ND
Conoco Fed #2	3/10/71	Mewbourne Oil Data	7199		4014			58745		113462					
Oil Well 83	1956	Roswell Geologic Society Nicholson and Clebsch 1961	5240	0	2527			30900		62000					
Oil Well 89	1956	Roswell Geologic Society Nicholson and Clebsch 1961	300	100	ND			10000		12000					
Oil Well 90	1956	Roswell Geologic Society Nicholson and Clebsch *1961*	5330	*113*	1830			43700		82300					
Oil Well 92	1956	Roswell Geologic Society Nicholson and Clebsch 1961	3375	10	0			19500		44325					
Oil Well 93	1956	Roswell Geologic Society Nicholson and Clebsch 1961	7000	75	0			47500		103898					

Table 1: Water Analyses

mg/l

Well #	Sulfate	HCO3	Conductivity	TDS	Bromine	Silver	Arsenic	Barium	Cadmium	Chromium	Mercury	Lead	Selenium	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPH
Carter 1, 2, 3 Production Wells	1110	237	296000	196000														
Conoco Fed #2	1700	243																
Oil Well 83	2080			93400														
Oil Well 89	3200	710		37000														
Oil Well 90	2250	428		141300														
Oil Well 92	1689	744		81208														
Oil Well 93	1402	469		166800														

Table 1: Water Analyses

mg/l

Well #	Date	Source	Ca	Fe	Mg	K	Si	Na	Zn	Cl	F	Nitrate	Nitrite	Phosphorus	Ortho P.
McCasland Tank	8/17/99	Hicks (Sept. 99 Report)	916	0.27	87.4	9.4		447		2450	ND	2.2	ND		
McCasland Tank	3/28/01	Hicks Sampling 2001	893	2.94	94.5	11.7	31.5	438	1.21	5230	ND	2.69	ND		ND
McCasland Tank Average			904.5	1.605	90.95	10.55	31.5	442.5	1.21	3840		2.445			
McCasland Windmill	3/31/98	Hicks (Sept. 99 Report)	700		90	7.4		285		1771		3			
McCasland Windmill	9/1/98	Hicks (Sept. 99 Report)	749	19.9	73.9	8.3	21.8	373	3.8	1930	ND	1	ND		ND
McCasland Windmill	1/25/99	Bybee NMOCD Files								5000	0.5	0.5	0.5		2.5
McCasland Windmill	8/16/99	Hicks (Sept. 99 Report)	411	1.93	48.4	6.2		244		1130	ND	1.6	ND		
McCasland Windmill	9/17/99	Bybee NMOCD Files								1400	0.2	1.5	0.2		1
McCasland Windmill	11/28/00	HGS (Jan. 01 Report)	692		64.6	8.9		344		1500	ND	1.8	ND	43	
McCasland Windmill	11/28/00	HGS (Jan. 01 Report)	698		62.3	8.5		334		1100	ND	1.7	ND	ND	
McCasland Windmill	11/28/00	Olson NMOCD Files	525		46.9	9.07		194		1300	1	2.4			
McCasland Windmill	12/26/00	HGS (Jan. 01 Report)								1500	ND	1.8	ND	43	
McCasland Windmill	12/27/01	Bybee NMOCD Files								1340					
McCasland Windmill	3/27/01	Hicks Sampling 2001	531	0.07	52.9	6.9	23.8	247	0.27	1420	ND	1.42	ND		ND
McCasland Windmill	3/28/01	Bybee NMOCD Files								1290					
McCasland Windmill	3/28/01	Hicks Sampling 2001	592	ND	56.7	7.5	24.1	258	0.08	1580	ND	1.52	ND		ND
McCasland Windmill	3/29/01	Bybee NMOCD Files								1450					
McCasland Windmill	3/29/01	Hicks Sampling 2001	610	ND	57.1	7.4	23.4	266	0.05	1620	ND	1.48	ND		ND
McCasland Windmill Average			612	7.3	61.4222	7.79667	23.275	282.778	1.05	1688.73		1.64333		43	
"McCasland Water Well"	8/16/99	Bybee NMOCD Files	308		38	6		188		720	0.2	1.4	ND		ND
MW-3	1/8/01	HGS (Jan. 01 Report)	393		67.3	9		143		870	ND	1		ND	
MW-3	3/27/01	Hicks Sampling 2001	295	0.15	50.9	7	23.2	97.6	ND	679	ND	ND	ND		ND
MW-3 Average			344	0.15	59.1	8	23.2	120.3		774.5		1			

Table 1: Water Analyses

mg/l

Well #	Sulfate	HCO3	Conductivity	TDS	Bromine	Silver	Arsenic	Barium	Cadmium	Chromium	Mercury	Lead	Selenium	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPH
McCasland Tank	124	55.4	7260	4270														
McCasland Tank	149	105	6570	4720														
McCasland Tank Average	136.5	80.2	6915	4495														
McCasland Windmill	108	171		4113														
McCasland Windmill																		
McCasland Windmill	110				12									ND	ND	ND	ND	
McCasland Windmill	84.3	186	3960	2060														
McCasland Windmill	100				3.6													1
McCasland Windmill	100				4													
McCasland Windmill	88				2.9	0.005	0.01	0.303	0.002	0.006	0.0004	0.01	0.02					
McCasland Windmill	88	150																
McCasland Windmill	100				4													
McCasland Windmill			4456		5.43													
McCasland Windmill	82		3920	2690	3.22													
McCasland Windmill			4467		4.23													
McCasland Windmill	84.3	147	4140	3050	3.35													
McCasland Windmill			4829		4.28													
McCasland Windmill	86	146	4470	3220	3.53													
McCasland Windmill Average	93.6909	160	4320.28571	3026.6	4.59455	0.005	0.01	0.303	0.002	0.006	0.0004	0.01	0.02					
"McCasland Water Well"	77				2.4													ND
MW-3	95				2.8	0.005	0.02	0.532	0.002	0.006	0.0002	0.01	0.02					ND
MW-3	61.5	166	2180	1500	1.91													
MW-3 Average	78.25	166	2180	1500	2.355	0.005	0.02	0.532	0.002	0.006	0.0002	0.01	0.02					

Table 1: Water Analyses

mg/l

Well #	Date	Source	Ca	Fe	Mg	K	Si	Na	Zn	Cl	F	Nitrate	Nitrite	Phosphorus	Ortho P.
HELSTF-1	5/14/90	USGS Report 93-4192	440	0.03	410	29	0.03	2100		750					
HELSTF-2	6/9/90	USGS Report 93-4192	760	1.1	4800	450	0.0076	28000		46000					
HELSTF-2	6/10/90	USGS Report 93-4192	1000	0.6	2200	270	0.014	17000		33000					
HELSTF-2	6/11/90	USGS Report 93-4192	590	0.09	550	98	0.019	4400		4500					
HELSTF-2	6/11/90	USGS Report 93-4192	720	0.1	680	98	0.016	3800		46000					
HELSTF-2	6/11/90	USGS Report 93-4192	370	0.08	210	34	0.02	1200		12000					
AverageHELSTF-2			688	0.394	1688	190	0.01532	10880		28300					
HELSTF-3	7/2/90	USGS Report 93-4192	390	0.05	420	53	0.025	2500		2400					
MAR-CW	11/21/84	USGS Report 93-4192	69		370	27	0.022	2000		670					
MAR-CW	4/3/89	USGS Report 93-4192	360	0.04	510	60	0.021	2300		1200					
AverageMAR-CW			214.5	0.04	440	43.5	0.0215	2150		935					
MW-1	1/8/01	HGS (Jan. 01 Report)	90.4		12.7	4.4		67.4		100	ND	1.8		ND	
MW-1	3/27/01	Hicks Sampling 2001	92.2	ND	13.3	4.2	22.2	59.2	ND	133	ND	1.37	ND		ND
MW-1 Average			91.3		13	4.3	22.2	63.3		116.5		1.585			
MW-2	1/8/01	HGS (Jan. 01 Report)	83.4		14.2	4.5		70.8		130	ND	1.1		ND	
MW-2	3/27/01	Hicks Sampling 2001	95.8	1.13	15.4	5	28.1	62	ND	146	ND	0.62	ND		ND
MW-2 Average			89.6	1.13	14.8	4.75	28.1	66.4		138		0.86			
Mewbourne A	8/16/99	Bybee NMOCD Files	88		16	4		81							
Mewbourne A	8/17/99	Hicks (Sept. 99 Report)	86.3	nd	15	4		76.5		121	ND	3	ND		
Mewbourne A	8/20/99	Bybee NMOCD Files								120	0.3	3.3	ND		ND
Mewbourne A	3/27/01	Hicks Sampling 2001	85.2	0.06	10.4	3.5	24	59	ND	105	ND	1.66	ND		ND
Mewbourne A Average			86.5	0.06	13.8	3.83333	24	72.1667		115.333	0.3	2.65333			
Mewbourne 2	9/1/98	Hicks (Sept. 99 Report)	99.3	0.6	18.9	17	23.7	103	ND	114	0.9	0.5	ND		ND
Windmill #2	1/25/99	Bybee NMOCD Files								87	1	3.3	ND		ND
Mewbourne 4	9/1/98	Hicks (Sept. 99 Report)	310	0.6	52.8	15.5	22	275	ND	453	0.6	0.5	ND		1.9
Ogallala 7	9/19/29	USGS Nicholson and Clebsch 1961	68					71		32					
Ogallala 29	9/9/58	USGS Nicholson and Clebsch 1961								61					
Ogallala 30	8/1/42	USGS Nicholson and Clebsch 1961	50		31			563		208	1.8	0.5			
Ogallala 31	7/31/54	USGS Nicholson and Clebsch 1961	40		20			100		50	3.6	4.6			

Table 1: Water Analyses

mg/l

Well #	Sulfate	HCO3	Conductivity	TDS	Bromine	Silver	Arsenic	Barium	Cadmium	Chromium	Mercury	Lead	Selenium	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPH
HELSTF-1	6700	243.856																
HELSTF-2	15000	178.015																
HELSTF-2	8200	157.287																
HELSTF-2	7400	179.234																
HELSTF-2	6600	198.743																
HELSTF-2	2800	173.138																
AverageHELSTF-2	8000	177.283																
HELSTF-3	5100	107.297																
MAR-CW	5700	146.314																
MAR-CW	6600	145.094																
AverageMAR-CW	6150	145.704																
MW-1	69				1	0.005	0.01	0.106	0.002	0.006	0.0004	0.01	0.01					ND
MW-1	64.9	182	779	538														
MW-1 Average	66.95	182	779	538	1	0.005	0.01	0.106	0.002	0.006	0.0004	0.01	0.01					
MW-2	61				1	0.005	0.01	0.112	0.002	0.006	0.0002	0.01	0.01					ND
MW-2	53.4	177	778	570	0.82													
MW-2 Average	57.2	177	778	570	0.91	0.005	0.01	0.112	0.002	0.006	0.0002	0.01	0.01					
Mewbourne A														ND	ND	ND	ND	ND
Mewbourne A	74.9	198		547														
Mewbourne A	79				1.2													ND
Mewbourne A	51.4	185	693	526	0.88													
Mewbourne A Average	68.4333	191.5	693	536.5	1.04													
Mewbourne 2	127	275	1160															
Windmill #2	110				0.8									ND	ND	ND	ND	
Mewbourne 4	775	172	3700															
Ogallala 7	54	307		383														
Ogallala 29	108	240		186														
Ogallala 30	855	360		1900														
Ogallala 31	97	247		445														

Table 1: Water Analyses

mg/l

Table 2: Field Measurments for Mewbourne Oil Project

Well Name on Plate 4	Ground Elevation	Distance between ground and measuring point	Depth to Groundwater	Groundwater Elevation
McCasland Windmill	3558	1	78	3481
Mew #2	3545	1	55.5	3490.5
Mew #3	3540	1.5	57	3484.5
Mew #4	3572	1	58	3515
Mewbourne A	3553	1	72.99	3481.01

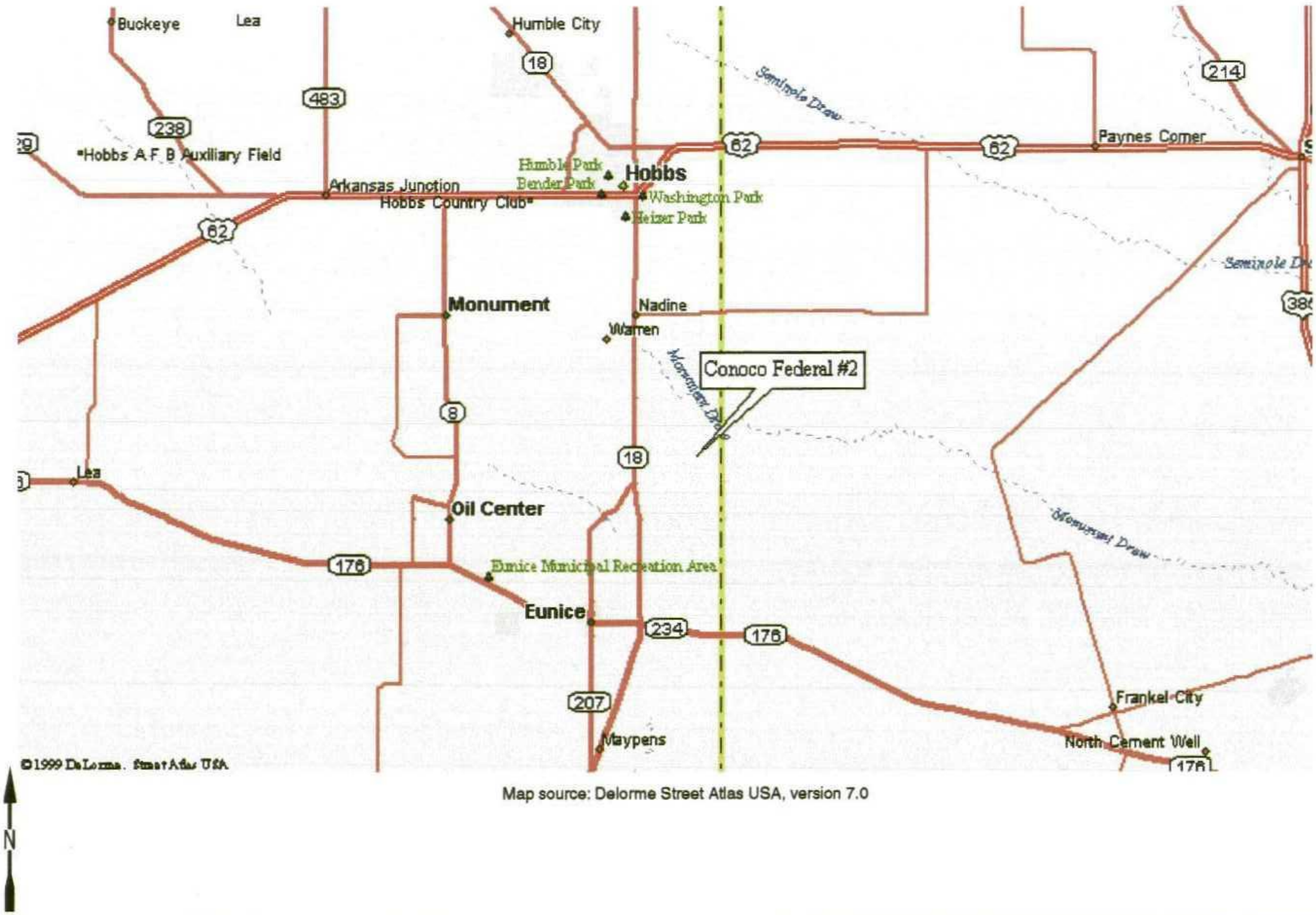
	RTHicks Survey (feet above (+) / below (-) MW2)	*TOC (feet)	DTW (feet)	Hicks's relative elevation (feet)	HGS's relative elevation (feet)
Mew A	-4.81	95.19	73.21	21.98	
MW1	-0.58	99.42	79.87	19.55	20.19
MW2	0.00	100.00	80.51	19.49	22.77
MW3	-1.35	98.65	79.53	19.12	16.78
Windmill	-1.25	98.75	79.50	19.25	

*datum 200 feet below MW2 top of screen

Table 3: Chemical Analyses of Soil at Conoco Federal #2

	Chloride	Fluoride	Sulfate	Calcium	Iron	Mg	K	Sodium
Test Pit #1, 6 feet deep	5.1	nd	23.8	2880	1390	1470	292	nd
Test Pit #2, 9 feet deep	6.2	1.9	31.1	413	2250	348	428	106
Test Pit #3, 7 feet deep	2.1	nd	9.8	257	1270	150	238	nd
Test Pit #4, 7 feet deep	15.4	nd	11.7	1530	1740	242	338	62.7

PLATES



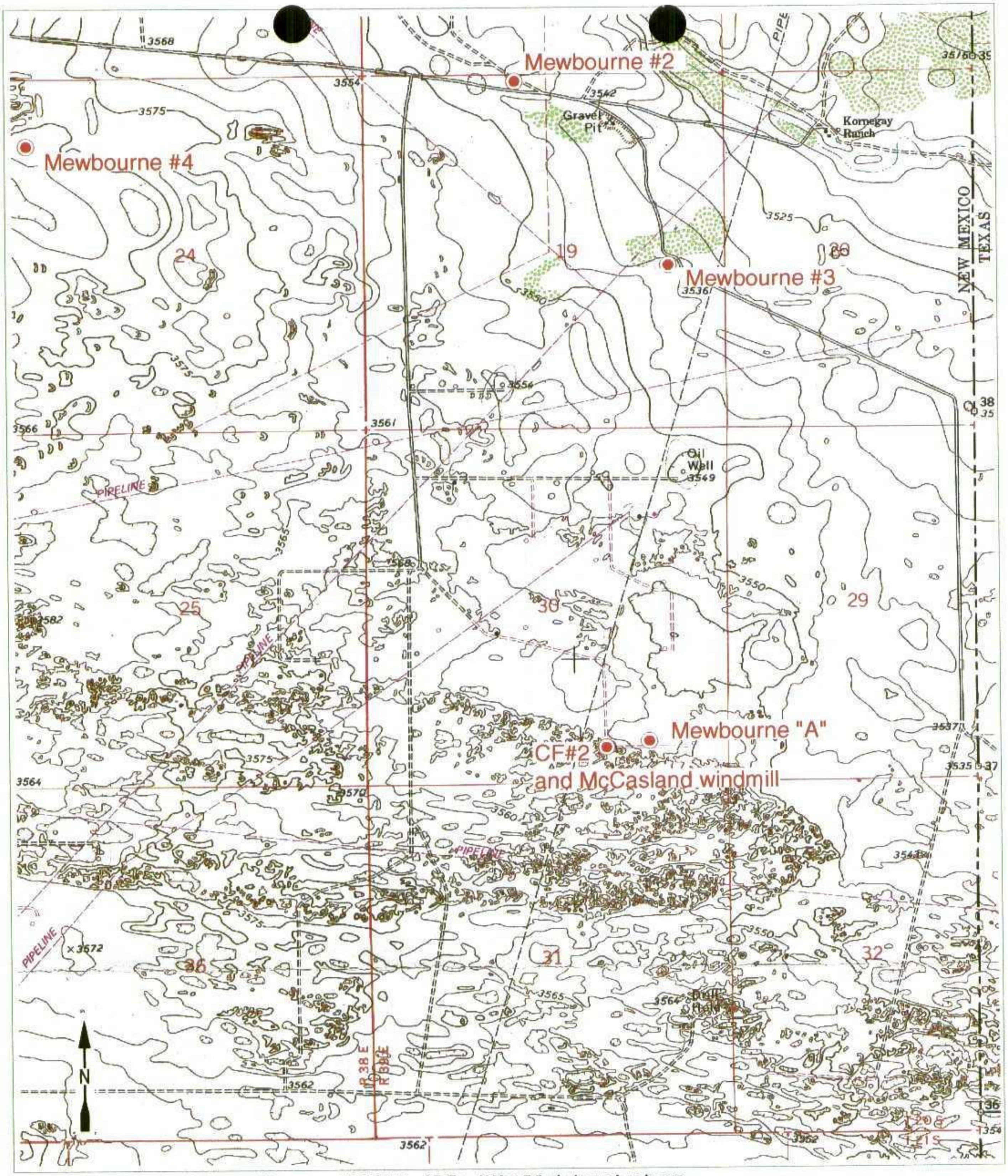
Map source: Delorme Street Atlas USA, version 7.0

R.T. HICKS CONSULTANTS, LTD.	Hinkle Law Firm	Plate 1
4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Location Map	July 2001

Map source: Delorme Street Atlas USA, version 7.0

R.T. HICKS CONSULTANTS, LTD.
4665 Indian School Road NE Suite 106 Albuquerque, NM 87110
505.266.5004 Fax: 505.266.7738

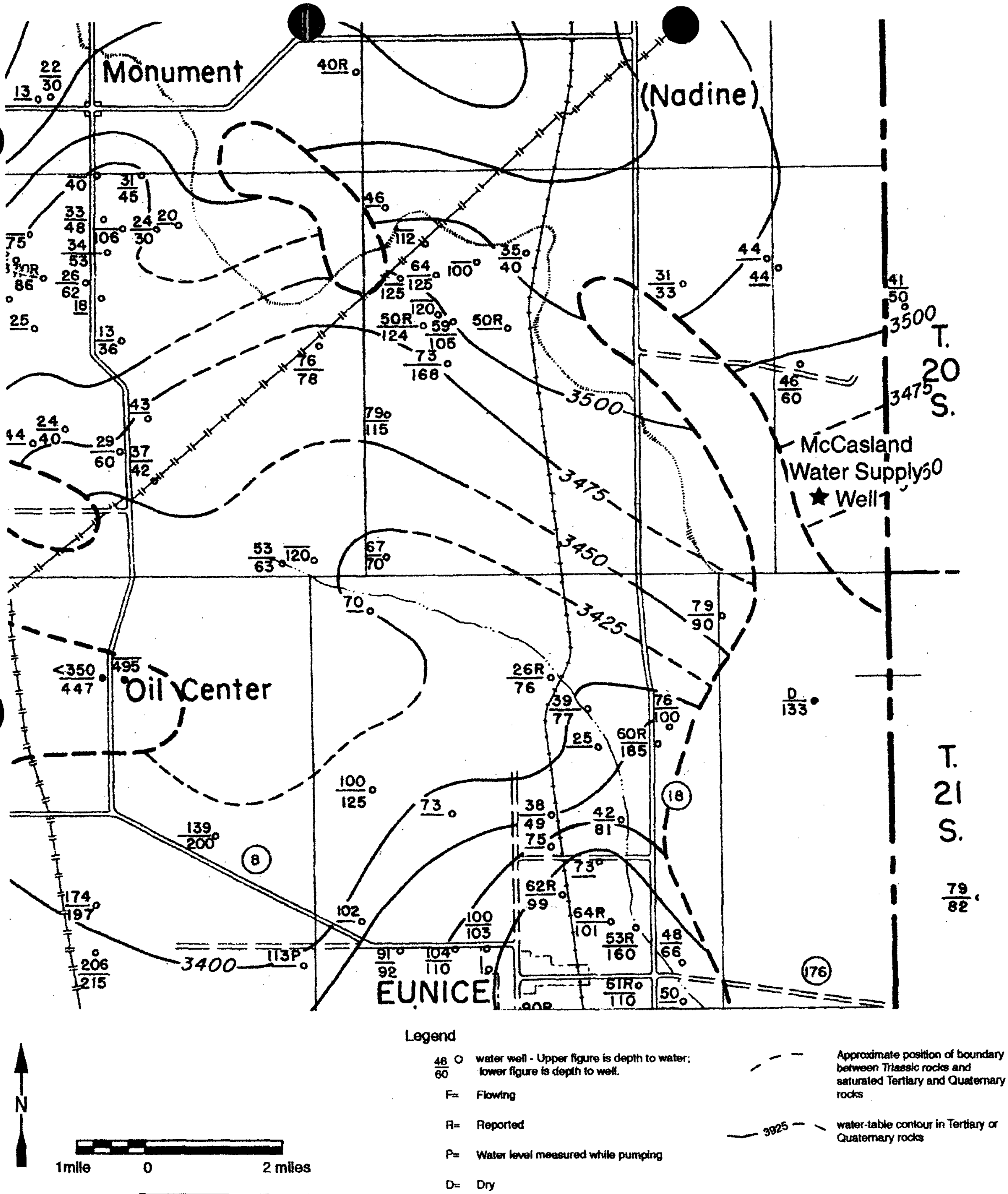
Hinkle Law Firm	Plate 2
Access to the Site	July 2001



Map source: USGS Hobbs SE, Tex.- N.Mex. 7.5 minute quadrangle map

1000 0 2000 feet

R.T. Hicks Consultants, Ltd.	Hinkle Law Firm	Plate 3
4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Topographic Map	July 2001



R.T. HICKS CONSULTANTS, LTD.

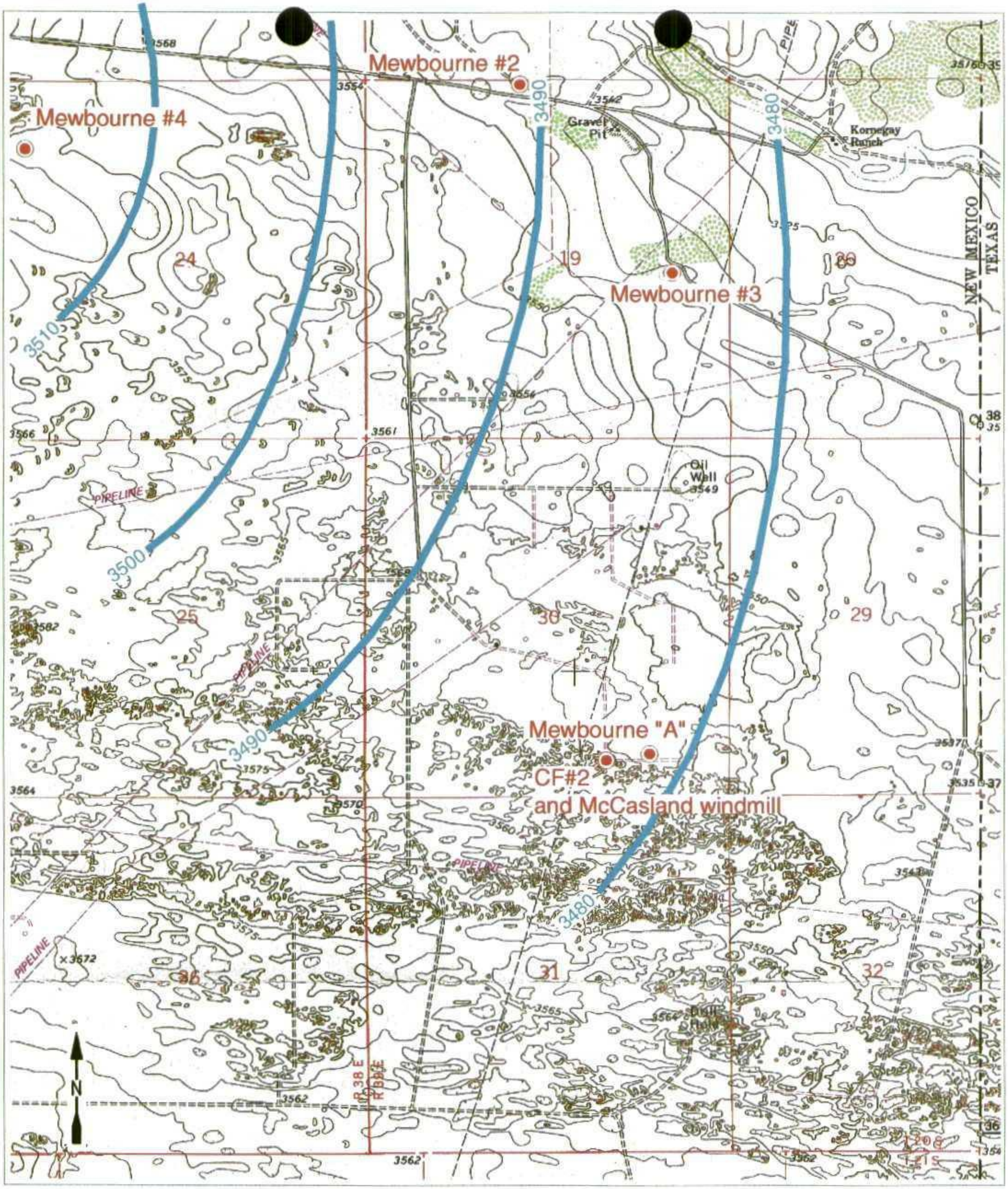
4665 Indian School Road NE Suite 106 Albuquerque, NM 87110
505.266.5004 Fax: 505.266.7738

Hinkle Law Firm

Groundwater Map of Southern Lea County

Plate 4

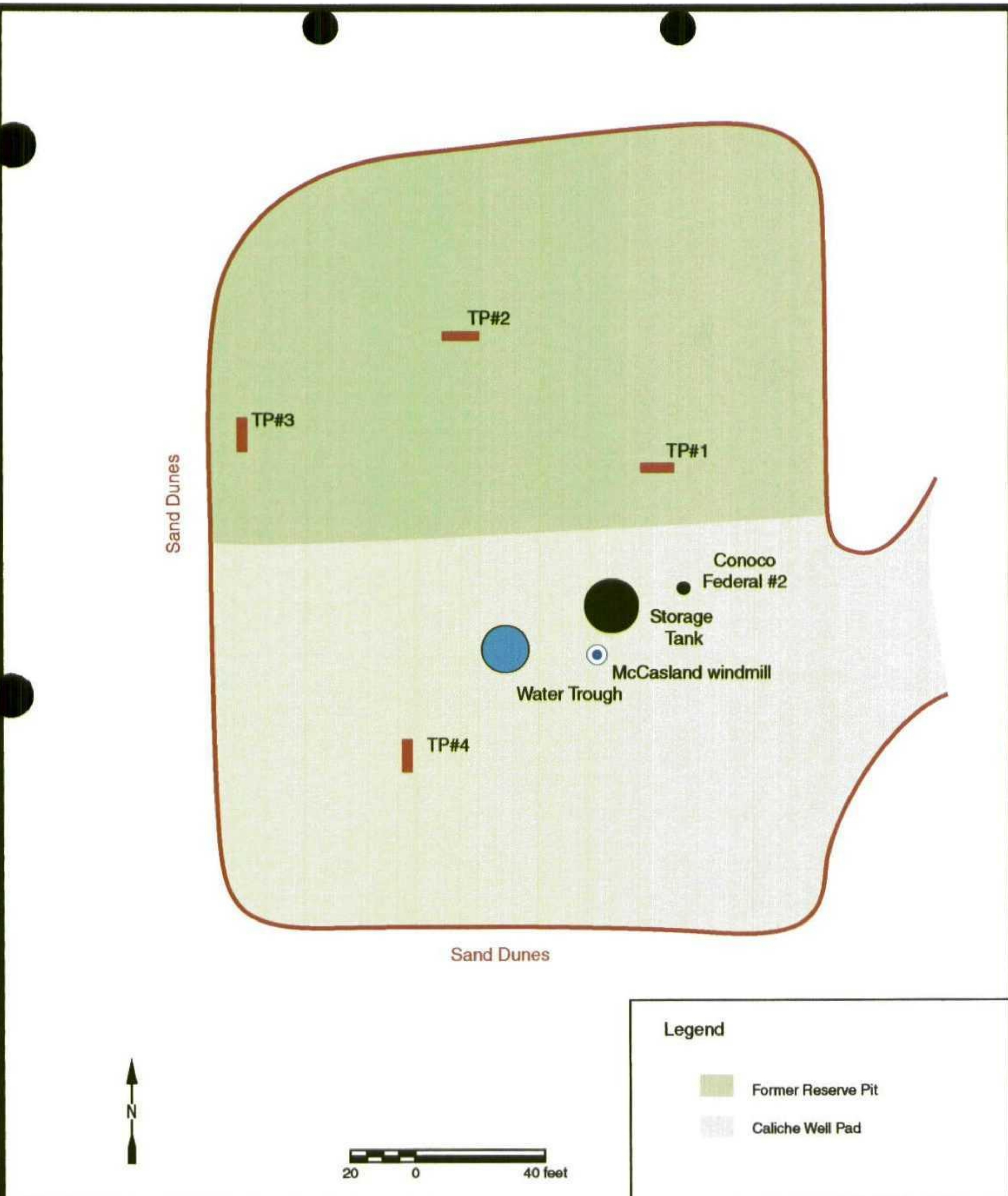
July 2001



Map source: USGS Hobbs SE, Tex.- N.Mex. 7.5 minute quadrangle map

1000 0 2000 feet

R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Hinkle Law Firm	Plate 5
	Potentiometric Surface Map August 1999	July 2001



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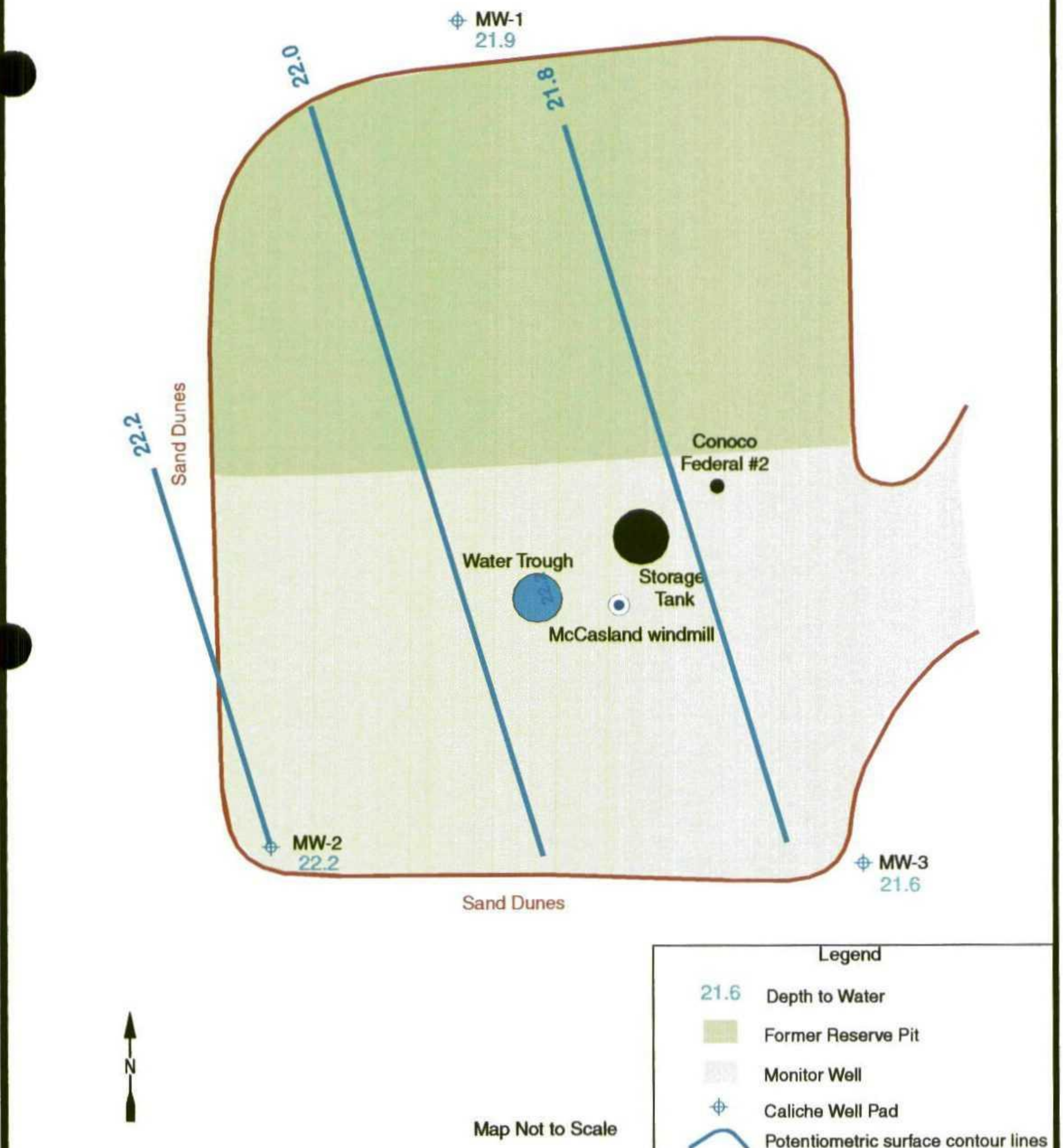
Hinkle Law Firm

Plate 6

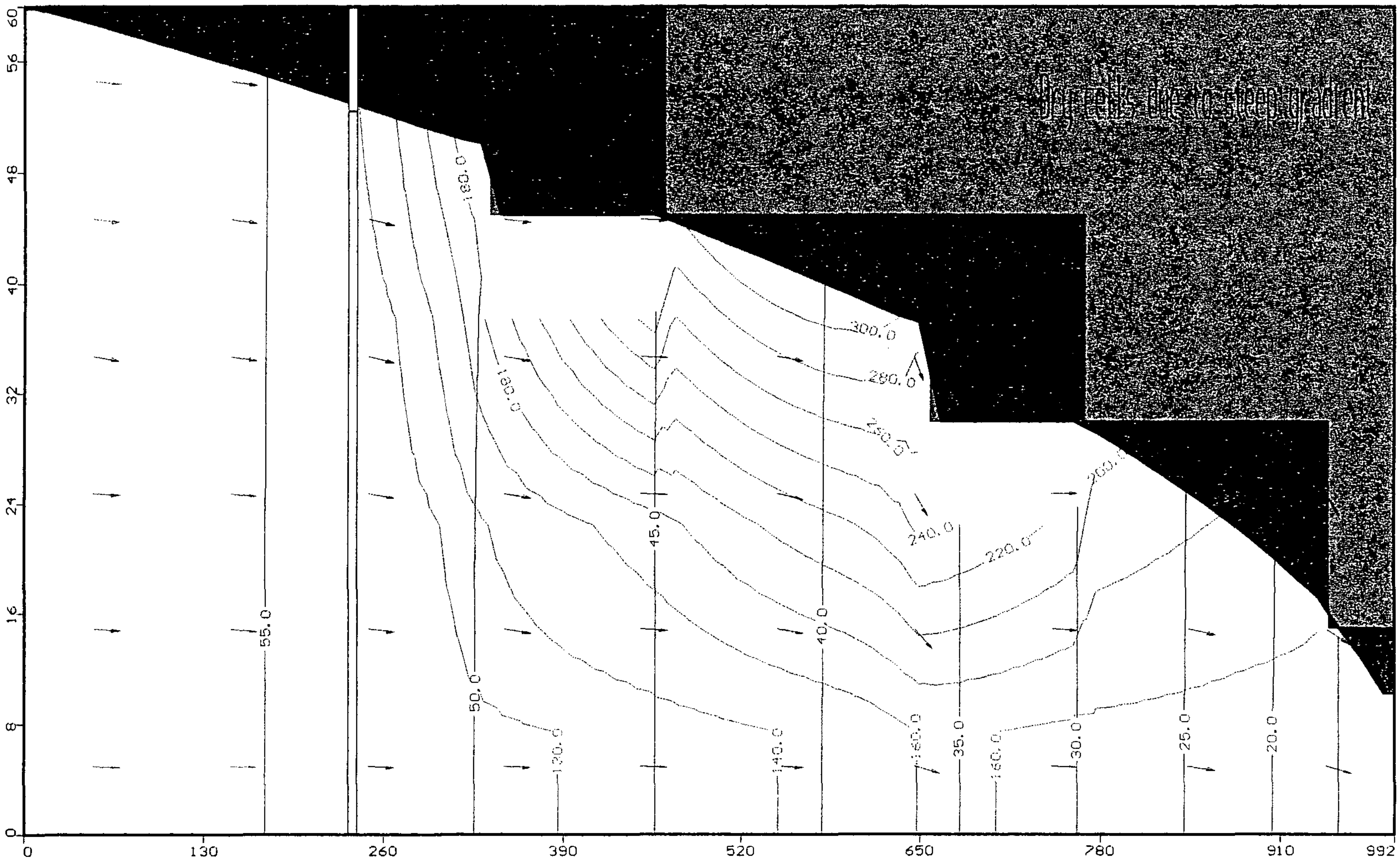
Detailed Site Map
Conoco Federal #2

July 2001



R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Hinkle Law Firm	Plate 7
	Potentiometric Surface Map at McCasland Windmill Site	July 2001

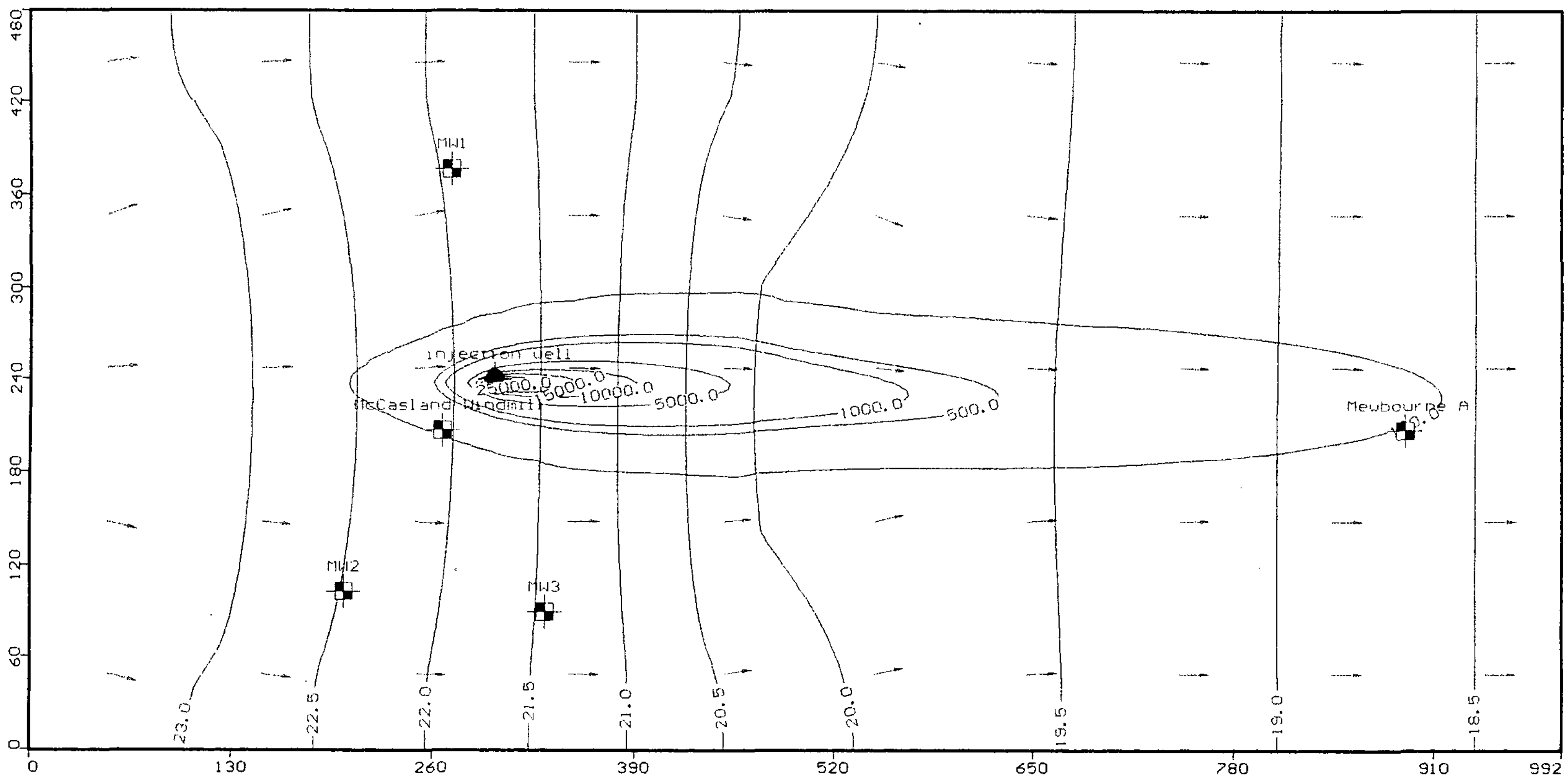
Plate 8



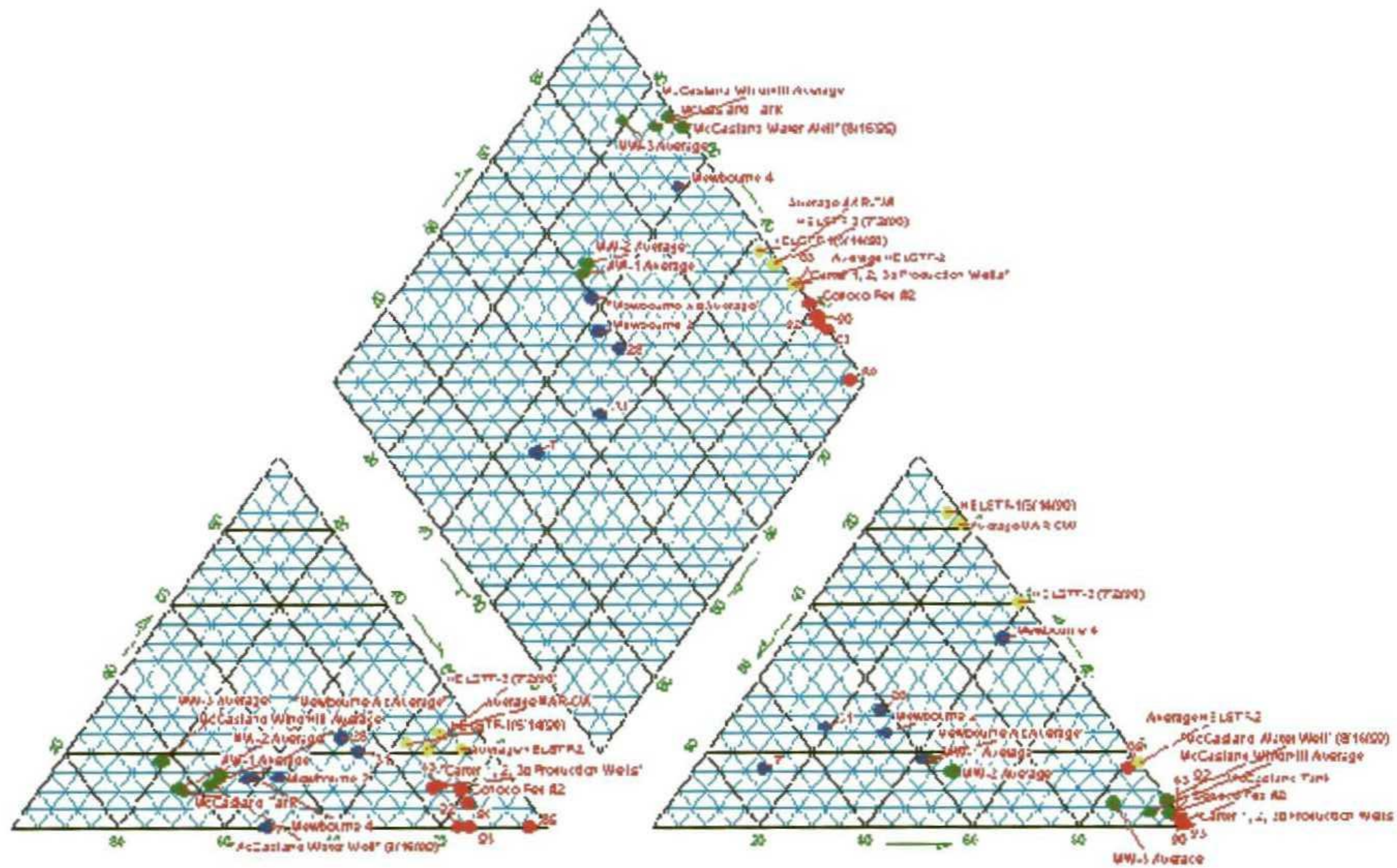
R. T. Hicks Consultants
Project: Hinkle: Mewbourne
Description: HGS Data, Cl Federal #2
Modeller: Hicks Consultants
18 Jul 01

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 78 NR: 52 NL: 4
Current Row: 33

Plate 9



R. T. Hicks Consultants Project: Hinkle: Mewbourne Description: Hicks data, Cl Federal #2 Modeller: Hicks Consultants 18 Jul 01	Visual MODFLOW v.2.8.2, (C) 1995–1999 Waterloo Hydrogeologic, Inc. NC: 80 NR: 48 NL: 1 Current Layer: 1



R.T. HICKS CONSULTANTS, LTD. 4665 Indian School Road NE Suite 106 Albuquerque, NM 87110 505.266.5004 Fax: 505.266.7738	Hinkle Law Firm	Plate 10
	Trilinear Diagram	July 2001

APPENDIX A

R.T.Hicks Consultants, Ltd. 4665 Indian School Rd. NE #106 Albuquerque, New Mexico 87110		Mewbourne Project Name	Mewbourne A
Logger	R. Hicks	Hinkle Client	
Driller	Eades Drilling	T20S R39E S30 1380 FEL 560 FSL	
Method	Air/Water Rotary		
Start Date	8/16/99	Lea County	
End Date	8/16/99	New Mexico	

Sample Depth	Sample Number	PID	Description	Grade	Lith	Well Construction
						No pad
			0-3 Brown blow sand			
			4-6 Red sand, some consolidated			Neat Cement Grout5 feet to surface
			7-12 Red/Brn blow sand	10		
			13-16 White/lt. brown caliche sand			
			17-28 Lt brn sand w/ caliche streaks	20		Bentonite Plug 25-5
			29-31 Hard sand lt. Brn/red	30		
			32-44 White/brown sand, minor clay, w/ caliche	40		
			45-54 Brn sand, some clay, wt. Caliche @ 54-55	50		91-25 Grade 5 gravel pack - Brady Texas
			55-61 Red/brn sand, some caliche	60		
			62-73 Brn sand, v. minor caliche, moist @68	70		
			73 thin gravel			
			74-78 Brn sand			
			79-88 Sandy gravel with sand, some caliche	80		91-71 0.035 inch slotted screen
			88-91 White and red clay	90		
			91 Red Claystone			

ed June 1972

ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Dallas McCasland Owner's Well No. 2

treet or Post Office Address P.O. Box 206

ity and State Eunice, NM 88231

Well was drilled under Permit No. L-10,044 and is located in the:

a. ____ ¼ NX SW¼ ¼ XX ¼ SE ¼ of Section 30 Township 20S Range 39E N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____ Subdivision, recorded in Lea County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Dallas McCasland License No. WD 1196

Address P.O. Box 206, Eunice, NM 88231

Drilling Began 12-16-88 Completed 12-17-88 Type tools rotary Size of hole 7 7/8 in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 90 ft.

Completed well is [X] shallow [ ] artesian. Depth to water upon completion of well 40 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
58	70	12	Gray sand	5

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
5" ID	2.4	PVC	0	90	? 20	None	50	90

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				
					None

Section 5. PLUGGING RECORD

Plugging Contractor ____

Address ____

Plugging Method ____

Date Well Plugged ____

Plugging approved by:

____

State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received January 9, 1989

Quad ____ FWL ____ FSL ____

File No. L-10,044 #2 Use EXP. Location No. 20.39.30.430

1980' FEL & 660' FSL

(THIS IS NOW STOCK WELL NO. L-10,056)

Section 6. LOG OF HOLE

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color and Type of Material Encountered
Surface	15	15	Sand
15	25	10	Caliche
[illegible]	45	15	Broken Anhydrite
45	58	13	Hard Anhydrite with gray lime
58	70	12	Gray sand
70	88	12	Anhydrite
88	90	2	Red Bed

Section 7. REMARKS AND ADDITIONAL INFORMATION

JAN 9 8 30 AM '89

STATE ENGINEER
ROSWELL, NM

T[illegible]gned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above de[illegible]ibed hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All [illegible]s, except Section 5, s[illegible] answered as completely and accurate[illegible] ossible whe[illegible] any well is drilled, repaired or deepened. [illegible] this form is used as a [illegible] ecord, only Section 1(a) and Section [illegible] d be comp ed June 1972

NGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Dallas McCasland Owner's Well No. 3

treet or Post Office Address P.O. Box 206

City and State Eunice, NM 88231

Well was drilled under Permit No. L-10,044 and is located in the:

a. ____ ¼ SW¼ ~~XXX~~ ¼ NW ¼ NW ¼ of Section 24 Township 20S Range 38E N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor Dallas McCasland License No. WD 1196

Address P.O. Box 206, Eunice, NM 88231

Drilling Began 12-28-88 Completed 12-29-88 Type tools rotary Size of hole 6¼ in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 58 ft.

Completed well is ☐ shallow ☐ artesian. Depth to water upon completion of well ____ ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet		Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
From	To			
46	54	8	Gray sand	3

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet		Length (feet)	Type of Shoe	Perforations	
			Top	Bottom			From	To
4½" ID	2.0	PVC			20'	none	38	56

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet		Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement
From	To				
					None

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet		Cubic Feet of Cement
	Top	Bottom	
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received January 9, 1989

Quad ____ FWL ____ FSL ____

File No. L-10,044 #3 Use EXP. Location No. 20.38.24.11333

HIS IS NOW STOCK WELL NO. L-10,057)

Section 6. LOG OF HOLE

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		
0	5	5	Red clay
5	15	10	Caliche
[illegible]	46	21	Anhydrite
46	54	8	Gray sand
54	58	4	Anhydrite
58			Red bed

Section 7. REMARKS AND ADDITIONAL INFORMATION

This well was drilled 600' north from well #1.

JAN 9 8 30 AM '89

STATE ENGINEER
ROSWELL NM

T[illegible]signed hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above de[illegible]ibed hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All [illegible]s, except Section 5, [illegible] answered as completely and accurate[illegible] [illegible]ossible wh[illegible] well is drilled, repaired or deepened [illegible] this form is used as a [illegible] record, only Section 1(a) and Section [illegible] comp[illegible]

Form WR-23 FIELD ENGR. LOG STATE ENGINEER OFFICE

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1

	716	FEL	
	1633	FNL	

(Plat of 640 acres)

(A) Owner of well ANNA L. FOSTER

Street and Number STAR Rt. A

City Hobbs State N.M.

Well was drilled under Permit No. L-3519 and is located in the E½ ¼ NE ¼ ¼ of Section 31 Twp. 19S Rge. 39E

(B) Drilling Contractor M.L. Fullingim License No. WD124

Street and Number 317 N Fowler

City Hobbs State N.M.

Drilling was commenced 3-23 1960

Drilling was completed 3-26 1960

Elevation at top of casing in feet above sea level ______ Total depth of well 133 ft.

State whether well is shallow or artesian SHALLOW Depth to water upon completion 60

Section 2 PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation
1	60	90	30	1st water Sand
2	100	131	31	2nd water Sand
3				
4				
5				

Section 3 RECORD OF CASING

Dia in.	Pounds ft.	Threads in	Depth Top	Depth Bottom	Feet	Type Shoe	Perforations From	Perforations To
16		Welded	0	133	133	No Shoe	60	133

Section 4 RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used

Section 5 PLUGGING RECORD

Name of Plugging Contractor ______ License No. ______

Street and Number ______ City ______ State ______

Tons of Clay used ______ Tons of Roughage used ______ Type of roughage ______

Plugging method used ______ Date Plugged ______ 19__

Plugging approved by:

______ Basin Supervisor

Cement Plugs were placed as follows:

No.	Depth of Plug From	Depth of Plug To	No. of Sacks Used

FOR USE OF STATE ENGINEER ONLY

Date Received STATE ENGINEER OFFICE 1960 APR 11 AM 9:05

File No. L-3519 Use Irr. Location No. 19.39.31.200

Section 6

LOG OF WELL

Depth in Feet From	Depth in Feet To	Thickness in Feet	Color	Type of Material Encountered
0	8	8		Sub Soil
8	28	20		Caliche
[illegible]	53	25		Sandy Clay
53	60	7		Hard Rock
60	80	20		1st water Sand
80	95	15		Sandy Clay
95	100	5		Hard Rock
100	131	31		2nd water
131	133	2		Red Bed

L S Elev 3587'
Depth To K Tr 131'
Elev of K Tr 3456'

Loc. No. 19. 39. 31. 22342
Hydro. Survey Field Check X

SOURCE OF ALTITUDE GIVEN
Interpolated from Topo. Sheet X
Determined by Inst. Leveling
Other

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

M. L. Fullingim
Well Driller

Revised
June 1972

STATE ENGINEER OFFICE
WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Jayson Ussery Owner's Well No. ______

Street or Post Office Address E. Nadine Rd.

City and State Hobbs, New Mexico 88240

Well was drilled under Permit No. L-10,557 and is located in the :

a. ____ 1/4 ____ 1/2 N 1/2 ____ 1/4 of Section 31 Township 19S

Range 39E N.M.P.M.

b. Tract No. ______ of Map No. ______ of the ______

c. Lot No. ______ of block No. ______ of the ______

Subdivision, recorded in ______ County.

d. X= ______ feet, Y= ______ feet, N.M. Coordinate System ______

Zone in the ______ Grant

(B) Drilling Contractor Alan G. Eades License No. WD-1044

Address 1200 E. Bender Blvd. Hobbs, New Mexico 88240

Drilling Began 5-4-96 Completed 5-4-96 Type Tools Rotary Size of hole 7 7/8 in.

Elevation of land surface or ______ at well is ______ ft. Total depth of well 135 ft.

Completed well is [X] shallow [ ] artesian Depth to water upon completion of well 75 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
75	135	60	Water Sand with Sandstone Stringers	35

Section 3. RECORD OF CASING

Diameter (INCHES)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
5 3/4	160psi				135		115	135

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

Section 5. PLUGGING RECORD

Plugging Contractor ______

Address ______

Plugging Method ______

Date Well Plugged ______

Plugging approved by:

______
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received 06/14/96

Quad ______ FWL ______ FSL ______

File No. L-10,557 Use Domestic Location No. 19.39.31.21121

Section 6. LOG OF HOLE

Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		
0	1	1	Top Soil
1	32	31	Caliche
32	34	2	Sandstone
34	73	39	Sand & Sandstone Stringers
73	75	2	Sandstone
75	135	60	Water Sand with Sandstone Stringers
			Jayson Ussery

Section 7. REMARKS AND ADDITIONAL INFORMATION

STATE ENGINEER OFFICE
ROSWELL NEW MEXICO
'96 JUN 14 AM 10 58

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Alan Eades by Andrea Koot
Driller

INSTRUCTIONS:

This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.

APPENDIX B

ASSAIGAI ANALYTICAL LABORATORIES, INC.

Chain of Custody Record

7300 JEFFERSON, N.E.
ALBUQUERQUE, NEW MEXICO 87109
(505) 345-8964

3332 WEDGEWOOD
EL PASO, TEXAS 79925
(915) 593-6000

Lab job no.: 9021 Date: ______

Page 1 of 1

Client: Hicks Consultants
Project Manager / Contact: Melissa Snodgrass
Address: 4665 Indian School NE Ste 106
Telephone No.: 266-5004
City / State / Zip: Albq NM 87110
Fax No.: 266-7738
Project Name / Number: Meuibourne
Samplers: (Signature) Melissa Snodgrass
Contract / Purchase Order / Quote: J2

AAL Action Number	Field Sample Number / Location	Date	Time	Sample Type	Type / Size of Container	Preservation Temp.	Preservation Chemical	No. of Containers	Cations	Anions							Remarks
1A	Fed #2	9/1/98	10:30	G	Plastic 500 ml		HNO3	1	X								
1B	Fed #2	9/1/98	10:30	G	Plastic 500 ml			1		X							
2A	Mew #2	9/1/98	10:40	G	Plastic 500 ml		HNO3	1	X								
2B	Mew #2	9/1/98	10:40	G	Plastic 500 ml			1		X							
3A	Mew #4	9/1/98	11:36	G	Plastic 500 ml		HNO3	1	X								
3B	Mew #4	9/1/98	11:36	G	Plastic 500 ml			1		X							

OFFICE USE

Relinquished by:	Date / Time	Received by:	Relinquished by:	Date / Time	Received by:
Signature: Melissa Snodgrass	Date: 9/2/98	Signature: Rich Childress	Signature:	Date:	Signature:
Printed: Melissa Snodgrass	Time: 8:30A	Printed: Rich Childress	Printed:	Time:	Printed:
Company: Hicks Consultants		Company: AAL	Company:		Company:
Reason:		Reason:	Reason:		Reason:

Method of Shipment: ______
Shipment No. ______
Special Instructions: ______

Comments: ______

After analysis, samples are to be:
- ☐ Disposed of (additional fee)
- ☐ Stored (30 days max)
- ☐ Stored over 30 days (additional fee)
- ☐ Returned to customer

COURIER

ASSAIGAI ANALYTICAL LABORATORIES, INC.

7300 Jefferson, NE • Albuquerque, New Mexico 87109 • (505) 345-8964 • FAX (505) 345-7259

3332 Wedgewood, E-5 • El Paso, Texas 79925 • (915) 593-6000 • FAX (915) 593-7820

127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

RT HICKS CONSULTING, LTD
attn: **RANDY HICKS**
4665 INDIAN SCH. NE 106
ALBUQUERQUE, NM 87110

* explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: RT HICKS CONSULTING, LTD
Project: 9809021 MEWBOURNE

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID: *FED #2* — Sample Matrix: *WATER_GRAB* — Sample Collected: *09/01/98 10:30:00*

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	R Date
			Test: EPA-200.7 ICP							
9809021-01A	M98659	7440-70-2	Calcium	749	mg / L	100	0.4		MW.1998.1267-24	09/23/98
	M98659	7439-89-6	Iron	19.9	mg / L	1	0.2		MW.1998.1233-68	09/15/98
	M98659	7439-95-4	Magnesium	73.9	mg / L	1	0.2		MW.1998.1233-68	
	M98659	7440-09-7	Potassium	8.3	mg / L	1	0.4		MW.1998.1233-68	
	M98659	7440-21-3	Silicon	21.8	mg / L	1	0.5		MW.1998.1233-68	
	M98659	7440-23-5	Sodium	373	mg / L	1	0.4		MW.1998.1233-68	
	M98659	7440-66-6	Zinc	3.8	mg / L	1	0.7		MW.1998.1233-68	
			Test: SM 1030F							
9809021-01A	MT.1998.2460		Anion Sum	59.57117	meq/L	1	0		MT.1998.2460-1	09/22/98
	MT.1998.2460		Cation Sum	61.00287	meq/L	1	0		MT.1998.2460-1	
	MT.1998.2460		Cation-Anion Balance	1	%	1	0		MT.1998.2460-1	
			Test: EPA-120.1							
9809021-01B	CON9831		Conductivity	7,800	umhos/cm	1	1		MT.1998.2440-4	09/22/98
			Test: EPA-300.0 anions							
9809021-01B	W98293		Chloride	1930	mg / L	1000	0.5		MW.1998.1251-12	09/19/98
	W98286		Fluoride	ND	mg / L	1	0.5		MW.1998.1221-30	09/10/98
	W98286		Nitrate, as N	1.0	mg / L	1	0.2	H	MW.1998.1221-30	
	W98286		Nitrite, as N	ND	mg / L	1	0.2	H	MW.1998.1221-30	
	W98286		Orthophosphorus, as P	ND	mg / L	1	0.4	H	MW.1998.1221-30	
	W98286		Sulfate	112	mg / L	1	0.5		MW.1998.1221-30	

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: RT HICKS CONSULTING, LTD

Project: 9809021 MEWBOURNE

			Test: EPA-310.1							
9809021-01B	ALK9831		Alkalinity, Total	117	mg / L	1	2		MT.1998.2343-2	09/14/98

Client Sample ID **MEW #2** Sample Matrix **WATER_GRAB** Sample Collected **09/01/98 10:40:00**

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
			Test: EPA-200.7 ICP							
9809021-02A	M98659	7440-70-2	Calcium	99.3	mg / L	1	0.4		MW.1998.1233-71	09/15/98
	M98659	7439-89-6	Iron	0.6	mg / L	1	0.2		MW.1998.1233-71	
	M98659	7439-95-4	Magnesium	18.9	mg / L	1	0.2		MW.1998.1233-71	
	M98659	7440-09-7	Potassium	17.0	mg / L	1	0.4		MW.1998.1233-71	
	M98659	7440-21-3	Silicon	23.7	mg / L	1	0.5		MW.1998.1233-71	
	M98659	7440-23-5	Sodium	103	mg / L	1	0.4		MW.1998.1233-71	
	M98659	7440-66-6	Zinc	ND	mg / L	1	0.7		MW.1998.1233-71	
			Test: SM 1030F							
9809021-02A	MT.1998.2435		Anion Sum	10.41981	meq/L	1	0		MT.1998.2435-2	09/22/98
	MT.1998.2435		Cation Sum	11.49764	meq/L	1	0		MT.1998.2435-2	
	MT.1998.2435		Cation-Anion Balance	5	%	1	0		MT.1998.2435-2	
			Test: EPA-120.1							
9809021-02B	CON9831		Conductivity	1,160	umhos/cm	1	1		MT.1998.2440-3	09/22/98
			Test: EPA-300.0 anions							
9809021-02B	W98290		Chloride	114	mg / L	20	0.5		MW.1998.1241-33	09/16/98
	W98286		Fluoride	0.9	mg / L	1	0.5		MW.1998.1221-31	09/10/98
	W98286		Nitrate, as N	0.5	mg / L	1	0.2	H	MW.1998.1221-31	
	W98286		Nitrite, as N	ND	mg / L	1	0.2	H	MW.1998.1221-31	
	W98286		Orthophosphorus, as P	ND	mg / L	1	0.4	H	MW.1998.1221-31	
	W98290		Sulfate	127	mg / L	2	0.5		MW.1998.1241-32	09/15/98
			Test: EPA-310.1							
9809021-02B	ALK9831		Alkalinity, Total	275	mg / L	1	2		MT.1998.2343-3	09/14/98

Client Sample ID **MEW #4** Sample Matrix **WATER_GRAB** Sample Collected **09/01/98 11:36:00**

Fraction	QC Group	CAS #		Result	Units	Dilution Factor	Detection Limit	*	Sequence	Run Date
			Test: EPA-200.7 ICP							
9809021-03A	M98659	7440-70-2	Calcium	310	mg / L	1	0.4		MW.1998.1233-72	09/15/98
	M98659	7439-89-6	Iron	0.6	mg / L	1	0.2		MW.1998.1233-72	
	M98659	7439-95-4	Magnesium	52.8	mg / L	1	0.2		MW.1998.1233-72	
	M98659	7440-09-7	Potassium	15.5	mg / L	1	0.4		MW.1998.1233-72	
	M98659	7440-21-3	Silicon	22.0	mg / L	1	0.5		MW.1998.1233-72	
	M98659	7440-23-5	Sodium	275	mg / L	1	0.4		MW.1998.1233-72	

Assalgal Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**

Project: **9809021 MEWBOURNE**

9809021-03A	M98659	7440-66-6	Zinc	ND	mg / L	1	0.7		MW.1998.1233-72	09/15/98
			Test: SM 1030F							
9809021-03A	MT.1998.2435		Anion Sum	32.45269	meq/L	1	0		MT.1998.2435-3	09/22/98
	MT.1998.2435		Cation Sum	32.24483	meq/L	1	0		MT.1998.2435-3	
	MT.1998.2435		Cation-Anion Balance	0	%	1	0		MT.1998.2435-3	
			Test: EPA-120.1							
9809021-03B	CON9831		Conductivity	3,700	umhos/cm	1	1		MT.1998.2440-5	09/22/98
			Test: EPA-300.0 anions							
9809021-03B	W98291		Chloride	453	mg / L	50	0.5		MW.1998.1241-38	09/16/98
	W98286		Fluoride	0.6	mg / L	1	0.5		MW.1998.1221-32	09/10/98
	W98286		Nitrate, as N	0.5	mg / L	1	0.2	H	MW.1998.1221-32	
	W98286		Nitrite, as N	ND	mg / L	1	0.2	H	MW.1998.1221-32	
	W98286		Orthophosphorus, as P	1.9	mg / L	1	0.4	H	MW.1998.1221-32	
	W98291		Sulfate	775	mg / L	25	0.5		MW.1998.1241-37	09/16/98
			Test: EPA-310.1							
9809021-03B	ALK9831		Alkalinity, Total	172	mg / L	1	2		MT.1998.2343-4	09/14/98

**** Sample specific analytical Detection Limit is determined by multiplying the sample Dilution Factor by the listed method Detection Limit. ****

**** Results relate only to the items tested. ****

ASSAIGAI
ANALYTICAL LABORATORIES, INC. • 7300 Jefferson, N.E. • Albuquerque, New Mexico 87109
3332 Wedgewood, Suite E-5 El Paso Texas 79925

INVOICE

09/25/98 14:18:03

ORD # 98-09-021
INVOICE # 934607

INVOICE TO RT HICKS CONSULTING, LTD
4665 INDIAN SCHOOL NE STE.106
ALBUQUERQUE, NM 87110

REMIT TO Assaigai Analytical Labs
P.O. Box 90430
Albuquerque, NM 87199-0430

TERMS NET 30 DAYS

ATTEN RANDY HICKS

ATTEN ACCOUNTS RECEIVABLE
PHONE (505)822-8061

WORK ID MEWBOURNE
P.O. #

ASSAIGAI ANALYTICAL LABS ACCEPTS VISA AND MASTERCARD PAYMENTS.

REPORT TO RT HICKS CONSULTING, LTD
4665 INDIAN SCHOOL NE STE.106
ALBUQUERQUE, NM 87110

ATTEN RANDY HICKS

RECEIVED 09/02/98 CLIENT RTHC01
REPORTED 09/25/98 PROJECT

	ID	CODE	DESCRIPTION	REMARK	PRICE	QTY	DISCOUNT	AMOUNT
SPECIALS	01A	W2007	WATER METALS-ICP/EPA 200.7	CATIONS	60.00	1		60.00
	01B	WICCL	CHLORIDE/EPA 300	ANIONS	55.00	1		55.00
	02A	W2007	WATER METALS-ICP/EPA 200.7	CATIONS	60.00	1		60.00
	02B	WICCL	CHLORIDE/EPA 300	ANIONS	55.00	1		55.00
	03A	W2007	WATER METALS-ICP/EPA 200.7	CATIONS	60.00	1		60.00
	03B	WICCL	CHLORIDE/EPA 300	ANIONS	55.00	1		55.00
STS		WCOND	SPEC CONDUCTANCE/EPA 120.1		10.00	3		30.00

SUBTOTAL $375.00
TOTAL INVOICE AMOUNT $375.00

Hall Environmental Analysis Laboratory

Client: ECD Environmental
Project: McCausland
Project Manager: Greg Bybee
Project Number: -

Date Collected: 1/25/99
Date Received: 1/28/99
Sample Matrix: Aqueous

Inorganic Compounds

HEAL LAB ID	Sample ID	Floride (mg/L)	Chloride (mg/L)	Nitrite-N (mg/L)	Bromide (mg/L)	Nitrate-N (mg/L)	Sulfate (mg/L)	o-Phosphate-P (mg/L)
9901105-1	#1 Windmill	<0.5	5,000	*<0.5	12	*<0.5	110	<2.5
9812121-2	#2 Windmill	1.0	87	*ND	0.8	*3.3	110	ND
Detection Limits		0.1	0.1	0.1	0.1	0.1	0.5	0.5
Method		300.0	300.0	300.0	300.0	300.0	300.0	300.0
Date Analyzed		1/28/99	1/29/99	1/28/99	1/28/99	1/28/99	1/28/99	1/28/99

***Sample run outside of the EPA holding time of 48 hours.**

Hall Environmental Analysis Laboratory

Client:	ECD Environmental	**Date Collected:**	1/25/99
Project:	McCausland	**Date Received:**	1/28/99
Project Manager:	Greg Bybee	**Sample Matrix:**	Aqueous
Project Number:	-	**Date Extracted:**	NA

EPA Method - 8021

Units: PPB(ug/L)

HEAL LAB ID	Sample ID	Benzene	Toluene	Ethyl-benzene	Total Xylenes	BFB % Recovery	Dilution Factor	Date Analyzed
9901105-1	#1 Windmill	ND	ND	ND	ND	94	2	1/28/99
9901105-2	#2 Windmill	ND	ND	ND	ND	100	1	1/28/99
Reag Blk.	-	ND	ND	ND	ND	98	1	1/28/99
MRL		0.5	0.5	0.5	0.5			

ASSAIGAI ANALYTICAL LABORATORIES, INC.

7300 JEFFERSON, N.E.
ALBUQUERQUE, NEW MEXICO 87109
(505) 345-8964

3332 WEDGEWOOD
EL PASO, TEXAS 79925
(915) 593-6000

127 EASTGATE DRIVE, 212-C
LOS ALAMOS, NEW MEXICO 87544
(505) 662-2558

Chain of Custody Record

Lab job no.: 9408178 Date: 8/16/99

Page 1 of 1

Client: R.T. HICKS CONSULTING
Address: 4665 INDIAN SCH NE
City / State / Zip: ALBUQUERQUE NM
Project Name / Number: NEWBOURNE
Contract / Purchase Order / Quote:

Project Manager / Contact: R. Hicks
Telephone No.: 266-5004
Fax No.: 266-7738
Samplers: (Signature) [signature]

Lab Identification Number	Field Sample Identification / Location	Date	Time	Sample Type	Type / Size of Container	Preservation: Temp.	Preservation: Chemical	No. of Containers	Cations / Anions	TDS	BTEX + MTBE							Remarks
01A	CF2 TP4 7ft	8/16	1610	Soil	GLASS			1	*									AS SOON AS
02A	CF2 TP3 7ft	8/16	1620	Soil	"			1	*									POSSIBLE
03A	CF2 TP1 6ft	8/16	1300	Soil	"			1	X									W/O EXTRA
04A,B,C	McCAS AND WINDMILL	8/16	1715	W	Plastic [illegible]			3	*	*	[illegible]							CHARGE (BUT)
05A,B,C,D	NEWBOURNE A	8/16	1535	W	Plastic + VOAs			5	*	*	*							MUST BE DONE
06A,B,C	McCAS AND W.M TANK	8/16	1422	W	Plastic			3	*	*	*							BEFORE 8/31
07A	CF2 TP2 9'	8/16	1810	Soil	Glass			1	*									
																		RTHC/1
																		L-8 / Fe16 2K
																		8/27/99

Relinquished by:	Date / Time	Received by:	Relinquished by:	Date / Time	Received by:
Signature: [signature]	Date: 8/16/99	Signature: [signature]	Signature:	Date:	Signature:
Printed: Randall Hicks	Time: 16:10	Printed: [illegible]	Printed:	Time:	Printed:
Company: RTHC		Company: Bill	Company:		Company:
Reason: Analytical LAB		Reason: [illegible]	Reason:		Reason:

Method of Shipment:
Shipment No.
Special Instructions:

Comments:

After analysis, samples are to be:
- ☐ Disposed of (additional fee)
- ☐ Stored (30 days max)
- ☐ Stored over 30 days (additional fee)
- ☐ Returned to customer

COURIER

ASSAIGAI ANALYTICAL LABORATORIES, INC.
7300 Jefferson, NE • Albuquerque, New Mexico 87109 • (505) 345-8964 • FAX (505) 345-7259
3332 Wedgewood Dr., Suite N • El Paso, Texas 79925 • (915) 593-6000 • FAX (915) 593-7820
127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

RT HICKS CONSULTING, LTD
attn: **MICHELLE HUNTER/RANDY HICKS**
4665 INDIAN SCH. NE 106
ALBUQUERQUE, NM 87110

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**
Project: **9908178 MEWBOURNE**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID: ***CF2 TP4 7FT*** Sample Matrix: ***SOIL*** Sample Collected: ***08/16/99 16:10:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9908178-01A		**EPA 300.0**							
W99178	MW.1999.984-59		Nitrate, as N	1.7	mg / Kg	2	0.2		08/20/99
W99178	MW.1999.984-59		Nitrite, as N	ND	mg / Kg	2	0.2		08/20/99
9908178-01A		**EPA 300.0**							
W99178	MW.1999.984-59		Chloride	15.4	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-59		Fluoride	ND	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-59		Sulfate	11.7	mg / Kg	2	0.5		08/20/99
9908178-01A		**SW846 3050A/6010A ICP**							
M99964	MW.1999.1010-63	7440-70-2	Calcium	1530	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-63	7439-89-6	Iron	1740	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-63	7439-95-4	Magnesium	242	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-63	7440-09-7	Potassium	338	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-63	7440-23-5	Sodium	62.7	mg / Kg	1	15		08/25/99

Client Sample ID: ***CF2 TP3 7FT*** Sample Matrix: ***SOIL*** Sample Collected: ***08/16/99 16:20:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9[illegible]02A		**EPA 300.0**							
V[illegible]	MW.1999.984-64		Nitrate, as N	1.2	mg / Kg	2	0.2		08/20/99

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
W99178	MW.1999.984-64		Nitrite, as N	ND	mg / Kg	2	0.2		08/20/99

9908178-02A EPA 300.0

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
W99178	MW.1999.984-64		Chloride	2.1	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-64		Fluoride	ND	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-64		Sulfate	9.8	mg / Kg	2	0.5		08/20/99

9908178-02A SW846 3050A/6010A ICP

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
M99964	MW.1999.1010-64	7440-70-2	Calcium	257	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-64	7439-89-6	Iron	1270	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-64	7439-95-4	Magnesium	150	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-64	7440-09-7	Potassium	238	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-64	7440-23-5	Sodium	ND	mg / Kg	1	15		08/25/99

Client Sample ID: ***CF2 TP1 6FT*** Sample Matrix: ***SOIL*** Sample Collected: ***08/16/99 18:00:00***

9908178-03A EPA 300.0

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
W99178	MW.1999.984-67		Nitrate, as N	3.0	mg / Kg	2	0.2		08/20/99
V[illegible]	MW.1999.984-67		Nitrite, as N	ND	mg / Kg	2	0.2		08/20/99

9908178-03A EPA 300.0

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
W99178	MW.1999.984-67		Chloride	5.1	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-67		Fluoride	ND	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-67		Sulfate	23.8	mg / Kg	2	0.5		08/20/99

9908178-03A SW846 3050A/6010A ICP

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
M99964	MW.1999.1010-65	7440-70-2	Calcium	2880	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-65	7439-89-6	Iron	1390	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-65	7439-95-4	Magnesium	1470	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-65	7440-09-7	Potassium	292	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-65	7440-23-5	Sodium	ND	mg / Kg	1	15		08/25/99

Client Sample ID: ***MCCASLAND WINDMILL*** Sample Matrix: ***W*** Sample Collected: ***08/16/99 17:15:00***

9908178-04A EPA200.7 ICP

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
M99951	MW.1999.997-63	7440-70-2	Calcium	411	mg / L	1	0.4		08/21/99
M99951	MW.1999.997-63	7439-89-6	Iron	1.93	mg / L	1	0.05		08/21/99
M99951	MW.1999.997-63	7439-95-4	Magnesium	48.4	mg / L	1	0.1		08/21/99
M99951	MW.1999.997-63	7440-09-7	Potassium	6.2	mg / L	1	0.2		08/21/99
M[illegible]	MW.1999.997-63	7440-23-5	Sodium	244	mg / L	1	0.2		08/21/99

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

RT HICKS CONSULTING, LTD

Project: 9908178 MEWBOURNE

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9908178-04B		**EPA 300.0**							
W99182	MW.1999.984-17		Nitrate, as N	1.6	mg / L	1	0.1	H	08/19/99
W99182	MW.1999.984-17		Nitrite, as N	ND	mg / L	1	0.1	H	08/19/99
9908178-04B		**EPA 120.1**							
CON9943	MT.1999.2013-4		Conductivity	3,960	umhos/cm	1	1		08/25/99
9908178-04B		**EPA 300.0**							
W99182	MW.1999.998-4		Chloride	1130	mg / L	100	0.5		08/20/99
W99182	MW.1999.984-17		Fluoride	ND	mg / L	1	0.5		08/19/99
W99182	MW.1999.984-17		Sulfate	84.3	mg / L	1	0.5		08/19/99
9908178-04C		**EPA 160.1**							
TD9923	MT.1999.1995-8		Total Dissolved Solids	2,060	mg / L	1	10		08/19/99
9908178-04C		**EPA 310.1**							
ALK9936	MT.1999.2068-1		Alkalinity, Carbonate	ND	mg / L	1	2		08/27/99
ALK9936	MT.1999.2056-2		Alkalinity, Total	186	mg / L	1	2		08/27/99

Client Sample ID: ***MEWBOURNE A*** Sample Matrix: ***W*** Sample Collected: *08/16/99 15:35:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9908178-05A		**EPA200.7 ICP**							
M99951	MW.1999.997-64	7440-70-2	Calcium	86.3	mg / L	1	0.4		08/21/99
M99951	MW.1999.997-64	7439-89-6	Iron	ND	mg / L	1	0.05		08/21/99
M99951	MW.1999.997-64	7439-95-4	Magnesium	15.0	mg / L	1	0.1		08/21/99
M99951	MW.1999.997-64	7440-09-7	Potassium	4.0	mg / L	1	0.2		08/21/99
M99951	MW.1999.997-64	7440-23-5	Sodium	76.5	mg / L	1	0.2		08/21/99
9908178-05B		**EPA 300.0**							
W99182	MW.1999.984-19		Nitrate, as N	3.0	mg / L	1	0.1	H	08/19/99
W99182	MW.1999.984-19		Nitrite, as N	ND	mg / L	1	0.1	H	08/19/99
9908178-05B		**EPA 120.1**							
CON9943	MT.1999.2013-5		Conductivity	891	umhos/cm	1	1		08/25/99
9908178-05B		**EPA 300.0**							
W99182	MW.1999.984-20		Chloride	121	mg / L	10	0.5		08/19/99
W99182	MW.1999.984-19		Fluoride	ND	mg / L	1	0.5		08/19/99
W99182	MW.1999.984-19		Sulfate	74.9	mg / L	1	0.5		08/19/99
9908178-05C		**EPA 160.1**							
TD9923	MT.1999.1995-9		Total Dissolved Solids	547	mg / L	1	10		08/19/99

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: RT HICKS CONSULTING, LTD
Project: 9908178 MEWBOURNE

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9908178-05C		**EPA 310.1**							
ALK9936	MT.1999.2068-2		Alkalinity, Carbonate	ND	mg / L	1	2		08/27/99
ALK9936	MT.1999.2056-3		Alkalinity, Total	198	mg / L	1	2		08/27/99
9908178-05D		**SW846 8260A Purgeable VOCs by GC/MS**							
X99266	XG.1999.711-2	71-43-2	Benzene	ND	ug / L	1	1		08/20/99
X99266	XG.1999.711-2	100-41-4	Ethylbenzene	ND	ug / L	1	1		08/20/99
X99266	XG.1999.711-2		Naphthalene	ND	ug / L	1	5		08/20/99
X99266	XG.1999.711-2	95-47-6	o-Xylene	ND	ug / L	1	1		08/20/99
X99266	XG.1999.711-2		p/m Xylenes	ND	ug / L	1	2		08/20/99
X99266	XG.1999.711-2	108-88-3	Toluene	ND	ug / L	1	1		08/20/99

Client Sample ID: ***MCCASLAND WM TANK*** Sample Matrix: ***W*** Sample Collected: ***08/16/99 14:22:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9908178-06A		**EPA200.7 ICP**							
M99951	MW.1999.1007-30	7440-70-2	Calcium	916	mg / L	11	0.4		08/23/99
M99951	MW.1999.997-65	7439-89-6	Iron	0.27	mg / L	1	0.05		08/21/99
M9995[illegible]	MW.1999.997-65	7439-95-4	Magnesium	87.4	mg / L	1	0.1		08/21/99
M[illegible]	MW.1999.997-65	7440-09-7	Potassium	9.4	mg / L	1	0.2		08/21/99
M99951	MW.1999.997-65	7440-23-5	Sodium	447	mg / L	1	0.2		08/21/99
9908178-06B		**EPA 300.0**							
W99182	MW.1999.984-21		Nitrate, as N	2.2	mg / L	1	0.1	H	08/19/99
W99182	MW.1999.984-21		Nitrite, as N	ND	mg / L	1	0.1	H	08/19/99
9908178-06B		**EPA 120.1**							
CON9943	MT.1999.2013-6		Conductivity	7,260	umhos/cm	1	1		08/25/99
9908178-06B		**EPA 300.0**							
W99182	MW.1999.998-5		Chloride	2450	mg / L	100	0.5		08/20/99
W99182	MW.1999.984-21		Fluoride	ND	mg / L	1	0.5		08/19/99
W99182	MW.1999.984-22		Sulfate	124	mg / L	10	0.5		08/19/99
9908178-06C		**EPA 160.1**							
TD9923	MT.1999.1995-10		Total Dissolved Solids	4,270	mg / L	1	10		08/19/99
9908178-06C		**EPA 310.1**							
ALK9936	MT.1999.2068-3		Alkalinity, Carbonate	ND	mg / L	1	2		08/27/99
ALK9936	MT.1999.2056-4		Alkalinity, Total	55.4	mg / L	1	2		08/27/99

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

C RT HICKS CONSULTING, LTD

Project: 9908178 MEWBOURNE

Client Sample ID	CF2 TP2 9'	Sample Matrix	SOIL	Sample Collected	08/16/99 18:10:00

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
9908178-07A		EPA 300.0							
W99178	MW.1999.984-70		Nitrate, as N	1.4	mg / Kg	2	0.2		08/20/99
W99178	MW.1999.984-70		Nitrite, as N	ND	mg / Kg	2	0.2		08/20/99
9908178-07A		EPA 300.0							
W99178	MW.1999.984-70		Chloride	6.2	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-70		Fluoride	1.9	mg / Kg	2	0.5		08/20/99
W99178	MW.1999.984-70		Sulfate	31.1	mg / Kg	2	0.5		08/20/99
9908178-07A		SW846 3050A/6010A ICP							
M99964	MW.1999.1010-66	7440-70-2	Calcium	413	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-66	7439-89-6	Iron	2250	mg / Kg	1	15		08/25/99
M99964	MW.1999.1010-66	7439-95-4	Magnesium	348	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-66	7440-09-7	Potassium	428	mg / Kg	1	10		08/25/99
M99964	MW.1999.1010-66	7440-23-5	Sodium	106	mg / Kg	1	15		08/25/99

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****

**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

CATION-ANION BALANCE FOR 99-8178-06

CATION	mg/L	CONV. FACTOR	meq/L	ANION	mg/L	CONV. FACTOR	meq/L
Ca	916	0.0499	45.7084	Alk CO3 as CaCO3	0	0.02	0
Fe	0.27	0.05372	0.014504	Alk HCO3 as CaCO3	55.4	0.01	0.554
K	9.4	0.02558	0.240452	Cl	2450	0.02821	69.1145
Mg	87.4	0.08229	7.192146	SO4	124	0.02082	2.58168
Na	447	0.0435	19.4445	NO3 as N	2.2	0.07143	0.157146
				Br	0	0.01252	0
				F	0.5	0.05264	0.02632
				PO4 as P	0	0.0968	0
				SiO3 as Si	0	0.07122	0
CATION SUM			72.6	ANION SUM			72.43365

CATION-ANION BALANCE (%) =	0
Measured Conductivity (if available)	7260
Ion Sum Check - (0.9*EC)/100 Lo	65.34
(1.1*EC)/100 Hi	79.86
Measured TDS (if available)	4270
Calculated TDS	4070.01

CATION-ANION BALANCE FOR 99-8178-05

CATION	mg/L	CONV. FACTOR	meq/L	ANION	mg/L	CONV. FACTOR	meq/L
Ca	86.3	0.0499	4.30637	Alk CO3 as CaCO3	0	0.02	0
Fe	0.05	0.05372	0.002686	Alk HCO3 as CaCO3	198	0.01	1.98
K	4	0.02558	0.10232	Cl	121	0.02821	3.41341
Mg	15	0.08229	1.23435	SO4	74.9	0.02082	1.559418
Na	76.5	0.0435	3.32775	NO3 as N	3	0.07143	0.21429
				Br	0	0.01252	0
				F	0.5	0.05264	0.02632
				PO4 as P	0	0.0968	0
				SiO3 as Si	0	0.07122	0
CATION SUM			8.973476	ANION SUM			7.193438

CATION-ANION BALANCE (%) =	11
Measured Conductivity (if available)	891
Ion Sum Check - (0.9*EC)/100 Lo	8.019
(1.1*EC)/100 Hi	9.801
Measured TDS (if available)	547
Calculated TDS	500.05

CATION-ANION BALANCE FOR 99-8178-04

CATION	mg/L	CONV. FACTOR	meq/L
Ca	411	0.0499	20.5089
Fe	1.93	0.05372	0.10368
K	6.2	0.02558	0.158596
Mg	48.4	0.08229	3.982836
Na	244	0.0435	10.614
CATION SUM			35.36801

ANION	mg/L	CONV. FACTOR	meq/L
Alk CO3 as CaCO3	0	0.02	0
Alk HCO3 as CaCO3	186	0.01	1.86
Cl	1130	0.02821	31.8773
SO4	84.3	0.02082	1.755126
NO3 as N	1.6	0.07143	0.114288
Br	0	0.01252	0
F	0.5	0.05264	0.02632
PO4 as P	0	0.0968	0
SiO3 as Si	0	0.07122	0
ANION SUM			35.63303

CATION-ANION BALANCE (%) =	0
Measured Conductivity (if available)	3960
Ion Sum Check - (0.9*EC)/100 Lo	35.64
(1.1*EC)/100 Hi	43.56
Measured TDS (if available)	2060
Calculated TDS	2039.53

ASSAIGAI ANALYTICAL LABORATORIES, INC.

Chain of Custody Record

7300 JEFFERSON N.E.
ALBUQUERQUE, NEW MEXICO 87
(505) 345-8964

3332 WEDGEWOOD
EL PASO, TEXAS 79925
(915) 593-6000

127 EASTGATE DRIVE, 212-C
LOS ALAMOS, NEW MEXICO 87544
(505) 662-2558

Lab Job No.: ______ Date 03/29/01

Page 1 of 1

Client Hicks Consultants
Address 4665 Indian School
City / State / Zip Albuquerque, NM
Project Name / Number Newbourne / Hinkle
Contract / Purchase Order / Quote ______

Project Manager / Contact John Ayarbe
Telephone No. (505) 266-5004
Fax No. (505) 266-7738
Samplers: (signature) J Ayarbe

AAL Fraction Number	Field Sample Number / Location	Date	Time	Sample Type	Type / Size of Container	Preservation Temp.	Preservation Chemical	No. of Containers	Cations	Anions	TDS							Remarks
OFFICE USE ONLY	Windmill #1	03/27		H2O	liter		HNO3 for cations		✓	✓	✓							7-10 DAY
	Windmill #2	"		"	"		"		✓	✓	✓							HOLD
	Newbourne A	"	[illegible]	"	"		"		✓	✓	✓							
	MW-1	"		"	"		"		✓	✓	✓							
	MW-2	"		"	"		"		✓	✓	✓							
	MW-3	"		"	"		"		✓	✓	✓							7-10 DAY
	McCasland Tank	03/28		"	"		"		✓	✓	✓							7 10 DAY

Relinquished by:
Signature Randall Hicks
Printed Randall Hicks
Company RTHC
Reason ANALY

Date 3-27-01
Time 9:30

Received by:
Signature [illegible]
Printed [illegible]
Company AAL
Reason [illegible]

Relinquished by:
Signature ______
Printed ______
Company ______
Reason ______

Date ______
Time ______

Received by:
Signature ______
Printed ______
Company ______
Reason ______

Method of Shipment: ______
Shipment No. ______
Special Instructions: ______

Comments: 7-10 DAY TURNAROUND ON TDS Na Cl Ca PLEASE CALL JOHN AYARBE w/ RESULTS FOR SAMPLES MARKED

After analysis, samples are to be:
- ☐ Disposed of (additional fee)
- ☐ Stored (30 days max)
- ☐ Stored over 30 days (additional fee)
- ☐ Returned to customer

FIELD FILE

ASSAIGAI ANALYTICAL LABORATORIES, INC.

7300 JEFFERSON N.E.
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(505) 345-8964

3332 WEDGEWOOD
EL PASO, TEXAS 79925
(915) 593-6000

127 EASTGATE DRIVE, 212-C
LOS ALAMOS, NEW MEXICO 87544
(505) 662-2558

RT HC 01 4/13/01 C-le

Chain of Custody Record

Lab job No. 0103434 Date 03/30/01

Page 1 of 1

Client Hicks Consultants

Address 4665 Indian School

City / State / Zip Albuquerque, NM

Project Name / Number Newbourne / Hinkle

Contract / Purchase Order / Quote

Project Manager / Contact John Hyarbe

Telephone No. (505) 266- ~~7238~~ 5004

Fax No. 266-5004

Samplers : (signature) [illegible]

AAL Fraction Number	Field Sample Number / Location	Date	Time	Sample Type	Type / Size of Container	Preservation Temp.	Preservation Chemical	No. of Containers	Cations	Anions	Remarks
1A,B	Windmill #3	03/28	1830	~~H2O~~ H2O	Liter		Anions Cations		✓	✓	
2A,B	" #4	03/29	1730	H2O	Liter		"		✓	✓	

Relinquished by:	Date	Received by:	Relinquished by:	Date	Received by:
Signature [illegible]	03/30/01	Signature [illegible]	Signature		Signature
Printed John Hyarbe		Printed A. Brazil	Printed		Printed
Company Hicks Consultants	Time	Company AAL	Company	Time	Company
Reason Analysis	1105	Reason Analysis	Reason		Reason

Method of Shipment:

Shipment No.

Special Instructions:

Comments:

After analysis, samples are to be:
- ☐ Disposed of (additional fee)
- ☐ Stored (30 days max)
- ☐ Stored over 30 days (additional fee)
- ☐ Returned to customer

COURIER

ASSAIGAI
ANALYTICAL
LABORATORIES, INC.
7300 Jefferson, NE • Albuquerque, New Mexico 87109 • (505) 345-8964 • FAX (505) 345-7259
3332 Wedgewood Dr., Suite N • El Paso, Texas 79925 • (915) 593-6000 • FAX (915) 593-7820
127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-25

Explanation of codes

B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

RT HICKS CONSULTING, LTD
attn: **MICHELLE HUNTER / RANDY HICKS**
4665 INDIAN SCH. NE 106
ALBUQUERQUE, NM 87110

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

REVISED 4/24/01 5:HP

Client: **RT HICKS CONSULTING, LTD**
Project: **0103408 MEWBOURNE/HINKLE**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID: ***WINDMILL #1*** Sample Matrix: ***H2O*** Sample Collected: *03/27/01 13:05:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103408-01A		**EPA 4.1.3/200.7 ICP**							
M01352	MW.2001.491-44	7440-70-2	Calcium	531	mg / L	10	0.4		04/10/01
M01352	MW.2001.482-40	7439-89-6	Iron	0.07	mg / L	1	0.05		04/09/01
M01352	MW.2001.482-40	7439-95-4	Magnesium	52.9	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-40	7440-09-7	Potassium	6.9	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-40	7440-21-3	Silicon	23.8	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-40	7440-23-5	Sodium	247	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-40	7440-66-6	Zinc	0.27	mg / L	1	0.02		04/09/01
0103408-01B		**EPA 120.1**							
CON0112	TT.2001.878-6		Conductivity	3920	umhos/cm	1	1		04/09/01
0103408-01B		**EPA 160.1**							
TD0118	TT.2001.1027-3		Total Dissolved Solids	2690	mg / L	1	10		04/03/01
0103408-01B		**EPA 300.0**							
W01101	MW.2001.487-19		Bromide	3.22	mg / L	10	0.05		03/29/01
W01107	MW.2001.537-13	16887-00-6	Chloride	1420	mg / L	100	0.05		04/13/01
W01101	MW.2001.487-19	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-19	14797-65-0	Nitrate, as N	1.42	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-19	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-19		Orthophosphate, as P	ND	mg / L	10	0.05		03/29/01
W0110	MW.2001.487-19		Sulfate	82.0	mg / L	10	0.05		03/29/01

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: RT HICKS CONSULTING, LTD
Project: 0103408 MEWBOURNE/HINKLE

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103408-01B		**EPA 310.1**							
ALK016	TT.2001.801-11		Alkalinity, Bicarbonate	148	mg / L	1	2		04/02/01
ALK016	TT.2001.801-11		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01
0103408-01B		**SM 1030F**							
CATBAL	TT.2001.1028-1		Cation-Anion Balance	4	%	1	0		04/25/01

Client Sample ID: ***MEWBOURNE A*** — Sample Matrix: ***H2O*** — Sample Collected: *03/27/01 11:00:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103408-03A		**EPA 4.1.3/200.7 ICP**							
M01352	MW.2001.482-43	7440-70-2	Calcium	85.2	mg / L	1	0.4		04/09/01
M01352	MW.2001.482-43	7439-89-6	Iron	0.06	mg / L	1	0.05		04/09/01
M01352	MW.2001.482-43	7439-95-4	Magnesium	10.4	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-43	7440-09-7	Potassium	3.5	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-43	7440-21-3	Silicon	24.0	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-43	7440-23-5	Sodium	59.0	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-43	7440-66-6	Zinc	ND	mg / L	1	0.02		04/09/01
0103408-03B		**EPA 120.1**							
CON0112	TT.2001.878-7		Conductivity	693	umhos/cm	1	1		04/09/01
0103408-03B		**EPA 160.1**							
TD0118	TT.2001.841-11		Total Dissolved Solids	526	mg / L	1	10		04/03/01
0103408-03B		**EPA 300.0**							
W01101	MW.2001.487-20		Bromide	0.88	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-20	16887-00-6	Chloride	105	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-20	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-20	14797-65-0	Nitrate, as N	1.66	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-20	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-20		Orthophosphate, as P	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-20		Sulfate	51.4	mg / L	10	0.05		03/29/01
0103408-03B		**EPA 310.1**							
ALK016	TT.2001.801-12		Alkalinity, Bicarbonate	185	mg / L	1	2		04/02/01
ALK016	TT.2001.801-12		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01
0103408-03B		**SM 1030F**							
CATBAL	TT.2001.933-1		Cation-Anion Balance	1	%	1	0		04/16/01

Assaigal Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**

Project: **0103408 MEWBOURNE/HINKLE**

Client Sample ID: ***MW-1*** Sample Matrix: ***H2O*** Sample Collected: ***03/27/01 13:40:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103408-04A		**EPA 4.1.3/200.7 ICP**							
M01352	MW.2001.482-44	7440-70-2	Calcium	92.2	mg / L	1	0.4		04/09/01
M01352	MW.2001.482-44	7439-89-6	Iron	ND	mg / L	1	0.05		04/09/01
M01352	MW.2001.482-44	7439-95-4	Magnesium	13.3	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-44	7440-09-7	Potassium	4.2	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-44	7440-21-3	Silicon	22.2	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-44	7440-23-5	Sodium	59.2	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-44	7440-66-6	Zinc	ND	mg / L	1	0.02		04/09/01
0103408-04B		**EPA 120.1**							
CON0112	TT.2001.878-9		Conductivity	779	umhos/cm	1	1		04/09/01
0103408-04B		**EPA 160.1**							
TD0118	TT.2001.841-12		Total Dissolved Solids	538	mg / L	1	10		04/03/01
0103408-04B		**EPA 300.0**							
W01101	MW.2001.487-21		Bromide	1.01	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-21	16887-00-6	Chloride	133	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-21	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-21	14797-65-0	Nitrate, as N	1.37	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-21	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-21		Orthophosphate, as P	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-21		Sulfate	64.9	mg / L	10	0.05		03/29/01
0103408-04B		**EPA 310.1**							
ALK016	TT.2001.801-13		Alkalinity, Bicarbonate	182	mg / L	1	2		04/02/01
ALK016	TT.2001.801-13		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01
0103408-04B		**SM 1030F**							
CATBAL	TT.2001.933-2		Cation-Anion Balance	4	%	1	0		04/16/01

Client Sample ID: ***MW-2*** Sample Matrix: ***H2O*** Sample Collected: ***03/27/01 14:45:00***

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103408-05A		**EPA 4.1.3/200.7 ICP**							
M01352	MW.2001.482-45	7440-70-2	Calcium	95.8	mg / L	1	0.4		04/09/01
M01352	MW.2001.482-45	7439-89-6	Iron	1.13	mg / L	1	0.05		04/09/01
M01352	MW.2001.482-45	7439-95-4	Magnesium	15.4	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-45	7440-09-7	Potassium	5.0	mg / L	1	0.2		04/09/01

Assaigal Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**

Project: **0103408 MEWBOURNE/HINKLE**

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
M01352	MW.2001.482-45	7440-21-3	Silicon	28.1	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-45	7440-23-5	Sodium	62.0	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-45	7440-66-6	Zinc	ND	mg / L	1	0.02		04/09/01
0103408-05B		**EPA 120.1**							
CON0112	TT.2001.878-10		Conductivity	778	umhos/cm	1	1		04/09/01
0103408-05B		**EPA 160.1**							
TD0118	TT.2001.841-6		Total Dissolved Solids	570	mg / L	1	10		04/03/01
0103408-05B		**EPA 300.0**							
W01101	MW.2001.487-22		Bromide	0.82	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-22	16887-00-6	Chloride	146	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-22	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-22	14797-65-0	Nitrate, as N	0.62	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-22	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-22		Orthophosphate, as P	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-22		Sulfate	53.4	mg / L	10	0.05		03/29/01
0103408-05B		**EPA 310.1**							
ALK016	TT.2001.801-14		Alkalinity, Bicarbonate	177	mg / L	1	2		04/02/01
ALK016	TT.2001.801-14		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01
0103408-05B		**SM 1030F**							
CATBAL	TT.2001.933-3		Cation-Anion Balance	1	%	1	0		04/16/01

Client Sample ID ***MW-3*** Sample Matrix ***H2O*** Sample Collected *03/27/01 17:20:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103408-06A		**EPA 4.1.3/200.7 ICP**							
M01352	MW.2001.482-49	7440-70-2	Calcium	295	mg / L	1	0.4		04/09/01
M01352	MW.2001.482-49	7439-89-6	Iron	0.15	mg / L	1	0.05		04/09/01
M01352	MW.2001.482-49	7439-95-4	Magnesium	50.9	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-49	7440-09-7	Potassium	7.0	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-49	7440-21-3	Silicon	23.2	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-49	7440-23-5	Sodium	97.6	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-49	7440-66-6	Zinc	ND	mg / L	1	0.02		04/09/01
0103408-06B		**EPA 120.1**							
CON0112	TT.2001.878-11		Conductivity	2180	umhos/cm	1	1		04/09/01
0103408-06B		**EPA 160.1**							
TD0118	TT.2001.841-13		Total Dissolved Solids	1500	mg / L	1	10		04/03/01
0103408-06B		**EPA 300.0**							
W01101	MW.2001.487-23		Bromide	1.91	mg / L	10	0.05		03/29/01

Certificate of Analysis

Cli[illegible] **RT HICKS CONSULTING, LTD**

Project: **0103408** **MEWBOURNE/HINKLE**

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
W01112	MW.2001.514-2	16887-00-6	Chloride	679	mg / L	50	0.05		04/05/01
W01101	MW.2001.487-23	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-23	14797-65-0	Nitrate, as N	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-23	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-23		Orthophosphate, as P	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-23		Sulfate	61.5	mg / L	10	0.05		03/29/01
0103408-06B		**EPA 310.1**							
ALK016	TT.2001.801-15		Alkalinity, Bicarbonate	166	mg / L	1	2		04/02/01
ALK016	TT.2001.801-15		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01
0103408-06B		**SM 1030F**							
CATBAL	TT.2001.933-4		Cation-Anion Balance	2	%	1	0		04/16/01

Client Sample ID **MCCASLAND TANK** Sample Matrix **H2O** Sample Collected *03/28/01 06:43:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103408-07A		**EPA 4.1.3/200.7 ICP**							
M013[illegible]	MW.2001.491-45	7440-70-2	Calcium	893	mg / L	10	0.4		04/10/01
M01[illegible]	MW.2001.482-50	7439-89-6	Iron	2.94	mg / L	1	0.05		04/09/01
M01352	MW.2001.482-50	7439-95-4	Magnesium	94.5	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-50	7440-09-7	Potassium	11.7	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-50	7440-21-3	Silicon	31.5	mg / L	1	0.1		04/09/01
M01352	MW.2001.482-50	7440-23-5	Sodium	438	mg / L	1	0.2		04/09/01
M01352	MW.2001.482-50	7440-66-6	Zinc	1.21	mg / L	1	0.02		04/09/01
0103408-07B		**EPA 120.1**							
CON0112	TT.2001.878-12		Conductivity	6570	umhos/cm	1	1		04/09/01
0103408-07B		**EPA 160.1**							
TD0118	TT.2001.1027-4		Total Dissolved Solids	4720	mg / L	1	10		04/03/01
0103408-07B		**EPA 300.0**							
W01101	MW.2001.487-24		Bromide	5.76	mg / L	10	0.05		03/29/01
W01107	MW.2001.537-14	16887-00-6	Chloride	2620	mg / L	500	0.05		04/13/01
W01101	MW.2001.523-1	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-24	14797-65-0	Nitrate, as N	2.69	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-24	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-24		Orthophosphate, as P	ND	mg / L	10	0.05		03/29/01
W01101	MW.2001.487-24		Sulfate	149	mg / L	10	0.05		03/29/01
0103408-07B		**EPA 310.1**							
ALK016	TT.2001.801-16		Alkalinity, Bicarbonate	105	mg / L	1	2		04/02/01
ALK016	TT.2001.801-16		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**

Project: **0103408** **MEWBOURNE/HINKLE**

0103408-07B **SM 1030F**

CATBAL	TT.2001.1028-2		Cation-Anion Balance	6	%	1	0		04/25/01

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****

**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

ASSAIGAI
ANALYTICAL
LABORATORIES, INC.
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3332 Wedgewood Dr., Suite N • El Paso, Texas 79925 • (915) 593-6000 • FAX (915) 593-7820
127 Eastgate Drive, 212-C • Los Alamos, New Mexico 87544 • (505) 662-2558

Explanation of codes

B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

RT HICKS CONSULTING, LTD
attn: **MICHELLE HUNTER / RANDY HICKS**
4665 INDIAN SCH. NE 106
ALBUQUERQUE, NM 87110

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**
Project: **0103434 MEWBOURNE/HINKLE**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID: ***WINDMILL #3*** Sample Matrix: ***H2O*** Sample Collected: *03/28/01 18:30:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103434-01A		**EPA 4.1.3/200.7 ICP**							
M01366	MW.2001.491-58	7440-70-2	Calcium	592	mg / L	10	0.4		04/10/01
M01366	MW.2001.482-66	7439-89-6	Iron	ND	mg / L	1	0.05		04/09/01
M01366	MW.2001.482-66	7439-95-4	Magnesium	56.7	mg / L	1	0.1		04/09/01
M01366	MW.2001.482-66	7440-09-7	Potassium	7.5	mg / L	1	0.2		04/09/01
M01366	MW.2001.482-66	7440-21-3	Silicon	24.1	mg / L	1	0.1		04/09/01
M01366	MW.2001.482-66	7440-23-5	Sodium	258	mg / L	1	0.2		04/09/01
M01366	MW.2001.482-66	7440-66-6	Zinc	0.08	mg / L	1	0.02		04/09/01
0103434-01B		**EPA 120.1**							
CON0112	TT.2001.878-15		Conductivity	4140	umhos/cm	1	1		04/09/01
0103434-01B		**EPA 160.1**							
TD0118	TT.2001.1027-5		Total Dissolved Solids	3050	mg / L	1	10		04/03/01
0103434-01B		**EPA 300.0**							
W01101	MW.2001.487-30		Bromide	3.35	mg / L	10	0.05		03/30/01
W01112	MW.2001.514-3	16887-00-6	Chloride	1580	mg / L	100	0.05		04/05/01
W01101	MW.2001.487-30	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/30/01
W01101	MW.2001.487-30	14797-65-0	Nitrate, as N	1.52	mg / L	10	0.05		03/30/01
W01101	MW.2001.487-30	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/30/01
W01101	MW.2001.487-30		Orthophosphate, as P	ND	mg / L	10	0.05		03/30/01
W011[illegible]	MW.2001.487-30		Sulfate	84.3	mg / L	10	0.05		03/30/01

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: RT HICKS CONSULTING, LTD

Project: 0103434 MEWBOURNE/HINKLE

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103434-01B	**EPA 310.1**								
ALK016	TT.2001.801-19		Alkalinity, Bicarbonate	147	mg / L	1	2		04/02/01
ALK016	TT.2001.801-19		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01
0103434-01B	**SM 1030f**								
CATBAL	TT.2001.1028-3		Cation-Anion Balance	4	%	1	0		04/25/01

Client Sample ID: ***WINDMILL #4*** Sample Matrix: ***H2O*** Sample Collected: *03/29/01 17:30:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0103434-02A	**EPA 4.1.3/200.7 ICP**								
M01366	MW.2001.491-59	7440-70-2	Calcium	610	mg / L	10	0.4		04/10/01
M01366	MW.2001.482-67	7439-89-6	Iron	ND	mg / L	1	0.05		04/09/01
M01366	MW.2001.482-67	7439-95-4	Magnesium	57.1	mg / L	1	0.1		04/09/01
M01366	MW.2001.482-67	7440-09-7	Potassium	7.4	mg / L	1	0.2		04/09/01
M01366	MW.2001.482-67	7440-21-3	Silicon	23.4	mg / L	1	0.1		04/09/01
M01366	MW.2001.482-67	7440-23-5	Sodium	266	mg / L	1	0.2		04/09/01
M01366	MW.2001.482-67	7440-66-6	Zinc	0.05	mg / L	1	0.02		04/09/01
0103434-02B	**EPA 120.1**								
CON0112	TT.2001.878-16		Conductivity	4470	umhos/cm	1	1		04/09/01
0103434-02B	**EPA 160.1**								
TD0118	TT.2001.1027-6		Total Dissolved Solids	3220	mg / L	1	10		04/03/01
0103434-02B	**EPA 300.0**								
W01101	MW.2001.487-31		Bromide	3.53	mg / L	10	0.05		03/30/01
W01107	MW.2001.537-16	16887-00-6	Chloride	1620	mg / L	200	0.05		04/13/01
W01101	MW.2001.487-31	16984-48-8	Fluoride	ND	mg / L	10	0.05		03/30/01
W01101	MW.2001.487-31	14797-65-0	Nitrate, as N	1.48	mg / L	10	0.05		03/30/01
W01101	MW.2001.487-31	14797-55-8	Nitrite, as N	ND	mg / L	10	0.05		03/30/01
W01101	MW.2001.487-31		Orthophosphate, as P	ND	mg / L	10	0.05		03/30/01
W01101	MW.2001.487-31		Sulfate	86.0	mg / L	10	0.05		03/30/01
0103434-02B	**EPA 310.1**								
ALK016	TT.2001.801-20		Alkalinity, Bicarbonate	146	mg / L	1	2		04/02/01
ALK016	TT.2001.801-20		Alkalinity, Carbonate	ND	mg / L	1	2		04/02/01
0103434-02B	**SM 1030f**								
CATBAL	TT.2001.1028-4		Cation-Anion Balance	4	%	1	0		04/25/01

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

C RT HICKS CONSULTING, LTD

Project: 0103434 MEWBOURNE/HINKLE

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****

**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

Table: Water Chemistry
McCasland Well Area

Lab ID			Mew #2	Mew #4	McCasland WM	McCasland WM	McCasland WM	McCasland Tank	Mewbourne A
Date			9/1/98	9/1/98	3/31/98	9/1/98	8/17/99	8/17/99	8/17/99
Ca	µg/l		99.3	310	700	749	411	916	86.3
Fe	µg/l		0.6	0.6		19.9	1.93	0.27	nd
Mg	µg/l		18.9	52.8	90	73.9	48.4	87.4	15
K	µg/l		17	15.5	7.4	8.3	6.2	9.4	4
Si	µg/l		23.7	22		21.8			
Na	µg/l		103	275	285	373	244	447	76.5
Zn	µg/l		ND	ND		3.8			
Cl	µg/l		114	453	1771	1930	1130	2450	121
Fl	µg/l		0.9	0.6		ND	nd	nd	nd
Nitrate	µg/l		0.5	0.5	3	1	1.6	2.2	3
Nitrite	µg/l		ND	ND		ND	nd	nd	nd
Ortho. P	µg/l		ND	1.9		ND			
Sulfate	µg/l		127	775	108	112	84.3	124	74.9
Carbonate	µg/l		275	172	171	117			150
Conductivity	µmhos/cm		1160	3700		7800			
TDS					4113		2060	4270	547
Br					**Milliequivalents per liter**				
	Conversion Factor								
Ca+2	0.0499		4.96	15.47	34.93	37.38	20.51	45.71	4.31
Mg +2	0.08229		1.56	4.34	7.41	6.08	3.98	7.19	1.23
Na +K	0.0435	0.0256	1.47	1.35	0.19	1.16	0.16	0.24	0.10
HCO3 -1	0.01		2.75	1.72	1.71	1.17	0.00	0.00	1.50
SO4 -2	0.02082		2.64	16.14	2.25	2.33	1.76	2.58	1.56
Cl -1	0.02821		3.22	12.78	49.96	54.45	31.88	69.11	3.41
Total Cations			7.98	21.17	42.53	44.62	24.65	53.14	5.64
Total Anions			8.61	30.63	53.92	57.95	33.63	71.70	6.47
% Ca+2			62%	73%	82%	84%	83%	86%	76%
% Mg +2			19%	21%	17%	14%	16%	14%	22%
% Na + K			18%	6%	0%	3%	1%	0%	2%
% HCO3 -1			32%	6%	3%	2%	0%	0%	23%
% SO4 -2			31%	53%	4%	4%	5%	4%	24%
% Cl -1			37%	42%	93%	94%	95%	96%	53%

Table: Wate[illegible]emistry
McCasland[illegible]ll Area

Lab ID	Mewbourne A	McCasland Tank	Windmill #4 (1730)	MW-3
Date	3/27/01	3/28/01	3/29/01	3/27/01
Ca	85.2	893	610	295
Fe	0.06	2.94	nd	0.015
Mg	10.4	94.5	57.4	50.9
K	3.5	11.7	7.4	7
Si	24	31.5	23.4	23%
Na	59	438	266	98%
Zn	nd	1.21	0.05	nd
Cl	105	5230	1620	679%
Fl	nd	nd	nd	nd
Nitrate	1.66	2.69	1.48	nd
Nitrite	nd	nd	nd	nd
Ortho. P	nd	nd		nd
Sulfate	51.4	149	86	61.5
Carbonate	185	105	146	166
Conductivity	693	6570	4470	2180
TDS	526	4720	3220	1500
Br	0.88	5.76	3.53	1.91
Ca+2				
Mg +2				
Na +K				
HCO3 -1				
SO4 -2				
Cl -1				
Total Cations				
Total Anions				
% Ca+2				
% Mg +2				
% Na + K				
% HCO3 -1				
% SO4 -2				
% Cl -1				

ASSAIGAI ANALYTICAL LABORATORIES, INC.

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Explanation of codes	
B	analyte detected in Method Blank
E	result is estimated
H	analyzed out of hold time
N	tentatively identified compound
S	subcontracted
1-9	see footnote

RT HICKS CONSULTING, LTD
attn: **MICHELLE HUNTER / RANDY HICKS**
4665 INDIAN SCH. NE 106
ALBUQUERQUE, NM 87110

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**
Project: **0104039 MEWBORNE**

William P. Biava: President of Assaigai Analytical Laboratories, Inc.

Client Sample ID: ***CARTER #1,2,3*** — Sample Matrix: ***W*** — Sample Collected: *04/03/01 12:00:00*

QC Group	Run Sequence	CAS #	Analyte	Result	Units	Dilution Factor	Detection Limit	Code	Run Date
0104039-01A		**EPA 4.1.3/200.7 ICP**							
M01382	MW.2001.596-26	7440-70-2	Calcium	8630	mg / L	100	0.4	E	04/24/01
M01382	MW.2001.546-19	7439-89-6	Iron	1.37	mg / L	10	0.05		04/17/01
M01382	MW.2001.546-19	7439-95-4	Magnesium	3590	mg / L	10	0.1		04/17/01
M01382	MW.2001.546-19	7440-09-7	Potassium	1700	mg / L	10	0.2		04/17/01
M01382	MW.2001.546-19	7440-21-3	Silicon	4.3	mg / L	10	0.1		04/17/01
M01382	MW.2001.596-27	7440-23-5	Sodium	44800	mg / L	1000	0.2		04/24/01
M01382	MW.2001.546-19	7440-66-6	Zinc	ND	mg / L	10	0.02		04/17/01
0104039-01B		**EPA 120.1**							
CON0114	TT.2001.1095-8		Conductivity	296000	umhos/cm	10	1		05/01/01
0104039-01B		**EPA 160.1**							
TD0119	TT.2001.1085-1		Total Dissolved Solids	196000	mg / L	1	10		04/05/01
0104039-01B		**EPA 300.0**							
W01112	MW.2001.514-4	16887-00-6	Chloride	125000	mg / L	10000	0.05		04/05/01
W01105	MW.2001.628-1	16984-48-8	Fluoride	ND	mg / L	20	0.05		04/04/01
W01105	MW.2001.628-1	14797-65-0	Nitrate, as N	127	mg / L	20	0.05		04/04/01
W01105	MW.2001.628-1		Orthophosphate, as P	ND	mg / L	20	0.05		04/04/01
W01105	MW.2001.555-12		Sulfate	1110	mg / L	100	0.05		04/04/01
0104039-01B		**EPA 310.1**							
ALK0[illegible]	TT.2001.928-2		Alkalinity, Bicarbonate	237	mg / L	1	2		04/14/01

Assaigai Analytical Laboratories, Inc.

Certificate of Analysis

Client: **RT HICKS CONSULTING, LTD**

Project: **0104039** **MEWBORNE**

ALK017	TT.2001.928-2		Alkalinity, Carbonate	ND	mg / L	1	2		04/14/01
0104039-01B		**SM 1030F**							
CATBAL	TT.2001.1100-1		Cation-Anion Balance	13	%	1	0		05/02/01

**** Sample specific Detection Limit is determined by multiplying the sample Dilution Factor by the listed Reporting Detection Limit. ****

**** ND = Not detected: less than the sample specific Detection Limit. Results relate only to the items tested. ****

R.T. HICKS CONSULTING, LTD.

WATER SAMPLE FIELD DATA SHEET

CLIENT NAME: Hinkle

SAMPLE ID: ____________

PURGED BY: JPA / Roy

PROJECT NAME: Newbourne Oil

SAMPLED BY: JPA

LOCATION/WELL NO: Windmill

TYPE: Ground Water X Surface Water ____ Treatment Effluent ____ Other ____

CASING DIAMETER (inches): 1.5 ____ 2 ____ 4 ____ 6 ____ Other 5.0" ID

CASING ELEVATION (feet/MSL):	STANDING COLUMN OF WATER:
DEPTH TO LNAPL (feet): ____ TO DNAPL ____	VOLUME IN CASING (gal.): 16
DEPTH TO WATER (feet): 79.50	ACTUAL PURGE VOL. (gal.):
DEPTH OF WELL (feet): 90' (Roy 95.35)	DEPTH TO WATER AFTER PURGING: 81.86'

DATE SAMPLED: ____________ Start (2400 Hr) ____________ End (2400 Hr) ____________

RECORD OF PURGING

TIME (2400 Hr)	VOLUME (gal.)	pH (units)	E.C. (µmhos/cm @ 25°C)	TEMPERATURE (°F)	COLOR (visual)	TURBIDITY (visual)
1250	35		3,780		Clear	none
1300	49		3,790		Clear	none
1315	74.5		3,840			
1420	178.5		4,090			

D.O. (ppm): ____ ODOR: ____

Field QC samples collected at this well: ____________

Parameters field filtered at this well: ____________

SAMPLES COLLECTED

# of Containers		# of Containers		# of Containers	
	80 ml VOAs	2	Anions & Cations		Rad:
	SVOCs		Nitrogen Species		Iron:
	"RCRA" Metals, Metals		Plate Counts		Other:

WELL INTEGRITY: Good [illegible] @ 1.4 gal/min LOCK#: ____

REMARKS: 1.4 gal/min @ 12:40, 1.7 gal/min @ 1315, 1.6 gal/min @ 1400 & 1.5 gal/min @ 15:40; [illegible] @ 16:20, [illegible] @ [illegible]:30

REMARKS ABOUT WELL RECOVERY

Signature: ____________ Reviewed By: ____________ Page 1 of 2

VOLUME / UNIT LENGTH FOR CASING DIAMETERS

Nominal Pipe Size	Gal./Ft. Sch. 40	Gal./Ft. Sch. 80	Liters/Ft. Sch. 40	Liters/Ft. Sch.80
1.5	.106	.092	.401	.348
2.0	.174	.153	.658	.579
4.0	.661	.597	2.50	2.26
6.0	1.50	1.35	5.68	5.11

VOLUME / UNIT LENGTH FOR TUBING DIAMETERS

Tbg. I.D.	Gal/Ft.	Mis/Ft.
1/4"	.0026	9.65
3/8"	.0057	21.71
1/2"	.0102	38.60

CONVERSIONS

To Convert	Into	Multiply By
Ft. of Water	Lbs/Sq In (PSI)	.434
Lbs/Sq In	Ft. of Water	2.31
Cubic Ft.	Gallons	7.48
Gallons	Liters	3.78
Liters	Gallons	.264
Feet	Meters	.305
Inches	Centimeters	2.54

Additional remarks

Wm #1 baker @ 1305 (~56 gal)
Wm #2 bake @ 1420 (~18 gal)

Page ____ of ____

3.5
60
210
.210
1.5
1050
210
3150 gal

R.T. HICKS CONSULTING, LTD.

WATER SAMPLE FIELD DATA SHEET

CLIENT NAME: See Page 1 SAMPLE ID: ______

PURGED BY: ______ PROJECT NAME: ______

SAMPLED BY: ______ LOCATION/WELL NO: Windmill

TYPE: Ground Water ____ Surface Water ____ Treatment Effluent ____ Other ______

CASING DIAMETER (inches): 1.5 ____ 2 ____ 4 ____ 6 ____ Other ______

CASING ELEVATION (feet/MSL): ______ STANDING COLUMN OF WATER: ______

DEPTH TO LNAPL (feet): ______ TO DNAPL ______ VOLUME IN CASING (gal.): ______

DEPTH TO WATER (feet): ______ ACTUAL PURGE VOL. (gal.): ______

DEPTH OF WELL (feet): ______ DEPTH TO WATER AFTER PURGING: ______

DATE SAMPLED: ______ Start (2400 Hr) ______ End (2400 Hr) ______

RECORD OF PURGING

	TIME (2400 Hr)	VOLUME (gal.)	pH (units)	E.C. (µmhos/cm @ 25°C)	TEMPERATURE (°F)	COLOR (visual)	TURBIDITY (visual)
03/27	1600	315	4040	→			
3/28	0655		3,330	→			
	1830		4,190	→			
03/29	0700		4,080	→			

D.O. (ppm): ______ ODOR: ______

Field QC samples collected at this well: ______ Parameters field filtered at this well: ______

SAMPLES COLLECTED

# of Containers		# of Containers		# of Containers	
	80 ml VOAs		Anions & Cations		Rad:
	SVOCs		Nitrogen Species		Iron:
	"RCRA" Metals, Metals		Plate Counts		Other:

WELL INTEGRITY: ______ LOCK#: ______

REMARKS:
3/29 1730 3980 umhos/cm

REMARKS ABOUT WELL RECOVERY

Signature: ______ Reviewed By: ______ Page 2 of 2

VOLUME / UNIT LENGTH FOR CASING DIAMETERS

Nominal Pipe Size	Gal./Ft. Sch. 40	Gal./Ft. Sch. 80	Liters/Ft. Sch. 40	Liters/Ft. Sch.80
1.5	.106	.092	.401	.348
2.0	.174	.153	.658	.579
4.0	.661	.597	2.50	2.26
6.0	1.50	1.35	5.68	5.11

VOLUME / UNIT LENGTH FOR TUBING DIAMETERS

Tbg. I.D.	Gal/Ft.	Mls/Ft.
1/4"	.0026	9.65
3/8"	.0057	21.71
1/2"	.0102	38.60

CONVERSIONS

To Convert	Into	Multiply By
Ft. of Water	Lbs/Sq In (PSI)	.434
Lbs/Sq In	Ft. of Water	2.31
Cubic Ft.	Gallons	7.48
Gallons	Liters	3.78
Liters	Gallons	.264
Feet	Meters	.305
Inches	Centimeters	2.54

Additional remarks

R.T. HICKS CONSULTING, LTD.

WATER SAMPLE FIELD DATA SHEET

CLIENT NAME: Hinkle | SAMPLE ID: ____

PURGED BY: JPA | PROJECT NAME: Newbourne Oil

SAMPLED BY: JPA | LOCATION/WELL NO: NW-1

TYPE: Ground Water X Surface Water ____ Treatment Effluent ____ Other ____

CASING DIAMETER (inches): 1.5 ____ 2 ____ 4 ____ 6 ____ Other 3.0'

CASING ELEVATION (feet/MSL): ____ | STANDING COLUMN OF WATER: 15.45'

DEPTH TO LNAPL (feet): na TO DNAPL na | VOLUME IN CASING (gal.): 8.9

DEPTH TO WATER (feet): 79.55' | ACTUAL PURGE VOL. (gal.): 27

DEPTH OF WELL (feet): 95' | DEPTH TO WATER AFTER PURGING: ____

DATE SAMPLED: ____ Start (2400 Hr) ____ End (2400 Hr) ____

RECORD OF PURGING

TIME (2400 Hr)	VOLUME (gal.)	pH (units)	E.C. (µmhos/cm @ 25°C)	TEMPERATURE (°F)	COLOR (visual)	TURBIDITY (visual)
1530	2.5		840			
1540	7.5		847			

D.O. (ppm): ____ ODOR: ____

Field QC samples collected at this well: ____

Parameters field filtered at this well: ____

SAMPLES COLLECTED

# of Containers		# of Containers		# of Containers	
____	80 ml VOAs	____	Anions & Cations	____	Rad: ____
____	SVOCs	____	Nitrogen Species	____	Iron: ____
____	"RCRA" Metals, Metals	____	Plate Counts	____	Other: ____

WELL INTEGRITY: ____ LOCK#: ____

REMARKS: ____

REMARKS ABOUT WELL RECOVERY

Signature: ____ Reviewed By: ____ Page ____ of ____

VOLUME / UNIT LENGTH FOR CASING DIAMETERS

Nominal Pipe Size	Gal./Ft. Sch. 40	Gal./Ft. Sch. 80	Liters/Ft. Sch. 40	Liters/Ft. Sch.80
1.5	.106	.092	.401	.348
2.0	.174	.153	.658	.579
4.0	.661	.597	2.50	2.26
6.0	1.50	1.35	5.68	5.11

VOLUME / UNIT LENGTH FOR TUBING DIAMETERS

Tbg. I.D.	Gal/Ft.	Mis/Ft.
1/4"	.0026	9.65
3/8"	.0057	21.71
1/2"	.0102	38.60

1.50
.661
2.161

1.03
2)2.161
2

CONVERSIONS

To Convert	Into	Multiply By
Ft. of Water	Lbs/Sq In (PSI)	.434
Lbs/Sq In	Ft. of Water	2.31
Cubic Ft.	Gallons	7.48
Gallons	Liters	3.78
Liters	Gallons	.264
Feet	Meters	.305
Inches	Centimeters	2.54

Additional remarks

R.T. HICKS CONSULTING, LTD.

WATER SAMPLE FIELD DATA SHEET

CLIENT NAME: Hinkle SAMPLE ID:

PURGED BY: NA PROJECT NAME: Newbourne Oil

SAMPLED BY: NA LOCATION/WELL NO: Newbourne A

TYPE: Ground Water X Surface Water ____ Treatment Effluent ____ Other ____

CASING DIAMETER (inches): 1.5 ____ 2 ____ 4 X 6 ____ Other 5.0"

CASING ELEVATION (feet/MSL): ____ STANDING COLUMN OF WATER: 17.8'

DEPTH TO LNAPL (feet): na TO DNAPL na VOLUME IN CASING (gal.): 18.2

DEPTH TO WATER (feet): 73.21' ACTUAL PURGE VOL. (gal.): 56

DEPTH OF WELL (feet): 91' DEPTH TO WATER AFTER PURGING: ____

DATE SAMPLED: 03/27/01 Start (2400 Hr) ____ End (2400 Hr) ____

RECORD OF PURGING

TIME (2400 Hr)	VOLUME (gal.)	pH (units)	E.C. (µmhos/cm @ 25°C)	TEMPERATURE (°F)	COLOR (visual)	TURBIDITY (visual)
1033	9		754		Clear	none
1055	28		724		Clear	none
1112	35		739		Clear	none
1120	49		737		Clear	none

D.O. (ppm): ____ ODOR: none

Field QC samples collected at this well: ____

Parameters field filtered at this well: ____

SAMPLES COLLECTED

# of Containers		# of Containers		# of Containers	
	80 ml VOAs	2	Anions & Cations		Rad:
	SVOCs		Nitrogen Species		Iron:
	"RCRA" Metals, Metals		Plate Counts		Other:

WELL INTEGRITY: good, was locked LOCK#: ____

REMARKS: no cover, had to cut lock, see field note book for additional notes.

REMARKS ABOUT WELL RECOVERY

Signature: [signature] Reviewed By: ____ Page 1 of 2

VOLUME / UNIT LENGTH FOR CASING DIAMETERS

Nominal Pipe Size	Gal./Ft. Sch. 40	Gal./Ft. Sch. 80	Liters/Ft. Sch. 40	Liters/Ft. Sch.80
1.5	.106	.092	.401	.348
2.0	.174	.153	.658	.579
4.0	.661	.597	2.50	2.26
6.0	1.50	1.35	5.68	5.11

VOLUME / UNIT LENGTH FOR TUBING DIAMETERS

Tbg. I.D.	Gal/Ft.	Mis/Ft.
1/4"	.0026	9.65
3/8"	.0057	21.71
1/2"	.0102	38.60

CONVERSIONS

To Convert	Into	Multiply By
Ft. of Water	Lbs/Sq In (PSI)	.434
Lbs/Sq In	Ft. of Water	2.31
Cubic Ft.	Gallons	7.48
Gallons	Liters	3.78
Liters	Gallons	.264
Feet	Meters	.305
Inches	Centimeters	2.54

Additional remarks

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R.T. HICKS CONSULTING, LTD.

WATER SAMPLE FIELD DATA SHEET

CLIENT NAME: Hinkle SAMPLE ID: ____

PURGED BY: JPA PROJECT NAME: Newbourne Oil

SAMPLED BY: JPA LOCATION/WELL NO: MW-2

TYPE: Ground Water X Surface Water ____ Treatment Effluent ____ Other ____

CASING DIAMETER (inches): 1.5 ____ 2 ____ 4 X 6 ____ Other 3.0

CASING ELEVATION (feet/MSL): ____ STANDING COLUMN OF WATER: 18.74'

DEPTH TO LNAPL (feet): na *TO DNAPL na VOLUME IN CASING (gal.): 12.4

DEPTH TO WATER (feet): *80.26 ACTUAL PURGE VOL. (gal.): 37

DEPTH OF WELL (feet): 99 DEPTH TO WATER AFTER PURGING: ____

DATE SAMPLED: ____ Start (2400 Hr) ____ End (2400 Hr) ____

RECORD OF PURGING

TIME (2400 Hr)	VOLUME (gal.)	pH (units)	E.C. (µmhos/cm @ 25°C)	TEMPERATURE (°F)	COLOR (visual)	TURBIDITY (visual)
1440	21		843		Cloudy	Slight

D.O. (ppm): ____ ODOR: ____

Field QC samples collected at this well: ____ Parameters field filtered at this well: ____

SAMPLES COLLECTED

# of Containers		# of Containers		# of Containers	
	80 ml VOAs		Anions & Cations		Rad:
	SVOCs		Nitrogen Species		Iron:
	"RCRA" Metals, Metals		Plate Counts		Other:

WELL INTEGRITY: ____ LOCK#: ____

REMARKS: Went dry at high flow rates; sustained flow @ <0.5 gpm. All samples contained suspended [illegible]. [illegible] [illegible] [illegible] Well was influenced by pumping [illegible] windmill. *pumping windmill may have influenced this reading

REMARKS ABOUT WELL RECOVERY ____

Signature: ____ Reviewed By: ____ Page ____ of ____

VOLUME / UNIT LENGTH FOR CASING DIAMETERS

Nominal Pipe Size	Gal./Ft. Sch. 40	Gal./Ft. Sch. 80	Liters/Ft. Sch. 40	Liters/Ft. Sch.80
1.5	.106	.092	.401	.348
2.0	.174	.153	.658	.579
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VOLUME / UNIT LENGTH FOR TUBING DIAMETERS

Tbg. I.D.	Gal/Ft.	Mis/Ft.
1/4"	.0026	9.65
3/8"	.0057	21.71
1/2"	.0102	38.60

CONVERSIONS

To Convert	Into	Multiply By
Ft. of Water	Lbs/Sq In (PSI)	.434
Lbs/Sq In	Ft. of Water	2.31
Cubic Ft.	Gallons	7.48
Gallons	Liters	3.78
Liters	Gallons	.264
Feet	Meters	.305
Inches	Centimeters	2.54

Additional remarks

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R.T. HICKS CONSULTING, LTD.

WATER SAMPLE FIELD DATA SHEET

CLIENT NAME: Hinkle　　　　SAMPLE ID: ____

PURGED BY: JPA　　　　PROJECT NAME: Newbourne Oil

SAMPLED BY: JPA　　　　LOCATION/WELL NO: MW-3

TYPE: Ground Water X　Surface Water ____　Treatment Effluent ____　Other 3.0

CASING DIAMETER (inches): 1.5 ____　2 ____　4 X　6 ____　Other ____

CASING ELEVATION (feet/MSL): ____	STANDING COLUMN OF WATER: 14.7'
DEPTH TO LNAPL (feet): na　TO DNAPL na	VOLUME IN CASING (gal.): 9.7
DEPTH TO WATER (feet): *79.32	ACTUAL PURGE VOL. (gal.): 29.1
DEPTH OF WELL (feet): 94	DEPTH TO WATER AFTER PURGING: 81.87

DATE SAMPLED: ____　Start (2400 Hr) ____　End (2400 Hr) ____

RECORD OF PURGING

TIME (2400 Hr)	VOLUME (gal.)	pH (units)	E.C. (µmhos/cm @ 25°C)	TEMPERATURE (°F)	COLOR (visual)	TURBIDITY (visual)
1710	14		2200			
1717	21		2160			
1725	35		2550			

D.O. (ppm): ____　ODOR: ____

Field QC samples collected at this well: ____

Parameters field filtered at this well: ____

SAMPLES COLLECTED

# of Containers		# of Containers		# of Containers	
	80 ml VOAs		Anions & Cations		Rad:
	SVOCs		Nitrogen Species		Iron:
	"RCRA" Metals, Metals		Plate Counts		Other:

WELL INTEGRITY: ____　LOCK#: ____

REMARKS: * pumping at windmill may have influenced this reading

REMARKS ABOUT WELL RECOVERY ____

Signature: ____　Reviewed By: ____　Page ____ of ____

VOLUME / UNIT LENGTH FOR CASING DIAMETERS

Nominal Pipe Size	Gal./Ft. Sch. 40	Gal./Ft. Sch. 80	Liters/Ft. Sch. 40	Liters/Ft. Sch.80
1.5	.106	.092	.401	.348
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6.0	1.50	1.35	5.68	5.11

VOLUME / UNIT LENGTH FOR TUBING DIAMETERS

Tbg. I.D.	Gal/Ft.	Mls/Ft.
1/4"	.0026	9.65
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Lbs/Sq In	Ft. of Water	2.31
Cubic Ft.	Gallons	7.48
Gallons	Liters	3.78
Liters	Gallons	.264
Feet	Meters	.305
Inches	Centimeters	2.54

Additional remarks

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Hall Environmental
Analysis Laboratory

Client: ECD Environmental
Project: McCasland
Project Manager: Greg Bybee
Project Number: -

Date Collected: 9/17/99
Date Received: 9/17/99
Sample Matrix: Aqueous

Inorganic Compounds

HEAL LAB ID	Sample ID	Floride (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	o-Phosphate-P (mg/L)
9909073-1	McCasland Windmill	<0.2	1,400	3.6	<0.2	1.5	100	<1.0
Detection Limits		0.1	0.1	0.1	0.1	0.1	0.5	0.5
Method		300.0	300.0	300.0	300.0	300.0	300.0	300.0
Date Analyzed		9/17/99	9/27/99	9/17/99	9/17/99	9/17/99	9/17/99	9/17/99

APPENDIX C

McCASLAND RANCH INITIAL SITE & GROUNDWATER INVESTIGATION
HOBBS, NEW MEXICO

January, 2001

Prepared For:

McCasland Ranch

Prepared By:

HydroGeologic Services, Inc.
8600 Beverly Hills NE
Albuquerque, New Mexico 87122
505-856-6498

TABLE OF CONTENTS

1.0 INTRODUCTION

This report identifies the geologic field investigation which was performed for the McCasland Ranch. High levels of chloride, bromide and conductivity have been identified in the water trough and windmill well which the livestock drink from which lead to this investigation. The apparent source of the chloride contamination is from an abandoned oil/gas well which is located approximately 40 feet from the windmill well.

The site is located approximately 10 miles south of Hobbs, New Mexico to the east of State Highway 18 (mile marker 41) in Township 20 South, Range 39 East, Section 30. Open space, ranching and oil/gas operations are principle of the land in the immediate area. Vegetation is sparse in the site vicinity and consists of mesquite covered dunes (5 to 15 feet high) and yucca plants. The climate at the site area is characterized by low precipitation, a rapid rate of evaporation, and a high annual temperature and can be classified as semi-arid conditions.

2.0 FIELD INVESTIGATION

A field investigation was performed at the McCasland Ranch to help confirm the source and identify the extent of the chloride groundwater contamination. The investigation consisted of mobilizing a Speedstar 30K air/mud rotary drill rig with a 900cfm/350 psi compressor to the site. Three soil borings were advance to approximately 100 feet below surface grade each using the air rotary drilling method and converted into groundwater monitoring wells which the locations can be identified in the Site Plan (Figure 1). While the soil borings were being advanced to determine the subsurface conditions, soil samples were collected every 10 feet or change in lithology and recorded by a Certified Professional Geologist. The monitor wells were installed in a triangular formation around the plugged oil/gas well to help determine the site specific groundwater flow direction (Figure 2) and help determine the extent of the contamination.

The three soil borings were very similar in lithologies as can be viewed in Figures 4, 5, & 6. Soil boring MW-1 consisted of a silty sand layer (SM) from surface to 5 feet, a red brown clay layer (CL) from 5 feet to 14 feet, a caliche layer (SC/CL) with varying colors from 14 feet to 75 feet, a silty sand with fine gravels layer from 75 feet to 92.5 feet (water bearing zone), and a red clay layer (red bed) at 92.5 feet to total depth of 96 feet. Soil boring MW-2 consisted of a silty sand layer from surface to 6 feet, a brown clay layer from 6 feet to 17 feet, a caliche layer with varying colors from 17 feet to 80.5 feet, a sand with silt layer from 80.5 feet to 98.5 feet (water bearing), and a red clay layer from 98.5 feet to total depth of 101 feet. Soil boring MW-3 consisted of sand with silt layer from surface to 7 feet, a red-brown clay layer from 5 feet to 19 feet, a caliche layer from 19 feet to 81 feet, a sand with silt layer from 81 feet to 92 (water bearing) and a red clay layer from 92 feet to total depth.

Each soil boring was converted into a groundwater monitoring well which consisted of 4-inch Schedule 40, flush threaded PVC blank casing with 20 feet of 0.020 inch factory slotted screen. Clean 10/20 graded silica sand was installed by tremie method around the screen to approximately 2 feet above the screen overlain by a minimum 4-foot bentonite seal hydrated with potable water every two feet. A bentonite grout seal was installed by the tremie method from the bentonite seal to surface. A 6-inch diameter by 5-foot long steel protective casing with locking cap was installed surrounded by a 2' x 2' x 4" concrete pad to complete the well. Each well was developed by bailing a minimum three well volumes prior to installing temporary pumps to further develop the wells until clear of sediment.

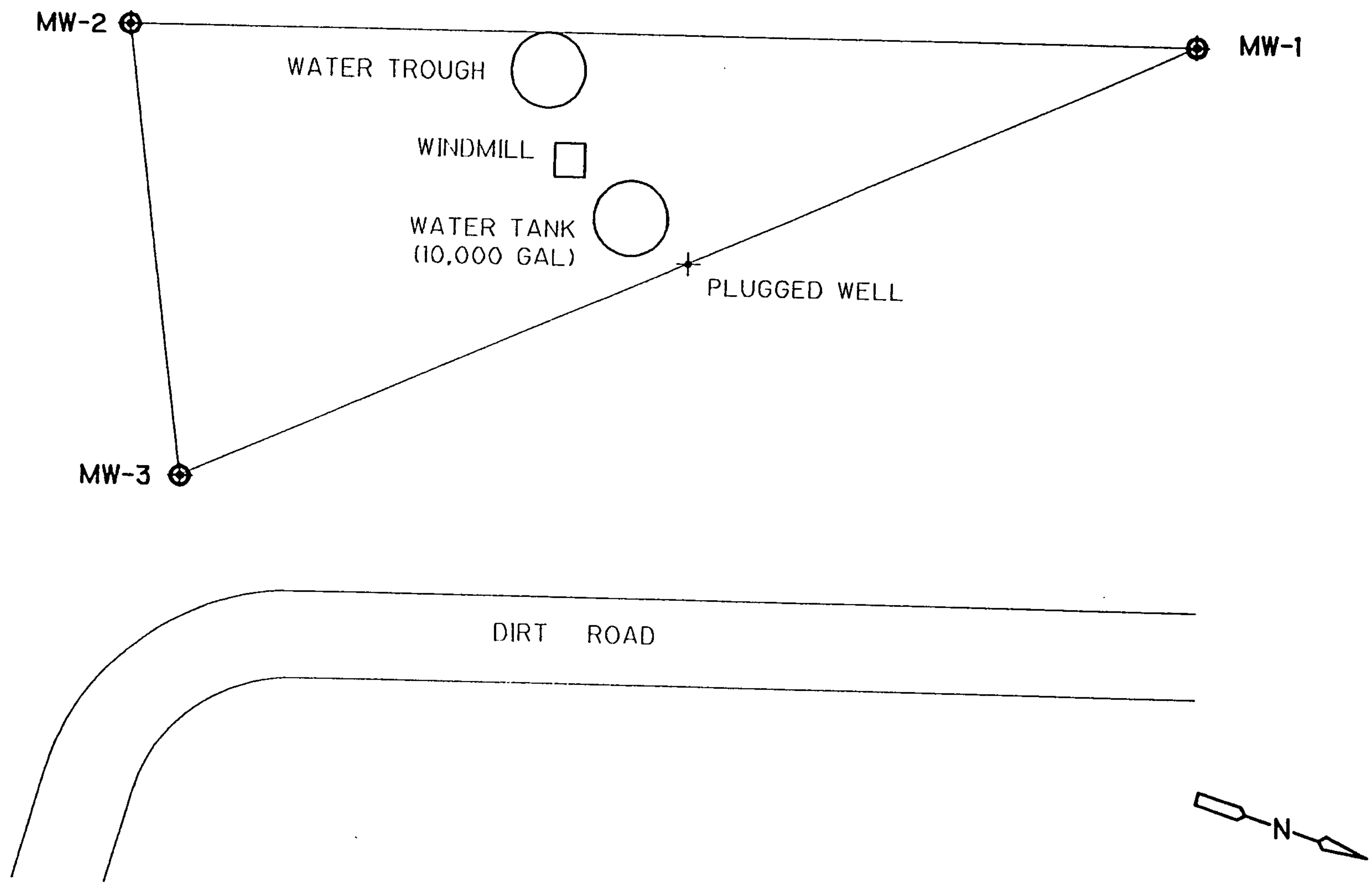
Each well was surveyed with a transit and rod to determine the top of casing (TOC) and groundwater elevations to the nearest 0.01 of a foot. Specifics of each well are as follows:

Monitor Well #	Top of Casing Elevation (FT)	Depth to Water from TOC (FT)	Groundwater Elevation (FT)
MW-1	99	78.81	20.19
MW-2	100	77.23	22.77
MW-3	98.5	81.72	16.78

Groundwater at the site appears to be flowing to the east-northeast direction with a gradient of 0.05 ft/ft. (Figure 2).

After well development, the wells were sampled for chloride concentrations , bromide, pH, and conductivity. The results are as follows:

Monitor Well #	Chloride ppm	Bromide ppm	pH	Conductivity
MW-1	100	1	7.04	796
MW-2	130	1	7.4	1109
MW-3	860	2.8	8.32	4520

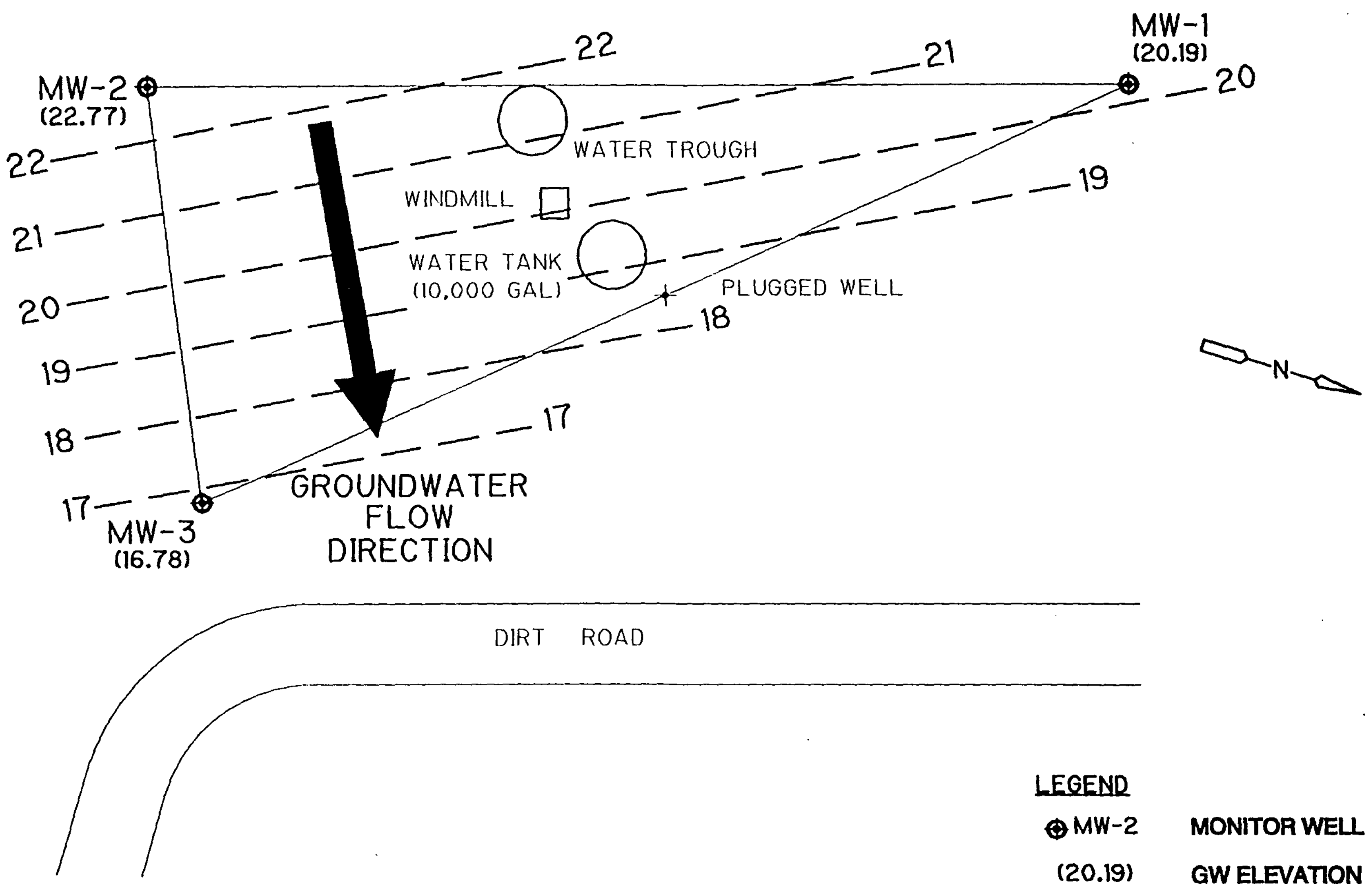


HydroGeologic Services, Inc.

HGS

McCASLAND RANCH, HOBBS, NM
SITE PLAN

Figure 1

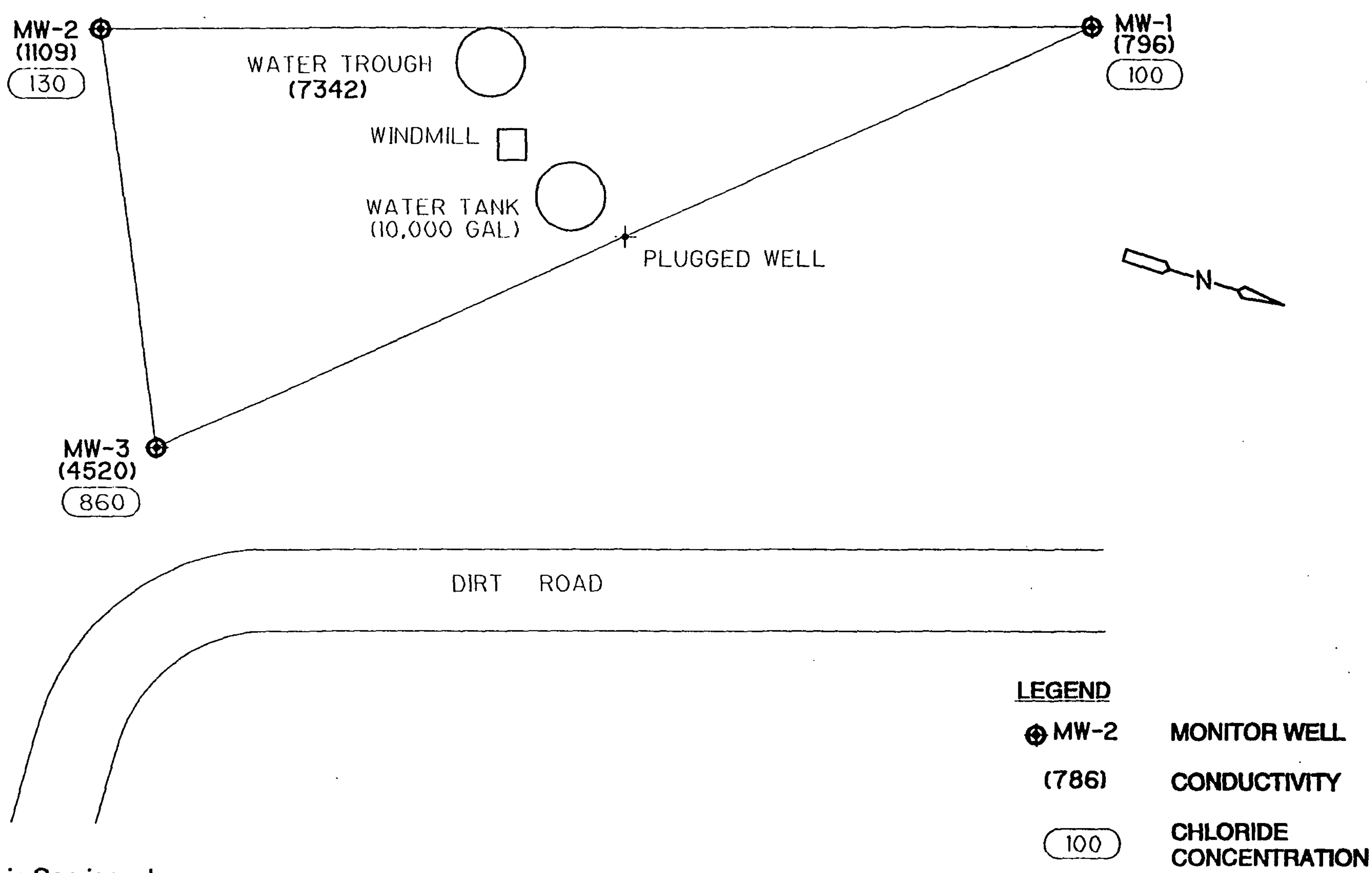


HydroGeologic Services, Inc.

HGS

McCASLAND RANCH, HOBBS, NM
GROUNDWATER FLOW DIRECTION MAP

Figure 2



HydroGeologic Services, Inc.

HGS

McCASLAND RANCH, HOBBS, NM
CONDUCTIVITY AND CHLORIDE CONCENTRATIONS MAP

Figure 3

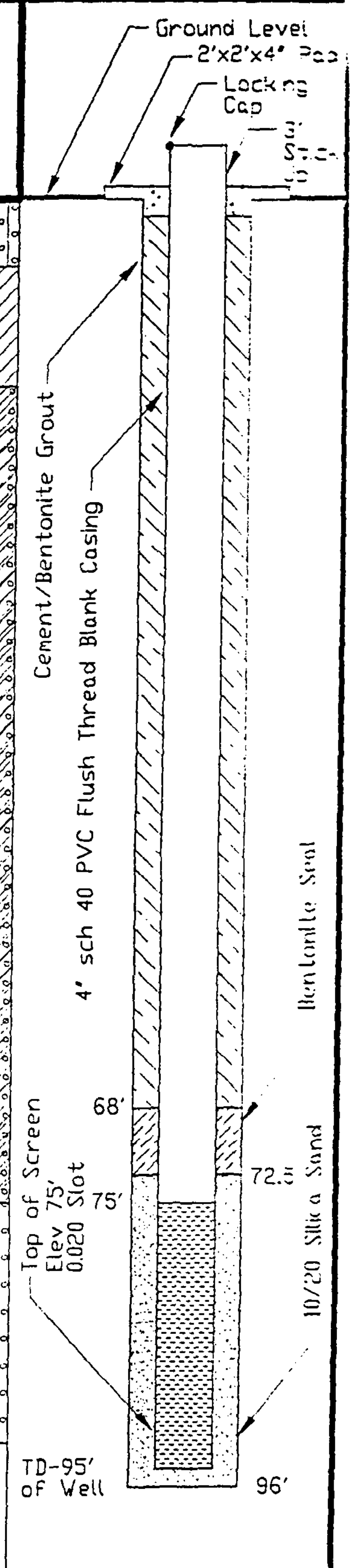
SOIL BORING NO. MW-1

SYMBOL (USCS)	SAMPLE DESCRIPTION		SAMPLING INTERVAL IN FEET
SM	0'-5'	Sand with silt, sli-moist, light brown, fine gravels	Continuously Sampled
CL	5'-14'	Clay with sand, moist, red-brown to brown, sli-plastic	
SC/CL	14'-75'	Sand with clay (Caliche), dry, tan to white, calcareous nodules	
	34'	yellow-brn to yellow, gravels to 1/2"	
	36'	brown	
	38'	yellow brown	
	43'	red brown to purple	
	49'	brown, large calcareous nodules	
	53'	purple	
	60'	tan-whitepurple	
	73'	yellow-brown	
SM	75'-92.5'	Sand with silt, wet, yellow-brown, fine gravels, subangular to subrounded	
	92.5'-TD	Clay, wet, red, sli-plastic, very fine gravels	
	96' TD		

DEPTH, FT.: 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

STRATIGRAPHY

SOIL BORING DETAILS



HydroGeologic Services, Inc.

HGS

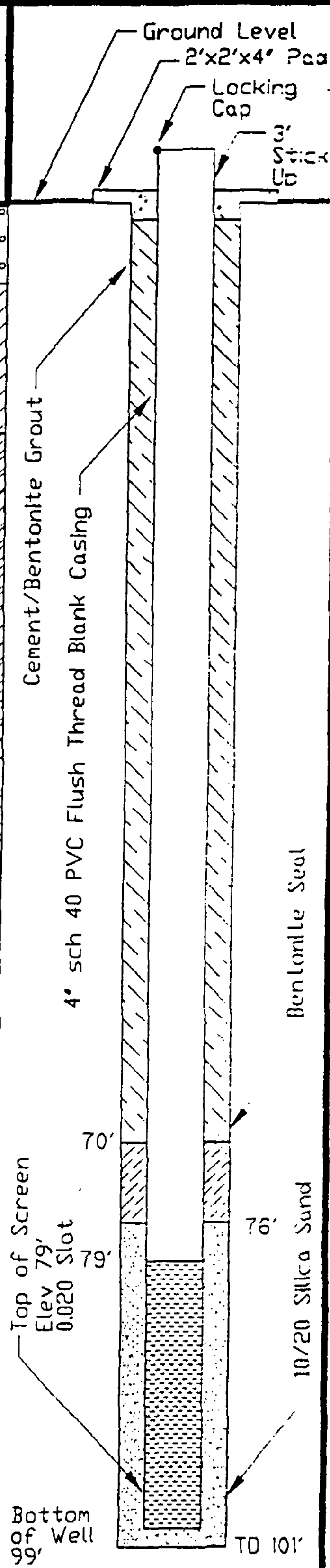
CLIENT: EDDIE SEAY
SITE: McCASLAND RANCH
TOTAL DEPTH = 96 FEET
DRILLER: DIAMOND BACK DRILLING

SOIL BORING NO.: MW-1
DRILLING METHOD: AR
LOGGED BY: B. WHALEY
DATE DRILLED: 1/4/01

SOIL BORING NO. MW-2

DEPTH, FT.	SYMBOL (USCS)	SAMPLE DESCRIPTION		SAMPLING INTERVAL IN FEET
0–6	SM	0'-6'	Sand with silt, sli-moist, brown to light brown, fine gravels	Continuously Sampled
6–17	CL	6'-17'	Clay with sand, moist, brown, sli-plastic	
17–80.5	SC/CL	17'-80.5'	Sand with clay (Caliche), dry, white to tan, hard	
		37'	yellow brown	
		45'	brown	
		47'	red brown	
		56'	tan to white	
		61'	yellow brown	
		64'	tan-white	
80.5–98.5	SM	80.5'-98.5'	Sand with silt, wet, yellow-brown, fine gravels, subangular to subrounded	
98.5–101	CL	98.5'-101' 101' TD	Clay with sand, wet, red, very fine gravels	

SOIL BORING DETAILS



HydroGeologic Services, Inc.

HGS

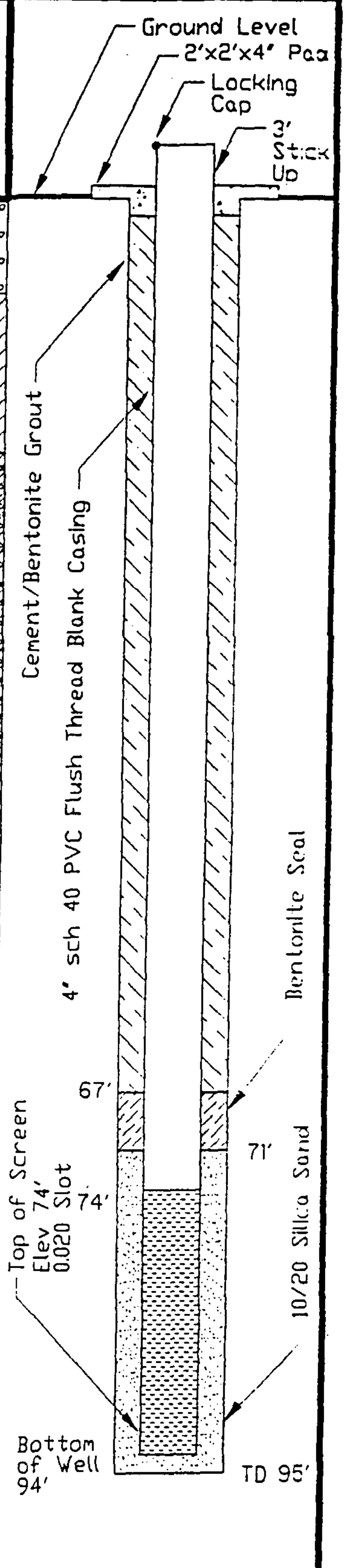
CLIENT: EDDIE SEAY
SITE: McCASLAND RANCH
TOTAL DEPTH = 99 FEET
DRILLER: DIAMOND BACK DRILLING

SOIL BORING NO.: MW-2
DRILLING METHOD: AR
LOGGED BY: B. WHALEY
DATE DRILLED: 1/4&5/01

SOIL BORING NO. MW-3

DEPTH, FT.	SYMBOL (USCS)	SAMPLE DESCRIPTION	SAMPLING INTERVAL IN FEET
0–7	SM	0'-7' Sand with silt, sli-moist, light brown, fine gravels	Continuously Sampled
5–19	CL	5'-19' Clay with sand, moist, red-brown, sli-plastic	
19–81	SC/ CL	19'-81' Sand with clay (Caliche), dry, white to tan, very hard 25'-29' 1" gravels, angular 39' yellow brown 44' red brown 48' purple 50' yellow-brown 68' tan-white	
81–92	SM	81'-92' Sand with silt, wet, yellow-brown, fine gravels, subangular to subrounded	
92–95		92'-95' Clay with sand, wet, red, sli-plastic, very fine gravels 95' TD	

SOIL BORING DETAILS



HydroGeologic Services, Inc.

HGS

CLIENT: EDDIE SEAY
SITE: McCASLAND RANCH
TOTAL DEPTH = 95 FEET
DRILLER: DIAMOND BACK DRILLING

SOIL BORING NO.: MW-3
DRILLING METHOD: AR
LOGGED BY: B. WHALEY
DATE DRILLED: 1/5/01

3.0 AQUIFER TEST

A 700 minute constant rate pump test was performed to determine the hydraulic characteristics of the water bearing formation. The pump test was performed in Monitor well MW-2 while MW-1 & MW-3 were used as observation wells. Prior to the pump test a step test was performed to determine the pumping rate for the constant rate test. It was determined that a pumping rate of 1 gallon per minute (GPM) was all the aquifer could handle without pumping under. HydroGeologic Services, Inc. (HGS) performed the pump test while Rio Grande Environmental (RGE) performed the pump test model.

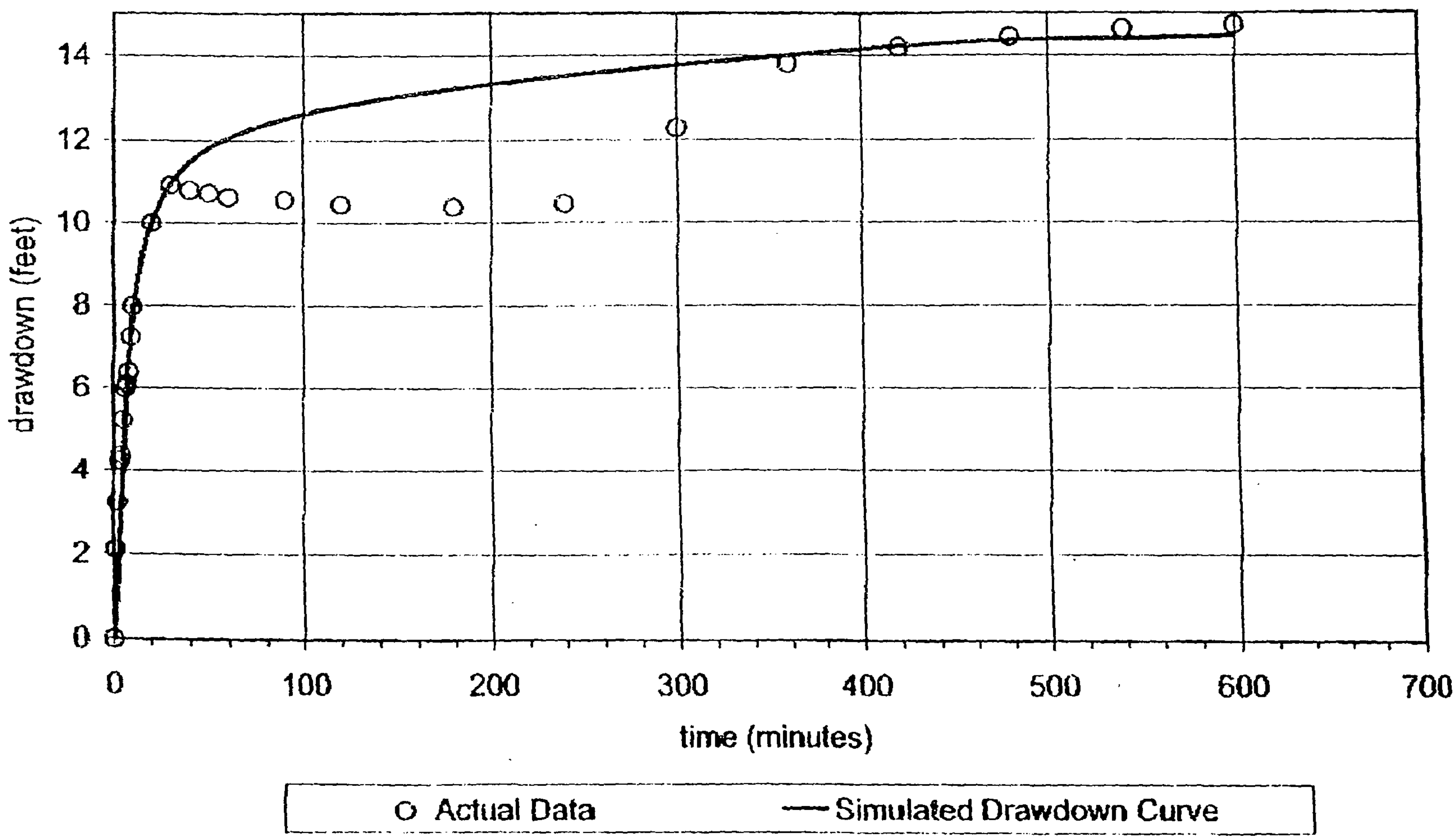
Due to the relatively high conductivity of the aquifer matrix, drawdown was not observed at either monitoring well, MW-1 and MW-3. Therefore, only the drawdown and recovery recorded at the pumping well MW-2 was analyzed. RGE utilized MODFLOW to analyze the drawdown data from MW-2. The MODFLOW model was set up an run using the graphic user interface, Groundwater Vistas. The model consists of three 15-foot thick layers and was approximately 300-feet by 300-feet. Constant head cells were positioned in the upper and lower layers of the model to simulate the relatively steep gradient across the site. The pumping well was positioned in the center of the model in the upper layer. The grid spacing was designed to reduce boundary effects within the vicinity of the pumping well. The model setup is shown in the attached figures.

Based on the model results, RGE estimated aquifer properties are as follows:

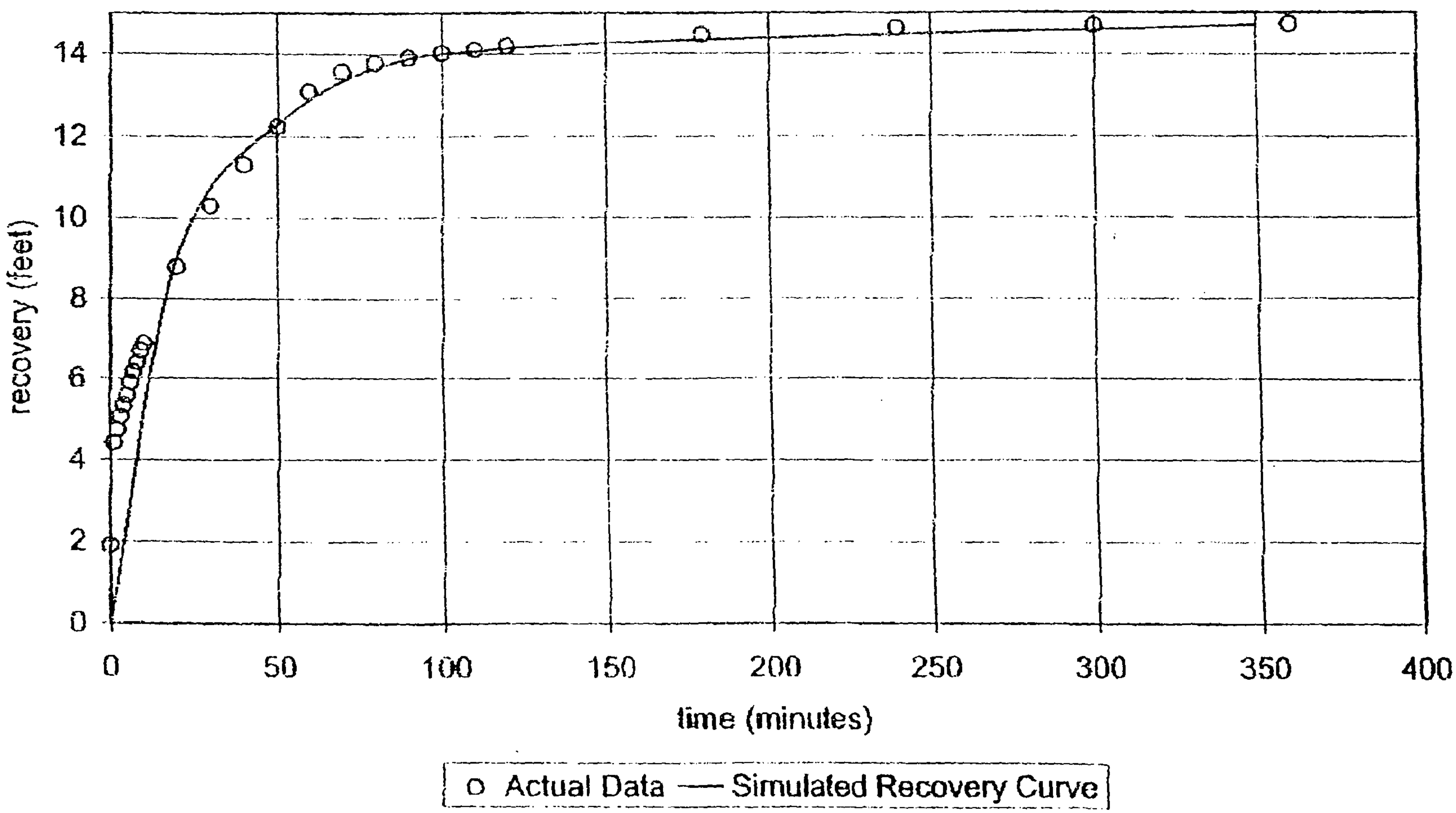
Horizontal Hydraulic Conductivity	Kx	0.87 feet/day
Vertical Hydraulic Conductivity	Kz	0.48 feet/day
Specific Yield	Sy	0.16
Storativity	S	0.0001

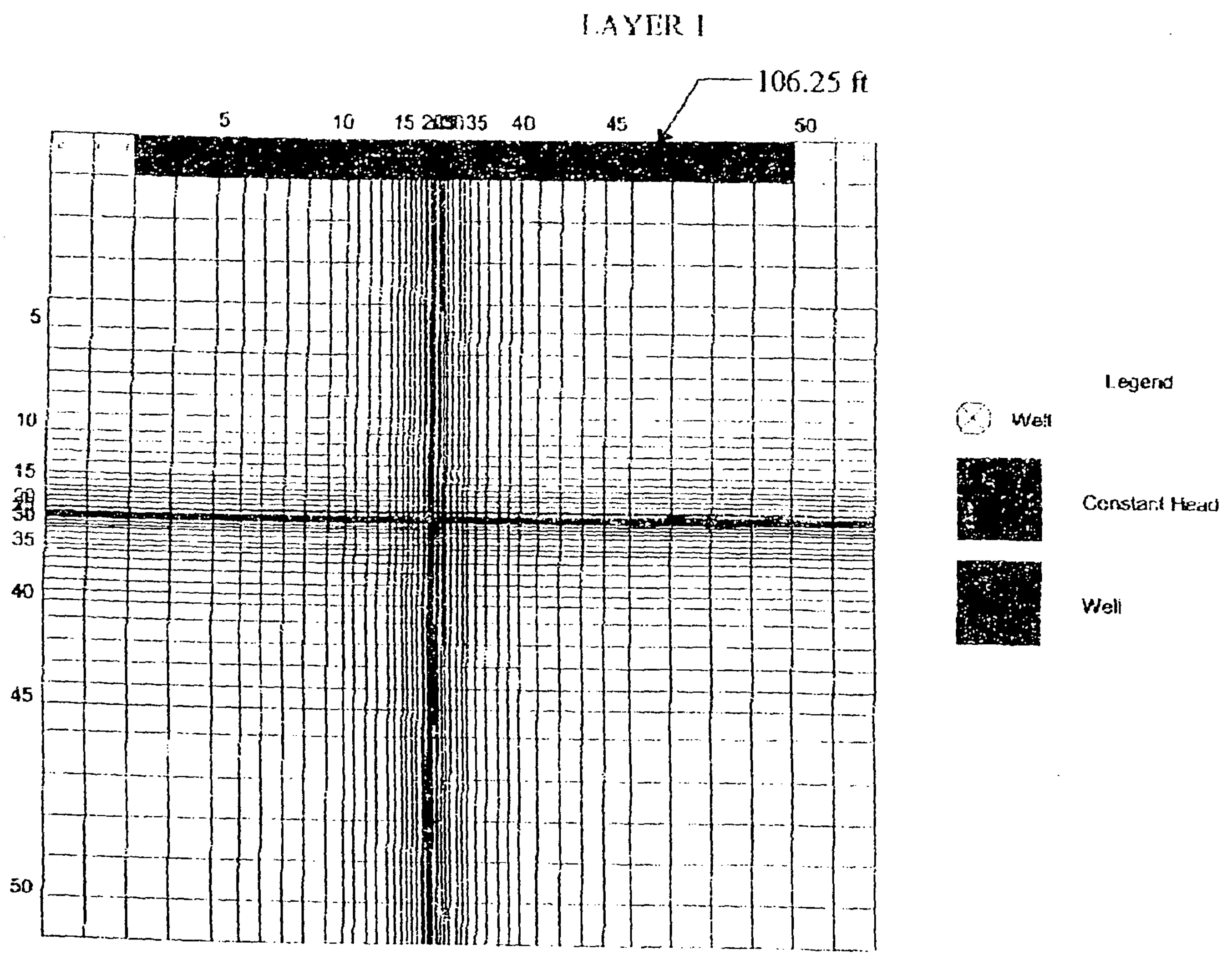
An iterative process was employed to achieve these estimates by comparing simulated drawdown verses the actual drawdown observed at MW-2 during pumping. The attached chart illustrates the match of the simulated and actual data. In addition, mass balance summaries from the model (steady-state and transient and simulated drawdown/head charts are included.

Hydrogeologic Pump Test Analysis Results
Drawdown @ MW-2
McCasland Ranch, New Mexico



Hydrogeologic Pump Test Analysis Results
Recovery @ MW-2
McCasland Ranch, New Mexico

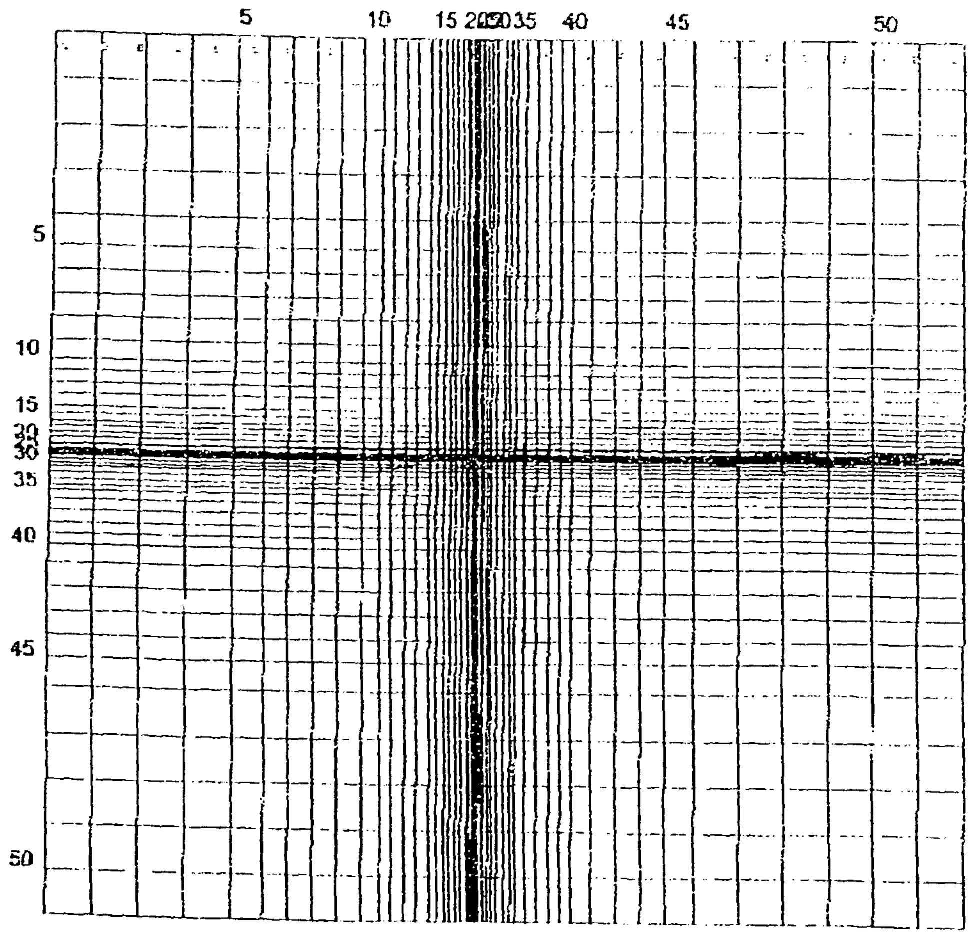




McCasland Ranch
Hydrogeologic Model
Grid Setup

RGE
January 2001

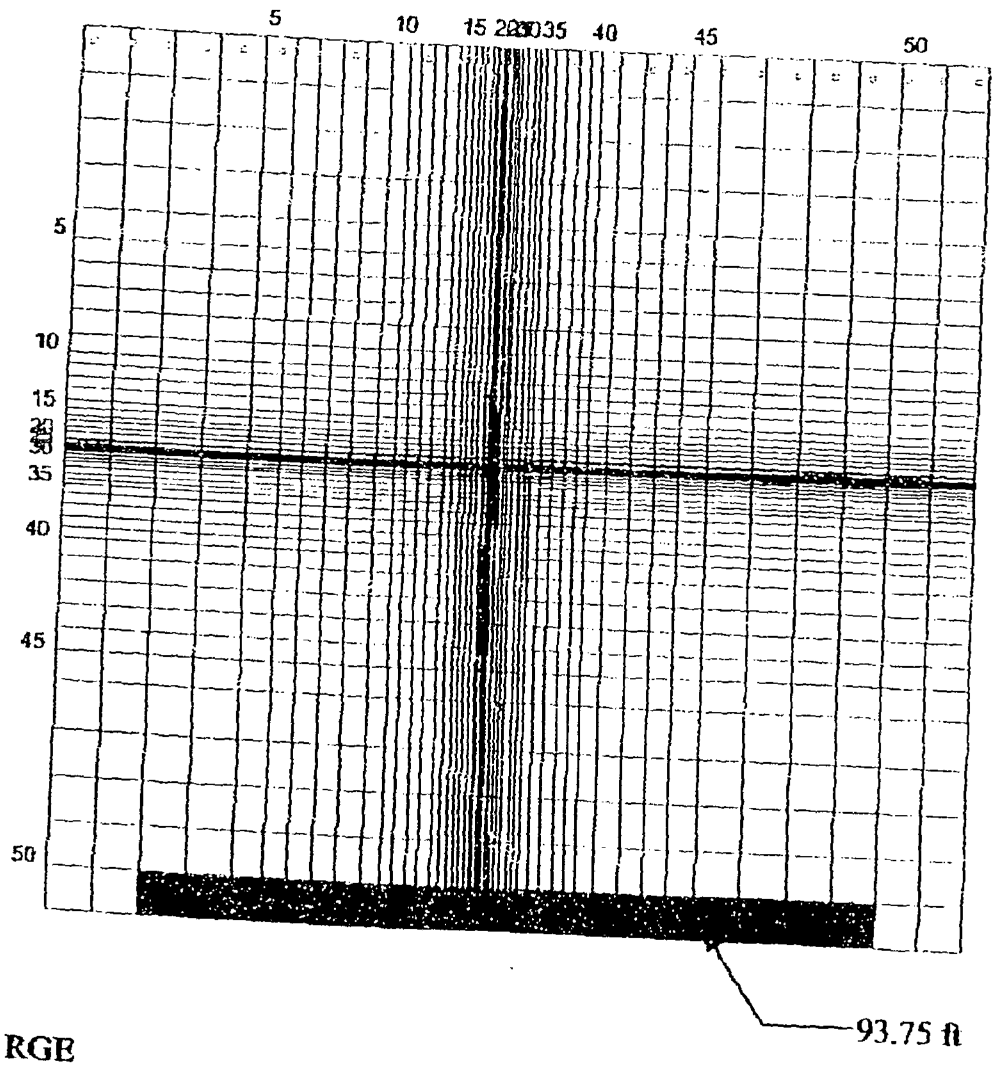
LAYER 2



RGE
January 2001

McCasland Ranch
Hydrogeologic Model
Grid Setup

LAYER 3



RGE
January 2001

McCasland Ranch
Hydrogeologic Model
Grid Setup

McCasland Ranch
Hydrogeologic Pump Test

MASS BALANCE SUMMARY
MODFLOW MODEL
STEADY-STATE SIMULATION

Type	row	column	layer	segment	reach	flux
Recharge Inflow	1	1	1	0	0	0
Recharge outflow	1	1	1	0	0	0
ET inflow	1	1	1	0	0	0
ET outflow	1	1	1	0	0	0
Qz Top inflow	1	1	1	0	0	0
Qz Top outflow	1	1	1	0	0	0
Qz Bottom inflow	1	1	1	0	0	0
Qz Bottom outflow	1	1	1	0	0	7722.883342
Storage inflow	1	1	1	0	0	0
Storage outflow	1	1	1	0	0	0
CH	1	3	1	0	0	876.105225
CH	1	4	1	0	0	461.609467
CH	1	5	1	0	0	289.386444
CH	1	6	1	0	0	227.496033
CH	1	7	1	0	0	225.047638
CH	1	8	1	0	0	223.31279
CH	1	9	1	0	0	222.054932
CH	1	10	1	0	0	165.934616
CH	1	11	1	0	0	110.393799
CH	1	12	1	0	0	110.237068
CH	1	13	1	0	0	110.103745
CH	1	14	1	0	0	109.991165
CH	1	15	1	0	0	82.431702
CH	1	16	1	0	0	54.929098
CH	1	17	1	0	0	54.91082
CH	1	18	1	0	0	54.894466
CH	1	19	1	0	0	54.87999
CH	1	20	1	0	0	41.151672
CH	1	21	1	0	0	27.430897
CH	1	22	1	0	0	21.942823
CH	1	23	1	0	0	16.456085
CH	1	24	1	0	0	10.970258
CH	1	25	1	0	0	8.227457
CH	1	26	1	0	0	10.989638
CH	1	27	1	0	0	16.453827
CH	1	28	1	0	0	21.937325
CH	1	29	1	0	0	27.420027
CH	1	30	1	0	0	27.418411
CH	1	31	1	0	0	41.124977
CH	1	32	1	0	0	54.829426
CH	1	33	1	0	0	54.82658
CH	1	34	1	0	0	54.825317
CH	1	35	1	0	0	54.825623
CH	1	36	1	0	0	82.241951
CH	1	37	1	0	0	109.67063
CH	1	38	1	0	0	109.700806
CH	1	39	1	0	0	109.744171

McCasland Ranch
Hydrogeologic Pump Test

MASS BALANCE SUMMARY
MODFLOW MODEL
STEADY-STATE SIMULATION

Type	row	column	layer	segment	reach	flux
CH	1	40	1	0	0	109.80162
CH	1	41	1	0	0	164.838348
CH	1	42	1	0	0	220.126007
CH	1	43	1	0	0	220.675156
CH	1	44	1	0	0	221.428437
CH	1	45	1	0	0	278.218262
CH	1	46	1	0	0	421.739838
CH	1	47	1	0	0	431.575287
CH	1	48	1	0	0	452.105621
CH	1	49	1	0	0	878.655029
Total IN	1	1	1	0	0	7723.0487
Total OUT	1	1	1	0	0	7722.883342
Recharge inflow	1	1	1	0	0	0
Recharge outflow	1	1	1	0	0	0
ET inflow	1	1	1	0	0	0
ET outflow	1	1	1	0	0	0
Qz Top inflow	1	1	2	0	0	7722.883342
Qz Top outflow	1	1	2	0	0	0
Qz Bottom inflow	1	1	2	0	0	0
Qz Bottom outflow	1	1	2	0	0	7722.560049
Storage inflow	1	1	2	0	0	0
Storage outflow	1	1	2	0	0	0
Total IN	1	1	2	0	0	7722.883342
Total OUT	1	1	2	0	0	7722.560049
Recharge inflow	1	1	1	0	0	0
Recharge outflow	1	1	1	0	0	0
ET inflow	1	1	1	0	0	0
ET outflow	1	1	1	0	0	0
Qz Top inflow	1	1	3	0	0	7722.560049
Qz Top outflow	1	1	3	0	0	0
Qz Bottom inflow	1	1	3	0	0	0
Qz Bottom outflow	1	1	3	0	0	0
Storage inflow	1	1	3	0	0	0
Storage outflow	1	1	3	0	0	0
CH	51	3	3	0	0	-878.555176
CH	51	4	3	0	0	-451.991302
CH	51	5	3	0	0	-289.445984
CH	51	6	3	0	0	-227.447586
CH	51	7	3	0	0	-224.921738
CH	51	8	3	0	0	-223.115784
CH	51	9	3	0	0	-221.79248
CH	51	10	3	0	0	-165.698471
CH	51	11	3	0	0	-110.219841
CH	51	12	3	0	0	-110.05162
CH	51	13	3	0	0	-109.80802
CH	51	14	3	0	0	-109.78643
CH	51	15	3	0	0	-82.273064

McCasland Ranch
Hydrogeologic Pump Test

MASS BALANCE SUMMARY
MODFLOW MODEL
STEADY-STATE SIMULATION

Type	row	column	layer	segment	reach	flux
CH	51	16	3	0	0	-54.821316
CH	51	17	3	0	0	-54.801686
CH	51	18	3	0	0	-54.78413
CH	51	19	3	0	0	-54.768635
CH	51	20	3	0	0	-41.067604
CH	51	21	3	0	0	-27.374641
CH	51	22	3	0	0	-21.89772
CH	51	23	3	0	0	-16.422211
CH	51	24	3	0	0	-10.947655
CH	51	25	3	0	0	-8.210497
CH	51	26	3	0	0	-10.947012
CH	51	27	3	0	0	-16.41987
CH	51	28	3	0	0	-21.892019
CH	51	29	3	0	0	-27.363358
CH	51	30	3	0	0	-27.361731
CH	51	31	3	0	0	-41.039967
CH	51	32	3	0	0	-54.716198
CH	51	33	3	0	0	-54.713642
CH	51	34	3	0	0	-54.712841
CH	51	35	3	0	0	-54.713795
CH	51	36	3	0	0	-82.075752
CH	51	37	3	0	0	-109.452827
CH	51	38	3	0	0	-109.487946
CH	51	39	3	0	0	-109.537651
CH	51	40	3	0	0	-109.602608
CH	51	41	3	0	0	-164.556
CH	51	42	3	0	0	-219.783188
CH	51	43	3	0	0	-220.374878
CH	51	44	3	0	0	-221.172775
CH	51	45	3	0	0	-277.971649
CH	51	46	3	0	0	-421.528442
CH	51	47	3	0	0	-431.592529
CH	51	48	3	0	0	-452.435089
CH	51	49	3	0	0	-878.888184
Total IN	1	1	3	0	0	7722.560049
Total OUT	1	1	3	0	0	7722.643522
Grand Total IN	0	0	0	0	0	7723.0487
Grand Total OUT	0	0	0	0	0	7722.643522
Grand Total ERROR	0	0	0	0	0	0.005248

RGE
January 2001

McCasland Ranch
Hydrogeologic Pump Test

MASS BALANCE SUMMARY
MODFLOW MODEL
TRANSIENT SIMULATION

Type	row	column	layer	segment	reach	flux
Recharge inflow	1	1	1	0	0	0
Recharge outflow	1	1	1	0	0	0
ET inflow	1	1	1	0	0	0
ET outflow	1	1	1	0	0	0
Qz Top inflow	1	1	1	0	0	0
Qz Top outflow	1	1	1	0	0	0
Qz Bottom inflow	1	1	1	0	0	0
Qz Bottom outflow	1	1	1	0	0	7670.80385
Storage inflow	1	1	1	0	0	4.854854
Storage outflow	1	1	1	0	0	44.036839
CH	1	3	1	0	0	878.084361
CH	1	4	1	0	0	450.614746
CH	1	5	1	0	0	288.646464
CH	1	6	1	0	0	226.880234
CH	1	7	1	0	0	224.417969
CH	1	8	1	0	0	222.672745
CH	1	9	1	0	0	221.405502
CH	1	10	1	0	0	165.441513
CH	1	11	1	0	0	110.082271
CH	1	12	1	0	0	109.903282
CH	1	13	1	0	0	109.767677
CH	1	14	1	0	0	109.652885
CH	1	15	1	0	0	82.176605
CH	1	16	1	0	0	54.758396
CH	1	17	1	0	0	54.73962
CH	1	18	1	0	0	54.722805
CH	1	19	1	0	0	54.707882
CH	1	20	1	0	0	41.022318
CH	1	21	1	0	0	27.344536
CH	1	22	1	0	0	21.873667
CH	1	23	1	0	0	16.404132
CH	1	24	1	0	0	10.935637
CH	1	25	1	0	0	8.201483
CH	1	26	1	0	0	10.934992
CH	1	27	1	0	0	16.401833
CH	1	28	1	0	0	21.867958
CH	1	29	1	0	0	27.333244
CH	1	30	1	0	0	27.331564
CH	1	31	1	0	0	40.994579
CH	1	32	1	0	0	54.655357
CH	1	33	1	0	0	54.652321
CH	1	34	1	0	0	54.650913
CH	1	35	1	0	0	54.651119
CH	1	36	1	0	0	81.980118
CH	1	37	1	0	0	109.321762
CH	1	38	1	0	0	109.352074
CH	1	39	1	0	0	109.396057

McCasland Ranch
Hydrogeologic Pump Test

MASS BALANCE SUMMARY
MODFLOW MODEL
TRANSIENT SIMULATION

Type	row	column	layer	segment	reach	flux
CH	1	40	1	0	0	109.454437
CH	1	41	1	0	0	164.31987
CH	1	42	1	0	0	219.439667
CH	1	43	1	0	0	219.99498
CH	1	44	1	0	0	220.752579
CH	1	45	1	0	0	277.384766
CH	1	46	1	0	0	420.509338
CH	1	47	1	0	0	430.391632
CH	1	48	1	0	0	451.049683
CH	1	49	1	0	0	878.517212
Well	25	25	1	0	0	0
Total IN	1	1	1	0	0	7714.629898
Total OUT	1	1	1	0	0	7714.640689
Recharge inflow	1	1	1	0	0	0
Recharge outflow	1	1	1	0	0	0
ET inflow	1	1	1	0	0	0
ET outflow	1	1	1	0	0	0
Qz Top inflow	1	1	2	0	0	7670.60385
Qz Top outflow	1	1	2	0	0	0
Qz Bottom inflow	1	1	2	0	0	0
Qz Bottom outflow	1	1	2	0	0	7865.489799
Storage inflow	1	1	2	0	0	16.211513
Storage outflow	1	1	2	0	0	21.451806
Total IN	1	1	2	0	0	7886.815363
Total OUT	1	1	2	0	0	7886.941605
Recharge inflow	1	1	1	0	0	0
Recharge outflow	1	1	1	0	0	0
ET inflow	1	1	1	0	0	0
ET outflow	1	1	1	0	0	0
Qz Top inflow	1	1	3	0	0	7865.489799
Qz Top outflow	1	1	3	0	0	0
Qz Bottom inflow	1	1	3	0	0	0
Qz Bottom outflow	1	1	3	0	0	0
Storage inflow	1	1	3	0	0	38.800561
Storage outflow	1	1	3	0	0	0
CH	51	3	3	0	0	-878.349548
CH	51	4	3	0	0	-450.514282
CH	51	5	3	0	0	-288.491425
CH	51	6	3	0	0	-226.715851
CH	51	7	3	0	0	-224.222672
CH	51	8	3	0	0	-222.450058
CH	51	9	3	0	0	-221.158876
CH	51	10	3	0	0	-165.242188
CH	51	11	3	0	0	-109.923119
CH	51	12	3	0	0	-109.75946
CH	51	13	3	0	0	-109.619606
CH	51	14	3	0	0	-109.500989

McCasland Ranch
Hydrogeologic Pump Test

MASS BALANCE SUMMARY
MODFLOW MODEL
TRANSIENT SIMULATION

Type	row	column	layer	segment	reach	flux
CH	51	15	3	0	0	-82.060417
CH	51	16	3	0	0	-54.679989
CH	51	17	3	0	0	-54.660522
CH	51	18	3	0	0	-54.643082
CH	51	19	3	0	0	-54.62759
CH	51	20	3	0	0	-40.961769
CH	51	21	3	0	0	-27.304029
CH	51	22	3	0	0	-21.84119
CH	51	23	3	0	0	-16.379782
CH	51	24	3	0	0	-10.919352
CH	51	25	3	0	0	-8.18926
CH	51	26	3	0	0	-10.918683
CH	51	27	3	0	0	-16.377344
CH	51	28	3	0	0	-21.835262
CH	51	29	3	0	0	-27.292313
CH	51	30	3	0	0	-27.290585
CH	51	31	3	0	0	-40.93298
CH	51	32	3	0	0	-54.573059
CH	51	33	3	0	0	-54.589904
CH	51	34	3	0	0	-54.56842
CH	51	35	3	0	0	-54.568615
CH	51	36	3	0	0	-81.856415
CH	51	37	3	0	0	-109.157257
CH	51	38	3	0	0	-109.188507
CH	51	39	3	0	0	-109.233887
CH	51	40	3	0	0	-109.294106
CH	51	41	3	0	0	-164.083588
CH	51	42	3	0	0	-219.134613
CH	51	43	3	0	0	-219.704407
CH	51	44	3	0	0	-220.479691
CH	51	45	3	0	0	-277.073395
CH	51	46	3	0	0	-420.118011
CH	51	47	3	0	0	-430.122131
CH	51	48	3	0	0	-450.951385
CH	51	49	3	0	0	-878.81189
Total IN	1	1	3	0	0	7704.29036
Total OUT	1	1	3	0	0	7704.351263
Grand Total IN	0	0	0	0	0	7769.641773
Grand Total OUT	0	0	0	0	0	7769.639908
Grand Total ERROR	0	0	0	0	0	-0.00255

4.0 CONCLUSIONS/RECOMMENDATIONS

1. Based on the recently installed monitoring wells, groundwater flow direction is to the East-Northeast at a gradient of 0.05 ft/ft.

2. Chloride contamination has been identified in MW-3 at 860 ppm.

3. The source of contamination appears to be from the plugged oil/gas well. If the well was not pressure grouted correctly the chloride contamination could migrate up through the well annulus.

4. Additional wells are needed (min 3 to 5) to determine the extent of the chloride plume.

5. The initial pump test served its purpose to help define the characteristics of the aquifer. When designing a pump and treat system, more information is needed. HGS suggest performing another pump test of longer duration (min. 24 hrs) with an observation within 10-feet of the pumping well.

6. To prevent further chloride contamination of the the aquifer, HGS suggests properly abandoning the upper portion of the plugged oil/gas well. The well should be overdrilled using the Air Rotary Casing Hammer (ARCH) method with 9 5/8" drive pipe to a minimum 200 feet and backfilled with grout from the bottom up to assure the a proper seal.

ESTIMATED COST OF CLEANUP OF GROUNDWATER
McCASLAND RANCH

The McCasland Ranch is approximately 15 minutes south of Hobbs, New Mexico on state road 18. There is oil production throughout the property. The fresh water zone is less than 100 feet from the surface. Water samples taken from various windmills on the property have shown one windmill with elevated levels of inorganic compounds (anions). This particular windmill has been tested several times since March 31,1998. Due to the continued indication of contamination in this area, it has become necessary to develop a program to treat the affected groundwater.

In order to formulate a reasonable cost of cleanup of the groundwater on the McCasland Ranch, three areas must be considered. The first is the elimination of the source of the contamination. The second is the definition of the boundaries of the plume. The final is the treatment of the impacted groundwater. A breakdown of all estimated costs is attached.

The source of the contamination must be eliminated in order to provide the most efficient and cost effective cost of cleanup of the impacted groundwater. Due to the fact that the levels of contamination have not significantly diminished in the last 2 years, it is reasonable to believe that the contamination is ongoing. The impacted groundwater contains elevated levels of both chloride and bromide. This is consistent with an impact from oil field type contamination

The recently placed monitor well, approximately 175 feet up gradient (MW1) from both the windmill and plugged well, had diminished levels of both chloride (100 ppm) and bromide (1 ppm). The monitor well approximately 125 feet down gradient (MW3) from both the windmill and plugged well had elevated levels of both chloride (870 ppm) and bromide (2.8 ppm). This information indicates that the contamination has occurred somewhere between the two monitor wells.

There are three check valves between the large holding tank and bottom of the windmill. These were inspected on November 28, 2000. The windmill pump was removed and the well developed with an electric pump. The water well service operator, Mr. Jay Anthony, inspected the check valves on the windmill pump. In addition, while the pipe was disconnected from the large water holding tank, the valve was opened. No water leaked from the tank. The water level was several feet above the level of the valve. The only other source of contamination between the two monitor wells is the plugged well approximately 50 feet northeast of the windmill. The plugged well is the most likely source of contamination.

In order to formulate a cost for the elimination of the source of the contamination, Maryo Marrs Casing Pullers of Kermit, Texas was contacted. After a description of the problem, a cost for the replugging of the well was formulated. This cost is only an estimate. The costs may increase depending on what is encountered once the well is entered.

Once the source has been eliminated, it would be necessary to delineate the groundwater contamination plume. This could be accomplished with the installation of monitor wells. Because the direction and southwestern boundary of the contamination has already been established, a limited number of monitor wells should be necessary to profile the existing plume. After a discussion with Mr. Bill Whaley CPG of HydroGeologic Services, Inc., an estimate of 3 to 5 additional wells should be sufficient.

Treatment of the groundwater would be accomplished by pumping out the contaminated water and running it through the system. Some or all of the monitor wells could be utilized to extract the groundwater to be treated. After considering several technologies, a reverse osmotic (RO) system was the most cost effective for the removal of the target contaminates.

Once the system had been installed the treatment of the groundwater would occur over several years. The length of time is dependent on the size of the plume, amount of contamination encountered and the mobility of the groundwater. An estimate for the duration of the treatment is between 8 to 10 years.

Additional costs not discussed previously would be the continued sampling and chemical analysis of the water. This analysis would occur before and after treatment on a quarterly basis. Maintenance of the treatment system would occur on an annual basis.

Estimated Cost of Cleanup

<u>Replugging Plugged Well</u>	
Drill Rig, Pulling Unit and hands:	$20,000 to $25,000
<u>Profile groundwater contamination</u>	
3 to 5 monitor wells	$9,500 ea.
pumps and piping	$1,800 ea.
<u>Installation reverse osmosis system</u>	
150 gal/day	$ 3,900
800 gal/day	$ 4,995
3000gal/day	$11,900
Annual maintenance	$ 2,000
<u>Quarterly sampling and analysis</u>	
Sampler, laboratory analysis	$10,000/yr

Total cost of cleanup Low $153,800 High $213,400

TraceAnalysis , Inc.
General Terms and Conditions

Article 1: General

1.1 The words "we", "us", and "our" refer to TraceAnalysis. You will deliver samples to us for analysis, accompanied, or preceded by, a signed Chain of Custody/Analysis Request defining the scope and timing of our work and stating either the testing criteria you require or identifying the agency to which the results will be submitted.

Article 2: Our General Responsibilities

2.1 [illegible] to provide the professional services described in this agreement. We will provide you with written reports containing analytical results. In performing our service, we will use that degree of care and skill o[illegible]cised under similar circumstances by reputable members of our profession practicing in the same locality.

2[illegible] and observations will be conducted using test procedures and laboratory protocols as specified in accepted Chain of Custody/Analysis Request. If you direct a manner of making tests that varies from our standard or recommended procedures, you agree to hold us harmless from all claims, damages, and expenses arising out of your direction.

2.3 We will not release information regarding our services for you or any information that we receive from you, except for information that is in the public domain and except as we are required by law.

Article 3: Your General Responsibilities

3.1 On each Chain of Custody/Analysis Request you will designate a representative who has authority to transmit instructions, receive information, and make decisions relative to our work.

3.2 You will respond in a reasonable time to our request for decisions, authorization for changes, additional compensation, or schedule extensions.

3.3 For each Chain of Custody/Analysis Request you will either provide us with the exact methods for analysis of each fraction or you will identify the regulations and agency under which or for which the analysis are to be prepared. If permits, consent orders, work plans, quality assurance plans, or correspondence with regulatory agencies address laboratory requirements, you will provide us with copies of the relevant provisions prior to our initiation of the analyses.

Article 4: Reports and Records

4.1 We will furnish copies of each report to you as specified in the Chain of Custody and Analysis Request. We will retain analytical data for seven years and financial data for three years relating to the services performed following transmittal of our final report.

4.2 If you do not pay for our services as agreed, you agree that we may retain all reports and work not yet delivered to you. You also agree that our work will not be used by you for any purpose unless paid for.

Article 5: Delivery and Acceptance of Samples

5.1 Until we accept delivery of samples by notation on chain of custody documents or otherwise in writing accept the samples, you are responsible for loss of or damage to samples. Until so accepted, we have no responsibility as to samples.

5.2 As to any samples that are suspected of containing hazardous substances or radioactive material, such that would make special handling required, you will specify the suspected or known substances and level and type of radioactive activity. This information will be given to us in writing as a part of the Chain of Custody/Analysis Request and will precede or accompany samples suspected of containing hazardous substances.

5.3 Samples accepted by us remain your property while in our custody. We will retain samples for a period of 14 days following the date of submission or our report. We will extend the retention period if you so direct. Following the retention period we will dispose of non-hazardous samples. We may return highly hazardous, acutely toxic, or radioactive samples and samples containers and residues to you. You agree to accept them.

5.4 Regardless of a prior acceptance, we may refuse acceptance or revoke acceptance of samples if we determine that the samples present a risk to health, safety, or the environment, or that we are not authorized to accept them. If we revoke acceptance of any sample, you will have it removed from our facilities promptly.

Article 6: Changes to Task Orders

6.1 No persons other than the designated representatives for each Chain of Custody/Analysis Request are authorized to act regarding changes to a Chain of Custody/Analysis Request. We will notify you promptly if we identify any activity that we regard as a change to the terms and conditions of a Chain of Custody/Analysis Request. Our notice will include the date, nature, circumstance, and cause of the activity regarded as a change. We will specify the particular elements of project performance for which we may seek an equitable adjustment.

6.2 You will respond to the notice provided for in paragraph 6.1 promptly. Changes may be made to a Chain of Custody/Analysis Request through issuance of an amendment. The amendment will specify the reason for the change and, as appropriate, include any modified budgets, schedules, scope of work, and other necessary provisions.

6.3 Until agreement is reached concerning the proposed change, we may regard the situation as a suspension directed by you.

Article 7: Compensation

7.1 O[illegible]cing for the work is predicated upon your acceptance of the conditions and allocations of risks and responsibilities described in this agreement. You agree to pay for services as stated in our proposal and acce[illegible] you or according to our then current standard pricing documents if there is no other written agreement as to price. An estimate or statement of probable cost is not a firm figure unless stated as such.

7.2 [illegible]otherwise agreed to elsewhere, you agree to pay invoices within 30 days of receipt unless, within 15 days from receipt of the invoice, you notify us in writing of a particular item that is alleged to be incorrect. You [illegible] to pay the uncontested portions of the invoices within 30 days of receipt. You agree to pay interest on unpaid balances beginning 60 days after receipt of invoice at the rate of 1.5% per month, but not to exceed the maximum rate allowed by law.

7.3 If you direct us to invoice another, we will do so, but you agree to be ultimately responsible for our compensation until you provide us with that third party's written acceptance of all terms of our agreement and until we agree to the substitution.

7.4 You agree to compensate us for our services and expenses if we are required to respond to legal process related to our services for you. Compensable services include hourly charges for all personnel involved in the response and attorney fees reasonably incurred in obtaining advice concerning the response, the preparation of the testifier, and appearances related to the legal process.

7.5 If we are delayed by, or the period of performance is materially extended because of, factors beyond our control, or if project condition or the scope or amount of work change, or if the standards or methods of testing change, we will give you timely notice of the change and we will receive an equitable adjustment of our compensation.

Article 8: Risk Allocation, Disputes, and Damages

8.1 Neither we nor you will be liable to the other for special, incidental, consequential or punitive losses or damages, including but not limited to those arising from delay, loss of use, loss of profits or revenue, or the cost of capital.

8.2 We will not be liable to you for damages unless suit is commenced within two years of injury or loss or within two years of the date of the completion of our services, whichever is earlier. In no event will we be liable to you unless you have notified us of the discovery of the negligent act, error, omission or breach within 30 days of the date of its discovery and unless you have given us an opportunity to investigate and to recommend ways of mitigating your damages.

8.3 In the event you fail to pay us within 90 days following the invoice date, we may consider the default a total breach of our agreement and we may, at our option, terminate all of our duties without liability to you or to others.

8.4 If it is claimed by a third party that we did not complete an acceptable analysis, at your request will seek further review and acceptance of the completed work by the third party and use your best efforts to obtain that acceptance. We will assist you as directed.

8.5 You and we agree that disputes will be submitted to "Alternative Dispute Resolution" (ADR) as a condition precedent to litigation and other remedies provided by law. Each of us agrees to exercise good faith efforts to resolve disputes through mediation unless we both agree upon another ADR procedure. All disputes will be governed by the law of the place where our services are rendered, or if our services are rendered in more than one state, you and we agree that the law of the place that services were first rendered will govern.

8.6 If either of us makes a claim against the other as to issues out of the performance of this agreement, the prevailing party will be entitled to recover its reasonable expenses of litigation, including reasonable attorney's fees. If we bring lawsuit against you to collect our invoiced fees and expenses, you agree to pay our reasonable collection expenses including attorney fees.

Article 9: Indemnities

9.1 We will indemnify and hold you harmless from and against demands, damages, and expenses caused by our negligent acts and omissions and breach of contract and by the negligent acts and omissions and breach of contract of persons for whom we are legally responsible. You will indemnify and hold us harmless from and against demands, damages, and expenses caused by your negligent act and omissions and breach of contract and by the negligent acts and omissions and breach of contract of persons for whom you are legally responsible. These indemnities are subject to specific limitations provided for in this agreement.

Article 10: Miscellaneous Provisions

10.1 This agreement constitutes the entire agreement between you and us, and it supersedes all prior agreements. Any term, condition, prior course of dealing, course of performance, usage of trade, understanding, purchase order conditions, or other agreement purporting to modify, vary, supplement, or explain any provision of this agreement is of no effect until placed in writing and signed by both parties subsequent to the date of this agreement. In no event will the printed terms or conditions stated in a purchase or work order, other than an agreed upon Chain of Custody/Analysis Request, be considered a part of this agreement, even if the document is signed by both of us.

10.2 [illegible]her party will assign this agreement without the express written approval of the other, but we may subcontract laboratory procedures with your approval as we deem necessary to meet our obligations to you.

10[illegible] of the provisions of this agreement are held to be invalid or unenforceable in any respect, the remaining terms will be in full effect and the agreement will be construed as if the invalid or unenforceable matters we[illegible] included in it. No waiver of any default will be waiver of any future default.

10.4 [illegible] you or we will have any liability for nonperformance caused in whole or in part by causes beyond our reasonable control. Such causes include but are not limited to Acts of God, civil unrest and war, labor unrest and strikes, equipment failures, matrix interference, acts of authorities, and failures of subcontractors that could not be reasonably anticipated.

10.5 You may stop our work by giving a written suspension or termination directive, but once work has been suspended, we need not resume work until we agree to change in scope, schedule, and compensation. Upon suspension or termination, we will use reasonable care to preserve samples provided that you agree to compensate us for any additional effort, but we will have no responsibility for meeting holding time limitations after the effective time of a suspension or termination directive. We will be compensated for service rendered and expenses incurred prior to termination that cannot reasonably be avoided.

Page 1 of 1

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

TraceAnalysis, Inc.

4725 Ripley Dr., Ste A
El Paso, Texas 79922-1028
Tel (915) 585-3443
Fax (915) 585-4944
1 (888) 588-3443

CHAIN-OF-CUSTODY AND ANALYSIS REQUEST

LAB Order ID # A00120106

Company Name: NM Oil Conservation Division Phone #: (505) 827-7154

Address: (Street, City, Zip) 2040 S. Pacheco, Santa Fe, NM 87505 Fax #: (505) 827-8177

Contact Person: Bill Olson

Invoice to: (If different from above)

Project #: Project Name: McCasland

Project Location: Sampler Signature: Will Olson

LAB # (LAB USE ONLY)	FIELD CODE	# CONTAINERS	Volume/Amount	MATRIX: WATER	SOIL	AIR	SLUDGE		PRESERVATIVE METHOD: HCL	HNO3	$NaHSO_4$	H_2SO_4	NaOH	ICE	NONE		SAMPLING: DATE	TIME
159868	0011281230 (windmill)	1	liter	✓										✓			11/28/00	12:30
	0011281230 (windmill)	1	500 ml	✓						✓				✓			11/28/00	12:30

ANALYSIS REQUEST (Circle or Specify Method No.)

Field Code	MTBE 8021B/602	BTEX 8021B/602	TPH 418.1/TX1005	PAH 8270C	Total Metals Ag As Ba Cd Cr Pb Se Hg 6010B/200.7	TCLP Metals Ag As Ba Cd Cr Pb Se Hg	TCLP Volatiles	TCLP Semi Volatiles	TCLP Pesticides	RCI	GC-MS Vol. 8260B/624	GC/MS Semi. Vol. 8270C/625	PCB's 8082/608	Pesticides 8081A/608	BOD, TSS, pH	Gen Chem (OCD Contract #24)	OCD metals (Contract #23)			Turn Around Time if different from standard	Hold
0011281230 (windmill), 1 liter																✓					
0011281230 (windmill), 500 ml																	✓				

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Will Olson	11/30/00	1600			
Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received at Laboratory by:	Date:	Time:
			Vicki	12-1-00	10:00

LAB USE ONLY
Intact (Y) / N
Headspace Y / N
Temp -1°
Log-in Review [initials]

REMARKS: 12/13

Carrier # 7816820980 764559

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

CHAIN-OF-CUSTODY RECORD

HALL ENVIRONMENTAL ANALYSIS LABORATORY
4901 Hawkins NE, Suite A
Albuquerque, New Mexico 87109
Tel. 505.345.3975 Fax 505.345.4107
www.hallenvironmental.com

Client: ECD Environmental

Address: P.O. Box 9338
Alb. NM
87119

Phone #: 268-2401

Fax #: 842-6213

Project Name: McCasland

Project #:

Project Manager:

Sampler: ES

Samples Cold?: ☒ Yes ☐ No

Date	Time	Matrix	Sample I.D. No.	Number/Volume	Preservative $HgCl_2$	Preservative HCl	HEAL No.
8/16/98		H_2O	McCasland water well				9908063-1
"		"	Marbourne [illegible] Mw				2

ANALYSIS REQUEST

HEAL No.	BTEX + MTBE/TMB's (8021)	BTEX + MTBE + TPH (Gasoline Only)	TPH Method 8015B MOD (Gas/Diesel)	TPH (Method 418.1)	Volatiles Full List (8021)	EDB (Method 504.1)	EDC (Method 8021)	8310 (PNA or PAH)	RCRA 8 Metals	Cations (Na, K, Ca, Mg)	Anions (F, Cl, NO_3, NO_2, PO_4, SO_4)	8081 Pesticides / PCB's (8082)	8260 (VOA)	8270 (Semi-VOA)	BC		Air Bubbles or Headspace (Y or N)
1				X						X	X				X		
2	X			X						X	X				X		

Date: 8/17/98 Time: Relinquished By: (Signature)

Received By: (Signature) 8/17

Date: Time: Relinquished By: (Signature)

Received By: (Signature)

Remarks:

CHAIN-OF-CUSTODY RECORD

HALL ENVIRONMENTAL ANALYSIS LABORATORY
4901 Hawkins NE, Suite A
Albuquerque, New Mexico 87109
Tel. 505.345.3975 Fax 505.345.4107
www.hallenvironmental.com

HII5V Fd Exl 10 sub

Client: SEE RIGHT

Address:

Phone #:

Fax #:

Project Name: McCasland

Project #: ~~KW~~ 9908063

Project Manager: G. McQuiff

Sampler:

Samples Cold?: ☒ Yes ☐ No

Date	Time	Matrix	Sample I.D. No.	Number/Volume	Preservative $HgCl_2$	Preservative HCl	Preservative None	HEAL No.
8/16/99		Aq	McCasland Water Well	1 500ml ~~Aq~~			X	001-99-56001
↓		↓	Meadowlark Oil Co MW	1-750ml			X	002 ↓

ANALYSIS REQUEST

Sample	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gasoline Only)	TPH Method 8015B MOD (Gas/Diesel)	TPH (Method 418.1)	Volatiles Full List (8021)	EDB (Method 504.1)	EDC (Method 8021)	8310 (PNA or PAH)	RCRA 8 Metals	Cations (Na, K, Ca, Mg)	Anions (F, Cl, NO_3, NO_2, PO_4, SO_4)	8081 Pesticides / PCB's (8082)	8260 (VOA)	8270 (Semi-VOA)				Air Bubbles or Headspace (Y or N)
001										X								
002										X								

Date: 8/19/99 Time: 2:40 Relinquished By: (Signature) [signature]

Received By: (Signature)

Date: Time: Relinquished By: (Signature)

Received By: (Signature) Krystal Simms 08/20/99 @ 1155

Remarks:

CHAIN-OF-CUSTODY RECORD

HALL ENVIRONMENTAL ANALYSIS LABORATORY
5121 69th St., Suite A-7
Lubbock, TX 79424
(806) 798-9882 • Fax (806) 798-8434

Client: ECO

Address: P.O. Box 9328
Alb., NM 87119

Phone #: (505) 268-2401

Fax #: 242-6213

Project Name: McCasland

Project #:

Project Manager:

Sampler: GB

Samples Cold?: ☒ Yes ☐ No

Date	Time	Matrix	Sample I.D. No.	Number/Volume	Preservative			HEAL No.
11/28/01		H_2O	McCasland windmill	1st purge				0011154-1
			McCasland windmill					-2
			McCasland Blank					-3

ANALYSIS REQUEST

HEAL No.	BTEX + MTBE (602/8020)	BTEX + MTBE + TPH (Gasoline Only)	TPH Method 8015 MOD (Gas/Diesel)	TPH (Method 418.1)	8010/8020 Volatiles	EDB (Method 504)	EDC (Method 8010)	8310 (PNA or PAH)	RCRA 8 Metals	Cations (Na, K, Ca, Mg)	Anions (F, Cl, NO_2, NO_3, PO_4, SO_4)	8081/8082 Pesticides/PCB's	8260 (VOA)	8270 (Semi-VOA)	TPH (TNRCC-TX Method 1005)	Bc		Air Bubbles or Headspace (Y or N)
0011154-1										X	X					X		
-2									X	X	X					X		
-3											X					X		

Date: 11/30/01 Time: 4:30 Relinquished By (Signature): [illegible]

Received By (Signature): [illegible] 11/30

Date: Time: Relinquished By (Signature):

Received By (Signature):

Remarks:

PM-10440

CHAIN-OF-CUSTODY RECORD

HALL ENVIRONMENTAL ANALYSIS LABORATORY
4901 Hawkins NE, Suite A
Albuquerque, New Mexico 87109
Tel. 505.345.3975 Fax 505.345.4107
www.hallenvironmental.com

Client: ECO

Address: PO Box 9328
Alb NM
87119

Phone #: 268-2401

Fax #: 242-6313

Project Name: McCaslnad

Project #:

Project Manager: G. Dykep

Sampler: GB

Samples Cold?: ☒ Yes ☐ No

Date	Time	Matrix	Sample I.D. No.	Number/Volume	Preservative $HgCl_2$	Preservative HCl		HEAL No.
1/8/01		H_2O	MW-1					0101044-1
"		"	MW-2					-2
"		"	MW-3					-3

ANALYSIS REQUEST

Sample I.D. No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gasoline Only)	TPH Method 8015B MOD (Gas/Diesel)	TPH (Method 418.1)	Volatiles Full List (8021)	EDB (Method 504.1)	EDC (Method 8021)	8310 (PNA or PAH)	RCRA 8 Metals	Cations (Na, K, Ca, Mg)	Anions (F, Cl, NO_3, NO_2, PO_4, SO_4)	8081 Pesticides / PCB's (8082)	8260 (VOA)	8270 (Semi-VOA)	BR		Air Bubbles or Headspace (Y or N)
MW-1				X					X	X	X				X		
MW-2				X					X	X	X				X		
MW-3				X					X	X	X				X		

Date: 1/9/01 Time: 5:30 Relinquished By: (Signature) [signature]

Received By: (Signature) Jeff Bue 1/9/01 erst

Date: Time: Relinquished By: (Signature)

Received By: (Signature)

Remarks: * 3day TAT if possible

Hall Environmental
Analysis Laboratory

January 12, 2001

Greg Bybee
ECD Environmental
PO Box 9328
Albuquerque, NM 87119
TEL: (505) 758-7686
FAX (505) 758-7601

RE: McCasland

Order No.: 0101044

Dear Greg Bybee:

Hall Environmental Analysis Laboratory received 3 samples on 1/9/01 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent.

Detection limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman, Senior Project Manager
Nancy McDuffie, Assistant Laboratory Manager

Hall Environmental Analysis Laboratory

Date: 12-Jan-01

CLIENT: ECD Environmental
Lab Order: 0101044
Project: McCasland
Lab ID: 0101044-01

Client Sample ID: MW-1
Collection Date: 1/8/01
Matrix: AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY 300.0		E300				Analyst: SDU
Bromide	1.0	0.50		mg/L	5	1/10/01
Chloride	100	0.50		mg/L	5	1/10/01
Fluoride	ND	0.50		mg/L	5	1/10/01
Nitrate (As N)+Nitrite (As N)	1.8	0.50		mg/L	5	1/10/01
Phosphorus, Dissolved Orthophosphate (As P)	ND	2.5		mg/L	5	1/10/01
Sulfate	89	2.5		mg/L	5	1/10/01
TPH BY 418.1		E418.1				Analyst: JT
Petroleum Hydrocarbons, TR	ND	1.0		mg/L	1	1/11/01

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Hall Environmental Analysis Laboratory

Date: *12-Jan-01*

CLIENT: ECD Environmental
Lab Order: 0101044
Project: McCasland
Lab ID: 0101044-02

Client Sample ID: MW-2
Collection Date: 1/8/01
Matrix: AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY 300.0		E300				Analyst: SDU
Bromide	1.0	0.50		mg/L	5	1/10/01
Chloride	130	0.50		mg/L	5	1/10/01
Fluoride	ND	0.50		mg/L	5	1/10/01
Nitrate (As N)+Nitrite (As N)	1.1	0.50		mg/L	5	1/10/01
Phosphorus, Dissolved Orthophosphate (As P)	ND	2.5		mg/L	5	1/10/01
Sulfate	61	2.5		mg/L	5	1/10/01
TPH BY 418.1		E418.1				Analyst: JT
Petroleum Hydrocarbons, TR	ND	1.0		mg/L	1	1/11/01

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

Hall Environmental Analysis Laboratory

Date: 12-Jan-01

CLIENT: ECD Environmental
Client Sample ID: MW-3
Lab Order: 0101044
Collection Date: 1/8/01
Project: McCasland
Lab ID: 0101044-03
Matrix: AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY 300.0		E300				Analyst: SDU
Bromide	2.8	0.50		mg/L	5	1/10/01
Chloride	870	10		mg/L	100	1/12/01
Fluoride	ND	0.50		mg/L	5	1/10/01
Nitrate (As N)+Nitrite (As N)	1.0	0.50		mg/L	5	1/10/01
Phosphorus, Dissolved Orthophosphate (As P)	ND	2.5		mg/L	5	1/10/01
Sulfate	95	2.5		mg/L	5	1/10/01
TPH BY 418.1		E418.1				Analyst: JT
Petroleum Hydrocarbons, TR	ND	1.0		mg/L	1	1/11/01

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
* - Value exceeds Maximum Contaminant Level
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range

SVL ANALYTICAL, INC.
One Government Gulch • P.O. Box 929 • Kellogg, Idaho 83837-0929 • Phone: (208)784-1258 • Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : HALL ENVIRONMENTAL
SVL JOB No. : 96636
SVL SAMPLE No.: 253063

CLIENT SAMPLE ID: 0101044-01C
Sample Collected: 1/08/01
Sample Receipt : 1/11/01
Date of Report : 1/12/01
Matrix: WATER

Determination	Result	Units	Dilution	Method	Test Date	Reference
Cation Sum	8.10	meq/L	1		1/11/01	
Calcium	80.4	mg/L	1	6010B	1/11/01	2
Potassium	4.4	mg/L	1	6010B	1/11/01	2
Magnesium	12.7	mg/L	1	6010B	1/11/01	2
Sodium	67.4	mg/L	1	6010B	1/11/01	2
Silver	<0.005	mg/L	1	6010B	1/11/01	2
Arsenic	0.01	mg/L	1	6010B	1/11/01	2
Barium	0.106	mg/L	1	6010B	1/11/01	2
Cadmium	<0.002	mg/L	1	6010B	1/12/01	2
Chromium	<0.006	mg/L	1	6010B	1/12/01	2
Mercury	<0.0004	mg/L	2	7470	1/11/01	2
Lead	<0.005	mg/L	1	6010B	1/12/01	2
Selenium	0.01	mg/L	1	6010B	1/11/01	2

REFERENCES: 1) "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020; 2) "Test Methods for Evaluating Solid Wastes, 3rd Edition", SW 846, 1994; 3) "Standard Methods for the Examination of Water and Wastewater", 18th ED. 1992; 4) ASTM Method; 5) 40 CFR, Part 261

Reviewed By: [signature] Date 1/12/01
1/12/01 11:50

Post-it® Fax Note 7671	Date	# of pages ▶
To STEPHANIE FLORES	From MELBA	
Co./Dept. HALL ENV.	Co. SVL ANALYTICAL	
Phone #	Phone #	
Fax # (505) 345-4107	Fax #	

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : HALL ENVIRONMENTAL

SVL JOB No. : 96636
SVL SAMPLE No.: 253054

CLIENT SAMPLE ID: 0101044-02C
Sample Collected: 1/08/01
Sample Receipt : 1/11/01
Date of Report : 1/12/01

Matrix: WATER

Determination	Result	Units	Dilution	Method	Test Date	Reference
Cation Sum	8.53	meq/L	1		1/11/01	
Calcium	83.4	mg/L	1	6010B	1/11/01	2
Potassium	4.5	mg/L	1	6010B	1/11/01	2
Magnesium	14.2	mg/L	1	6010B	1/11/01	2
Sodium	70.8	mg/L	1	6010B	1/11/01	2
Silver	<0.005	mg/L	1	6010B	1/11/01	2
Arsenic	<0.01	mg/L	1	6010B	1/11/01	2
Barium	0.112	mg/L	1	6010B	1/11/01	2
Cadmium	<0.002	mg/L	1	6010B	1/11/01	2
Chromium	<0.006	mg/L	1	6010B	1/11/01	2
Mercury	<0.0002	mg/L	1	7470	1/11/01	2
Lead	<0.005	mg/L	1	6010B	1/11/01	2
Selenium	<0.01	mg/L	1	6010B	1/11/01	2

REFERENCES: 1) "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020; 2) "Test Methods for Evaluating Solid Wastes, 3rd Edition", SW 846, 1994; 3) "Standard Methods for the Examination of Water and Wastewater", 19th ED. 1992; 4) ASTM Method; 5) 40 CFR, Part 261

Reviewed By: [signature] Date 1/12/01

1/12/01 11:50

SVL ANALYTICAL, INC.

One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : HALL ENVIRONMENTAL

SVL JOB No. : 96636

SVL SAMPLE No.: 253065

CLIENT SAMPLE ID: 0101044-03C

Sample Collected: 1/08/01

Sample Receipt : 1/11/01

Date of Report : 1/12/01

Matrix: WATER

Determination	Result	Units	Dilution	Method	Test Date	Reference
Cation Sum	31.6	meq/L	1		1/14/01	
Calcium	393	mg/L	1	6010B	1/11/01	2
Potassium	9.0	mg/L	1	6010B	1/11/01	2
Magnesium	67.3	mg/L	1	6010B	1/11/01	2
Sodium	143	mg/L	1	6010B	1/11/01	2
Silver	<0.005	mg/L	1	6010B	1/11/01	2
Arsenic	0.02	mg/L	1	6010B	1/11/01	2
Barium	0.532	mg/L	1	6010B	1/11/01	2
Cadmium	<0.002	mg/L	1	6010B	1/11/01	2
Chromium	<0.006	mg/L	1	6010B	1/11/01	2
Mercury	<0.0002	mg/L	1	7470	1/11/01	2
Lead	<0.005	mg/L	1	6010B	1/11/01	2
Selenium	0.02	mg/L	1	6010B	1/11/01	2

REFERENCES: 1) "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020; 2) "Test Methods for Evaluating Solid Wastes, 3rd Edition", SW 846, 1994; 3) "Standard Methods for the Examination of Water and Wastewater", 18th ED. 1992; 4) ASTM Method; 5) 40 CFR, Part 261

Reviewed By: [signature] Date 1/12/01

1/12/01 11:50

SVL ANALYTICAL, INC. **Quality Control Report**

Part I Prep Blank and Laboratory Control Sample

Client :HALL ENVIRONMENTAL SVL JOB No. :96636

Analyte	Method	Matrix	Units	Prep Blank	True—LCS	—Found	LCS %R	Analysis Date
Silver	6010B	WATER	mg/L	<0.005	1.00	0.984	98.4	1/11/01
Arsenic	6010B	WATER	mg/L	<0.01	1.00	1.01	101.0	1/11/01
Barium	6010B	WATER	mg/L	<0.002	1.00	0.994	99.4	1/11/01
Calcium	6010B	WATER	mg/L	<0.04	20.0	18.9	94.5	1/11/01
Cadmium	6010B	WATER	mg/L	<0.002	1.00	1.00	100.0	1/11/01
Chromium	6010B	WATER	mg/L	<0.006	1.00	1.00	100.0	1/11/01
Potassium	6010B	WATER	mg/L	<1.0	30.0	28.0	93.3	1/11/01
Magnesium	6010B	WATER	mg/L	<0.04	20.0	18.6	93.0	1/11/01
Sodium	6010B	WATER	mg/L	<0.1	20.0	18.1	90.5	1/11/01
Lead	6010B	WATER	mg/L	<0.005	1.00	0.987	98.7	1/11/01
Selenium	6010B	WATER	mg/L	<0.01	1.00	0.97	97.0	1/11/01
Mercury	7470	WATER	mg/L	<0.0002	0.0050	0.0048	96.0	1/11/01

LEGEND:

LCS = Laboratory Control Sample LCS %R = LCS Percent Recovery N/A = Not Applicable

SVL ANALYTICAL, INC.

Quality Control Report

Part II Duplicate and Spike Analysis

Client :HALL ENVIRONMENTAL SVL JOB No :96636

Test	Method	Matrix	QC SAMPLE ID	Units	Result	Duplicate or MSD Found	RPD%	Matrix Spike Result	SPK ADD		%R	Test Date
Ag	6010B	WATER	1	mg/L	<0.005	<0.005	UDL	1.01	1.00		101.0	1/11/01
As	6010B	WATER	1	mg/L	0.01	0.01	0.0	1.04	1.00		103.0	1/11/01
Ba	6010B	WATER	1	mg/L	0.106	0.113	6.4	1.10	1.00		99.4	1/11/01
Ca	6010B	WATER	1	mg/L	80.4	85.0	5.6	95.9	20.0		77.5	1/11/01
Cd	6010B	WATER	1	mg/L	<0.002	<0.002	UDL	0.998	1.00		99.8	1/12/01
Cr	6010B	WATER	1	mg/L	<0.006	<0.006	UDL	1.01	1.00		101.0	1/12/01
K	6010B	WATER	1	mg/L	4.4	4.5	2.2	32.9	30.0		95.0	1/11/01
Mg	6010B	WATER	1	mg/L	12.7	13.4	5.4	30.8	20.0		90.5	1/11/01
Na	6010B	WATER	1	mg/L	67.4	71.0	5.2	83.0	20.0	A	78.0	1/11/01
Pb	6010B	WATER	1	mg/L	<0.005	<0.005	UDL	0.988	1.00		98.8	1/12/01
Se	6010B	WATER	1	mg/L	0.01	<0.01	200.0	1.00	1.00		99.0	1/11/01
Hg	7470	WATER	1	mg/L	<0.0004	<0.0004	UDL	0.0022	0.0020		110.0	1/11/01

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100)   UDL = Both SAM & DUP not detected.

RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100)   M in Duplicate/MSD column indicates MSD.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 253063 Client Sample ID: 0101044-012

1/12/01 11:50

Hall Environmental Analysis Laboratory

Date: 26-Dec-00

CLIENT:	ECD Environmental	Client Sample ID:	McCasland Windmill 1st Purge
Lab Order:	0011154	Collection Date:	11/28/00
Project:	McCasland		
Lab ID:	0011154-01	Matrix:	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY 300.0		E300				Analyst: SDU
Bromide	4.0	0.50		mg/L	5	12/1/00
Chloride	1500	20		mg/L	200	12/14/00
Fluoride	ND	0.50		mg/L	5	12/1/00
Nitrogen, Nitrate (As N)	1.6	0.50		mg/L	5	12/1/00
Nitrogen, Nitrite (As N)	ND	2.5		mg/L	5	12/1/00
Phosphorus, Dissolved Orthophosphate (As P)	43	2.5		mg/L	5	12/1/00
Sulfate	100	2.5		mg/L	5	12/1/00

Qualifiers:

ND - Not Detected at the Reporting Limit

J - Analyte detected below quantitation limits

B - Analyte detected in the associated Method Blank

* - Value exceeds Maximum Contaminant Level

S - Spike Recovery outside accepted recovery limits

R - RPD outside accepted recovery limits

E - Value above quantitation range

1774

Hall Environmental Analysis Laboratory

Date: 26-Dec-00

CLIENT:	ECD Environmental	**Client Sample ID:**	McCasland Blank
Lab Order:	0011154	**Collection Date:**	11/28/00
Project:	McCasland		
Lab ID:	0011154-03	**Matrix:**	AQUEOUS

Analyses	Result	Limit	Qual	Units	DF	Date Analyzed
ANIONS BY 300.0		E300				Analyst: SCU
Bromide	0.20	0.10		mg/L	1	12/1/00
Chloride	22	0.10		mg/L	1	12/1/00
Fluoride	0.60	0.10		mg/L	1	12/1/00
Nitrogen, Nitrate (As N)	3.0	0.10		mg/L	1	12/1/00
Nitrogen, Nitrite (As N)	ND	0.50		mg/L	1	12/1/00
Phosphorus, Dissolved Orthophosphate (As P)	ND	0.50		mg/L	1	12/1/00
Sulfate	36	0.50		mg/L	1	12/1/00

Qualifiers:
- ND - Not Detected at the Reporting Limit
- J - Analyte detected below quantitation limits
- B - Analyte detected in the associated Method Blank
- * - Value exceeds Maximum Contaminant Level
- S - Spike Recovery outside accepted recovery limits
- R - RPD outside accepted recovery limits
- E - Value above quantitation range

SVL ANALYTICAL, INC.
One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : HALL ENVIRONMENTAL	SVL JOB No. : 96370
	SVL SAMPLE No.: 230970
CLIENT SAMPLE ID: 0011154-01A	
Sample Collected: 11/28/00	
Sample Receipt : 12/07/00	Matrix: WATER
Date of Report : 12/15/00	

Determination	Result	Units	Dilution	Method	Test Date	Reference
Calcium	692	mg/L	1	6010B	12/13/00	2
Potassium	8.9	mg/L	1	6010B	12/13/00	2
Magnesium	64.6	mg/L	1	6010B	12/13/00	2
Sodium	344	mg/L	1	6010B	12/13/00	2

REFERENCES: 1) "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020; 2) "Test Methods for Evaluating Solid Wastes, 3rd Edition", SW 846, 1994; 3) "Standard Methods for the Examination of Water and Wastewater", 18th ED. 1992; 4) ASTM Method; 5) 40 CFR, Part 251

Reviewed By: [signature] Date 12/15/00

12/15/00 10:19

ordered RPT

SVL ANALYTICAL, INC.

One Government Gulch ■ P.O. Box 929 ■ Kellogg, Idaho 83837-0929 ■ Phone: (208)784-1258 ■ Fax: (208)783-0891

REPORT OF ANALYTICAL RESULTS

CLIENT : HALL ENVIRONMENTAL

SVL JOB No. : 96370
SVL SAMPLE No.: 250971

CLIENT SAMPLE ID: 0011154-02B
Sample Collected: 11/28/00
Sample Receipt : 12/07/00
Date of Report : 12/15/00

Matrix: WATER

Determination	Result	Units	Dilution	Method	Test Date	Reference
Calcium	698	mg/L	1	6010B	12/13/00	2
Potassium	8.5	mg/L	1	6010B	12/13/00	2
Magnesium	62.3	mg/L	1	6010B	12/13/00	2
Sodium	334	mg/L	1	6010B	12/13/00	2
Silver	<0.005	mg/L	1	6010B	12/13/00	2
Arsenic	0.01	mg/L	1	6010B	12/13/00	2
Barium	0.303	mg/L	1	6010B	12/13/00	2
Cadmium	<0.002	mg/L	1	6010B	12/13/00	2
Chromium	<0.006	mg/L	1	6010B	12/13/00	2
Mercury	0.0004	mg/L	2	7470	12/14/00	2
Lead	0.005	mg/L	1	6010B	12/13/00	2
Selenium	0.02	mg/L	1	6010B	12/13/00	2

REFERENCES: 1) "Methods for Chemical Analysis of Water and Wastes", EPA-600/4-79-020; 2) "Test Methods for Evaluating Solid Wastes, 3rd Edition", SW 846, 1994; 3) "Standard Methods for the Examination of Water and Wastewater", 18th ED. 1992; 4) ASTM Method; 5) 40 CFR, Part 136

Reviewed By: [signature] Date 12/15/00
12/15/00 13:19

SVL ANALYTICAL, INC.

Quality Control Report

Part I Prep Blank and Laboratory Control Sample

Client :HALL ENVIRONMENTAL

SVL JOB No. 19637[illegible]

Analyte	Method	Matrix	Units	Prep Blank	True—LCS	—Found	LCS %R	Analysis Date
Silver	6010B	WATER	mg/L	<0.005	1.00	0.991	99.1	12/13/00
Arsenic	6010B	WATER	mg/L	<0.01	1.00	0.99	99.0	12/13/00
Barium	6010B	WATER	mg/L	<0.002	1.00	0.994	99.4	12/13/00
Calcium	6010B	WATER	mg/L	<0.04	20.0	21.0	105.0	12/13/00
Cadmium	6010B	WATER	mg/L	<0.002	1.00	0.985	98.5	12/13/00
Chromium	6010B	WATER	mg/L	<0.006	1.00	0.997	99.7	12/13/00
Potassium	6010B	WATER	mg/L	<1.0	30.0	30.2	100.7	12/13/00
Magnesium	6010B	WATER	mg/L	<0.04	20.0	19.6	98.0	12/13/00
Sodium	6010B	WATER	mg/L	<0.1	20.0	20.3	101.5	12/13/00
Lead	6010B	WATER	mg/L	<0.005	1.00	0.985	98.5	12/13/00
Selenium	6010B	WATER	mg/L	0.01	1.00	0.93	93.0	12/13/00
Mercury	7470	WATER	mg/L	<0.0002	0.0050	0.0052	104.0	12/14/00

LEGEND:

LCS - Laboratory Control Sample   LCS %R = LCS Percent Recovery   N/A = Not Applicable

12/15/00 13:19

SVL ANALYTICAL, INC.

Quality Control Report

Part II Duplicate and Spike Analysis

Client :HALL ENVIRONMENTAL — SVL JOB No :96370

Test	Method	Matrix	QC SAMPLE ID Units	Result	Duplicate or MSD Found	RPD%	Matrix Spike Result	SPK ADD	%R	Test Date
Ag	6010B	WATER	1 mg/L	<0.005	<0.005	UDL	1.08	1.00	108.0	12/13/00
As	6010B	WATER	1 mg/L	0.01	0.01	0.0	1.07	1.00	106.0	12/13/00
Ba	6010B	WATER	1 mg/L	0.303	0.309	2.0	1.27	1.00	96.7	12/13/00
Ca	6010B	WATER	1 mg/L	698	694	0.6	694	20.0	R >4S	12/13/00
Cd	6010B	WATER	1 mg/L	<0.002	<0.002	UDL	0.954	1.00	95.4	12/13/00
Cr	6010B	WATER	1 mg/L	<0.006	<0.006	UDL	0.972	1.00	97.2	12/13/00
K	6010B	WATER	1 mg/L	8.5	8.4	1.2	41.0	30.0	108.3	12/13/00
Mg	6010B	WATER	1 mg/L	62.3	61.5	1.3	81.0	20.0	93.5	12/13/00
Na	6010B	WATER	1 mg/L	334	330	1.2	348	20.0	R >4S	12/13/00
Pb	6010B	WATER	1 mg/L	0.005	0.005	18.2	0.971	1.00	96.6	12/13/00
Se	6010B	WATER	1 mg/L	0.02	0.02	0.0	1.05	1.00	103.0	12/13/00
Hg	7470	WATER	1 mg/L	0.0004	<0.0004	200.0	0.0022	0.0020	90.0	12/14/00

LEGEND:

RPD% = (|SAM - DUP|/((SAM + DUP)/2) * 100)   UDL = Both SAM & DUP not detected.

RPD% = (|SPK - MSD|/((SPK + MSD)/2) * 100)   M in Duplicate/MSD column indicates MSD.

SPIKE ADD column, A = Post Digest Spike; %R = Percent Recovery N/A = Not Analyzed; R > 4S = Result more than 4X the Spike Added

QC Sample 1: SVL SAM No.: 250971 Client Sample ID: 0011134-02B

12/13/00 10:19

96370

Hall Environmental Analysis Labor
4901 Hawkins NE, Suite A
Albuquerque, New Mexico 87109
(505) 345-3975

CHAIN-OF-CUSTODY RECORD

Page 1 of 1

Subcontractor:
SVL
One Government Gulch
Kellogg, ID 83837

TEL: (800) 597-7144
FAX:
Acct #:

06-Dec-00

Sample ID	Matrix	Collection Date	Bottle Type	Requested Tests: Alk, K, Ca, Mg	RCRA 8 Metals
0011154-01A	Aqueous	11/28/2000	500HDPE	1	
0011154-02B	Aqueous	11/28/2000	250HDPEHNO3	1	

Comments: Project Name: McCasland
Please fax results by: 12/21/00

		Date/Time			Date/Time
Relinquished by:	Stephanie Ulkhanso	12/6/00 1525	Received by:	[illegible]	12/7/00 1:30
Relinquished by:			Received by:		

Hall Environmental Analysis Laboratory | **Date:** *26-Dec-00*

CLIENT: ECD Environmental
Work Order: 0011154
Project: McCasland

QC SUMMARY REPORT
Method Blank

Sample ID: MB-R304 | Batch ID: R304 | Test Code: E300 | Units: mg/Kg | Analysis Date: 12/14/00 | Prep Date:
Client ID: | Run ID: WC_001214A | SeqNo: 5814

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Bromide	ND	0.30									
Chloride	ND	0.30									
Fluoride	ND	0.30									
Nitrate (As N)+Nitrite (As N)	ND	0									
Nitrogen, Nitrate (As N)	ND	0.30									
Nitrogen, Nitrite (As N)	ND	0.30									
Phosphorus, Dissolved Orthophosphate	ND	1.5									
Sulfate	ND	1.5									

Sample ID: mblk | Batch ID: R235 | Test Code: E300 | Units: mg/L | Analysis Date: 12/1/00 | Prep Date:
Client ID: | Run ID: WC_001201A | SeqNo: 6018

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Bromide	ND	0.10									
Chloride	ND	0.10									
Fluoride	ND	0.10									
Nitrogen, Nitrate (As N)	ND	0.10									
Nitrogen, Nitrite (As N)	ND	0.50									
Phosphorus, Dissolved Orthophosphate	ND	0.50									
Sulfate	ND	0.50									

Qualifiers:
ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Hall Environmental Analysis Laboratory

Date: 26-Dec-00

CLIENT: ECD Environmental
Work Order: 0011154
Project: McCasland

QC SUMMARY REPORT

Laboratory Control Spike - generic

Sample ID: LCS-R304 | Batch ID: R304 | Test Code: E300 | Units: mg/Kg | Analysis Date: 12/14/00 | Prep Date:
Client ID: | Run ID: WC_001214A | SeqNo: 5815

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Bromide	2.98	0.30	3	0	99.3	85	115	0			
Chloride	5.769	0.30	6	0	96.2	85	115	0			
Fluoride	0.623	0.30	0.6	0	104	85	115	0			
Nitrogen, Nitrate (As N)	3.016	0.30	3	0	101	85	115	0			
Nitrogen, Nitrite (As N)	1.165	0.30	1.2	0	97.1	85	115	0			
Phosphorus, Dissolved Orthophosphate	5.616	1.5	6	0	93.6	85	115	0			
Sulfate	11.52	1.5	12	0	96.0	85	115	0			

Sample ID: lcsd | Batch ID: R304 | Test Code: E300 | Units: mg/Kg | Analysis Date: 12/14/00 | Prep Date:
Client ID: | Run ID: WC_001214A | SeqNo: 5819

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Bromide	2.904	0.30	3	0	96.8	85	115	2.98	2.58	15	
Chloride	5.655	0.30	6	0	94.3	85	115	5.769	2.00	15	
Fluoride	0.609	0.30	0.6	0	102	85	115	0.623	2.27	15	
Nitrogen, Nitrate (As N)	2.95	0.30	3	0	[illegible]	85	115	3.016	2.21	15	
Nitrogen, Nitrite (As N)	1.14	0.30	1.2	0	95.0	85	115	1.165	2.17	15	
Phosphorus, Dissolved Orthophosphate	5.503	1.5	6	0	91.7	85	115	5.616	2.03	15	
Sulfate	11.26	1.5	12	0	93.6	85	115	11.52	2.31	15	

Sample ID: lcs | Batch ID: R235 | Test Code: E300 | Units: mg/L | Analysis Date: 12/1/00 | Prep Date:
Client ID | Run ID: WC_001201A | SeqNo: 6619

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Nitrogen, Nitrate (As N)	2.919	0.10	3	0	97.3	85	115	0			
Sulfate	11.43	0.50	12	0	95.2	05	115	0			

Qualifiers: ND - Not Detected at the Reporting Limit; S - Spike Recovery outside accepted recovery limits; B - Analyte detected in the associated Method Blank
J - Analyte detected below quantitation limits; R - RPD outside accepted recovery limits

QC SUMMARY REPORT

Laboratory Control Spike Duplicate

CLIENT: ECD Environmental
Work Order: 0011154
Project: McCasland

Sample ID: lcsd Batch ID: R235 Test Code: E300 Units: mg/l Analysis Date: 12/1/00 Prep Date:
Client ID. Run ID: WC_001201A SeqNo. 6625

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Nitrogen, Nitrate (As N)	2.964	0.10	3	0	98.8	85	115	0			
Sulfate	11.63	0.50	12	0	97.0	85	115	0			

Qualifiers: ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
B - Analyte detected in the associated Method Blank

Hall Environmental
Analysis Laboratory

Hall Environmental Analysis Laboratory
4901 Hawkins NE. Ste. A
Albuquerque, NM 87109

8/16/99

ECD Environmental
P. O Box 9328
Albuquerque NM 87119

Dear Mr. Greg Bycee:

Enclosed are the results for the analyses that were requested. These were done according to EPA procedures or equivalent.

Detection limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely:

Scott Hallenbeck
Laboratory Manager

Project: 9901105/McCausland

Hall Environmental Analysis Laboratory

Client:	ECD Environmental
Project:	McCasland
Project Manager:	Greg Bybee
Project Number:	-

Date Collected:	8/16/99
Date Received:	8/17/99
Sample Matrix:	Aqueous
Date Extracted:	NA

EPA Method - 8021

Units: PPB ug/L

HEAL LAB ID	Sample ID	MTBE	Benzene	Toluene	Ethyl-benzene	Total Xylenes	1,3,5-TMB	1,2,4-TMB	BFB % Recovery	Dilution Factor	Date Analyzed
9908063 2	Mewbourne Oil Co MW	ND	ND	ND	ND	ND	ND	ND	103	1	8/18/99
Reag. Blk.		ND	ND	ND	ND	ND	ND	ND	95	1	8/18/99
MRL		2.5	0.5	0.5	0.5	0.5	0.5	0.5			

Hall Environmental Analysis Laboratory

Client:	ECD Environmental
Project:	McCasland
Project Manager:	Greg Bybee
Project Number:	-

Date Collected:	NA
Date Received:	NA
Sample Matrix:	Aqueous
Date Extracted:	NA

8021 QC: BS/BSD 8/16

Compound	Sample Amount (ug/L)	Spike	Recovery	% Rec	Dup	% Dup	RPD
MTBE	<2.5	40.0	44.0	110	42.8	107	3
Benzene	<0.5	20.0	20.6	103	20.8	104	1
Toluene	<0.5	20.0	20.5	103	20.2	101	1
Ethylbenzene	<0.5	20.0	20.7	104	20.5	102	2
Total Xylenes	<0.5	60.0	61.5	103	61.1	102	1
1,3,5 TMB	<0.5	20.0	20.8	104	20.4	102	2
1,2,4-TMB	<0.5	20.0	20.6	103	20.6	103	0

Hall Environmental Analysis Laboratory

Client: ECO Environmental
Project: McCasland
Project Manager: Greg Bybee
Project Number: -

Date Collected: 8/16/99
Date Received: 8/17/99
Sample Matrix: Aqueous
Extraction Date: 8/20/99

EPA Method - 418.1

HEAL ID	Client ID	Dilution	TPH (mg/L)	Analysis Date
9908083-1	McCasland Water Well	1	ND	8/20/99
9908083-2	Mewbourne Oil Co MW	1	ND	8/20/99
Extraction Blank	-	1	ND	8/20/99

MRL 1.0

QA/QC

Sample ID	Sample Amount	Spike	Recovery	% Recovery
Blank Spike 8/20	<1.0	5.0	4.5	90

Sample ID	Sample Amount	Duplicate	RPD
Blank Duplicate 8/11	<1.0	<1.0	NA

Hall Environmental Analysis Laboratory

Client: ECD Environmental
Project: McCasland
Project Manager: Greg Bybee
Project Number: -

Date Collected: 8/16/99
Date Received: 8/17/99
Sample Matrix: Aqueous

Inorganic Compounds

HEAL LAB ID	Sample ID	Floride (mg/L)	Chloride (mg/L)	Bromide (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Sulfate (mg/L)	o-Phosphate P (mg/L)
9908083-1	McCasland Water Well	0.2	720	2.4	ND	1.4	77	ND
9908083-2	Mewbourne Oil Co MW	0.3	120	1.2	ND	3.3	79	ND
Detection Limits		0.1	0.1	0.1	0.1	0.1	0.5	0.5
Method		300.0	300.0	300.0	300.0	300.0	300.0	300.0
Date Analyzed		8/17/99	8/23/99	8/17/99	8/17/99	8/17/99	8/17,23/99	8/17/99

ENERGY LABORATORIES

ENERGY LABORATORIES, INC.
P.O. BOX 30916 • 1120 SOUTH 27TH STREET • BILLINGS, MT 59107-0916 • PHONE (406) 252-6325
FAX (406) 252-6069 • 1-800-735-4489 • E-MAIL eli@energylab.com

LABORATORY ANALYSIS REPORT

Hall Environmental Laboratory
Nancy McDuffie
4901 Hawkins NE
Suite A
Albuquerque, NM 87109

Project ID: MCCASLAND PROJ. #9908063
Sample ID: WATER WELL
Laboratory ID: 99-56021-1
Sample Matrix: Water
Sample Date: 16-Aug-99
Received at lab: 20-Aug-99
Reported: 26-Aug-99

	Results	Units	Qual	Reporting Limit	Regulatory Limit	Method	Analyzed	
Calcium	308	mg/l		1		EPA 200.7	25-Aug-99 1533	RLH
Magnesium	38	mg/l		1		EPA 200.7	25-Aug-99 1533	RLH
Potassium	6	mg/l		1		EPA 200.7	25-Aug-99 1533	RLH
Sodium	188	mg/l		1		EPA 200.7	25-Aug-99 1533	RLH

ENERGY LABORATORIES

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FAX (406) 252-6069 • 1-800-735-4489 • E-MAIL eli@energylab.com

LABORATORY ANALYSIS REPORT

Hall Environmental Laboratory
Nancy McDuffie
4901 Hawkins NE
Suite A
Albuquerque, NM 87109

Project ID: MCCASLAND PROJ. #9908063
Sample ID: MEWBOURNE OIL CO MW
Laboratory ID: 99-56021-2
Sample Matrix: Water
Sample Date: 16-Aug-99
Received at lab: 20-Aug-99
Reported: 26-Aug-99

	Results	Units	Qual	Reporting Limit	Regulatory Limit	Method	Analyzed	
Calcium	88	mg/l		1		EPA 200.7	25-Aug-99 1535	RLH
Magnesium	16	mg/l		1		EPA 200.7	25-Aug-99 1535	RLH
Potassium	4	mg/l		1		EPA 200.7	25-Aug-99 1535	RLH
Sodium	81	mg/l		1		EPA 200.7	25-Aug-99 1535	RLH

Lab Nos. 99-56021-1

QUALITY ASSURANCE DATA PACKAGE

This report includes the results of quality assurance tests performed with the sample analyses. They are performed to determine if the methodology is in control and to monitor the laboratory's ability to produce accurate and precise results.

Constituents	Duplicate Analysis mg/l (ppm) Original	Duplicate Analysis mg/l (ppm) Duplicate	Spiked Analysis, % Recovery	Blank Analysis, mg/l (ppm)	Calibration Verification Sample Analysis, mg/l (ppm)	Calibration Verification Acceptance Range, mg/l (ppm)	Date Analyzed
Calcium	59	59	102	<1	51	45-55	08/25/99
Magnesium	37	37	104	<1	52	45-55	08/25/99
Potassium	13	13	104	<1	52	45-55	08/25/99
Sodium	329	324	101	<1	53	45-55	08/25/99

Hall Environmental Analysis Laboratory

September 3, 1999

Hall Environmental Analysis Laboratory
4901 Hawkins NE. Ste. A
Albuquerque, NM 87109

ECD Environmental
P. O. Box 9328
Albuquerque, NM 87119

Dear Mr. Bybee:

Enclosed are the results for the analyses that were requested. These were done according to EPA procedures or equivalent.

Detection limits are determined by EPA methodology. No determination of compounds below these (denoted by the ND or < sign) has been made.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely

Andy Freeman
Assistant Laboratory Manager

Project: 9908063/McCasland

4901 Hawkins NE, Suite A, Albuquerque, NM 87109
Ph (505) 345-3975, Fax (505) 345-4107

Hall Environmental Analysis Laboratory

Client:	ECD Environmental	**Date Collected:**	1/25/99
Project:	McCausland	**Date Received:**	1/28/99
Project Manager:	Greg Bybee	**Sample Matrix:**	Aqueous
Project Number:		**Date Extracted:**	NA

EPA Method - 8021

Units: PPB(ug/L)

HEAL LAB ID	Sample ID	Benzene	Toluene	Ethyl benzene	Total Xylenes	BFB % Recovery	Dilution Factor	Date Analyzed
9901105-1	#1 Windmill	ND	ND	ND	ND	94	2	1/28/99
9901105-2	#2 Windmill	ND	ND	ND	ND	130	1	1/28/99
Reag Blk		ND	ND	ND	ND	98	1	1/28/99
MRL		0.5	0.5	0.5	0.5			

Hall Environmental Analysis Laboratory

Client:	ECD Environmental	**Date Collected:**	1/25/99
Project:	McCausland	**Date Received:**	1/28/99
Project Manager:	Greg Bybee	**Sample Matrix:**	Aqueous
Project Number:	-		

Inorganic Compounds

HEAL LAB ID	Sample ID	Floride (mg/L)	Chloride (mg/L)	Nitrite-N (mg/L)	Bromide (mg/L)	Nitrate-N (mg/L)	Sulfate (mg/L)	o-Phosphate-P (mg/L)
9901105-1	#1 Windmill	<0.5	5,000	*<0.5	12	*<0.5	110	<2.5
9812121-2	#2 Windmill	[illegible]	67	*ND	0.8	*3.3	110	ND
Detection Limits		0.1	0.1	0.1	0.1	0.1	0.5	0.5
Method		300.0	300.0	300.0	300.0	300.0	300.0	300.0
Date Analyzed		1/28/99	1/29/99	1/28/99	1/28/99	1/28/99	1/28/99	1/28/99

*Sample run outside of the EPA holding time of 48 hours.

CARDINAL LABORATORIES

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

ANALYTICAL RESULTS FOR
MEWBOURNE OIL CO.
ATTN: ROSS MURPHY
P.O. BOX 5270
HOBBS, NM 88241
FAX TO:

Receiving Date: 03/31/98
Reporting Date: 04/03/98
Project Number: NOT GIVEN
Project Name: NOT GIVEN
Project Location: NOT GIVEN

Sampling Date: 03/31/98
Sample Type: GROUNDWATER
Sample Condition: COOL & INTACT
Sample Received By: GP
Analyzed By: AH

LAB NUMBER	SAMPLE ID	Na (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Conductivity (u mhos/cm)	NO3 (mg/L)
ANALYSIS DATE:		4/2/98	4/1/98	4/1/98	4/1/98	4/1/98	4/1/98
H3543-1	D-K WINDMILL	285	700	90	7.4	6410	3.00
Quality Control		NR	50	50	NR	1445	5.07
True Value QC		NR	50	50	NR	1413	5.00
% Accuracy		NR	100	100	NR	102	101
Relative Percent Difference		NR	8.0	4.0	NR	0.3	0.2
METHODS:			SM3500-Ca-D	3500-Mg E	3049	120.1	353.2

LAB NUMBER	SAMPLE ID	Cl^- (mg/L)	SO_4 (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	pH (s.u.)	TDS (mg/L)
ANALYSIS DATE:		4/3/98	4/1/98	4/1/98	4/1/98	4/1/98	4/2/98
H3543-1	D-K WINDMILL	1771	108	0	171	7.23	4113
Quality Control		468	100	NR	NR	6.95	NR
True Value QC		500	100	NR	NR	7.00	NR
% Accuracy		93.6	100	NR	NR	99.3	NR
Relative Percent Difference		3.4	5.0	NR	NR	0.7	0.2
METHODS:		SM4500-Cl-B	375.4	310.1	310.1	150.1	160.1

APR 1998 Received Hobbs OCD

Gayle A. Potter, Chemist

04/03/98
Date

H3543 XLS

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TRACEANALYSIS, INC.

6701 Aberdeen Avenue, Suite 9 Lubbock, Texas 79424 800•378•1296 806•794•1296 FAX 806•794•1298
4725 Ripley Avenue, Suite A El Paso, Texas 79922 888•588•3443 915•585•3443 FAX 915•585•4944
E-Mail: lab@traceanalysis.com

Analytical and Quality Control Report

Bill Olson
OCD
2040 S. Pacheco
Santa Fe, NM 87505

Report Date: December 13, 2000

Order ID Number: A00120106

Project Number: N/A
Project Name: McCasland
Project Location: N/A

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

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
159868	0011281230 (Windmill)	Water	11/28/00	12:30	12/1/00

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

Dr. Blair Leftwich, Director

Cation-Anion Balance Sheet

Sample # 159868 Date: 12/13/00 MS

	Cations ppm	meq/L
Calcium	525	26.1975
Magnesium	46.9	3.859401
Sodium	194	8.439
Potassium	9.07	0.2320106

Total Cations
38.7279 in meq/L

	Anions ppm	meq/L
Alkalinity	150	3
Sulfate	88	1.83216
Chloride	1300	36.673
Nitrate as N	2.4	0.171336
Fluoride	1	0.05264

Total Anions
41.7291 in meq/L

Percentage Error
7.46044 %
(needs to be <10%)

OTHER INFORMATION

TDS	0
EC	0

Measure EC and Cation Sums	0	Range should be:	0	to	0
Measure EC and Anion Sums	0	Range should be:	0	to	0
Calculated TDS/Conductivity	0	Range should be:	0.55	to	0.77
Measure TDS and Cation Sums	0	Range should be:	0.55	to	0.77
Measure TDS and Anion Sums	0	Range should be:	0.55	to	0.77

Analytical and Quality Control Report

Sample: 159868 - 0011281230 (Windmill)

Analysis: Alkalinity | Analytical Method: E 310.1 | QC Batch: QC07123 | Date Analyzed: 12/5/00
Analyst: RS | Preparation Method: N/A | Prep Batch: PB06239 | Date Prepared: 12/5/00

Param	Flag	Result	Units	Dilution	RDL
Hydroxide Alkalinity		<1.0	mg/L as CaCo3	1	1
Carbonate Alkalinity		<1.0	mg/L as CaCo3	1	1
Bicarbonate Alkalinity		150	mg/L as CaCo3	1	1
Total Alkalinity		150	mg/L as CaCo3	1	1

Sample: 159868 - 0011281230 (Windmill)

Analysis: Conductivity | Analytical Method: SM 2510B | QC Batch: QC07062 | Date Analyzed: 12/1/00
Analyst: JS | Preparation Method: N/A | Prep Batch: PB06187 | Date Prepared: 12/1/00

Param	Flag	Result	Units	Dilution	RDL
Specific Conductance		4300	μMHOS/cm	1	

Sample: 159868 - 0011281230 (Windmill)

Analysis: Dissolved Metals | Analytical Method: E 200.7 | QC Batch: QC07192 | Date Analyzed: 12/6/00
Analyst: SSC | Preparation Method: E 3005A | Prep Batch: PB06172 | Date Prepared: 12/4/00

Param	Flag	Result	Units	Dilution	RDL
Dissolved Calcium		525	mg/L	1	0.50
Dissolved Magnesium		46.9	mg/L	1	0.50
Dissolved Potassium		9.07	mg/L	1	0.50
Dissolved Sodium		194	mg/L	1	0.50

Sample: 159868 - 0011281230 (Windmill)

Analysis: Hg. Total | Analytical Method: S 7470A | QC Batch: QC07302 | Date Analyzed: 12/11/00
Analyst: SSC | Preparation Method: N/A | Prep Batch: PB06362 | Date Prepared: 12/11/00

Param	Flag	Result	Units	Dilution	RDL
Total Mercury		<0.0002	mg/L	1	0.0002

Sample: 159868 - 0011281230 (Windmill)

Analysis: Ion Chromatography (IC) | Analytical Method: E 300.0 | QC Batch: QC07064 | Date Analyzed: 12/1/00
Analyst: JS | Preparation Method: N/A | Prep Batch: PB06189 | Date Prepared: 12/1/00

Param	Flag	Result	Units	Dilution	RDL
CL		1300	mg/L	1	0.50
Fluoride		1.0	mg/L	1	0.20
Nitrate-N	1	2.4	mg/L	1	0.20
Sulfate		88	mg/L	1	0.50

[1] Sample out of hold time for NO3.

Sample: 159868 - 0011281230 (Windmill)

Analysis:	TDS	Analytical Method:	E 160.1	QC Batch:	QC07152	Date Analyzed:	12/5/00
Analyst:	JS	Preparation Method:	N/A	Prep Batch:	PB06268	Date Prepared:	12/4/00

Param	Flag	Result	Units	Dilution	RDL
Total Dissolved Solids		2700	mg/L	1	10

Sample: 159868 - 0011281230 (Windmill)

Analysis:	Total Metals	Analytical Method:	S 6010B	QC Batch:	QC07156	Date Analyzed:	12/6/00
Analyst:	RR	Preparation Method:	E 3010A	Prep Batch:	PB06176	Date Prepared:	12/4/00

Param	Flag	Result	Units	Dilution	RDL
Total Aluminum		<0.5	mg/L	1	0.50
Total Arsenic		<0.01	mg/L	1	0.01
Total Barium		0.237	mg/L	1	0.01
Total Boron		<0.5	mg/L	1	0.50
Total Cadmium		<0.002	mg/L	1	0.002
Total Chromium		<0.005	mg/L	1	0.005
Total Cobalt		<0.01	mg/L	1	0.01
Total Copper		0.02	mg/L	1	0.01
Total Iron		0.02	mg/L	1	0.02
Total Lead		<0.01	mg/L	1	0.01
Total Manganese		<0.01	mg/L	1	0.01
Total Molybdenum		<0.02	mg/L	1	0.02
Total Nickel		<0.01	mg/L	1	0.01
Total Selenium		<0.01	mg/L	1	0.01
Total Silica		7.66	mg/L	1	0.50
Total Silver		<0.01	mg/L	1	0.01
Total Zinc		<0.1	mg/L	1	0.10

Sample: 159868 - 0011281230 (Windmill)

Analysis:	pH	Analytical Method:	E 150.1	QC Batch:	QC07119	Date Analyzed:	12/1/00
Analyst:	RS	Preparation Method:	N/A	Prep Batch:	PB06243	Date Prepared:	12/1/00

Param	Flag	Result	Units	Dilution	RDL
pH	[2]	7.5	s.u.	1	1

Quality Control Report
Method Blank

Sample: Method Blank QCBatch: QC07062

Param	Flag	Results	Units	Reporting Limit
Specific Conductance		15	μMHOS/cm	

[2]Sample was run out of holding time, but was tested the day it was received.

Sample: Method Blank QCBatch: QC07064

Param	Flag	Results	Units	Reporting Limit
CL		<0.5	mg/L	0.50
Fluoride		<0.2	mg/L	0.20
Nitrate-N		<0.2	mg/L	0.20
Sulfate		<0.5	mg/L	0.50

Sample: Method Blank QCBatch: QC07123

Param	Flag	Results	Units	Reporting Limit
Hydroxide Alkalinity		<1.0	mg/L as CaCo3	1
Carbonate Alkalinity		<1.0	mg/L as CaCo3	1
Bicarbonate Alkalinity		<4.0	mg/L as CaCo3	1
Total Alkalinity		<4.0	mg/L as CaCo3	1

Sample: Method Blank QCBatch: QC07152

Param	Flag	Results	Units	Reporting Limit
Total Dissolved Solids	3	31	mg/L	10

Sample: Method Blank QCBatch: QC07156

Param	Flag	Results	Units	Reporting Limit
Total Aluminum		<0.5	mg/L	0.50
Total Arsenic		<0.01	mg/L	0.01
Total Barium		<0.01	mg/L	0.01
Total Boron		<0.5	mg/L	0.50
Total Cadmium		<0.002	mg/L	0.002
Total Chromium		<0.005	mg/L	0.005
Total Cobalt		<0.01	mg/L	0.01
Total Copper		<0.01	mg/L	0.01
Total Iron		<0.02	mg/L	0.02
Total Lead		<0.01	mg/L	0.01
Total Manganese		<0.01	mg/L	0.01
Total Molybdenum		<0.02	mg/L	0.02
Total Nickel		<0.01	mg/L	0.01
Total Selenium		<0.01	mg/L	0.01
Total Silica		<0.5	mg/L	0.50
Total Silver		<0.01	mg/L	0.01
Total Zinc		<0.1	mg/L	0.10

Sample: Method Blank QCBatch: QC07192

[3] Blank was high due to rust from the oven getting into the crucible.

Param	Flag	Results	Units	Reporting Limit
Dissolved Calcium		<0.50	mg/L	0.50
Dissolved Magnesium		<0.50	mg/L	0.50
Dissolved Potassium		<0.50	mg/L	0.50
Dissolved Sodium		<0.50	mg/L	0.50

Sample: Method Blank QCBatch: QC07302

Param	Flag	Results	Units	Reporting Limit
Total Mercury		<0.0002	mg/L	0.0002

Quality Control Report
Lab Control Spikes and Duplicate Spikes

Sample: LCS QC Batch: QC07064

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
CL		11.64	mg/L	1	12.50	<0.5	93		80 - 120	25
Fluoride		2.40	mg/L	1	2.50	<0.2	96		80 - 120	20
Nitrate-N		2.40	mg/L	1	2.50	<0.2	96		80 - 120	20
Sulfate		11.80	mg/L	1	12.50	<0.5	94		80 - 120	20

Sample: LCSD QC Batch: QC07064

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
CL		11.66	mg/L	1	12.50	<0.5	93	0	80 - 120	25
Fluoride		2.45	mg/L	1	2.50	<0.2	98	2	80 - 120	20
Nitrate-N		2.42	mg/L	1	2.50	<0.2	96	1	80 - 120	20
Sulfate		11.92	mg/L	1	12.50	<0.5	95	1	80 - 120	20

Sample: LCS QC Batch: QC07156

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Aluminum		1.96	mg/L	1	2	<0.5	98		75 - 125	20
Total Arsenic		0.996	mg/L	1	1	<0.01	99		75 - 125	20
Total Barium		2.16	mg/L	1	2	<0.01	108		75 - 125	20
Total Boron		0.979	mg/L	1	1	<0.5	97		75 - 125	20
Total Cadmium		0.207	mg/L	1	0.20	<0.002	103		75 - 125	20

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Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Chromium		0.439	mg/L	1	0.40	<0.005	109		75 - 125	20
Total Cobalt		1.06	mg/L	1	1	<0.01	106		75 - 125	20
Total Copper		0.48	mg/L	1	0.40	<0.01	120		75 - 125	20
Total Iron		2.22	mg/L	1	2	<0.02	111		75 - 125	20
Total Lead		1.05	mg/L	1	1	<0.01	105		75 - 125	20
Total Manganese		0.214	mg/L	1	0.20	<0.01	107		75 - 125	20
Total Molybdenum		1.06	mg/L	1	1	<0.02	106		75 - 125	20
Total Nickel		1.04	mg/L	1	1	<0.01	104		75 - 125	20
Total Selenium		0.913	mg/L	1	1	<0.01	91		75 - 125	20
Total Silica		0.661	mg/L	1	0.50	<0.5	132		75 - 125	20
Total Silver		0.208	mg/L	1	0.20	<0.01	104		75 - 125	20
Total Zinc		0.242	mg/L	1	0.20	<0.1	121		75 - 125	20

Sample: LCSD QC Batch: QC07156

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Aluminum		1.9	mg/L	1	2	<0.5	95	3	75 - 125	20
Total Arsenic		0.98	mg/L	1	1	<0.01	98	2	75 - 125	20
Total Barium		2.09	mg/L	1	2	<0.01	104	3	75 - 125	20
Total Boron		0.938	mg/L	1	1	<0.5	93	4	75 - 125	20
Total Cadmium		0.202	mg/L	1	0.20	<0.002	101	2	75 - 125	20
Total Chromium		0.433	mg/L	1	0.40	<0.005	108	1	75 - 125	20
Total Cobalt		1.03	mg/L	1	1	<0.01	103	3	75 - 125	20
Total Copper		0.4	mg/L	1	0.40	<0.01	100	18	75 - 125	20
Total Iron		2.12	mg/L	1	2	<0.02	106	5	75 - 125	20
Total Lead		1.02	mg/L	1	1	<0.01	102	3	75 - 125	20
Total Manganese		0.207	mg/L	1	0.20	<0.01	103	3	75 - 125	20
Total Molybdenum		1.04	mg/L	1	1	<0.02	104	2	75 - 125	20
Total Nickel		1	mg/L	1	1	<0.01	100	4	75 - 125	20
Total Selenium		0.889	mg/L	1	1	<0.01	88	3	75 - 125	20
Total Silica		0.646	mg/L	1	0.50	<0.5	129	2	75 - 125	20
Total Silver		0.2	mg/L	1	0.20	<0.01	100	4	75 - 125	20
Total Zinc		0.198	mg/L	1	0.20	<0.1	99	20	75 - 125	20

Sample: LCS QC Batch: QC07192

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Dissolved Calcium		1020	mg/L	1	1000	<0.50	102		75 - 125	20
Dissolved Magnesium		972	mg/L	1	1000	<0.50	97		75 - 125	20
Dissolved Potassium		936	mg/L	1	1000	<0.50	94		75 - 125	20
Dissolved Sodium		965	mg/L	1	1000	<0.50	98		75 - 125	20

Sample: LCSD QC Batch: QC07192

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Dissolved Calcium		1020	mg/L	1	1000	<0.50	102	0	75 - 125	20
Dissolved Magnesium		988	mg/L	1	1000	<0.50	99	2	75 - 125	20
Dissolved Potassium		941	mg/L	1	1000	<0.50	94	0	75 - 125	20
Dissolved Sodium		979	mg/L	1	1000	<0.50	98	1	75 - 125	20

Sample: LCS

QC Batch: QC07302

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Mercury		0.00111	mg/L	1	0.001	<0.0002	111		80 - 120	20

Sample: LCSD

QC Batch: QC07302

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Mercury		0.00111	mg/L	1	0.001	<0.0002	111	0	80 - 120	20

Quality Control Report
Matrix Spikes and Duplicate Spikes

Sample: MS

QC Batch: QC07064

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
CL		121.36	mg/L	1	62.50	63	93		82 - 100	25
Fluoride		13.55	mg/L	1	12.50		94		81 - 109	20
Nitrate-N		13.81	mg/L	1	12.50		95		74 - 111	20
Sulfate		113.28	mg/L	1	62.50		94		81 - 106	20

Sample: MSD

QC Batch: QC07064

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
CL		121.34	mg/L	1	62.50	63	93	0	82 - 100	25
Fluoride		13.60	mg/L	1	12.50		94	0	81 - 109	20
Nitrate-N		13.90	mg/L	1	12.50		96	1	74 - 111	20
Sulfate		112.49	mg/L	1	62.50		93	1	81 - 106	20

Sample: MS QC Batch: QC07156

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Aluminum		2.06	mg/L	1	2	<0.5	103		75 - 125	20
Total Arsenic		0.938	mg/L	1	1	<0.01	93		75 - 125	20
Total Barium		2.1	mg/L	1	2	0.237	93		75 - 125	20
Total Boron		0.806	mg/L	1	1	<0.5	80		75 - 125	20
Total Cadmium		0.174	mg/L	1	0.20	<0.002	87		75 - 125	20
Total Chromium		0.379	mg/L	1	0.40	<0.005	94		75 - 125	20
Total Cobalt		0.878	mg/L	1	1	<0.01	87		75 - 125	20
Total Copper		0.389	mg/L	1	0.40	0.02	92		75 - 125	20
Total Iron		1.92	mg/L	1	2	0.02	95		75 - 125	20
Total Lead		0.896	mg/L	1	1	<0.01	89		75 - 125	20
Total Manganese		0.186	mg/L	1	0.20	<0.01	93		75 - 125	20
Total Molybdenum		0.928	mg/L	1	1	<0.02	92		75 - 125	20
Total Nickel		0.904	mg/L	1	1	<0.01	90		75 - 125	20
Total Selenium		0.858	mg/L	1	1	<0.01	85		75 - 125	20
Total Silica		8.08	mg/L	1	0.50	7.66	84		75 - 125	20
Total Silver		0.184	mg/L	1	0.20	<0.01	92		75 - 125	20
Total Zinc		0.249	mg/L	1	0.20	<0.1	124		75 - 125	20

Sample: MSD QC Batch: QC07156

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Aluminum		2.06	mg/L	1	2	<0.5	103	0	75 - 125	20
Total Arsenic		0.95	mg/L	1	1	<0.01	95	1	75 - 125	20
Total Barium		2.1	mg/L	1	2	0.237	93	0	75 - 125	20
Total Boron		0.771	mg/L	1	1	<0.5	77	4	75 - 125	20
Total Cadmium		0.175	mg/L	1	0.20	<0.002	87	0	75 - 125	20
Total Chromium		0.39	mg/L	1	0.40	<0.005	97	3	75 - 125	20
Total Cobalt		0.882	mg/L	1	1	<0.01	88	0	75 - 125	20
Total Copper		0.385	mg/L	1	0.40	0.02	91	1	75 - 125	20
Total Iron		1.95	mg/L	1	2	0.02	96	2	75 - 125	20
Total Lead		0.897	mg/L	1	1	<0.01	89	0	75 - 125	20
Total Manganese		0.186	mg/L	1	0.20	<0.01	93	0	75 - 125	20
Total Molybdenum		0.922	mg/L	1	1	<0.02	92	1	75 - 125	20
Total Nickel		0.911	mg/L	1	1	<0.01	91	1	75 - 125	20
Total Selenium		0.874	mg/L	1	1	<0.01	87	2	75 - 125	20
Total Silica		8.03	mg/L	1	0.50	7.66	73	13	75 - 125	20
Total Silver		0.183	mg/L	1	0.20	<0.01	91	0	75 - 125	20
Total Zinc		0.252	mg/L	1	0.20	<0.1	126	1	75 - 125	20

Sample: MS QC Batch: QC07192

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Dissolved Calcium		1570	mg/L	1	1000	525	104		75 - 125	20

Continued ...

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Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Dissolved Magnesium		1010	mg/L	1	1000	46.9	96		75 - 125	20
Dissolved Potassium		978	mg/L	1	1000	9.07	97		75 - 125	20
Dissolved Sodium		1160	mg/L	1	1000	194	97		75 - 125	20

Sample: MSD QC Batch: QC07192

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Dissolved Calcium		1560	mg/L	1	1000	525	104	1	75 - 125	20
Dissolved Magnesium		1020	mg/L	1	1000	46.9	97	1	75 - 125	20
Dissolved Potassium		974	mg/L	1	1000	9.07	96	0	75 - 125	20
Dissolved Sodium		1160	mg/L	1	1000	194	97	0	75 - 125	20

Sample: MS QC Batch: QC07302

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Mercury		0.00108	mg/L	1	0.001	<0.0002	108		80 - 120	20

Sample: MSD QC Batch: QC07302

Param	Flag	Sample Result	Units	Dil.	Spike Amount Added	Matrix Result	% Rec.	RPD	% Rec. Limit	RPD Limit
Total Mercury		0.00114	mg/L	1	0.001	<0.0002	114	5	80 - 120	20

Quality Control Report
Duplicate Samples

Sample: Duplicate QC Batch: QC07062

Param	Flag	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
Specific Conductance		4282	4300	μMHOS/cm	1	0	20

Sample: Duplicate QC Batch: QC07119

Param	Flag	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
pH		8.6	8.6	s.u.	1	0	1.2

Sample: Duplicate QC Batch: QC07123

Param	Flag	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
Hydroxide Alkalinity		<1.0	<1.0	mg/L as CaCo3	1	0	11
Carbonate Alkalinity		<1.0	<1.0	mg/L as CaCo3	1	0	11
Bicarbonate Alkalinity		104	108	mg/L as CaCo3	1	4	11
Total Alkalinity		104	108	mg/L as CaCo3	1	4	11

Sample: Duplicate QC Batch: QC07152

Param	Flag	Duplicate Result	Sample Result	Units	Dilution	RPD	RPD Limit
Total Dissolved Solids		3735	3700	mg/L	1	1	11

Quality Control Report
Continuing Calibration Verification Standards

Sample: CCV (1) QC Batch: QC07062

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Specific Conductance		μMHOS/cm	1413	1388	98	80 - 120	12/1/00

Sample: ICV (1) QC Batch: QC07062

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Specific Conductance		μMHOS/cm	1413	1398	98	80 - 120	12/1/00

Sample: CCV (1) QC Batch: QC07064

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Bromide		mg/L	2.50	2.53	101	80 - 120	12/1/00
CL		mg/L	12.50	11.57	92	80 - 120	12/1/00
Fluoride		mg/L	2.50	2.41	96	80 - 120	12/1/00

Continued ...

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Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Nitrate-N		mg/L	2.50	2.40	96	80 - 120	12/1/00
Sulfate		mg/L	12.50	11.92	95	80 - 120	12/1/00

Sample: ICV (1) QC Batch: QC07064

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Bromide		mg/L	2.50	2.54	101	80 - 120	12/1/00
CL		mg/L	12.50	11.72	93	80 - 120	12/1/00
Fluoride		mg/L	2.50	2.41	96	80 - 120	12/1/00
Nitrate-N		mg/L	2.50	2.45	98	80 - 120	12/1/00
Sulfate		mg/L	12.50	11.97	95	80 - 120	12/1/00

Sample: CCV (1) QC Batch: QC07119

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
pH		s.u.	7	7.0	100	80 - 120	12/1/00

Sample: ICV (1) QC Batch: QC07119

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
pH		s.u.	7	7.0	100	80 - 120	12/1/00

Sample: CCV (1) QC Batch: QC07123

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Hydroxide Alkalinity		mg/L as CaCo3	0	<1.0	0	80 - 120	12/5/00
Carbonate Alkalinity		mg/L as CaCo3	0	232	0	80 - 120	12/5/00
Bicarbonate Alkalinity		mg/L as CaCo3	0	6.0	0	80 - 120	12/5/00
Total Alkalinity		mg/L as CaCo3	250	238	95	80 - 120	12/5/00

Sample: ICV (1) QC Batch: QC07123

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Hydroxide Alkalinity		mg/L as CaCo3	0	<1.0	0	80 - 120	12/5/00
Carbonate Alkalinity		mg/L as CaCo3	0	244	0	80 - 120	12/5/00
Bicarbonate Alkalinity		mg/L as CaCo3	0	2.0	0	80 - 120	12/5/00
Total Alkalinity		mg/L as CaCo3	250	246	98	80 - 120	12/5/00

Sample: CCV (1) QC Batch: QC07152

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Dissolved Solids		mg/L	1000	1007	100	80 - 120	12/5/00

Sample: ICV (1) QC Batch: QC07152

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Dissolved Solids		mg/L	1000	995	99	80 - 120	12/5/00

Sample: CCV (1) QC Batch: QC07156

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Aluminum		mg/L	5	4.64	92	75 - 125	12/6/00
Total Arsenic		mg/L	2.50	2.41	96	75 - 125	12/6/00
Total Barium		mg/L	5	4.92	98	75 - 125	12/6/00
Total Boron		mg/L	2.50	2.24	89	75 - 125	12/6/00
Total Cadmium		mg/L	0.50	0.483	96	75 - 125	12/6/00
Total Chromium		mg/L	1	0.96	96	75 - 125	12/6/00
Total Cobalt		mg/L	2.50	2.43	97	75 - 125	12/6/00
Total Copper		mg/L	1	0.961	96	75 - 125	12/6/00
Total Iron		mg/L	5	4.91	98	75 - 125	12/6/00
Total Lead		mg/L	2.50	2.41	96	75 - 125	12/6/00
Total Manganese		mg/L	0.50	0.486	97	75 - 125	12/6/00
Total Molybdenum		mg/L	2.50	2.42	96	75 - 125	12/6/00
Total Nickel		mg/L	2.50	2.41	96	75 - 125	12/6/00
Total Selenium		mg/L	2.50	2.45	98	75 - 125	12/6/00
Total Silica		mg/L	2.50	2.46	98	75 - 125	12/6/00
Total Silver		mg/L	0.50	0.484	96	75 - 125	12/6/00
Total Zinc		mg/L	0.50	0.488	97	75 - 125	12/6/00

Sample: ICV (1) QC Batch: QC07156

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Aluminum		mg/L	5	4.88	97	75 - 125	12/6/00
Total Arsenic		mg/L	2.50	2.45	98	75 - 125	12/6/00
Total Barium		mg/L	5	5.09	101	75 - 125	12/6/00
Total Boron		mg/L	2.50	2.63	105	75 - 125	12/6/00
Total Cadmium		mg/L	0.50	0.495	99	75 - 125	12/6/00
Total Chromium		mg/L	1	0.986	98	75 - 125	12/6/00
Total Cobalt		mg/L	2.50	2.51	100	75 - 125	12/6/00
Total Copper		mg/L	1	1.01	101	75 - 125	12/6/00
Total Iron		mg/L	5	5.07	101	75 - 125	12/6/00
Total Lead		mg/L	2.50	2.47	98	75 - 125	12/6/00
Total Manganese		mg/L	0.50	0.502	100	75 - 125	12/6/00
Total Molybdenum		mg/L	2.50	2.52	100	75 - 125	12/6/00
Total Nickel		mg/L	2.50	2.52	100	75 - 125	12/6/00
Total Selenium		mg/L	2.50	2.48	99	75 - 125	12/6/00
Total Silica		mg/L	2.50	2.53	101	75 - 125	12/6/00
Total Silver		mg/L	0.50	0.504	100	75 - 125	12/6/00
Total Zinc		mg/L	0.50	0.495	99	75 - 125	12/6/00

Sample: CCV (1)   QC Batch: QC07192

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Dissolved Calcium		mg/L	25	25.8	100	75 - 125	12/6/00
Dissolved Magnesium		mg/L	25	25.6	100	75 - 125	12/6/00
Dissolved Potassium		mg/L	25	24.2	96	75 - 125	12/6/00
Dissolved Sodium		mg/L	25	23.8	96	75 - 125	12/6/00

Sample: ICV (1)   QC Batch: QC07192

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Dissolved Calcium		mg/L	25	25.9	100	75 - 125	12/6/00
Dissolved Magnesium		mg/L	25	25.6	100	75 - 125	12/6/00
Dissolved Potassium		mg/L	25	23.9	96	75 - 125	12/6/00
Dissolved Sodium		mg/L	25	24.7	96	75 - 125	12/6/00

Sample: CCV (1)   QC Batch: QC07302

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Mercury		mg/L	0.001	0.00104	104	80 - 120	12/11/00

Sample: ICV (1)   QC Batch: QC07302

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Mercury		mg/L	0.001	0.00106	106	80 - 120	12/11/00

APPENDIX D

Determination of aquifer transmissivity and hydraulic conductivity (K) based on the analysis of HGS recovery data. After 360 minutes of pumping DTW at MW-2 was 92.82 feet (see Exhibit 10: Whaley Deposition). Calculations and graphical approach presented in Domenico, Patrick and Schwartz, Franklin. 1982. *Physical and Chemical Hydrogeology.* John Wiley and Sons, Inc., New York. pp. 114-115.

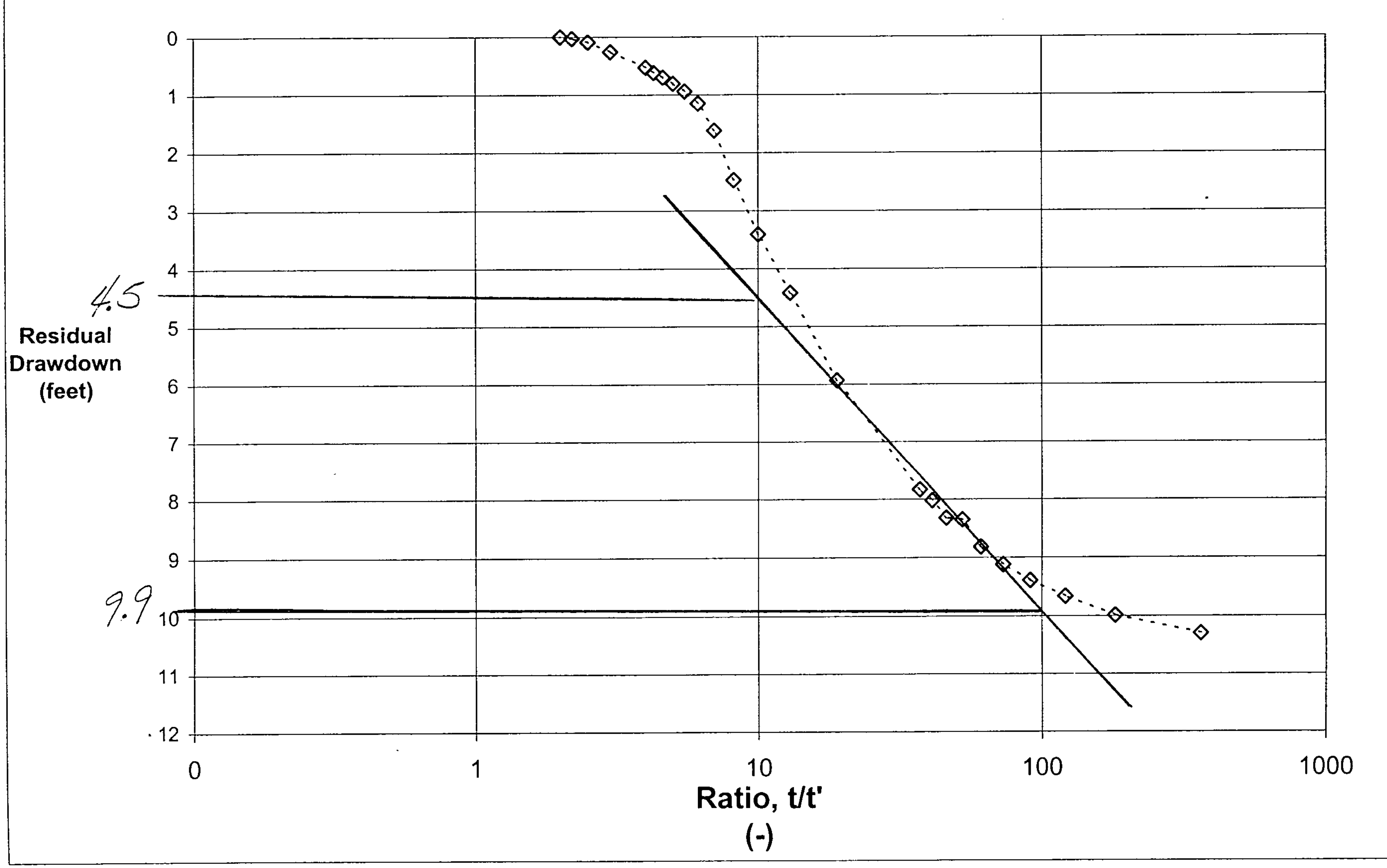
Table D-1: HGS Recovery Data and Residual Drawdown Calculation

Time Since Pumping Stopped, t' (min)	Time Since Pumping Started, t (min)	Ratio, t/t'	Depth to Water (feet)	Residual Drawdown (feet)
0.0	360.0	-	92.82	12.81
1.0	361.0	361.0	90.31	10.30
2.0	362.0	181.0	90.00	9.99
3.0	363.0	121.0	89.67	9.66
4.0	364.0	91.0	89.40	9.39
5.0	365.0	73.0	89.13	9.12
6.0	366.0	61.0	88.83	8.82
7.0	367.0	52.4	88.36	8.35
8.0	368.0	46.0	88.33	8.32
9.0	369.0	41.0	88.03	8.02
10.0	370.0	37.0	87.84	7.83
20.0	380.0	19.0	85.94	5.93
30.0	390.0	13.0	84.43	4.42
40.0	400.0	10.0	83.42	3.41
50.0	410.0	8.2	82.48	2.47
60.0	420.0	7.0	81.63	1.62
70.0	430.0	6.1	81.16	1.15
80.0	440.0	5.5	80.95	0.94
90.0	450.0	5.0	80.82	0.81
100.0	460.0	4.6	80.71	0.70
110.0	470.0	4.3	80.63	0.62
120.0	480.0	4.0	80.54	0.53
180.0	540.0	3.0	80.27	0.26
240.0	600.0	2.5	80.10	0.09
300.0	660.0	2.2	80.04	0.03
360.0	720.0	2.0	80.01	0.00

Calculations:

Parameter	Value	units	explanation / equation
Transmissivity (T)	**48.9**	gpd/ft	T = 2.3 * Q / (4 * pi * delta s); where Q is the pumping rate (1 gallon per minute), pi is 3.14, and delta s is the residual drawdown per log cycle (see attached graph)
Saturated Thickness (b)	21	feet	saturated thickness at MW-2
Hydraulic Conductivity (K)	**0.3**	feet/day	K = T / b

Analysis of Recovery Data



APPENDIX E

Visual MODFLOW Pro

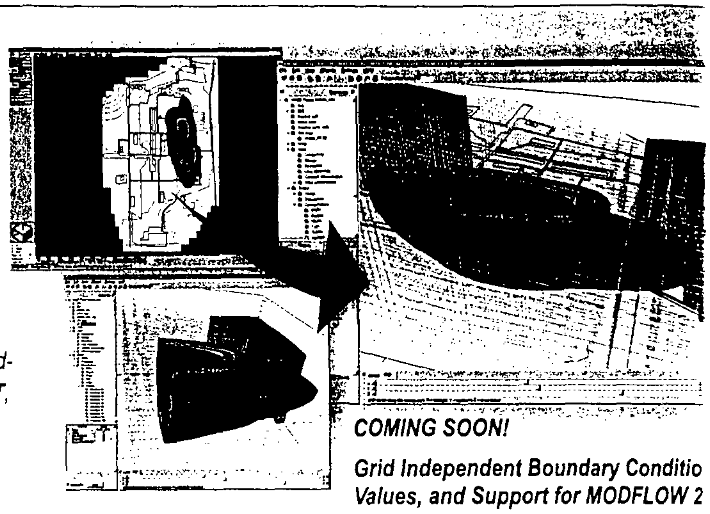
Fully Integrates MODFLOW, MODPATH, MT3DMS, RT3D, Zone Budget, and Win32 MODFLOW Suite

For Windows 95/98/NT/2000

Visual MODFLOW

Groundwater Flow & Contaminant Transport

*Visual MODFLOW Pro incorporates even more innovative tools to help you complete your groundwater flow and contaminant transport models. Visual MODFLOW Pro is based on the world-recognized Visual MODFLOW package and fully-integrates calibration techniques using **WinPEST**, and 3D visualization and animation effects using the Visual MODFLOW **3D-Explorer**. These added components give environmental professionals extra power for building, calibrating, and presenting model results in one reliable software package.*



COMING SOON!

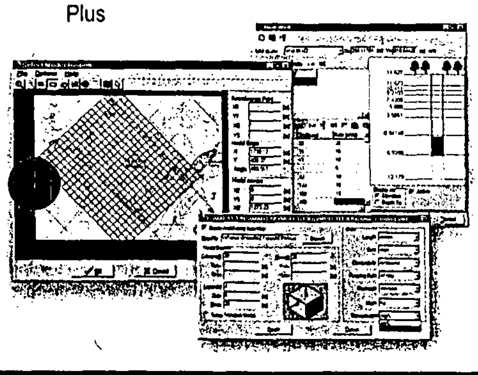
Grid Independent Boundary Conditio Values, and Support for MODFLOW 2

Model Design Features

The Visual MODFLOW Pro interface is built on proven technology and contains a logical menu structure that guides you through the steps required to effectively build, calibrate and evaluate your groundwater flow and contaminant transport models.

Model design features include:

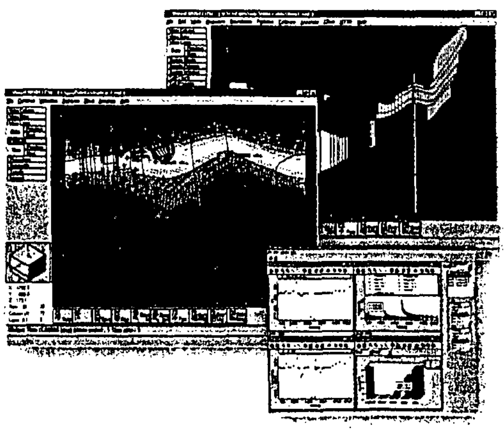
- Interactive model display using aerial and cross-sectional views
- Standard point-and-click functionality for assigning model input data
- Import AutoCAD (.dxf) files or bitmap image (.bmp) files for site base maps
- Rotate and align the model grid over the site base map
- Graphical grid design tools and automatic grid smoothing for improved data convergence
- Grid Cell Elevation Editor for on-the-fly modifications to individual cells elevations
- Import variable layer surface elevations from ASCII (X,Y,Z) files and Surfer (.grd) files
- Import time schedules for transient boundary conditions and observation points
- Assign multi-level observation wells and create observation groups for localized calibration analysis
- Import groundwater recharge and recharge concentrations from the WHI UnSat Suite Plus



Model Display Features

The ability to visualize and interpret the simulation results is almost as important as creating the model in the first place. In order to get the most out of the model that you build, it is critical that you have the tools necessary to properly analyze the results.

- Contour maps and color maps of model properties and simulation results such as heads, drawdown, concentrations, water table elevations, layer elevation, layer thickness, net recharge, flux between layers, and head difference between layers
- Flow velocity vectors and pathlines
- Color-coded plot of steady-state and transient pathlines with time markers
- Detailed graphical summaries of global and local mass budgets
- Model calibration plots and statistical summaries including mean error, absolute mean error, standard deviation, root mean square of the error, and normalized root mean square of the error
- Export screen display to graphics formats such as Enhanced Windows Metafile (.emf), AutoCAD (.dxf), and ESRI Shape (.shp) files
- Export model results to 2D or 3D ASCII text files supported by virtually ANY 3D visualization software
- Print full-color, high-resolution plots to any printer or plotter

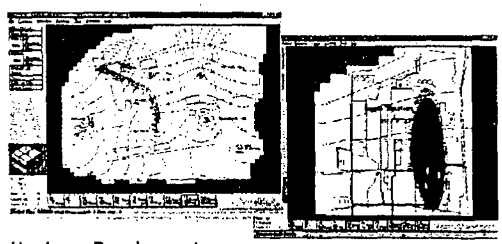


Simulation Capabilities

- Full integration of **MT3DMS** for multi-species contaminant transport simulations
- Full integration of **RT3D** for reactive transport simulations including:

  -Instantaneous BTEX degradation
  -Multi-path BTEX degradation
  -Reductive dechlorination of TCE/PCE
  -Sequential decay reactions
  -Rate-limited sorption reactions
  -Double-monod kinetic reactions

- Supports **MT3D99** for faster and more stable reactive transport simulations
- Seamless integration with the Win32 MODFLOW Suite *(runs MODFLOW, MODPATH, MT3DMS, RT3D, & Zone Budget as a 32-Bit Windows Application)*
- Interactive display of solution convergence for on-the-fly modification of solver settings and graphical display of transient simulation results
- Includes the WHS Solver (faster and more stable than PCG2)
- Built-in batch processing of multiple simulations for sensitivity analyses



Hardware Requirement

- PC Pentium, 64 Mb RAM
- 55 Mb free disk space
- Monitor with SVGA display
- Windows 95/98/NT/2000 installed

Documentation

- Visual MODFLOW User's Guide
- Official Reference Manuals are included on the installation CD-ROM in Portable Document Format

Visual MODFLOW US$ 995 00

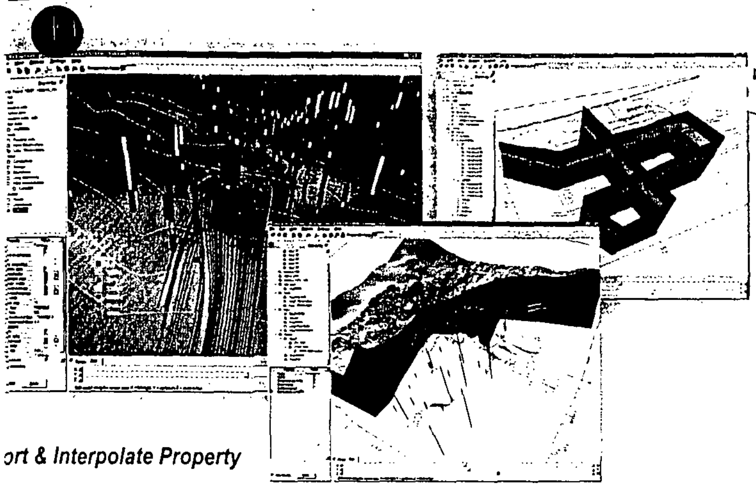
Visual MODFLOW Pro US$ 1995 00

Combines Visual MODFLOW, WinPEST, VMOD 3D-Explorer

For order information, please see page 26.

g Visual MODFLOW, Visual MODFLOW 3D-Explorer, and WinPEST into one powerful modeling environment!

Create High-Impact 3D Images Directly From the Visual MODFLOW Pro Interface!



ort & Interpolate Property

Visual MODFLOW Pro & VMOD 3D-Explorer prices valid until December 31st, 2000

Visual MODFLOW

3D-Explorer

3D Visualization & Animation Effects

The Visual MODFLOW 3D-Explorer is a built-in 3D visualization system for displaying and animating Visual MODFLOW models using state-of-the-art 3D graphics technology. The advanced visualization capabilities of the Visual MODFLOW 3D-Explorer give you all the tools you need to create impressive and informative 3D images and animations of your modeling data using vibrant colors and high-resolution graphics.

Model Display Features

- 2D and 3D model grid lines
- 3D pumping wells and observation wells
- Soil property zones and boundary conditions
- Contour maps and color maps of heads, draw-down, water table elevation, and multi-species concentrations
- 3D volumetric groundwater plumes
- 3D pathlines with time markers
- map overlays using AutoCAD (.dxf) files and bitmap (.bmp) files

Model Animation Effects

- Multi-species groundwater plume migration
- Seasonal water level fluctuations
- Water table drawdown due to pumping
- Sequential degradation of contaminants

Advanced Viewing Features

The Visual MODFLOW 3D-Explorer gives you a complete selection of 3D objects to represent the physical and chemical characteristics of your model such as:

- Horizontal and vertical slices
- Irregular shaped cross-sections
- Multiple 3D volumetric isosurfaces
- Irregular shaped 3D cut-away regions

Contour Maps and Color Maps

Plot contour maps and color maps of all distributed model parameters on any slice (horizontal or vertical) or cross-section through the model. Distributed model properties include soil property zones and simulated heads, drawdown, water table elevations, and multi-species concentrations.

3D Volumetric Isosurfaces

Multiple 3D volumetric isosurfaces can be created for any distributed model property including soil property zones and simulated heads, drawdown, water table elevations, and multi-species concentrations.

Cut-away Views

Cut-away views of the model can be created using any horizontal or vertical slice, or any cross-section through the model domain. The cut-away view allows you to see what is occurring inside the model domain, at any location, while still maintaining a true 3D perspective of the site.

Visual MODFLOW **3D-Explorer** Single-User License — US$ 795.00

Is It Really Too Good To Be True?

With the growing popularity of programs like WinPEST, non-linear parameter estimation technology has become the preferred method for assisting in the calibration of groundwater models. Not only does the application of this technology have the potential to reduce calibration time enormously, it can also open up new possibilities for creative, yet scientifically rigorous, model design. By applying WinPEST's powerful parameter estimation methods to your Visual MODFLOW models, you will gain valuable insight into the strengths and weaknesses of your dataset. In addition, WinPEST will allow you to make professional judgements about the degree of uncertainty associated with model predictions, and to make decisions regarding the appropriate levels of model complexity.

With WinPEST, you're free to unleash your creativity in the calibration and data interpretation process while the program carries out the numerically intensive calculations.

Benefits of WinPEST

- Save you time and money by reducing countless hours spent calibrating your model
- Improve the quality and reliability of your model
- Improve your sensitivity analysis capabilities
- Give you the graphical tools to interpret and display calibration parameters

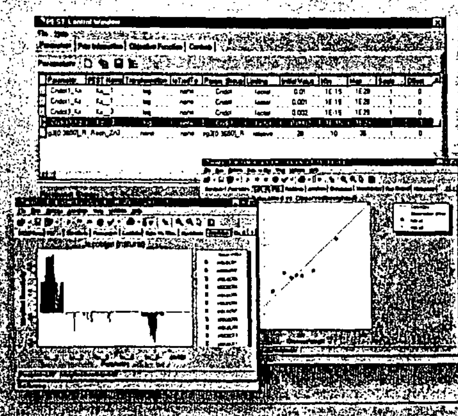
Why WinPEST?

WinPEST offers many advantages over other similar parameter estimation codes. With its powerful inversion engine and the ability to set upper and lower bounds on parameters, WinPEST has achieved outstanding results in the calibration of models of all kinds. Its unparalleled ability to work with large and complex models is further enhanced by the possibilities it offers for user interaction in the calibration process.

Automated Model Calibration Using Non-Linear Parameter Estimation and Predictive Analysis

Visual MODFLOW's

WinPEST



WinPEST Single-User License — US$ 400.00

Universities - 25% discount
Government/Research - 15% discount

Request your free WHI demonstration CD-ROM today!

U.S. Geological Survey modflow(1)

NAME

modflow - Modular three-dimensional finite-difference ground-water model

ABSTRACT

MODFLOW is a three-dimensional finite-difference ground-water model that was first published in 1984. It has a modular structure that allows it to be easily modified to adapt the code for a particular application. Many new capabilities have been added to the original model. OFR 00-92 (complete reference below) documents a general update to MODFLOW, which is called MODFLOW-2000 in order to distinguish it from earlier versions.

MODFLOW-2000 simulates steady and nonsteady flow in an irregularly shaped flow system in which aquifer layers can be confined, unconfined, or a combination of confined and unconfined. Flow from external stresses, such as flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through river beds, can be simulated. Hydraulic conductivities or transmissivities for any layer may differ spatially and be anisotropic (restricted to having the principal directions aligned with the grid axes), and the storage coefficient may be heterogeneous. Specified head and specified flux boundaries can be simulated as can a head dependent flux across the model's outer boundary that allows water to be supplied to a boundary block in the modeled area at a rate proportional to the current head difference between a "source" of water outside the modeled area and the boundary block. MODFLOW is currently the most used numerical model in the U.S. Geological Survey for ground-water flow problems.

In addition to simulating ground-water flow, the scope of MODFLOW-2000 has been expanded to incorporate related capabilities such as solute transport and parameter estimation.

METHOD

The ground-water flow equation is solved using the finite-difference approximation. The flow region is subdivided into blocks in which the medium properties are assumed to be uniform. In plan view the blocks are made from a grid of mutually perpendicular lines that may be variably spaced. Model layers can have varying thickness. A flow equation is written for each block, called a cell. Several solvers are provided for solving the resulting matrix problem; the user can choose the best solver for the particular problem. Flow-rate and cumulative-volume balances from each type of inflow and outflow are computed for each time step.

HISTORY

MODFLOW-2000 Version 1.2 2001/04/12 - Added support for using vendor-specific options for opening unformatted (binary) files. On personal computers, this can make it possible for programs compiled by different compilers to write files that have the same structure. The formula used to calculate dimensionless, scaled sensitivities of simulated equivalents to observations for log-transformed parameters is changed. Other changes include bug fixes and clarification of output. The MODFLOW-2000 distribution now includes Release Notes in the file release.txt in the doc directory -- this file describes in detail changes to MODFLOW-2000 for each version.

MODFLOW-2000 Version 1.1 2001/01/17 - Added IBS, HUF, LAK, ETS, and DRT Packages. Added HYDMOD option. The EVT Package was modified as described in the LAK documentation to include the option (NEVTOP=3) to apply ET to the uppermost wet cell in a vertical column of cells as done in the RCH Package.

MODFLOW-2000 Version 1.0 2000/07/20 - Enhanced modular structure that facilitates the addition of broader capabilities such as parameter estimation and solute transport. New data input methods are included to support parameter estimation. Vertical cell dimensions are specified in a separate discretization file. A new package called the LPF Package has been added as an alternative to the BCF Package.

The MODFLOW-2000 documenation report (OFR 00-92) does not include the STR Package; however, this code has been upgraded to use parameters and is included in this version of MODFLOW-2000. Revised STR input instructions can be found in file str6.pdf, which is included in the doc directory that is part of the distribution for MODFLOW-2000.

The ADV Package has been modified for use with MODFLOW-2000. Changes in input instructions are contained in file adv.txt, which is also in the doc distribution directory.

The RES and FHB Packages are included in MODFLOW-2000 without modification. These will work as before, but they do not incorporate parameters or observations.

The IBS, TLK, and GFD Packages are not included in this release. They require modification in order to work within MODFLOW-2000.

Note that MODFLOW-2000 sends some messages to the computer display. Some Fortran compilers make use of a reserved file unit, for example unit 6, for output to the display. If such compilers are used, it is important to avoid using a reserved unit for any files in the MODFLOW name file.

MODFLOW-96 Version 3.3 2000/05/02 - Error fixed in IBS code that caused incorrect values for critical head to be written when the option is invoked to save these values in an external file (variable IHCSV>0). The error did not affect the actual interbed storage calculations, and none of the other model results, such as computed head and budget flows, are affected by the correction. There are no changes to any other packages.

MODFLOW-96 Version 3.2 1998/01/09 - The Flow and Head Boundary Package, Version 1, (FHB1) has been added. This package allows for assignment of transient specified-flow and specified-head boundaries in applications of MODFLOW-96. The FHB1 package is documented in U.S. Geological Survey Open-File Report 97-571.

MODFLOW-96 Version 3.1 1997/03/11 - Calls to the Horizontal Flow Barrier (HFB) Package have been corrected in the main program. The main program for Version 3.0 incorrectly calls the HFB1RP module where it should call the HFB1FM module.

MODFLOW-96 Version 3.0 1996/12/03 - Updated version of overall model, which is called MODFLOW-96. A number of changes were made to make MODFLOW easier to use and easier to enhance. MODFLOW-96 can use existing input data sets, and has the same computational methods. Any package added to the original model (now referred to as MODFLOW-88) will also work with MODFLOW-96.

The Preconditioned Conjugate Gradient Package, Version 2 (PCG2) has been updated. This requires a minor change in input data compared to the documentation in U.S. Geological Survey Water-Resources Investigations Report (WRIR) 90-4048 (full reference below). WRIR 90-4048 specifies two lines of input data. All of the data are the same except the seventh value on the 2nd line. This value is named IPCGCD in WRIR-4048, but it has been replaced by a value named DAMP. That is, IPCGCD is no longer part of the input data. DAMP can be used to reduce oscillation when the solver is having difficulty converging due to excessive oscillation. The value of DAMP is multiplied times the head change calculated each iteration at all cells. Thus, if DAMP is 0.5, the head change is cut in half. If DAMP is 1.0, then PCG2 behaves as it did prior to the addition of this capability. DAMP should be set equal to 1.0 except when there is indication of excessive oscillation. If the value of DAMP is specified as 0.0 or less, it is automatically changed to 1.0.

Also the sign of the C.B. STORAGE cell-by-cell budget data in the TLK1 Package was changed to match the standard sign convention in MODFLOW. The change to TLK1 does not impact computed heads or the overall volumetric budget; it only affects data written to a cell-by-cell budget file.

MODFLOW-88 Version 2.6 1996/09/20 - Added Reservoir package (RES1) as documented in U.S. Geological Survey Open-File Report 96-364. Problem fixed for IBS package. Although subsidence is only meant to be active for layers in which IBQ>0, sometimes MODFLOW performed subsidence calculations when IBQ<0. Note that this was a problem only if negative IBQ values were specified. That is, the code has always worked correctly for IBQ=0 and IBQ>0.

MODFLOW-88 Version 2.5 1995/06/23 - Added direct solution package (DE45).

MODFLOW-88 Version 2.4 1995/06/15 - Added transient leakage package

(TLK1).

MODFLOW-88 Version 93/08/30 - Release with PCG2, BCF3, STR1, HFB1, ISB1, CHD1, and GFD1 additions.

MODFLOW-88 Version 87/07/24 - Fortran 77 version published in U.S. Geological Survey Techniques of Water-Resources Investigations 6-A1.

MODFLOW Version 83/12/28 - Fortran 66 version published in U.S. Geological Survey Open-File Report 83-875.

DATA REQUIREMENTS

In order to use MODFLOW, initial conditions, hydraulic properties, and stresses must be specified for every model cell in the finite-difference grid.

OUTPUT OPTIONS

Primary output is head, which can be written to the listing file or into a separate file. Other output includes the complete listing of all input data, drawdown, and budget data. Budget data are printed as a summary in the listing file, and detailed budget data for all model cells can be written into a separate file.

SYSTEM REQUIREMENTS

MODFLOW-2000 is written in Fortran 77 with the following extensions: use of variable names longer than 6 characters, Fortran 90 statements for dynamic memory allocation, and a call to SUBROUTINE GETCL to retrieve command-line arguments. Generally, the program is easily installed on most computer systems. The code has been used on UNIX-based computers and DOS-based 386 or greater computers having a math coprocessor and 4 mb of memory.

PROCESSES

This version of MODFLOW includes the following processes:

GWF1 -- Ground-Water Flow Process
SEN1 -- Sensitivity Process
OBS1 -- Observation Process
PES1 -- Parameter-Estimation Process

PACKAGES

This version of MODFLOW includes the following packages:

BAS6 -- Basic Package
BCF6 -- Block-Centered Flow Package
LPF1 -- Layer-Property Flow Package
RIV6 -- River Package
DRN6 -- Drain Package
WEL6 -- Well Package
GHB6 -- General Head Boundary Package
RCH6 -- Recharge Package
EVT6 -- Evapotranspiration Package
CHD6 -- Time-Variant Specified-Head Package
HFB6 -- Horizontal Flow Barrier Package
SIP5 -- Strongly Implicit Procedure Package
SOR5 -- Slice Successive Over-Relaxation Package

PCG2 -- Version 2 of Preconditioned Conjugate Gradient Package
DE45 -- Direct solver
STR6 -- Streamflow-Routing Package
ADV2 -- Advective-Transport Observation Package
RES1 -- Reservoir Package (RES is the file type in the MODFLOW name file)
FHB1 -- Flow and Head Boundary Package (FHB is the file type in the MODFLOW name file)
IBS6 -- Interbed Storage (subsidence) Package (IBS is the file type in the name file)
HUF1 -- Hydrogeologic-Unit Flow Package
LAK3 -- Lake Package
ETS1 -- Evapotranspiration with a Segmented Function Package
DRT1 -- Drains with Return Flow Package

ADDITIONAL CAPABILITIES:

HYDMOD -- Hydrograph option

DOCUMENTATION

The basic documentation is contained in the following five reports:

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to modularization concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, 121 p.

Hill, M.C., Banta, E.R., Harbaugh, A.W., and Anderman, E.R., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- User guide to the Observation, Sensitivity, and Parameter-Estimation Processes and three post-processing programs: U.S. Geological Survey Open-File Report 00-184, 210 p.

Harbaugh, A.W., and McDonald, M.G., 1996, User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-485, 56 p.

Harbaugh, A.W., and McDonald, M.G., 1996, Programmer's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-486, 220 p.

McDonald, M.G., and Harbaugh, A.W., 1988, A modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Techniques of Water-Resources Investigations, book 6, chap. A1, 586 p.

The BCF6 code is documented in several places. It includes the capabilities of BCF1, BCF2, and BCF3 Packages. The primary documentation is in the basic model documentation (TWRI 6-A1, OFR 96-485, and OFR 96-486).

BCF2 documentation describes the addition of the capability to convert dry cells to wet:

McDonald, M.G., Harbaugh, A.W., Orr, B.R., and Ackerman, D.J., 1992, A method of converting no-flow cells to variable-head cells for the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 91-536, 99 p.

BCF3 documentation describes the addition of alternate interblock transmissivities.

Goode, D.J., and Appel, C.E., 1992, Finite-difference interblock transmissivity for unconfined aquifers and for aquifers having smoothly varying transmissivity: U.S. Geological Survey Water-Resources Investigations Report 92-4124, 79 p.

Version 2 of Preconditioned Conjugate Gradient Package is documented in:

Hill, M.C., 1990, Preconditioned conjugate-gradient 2 (PCG2), a computer program for solving ground-water flow equations: U.S. Geological Survey Water-Resources Investigations Report 90-4048, 43 p.

The Streamflow-Routing Package is documented in:

Prudic, D.E., 1989, Documentation of a computer program to simulate stream-aquifer relations using a modular, finite-difference, ground-water flow model: U.S. Geological Survey Open-File Report 88-729, 113 p.

The Time-Variant Specified-Head Package is documented in:

Leake, S.A., and Prudic, D.E., 1991, Documentation of a computer program to simulate aquifer-system compaction using the modular finite-difference ground-water flow model: U.S. Geological Survey Techniques of Water-Resources Investigations, book 6, chap. A2, 68 p.

The Horizontal-Flow Barrier Package is documented in:

Hsieh, P.A., and Freckleton, J.R., 1993, Documentation of a computer program to simulate horizontal-flow barriers using the U.S. Geological Survey modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 92-477, 32 p.

The DE45 Package is documented in:

Harbaugh, A.W., 1995, Direct solution package based on alternating diagonal ordering for the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 95-288, 46 p.

The RES1 Package is documented in:

Fenske, J.P., Leake, S.A., and Prudic, D.E., 1996, Documentation of a computer program (RES1) to simulate leakage from reservoirs using the modular finite-difference ground-water flow model (MODFLOW): U.S.

Geological Survey Open-File Report 96-364, 51 p.

The FHB1 Package is documented in:

Leake, S.A., and Lilly, M.R., 1997, Documentation of a computer program (FHB1) for assignment of transient specified-flow and specified-head boundaries in applications of the modular finite- difference ground-water flow model (MODFLOW): U.S. Geological Survey Open-File Report 97-571, 50 p.

The ADV Package is documented in:

Anderman, E.R. and Hill, M.C., 1997, Advective-transport observation (ADV) package, a computer program for adding advective-transport observations of steady-state flow fields to the three-dimensional ground-water flow parameter-estimation model MODFLOWP: U.S. Geological Survey Open-File Report 97-14, 67 p.

HYDMOD is documented in:

Hanson, R.T. and Leake, S.A., 1999, Documentation of HYDMOD, a program for extracting and processing time-series data from the U.S. Geological Survey's modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Open-File report 98-564, 57 p.

The IBS Package is documented in:

Leake, S.A. and Prudic, D.E., 1991, Documentation of a computer program to simulate aquifer-system compaction using the modular finite-difference ground-water flow model: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 6, Chapter A2, 68 p.

The HUF Package is documented in:

Anderman, E.R., and Hill, M.C., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- Documentation of the Hydrogeologic-Unit Flow (HUF) Package: U.S. Geological Survey Open-File Report 00-342, 89 p.

The LAK Package is documented in:

Merritt, L.M. and Konikow, L.F., 2000, Documentation of a computer program to simulate lake-aquifer interaction using the MODFLOW ground-water flow model and the MOC3D solute-transport model: U.S. Geological Survey Water-Resources Investigations Report 00-4167, 146 p.

The ETS and DRT Packages are documented in:

Banta, E.R., 2000, MODFLOW-2000, the U.S. Geological Survey modular ground-water model -- Documentation of packages for simulating evapotranspiration with a segmented function (ETS1) and drains with return flow (DRT1): U.S. Geological Survey Open-File Report 00-466, 127 p.

REFERENCES

MODFLOW is widely used in the USGS and throughout the world.

Belitz, K., and Phillips, S.P., 1993, Numerical simulation of ground-water flow in the central part of the western San Joaquin Valley, California: U.S. Geological Survey Water-Supply Paper 2396, 69 p.

Prince, K.R., Franke, O.L., and Reilly, T.E., 1988, Quantitative assessment of the shallow ground-water flow system associated with Connetquot Brook, Long Island, New York: U.S. Geological Survey Water-Supply Paper 2309, 28 p.

TRAINING

Modeling of Ground-Water Flow Using Finite-Difference Methods (GW2096TC), offered annually at the USGS National Training Center.

Advanced Finite-Difference Modeling of Ground-Water Flow (GW3099TC), offered annually at the USGS National Training Center.

Calibration and uncertainty of Ground-Water Models (GW3089TC), offered annually at the USGS National Training Center.

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The USGS MODFLOW fact sheet (a short description of the MODFLOW model) can be retrieved using the World-Wide Web at site:

http://water.usgs.gov/public/pubs/FS/FS-121-97/

See

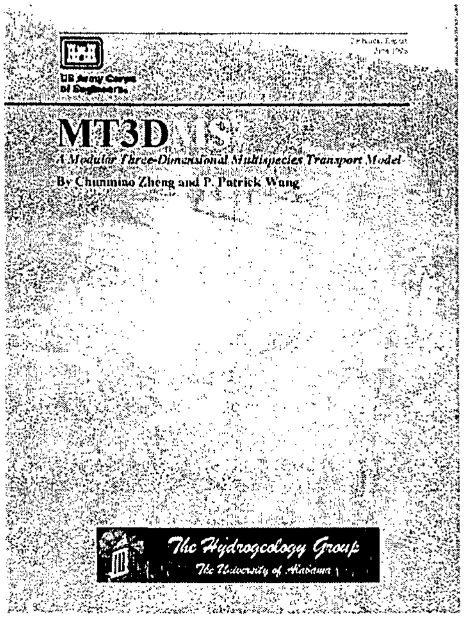
http://water.usgs.gov/software/ordering_documentation.html

for information on ordering printed copies of USGS publications.

SEE ALSO

modpath(1) - Particle-tracking postprocessor program for the modular three-dimensional finite-difference ground-water flow model

zonebudget(1) -- Program for computing subregional water budgets for MODFLOW ground-water flow models



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- Download MT3DMS Documentation in PDF Format
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- Bug Fixes and Upgrades
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Note:

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2. Acrobat Reader **4.0** is needed to view or print the MT3DMS documentation. Note that some graphics may not show up in Acrobat Reader 3.0. If you don't already have Acrobat Reader 4.0 installed in your computer, you can download it from:
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Abstract

This manual describes the next-generation of the modular three-dimensional transport model, MT3D, with significantly expanded capabilities, including the addition of, 1) a third-order total-variation-diminishing (TVD) scheme for solving the advection term that is mass conservative but does not introduce excessive numerical dispersion and artificial oscillation; 2) an efficient iterative solver based on generalized conjugate gradient methods and the Lanczos/ORTHOMIN acceleration scheme to remove stability constraints on the transport time stepsize; 3) options for accommodating nonequilibrium sorption and dual-domain advection-diffusion mass transport; and 4) a multi-component program structure that can accommodate add-on reaction packages for modeling general biological and geochemical reactions.

The new modular multispecies transport model, referred to as MT3DMS in this manual, is unique in that it includes the three major classes of transport solution techniques in a single code, i.e., the standard finite difference method; the particle-tracking-based Eulerian-Lagrangian methods; and the higher-order finite-volume TVD method. Since no single numerical technique has been shown to be effective for all transport conditions, the combination of these solution techniques, each having its own strengths and limitations, is believed to offer the best approach for solving the most wide-ranging transport problems with desired efficiency and accuracy.

MT3DMS can be used to simulate changes in concentrations of miscible contaminants in groundwater considering advection, dispersion, diffusion and some basic chemical reactions, with various types of boundary conditions and external sources or sinks. The basic chemical reactions included in the model are equilibrium-controlled or rate-limited linear or non-linear sorption, and first-order irreversible or reversible kinetic reactions. More sophisticated, multispecies chemical reactions can be simulated by add-on reaction packages. MT3DMS can accommodate very general spatial discretization schemes and transport boundary conditions, including: 1) confined, unconfined or variably confined/unconfined aquifer layers; 2) inclined model layers and variable cell thickness within the same layer; 3) specified concentration or mass flux boundaries; and 4) the solute transport effects of external hydraulic sources and sinks such as wells, drains, rivers, areal recharge and evapotranspiration. MT3DMS is designed for use with any block-centered finite-difference flow model, such as the U.S. Geological Survey modular finite-difference groundwater flow model, MODFLOW, under the assumption of constant fluid density and full saturation. However, MT3DMS can also be coupled with a variably saturated or density-dependent flow model for simulation of transport under such conditions.

Introduction

Purpose and Scope

The modular three-dimensional transport model referred to as MT3D was originally developed by Zheng (1990) at S. S. Papadopulos & Associates, Inc., and subsequently documented for the Robert S. Kerr Environmental Research Laboratory of the United States Environmental Protection Agency. In the past several years, various versions of the MT3D code have been commonly used in contaminant transport modeling and remediation assessment studies. This manual describes the next-generation of MT3D with significantly expanded capabilities, including the addition of, 1) a third-order total-variation-diminishing (TVD) scheme for solving the advection term that is mass conservative but does not introduce excessive numerical dispersion and artificial oscillation; 2) an efficient iterative solver based on generalized conjugate gradient methods to remove stability constraints on the transport time stepsize; 3) options for accommodating nonequilibrium sorption and dual-domain advection-diffusion mass transport; and 4) a multi-component program structure that can accommodate add-on reaction packages for modeling general biological and geochemical reactions.

Key Features

The new mass transport model documented in this manual is referred to as MT3DMS, where MT3D stands for the <u>M</u>odular <u>3-D</u>imensional <u>T</u>ransport model while MS denotes the <u>M</u>ulti-<u>S</u>pecies structure for accommodating add-on reaction packages. MT3DMS has a comprehensive set of options and capabilities for simulating advection, dispersion/diffusion, and chemical reactions of contaminants in groundwater flow systems under general hydrogeologic conditions. This section summarizes the key features of MT3DMS.

MT3DMS is unique in that it includes three major classes of transport solution techniques in a single code, i.e., the standard finite difference method; the particle-tracking-based Eulerian-Lagrangian methods; and the higher-order finite-volume TVD method. Since no single numerical technique has been shown to be effective for all transport conditions, the combination of these solution techniques, each having its own strengths and limitations, is believed to offer the best approach for solving the most wide-ranging transport problems with desired efficiency and accuracy.

In addition to the explicit formulation of the original MT3D code, MT3DMS includes an implicit formulation that is solved with an efficient and versatile solver. The iterative solver is based on generalized conjugate gradient (GCG) methods with three preconditioning options and the Lanczos/ORTHOMIN acceleration scheme for non-symmetrical matrices. If the GCG solver is selected, dispersion, sink/source, and reaction terms are solved implicitly without any stability constraints. For the advection term, the user has the option to select any of the solution schemes available, including the standard finite-difference method, the particle tracking based Eulerian-Lagrangian methods, and the third-order TVD method. The finite-difference method can be fully implicit without any stability constraint to limit transport step sizes, but the particle tracking based Eulerian-Lagrangian methods and the third-order TVD method still have time step constraints associated with particle tracking and TVD methodology. If the GCG solver is not selected, the explicit formulation is automatically used in MT3DMS with the usual stability constraints. The explicit formulation is efficient for solving advection-dominated problems in which the transport stepsizes are restricted by accuracy considerations. It is also useful when the implicit solver requires a large number of iterations to converge or when the computer system does not have enough memory to use the implicit solver.

MT3DMS is implemented with an optional, dual-domain formulation for modeling mass transport. With this formulation, the porous medium is regarded as consisting of two distinct domains, a mobile domain where transport is predominately by advection and an immobile domain where transport is predominately by molecular diffusion. Instead of a single "effective" porosity for each model cell, two porosities, one for the mobile domain and the other for the immobile domain, are used to characterize the porous medium. The exchange between the mobile and immobile domains is specified by a mass transfer coefficient. The dual-domain advective-diffusive model may be more appropriate for modeling transport in fractured media or extremely heterogeneous porous media than the single porosity advective-dispersive model, provided that the porosities and mass transfer coefficients can be properly characterized.

MT3DMS retains the same modular structure of the original MT3D code, similar to that implemented in the U.S. Geological Survey modular three-dimensional finite-difference groundwater flow model, MODFLOW, (McDonald and Harbaugh, 1988; Harbaugh and McDonald, 1996). The modular structure of the transport model makes it possible to simulate advection, dispersion/diffusion, source/sink mixing, and chemical reactions separately without reserving computer memory space for unused options; furthermore new packages involving other transport processes and reactions can be added to the model readily without having to modify the existing code.

As in the original MT3D code, MT3DMS is developed for use with any block-centered finite-difference flow model such as MODFLOW and is based on the assumption that changes in the concentration field will not affect the flow field significantly. After a flow model is developed and calibrated, the information needed by the transport model can be saved in disk files which are then retrieved by the transport model. Since most potential users of a transport model are likely to have been familiar with one or more flow models, MT3DMS provides an opportunity to simulate contaminant transport without having to learn a new flow model or to modify an existing flow model to fit the transport model. In addition, separate flow simulation and calibration outside the transport model can result in substantial savings in computer memory. The model structure also saves execution time when many transport runs are required while the flow solution remains the same. Although this report describes only the use of MT3DMS in conjunction with MODFLOW, MT3DMS can be linked to any other block-centered finite-difference flow model in a simple and straightforward fashion.

MT3DMS can be used to simulate changes in concentrations of miscible contaminants in groundwater considering advection, dispersion, diffusion and some basic chemical reactions, with various types of boundary conditions and external sources or sinks. The chemical reactions included in the model are equilibrium-controlled or rate-limited linear or non-linear sorption, and first-order irreversible or reversible kinetic reactions. It should be noted that the basic chemical reaction package included in MT3DMS is intended for single-species systems. An add-on reaction package such as RT3D (Clement, 1997) or SEAM3D (Widdowson and Waddill, 1997) must be used to model more sophisticated multi-species reactions. MT3DMS can accommodate very general spatial discretization schemes and transport boundary conditions, including: 1) confined, unconfined or variably confined/unconfined aquifer layers; 2) inclined model layers and variable cell thickness within the same layer; 3) specified concentration or mass flux boundaries; and 4) the solute transport effects of external hydraulic sources and sinks such as wells, drains, rivers, areal recharge and evapotranspiration.

Organization of the Report

This report covers the theoretical, numerical and application aspects of the MT3DMS transport model. Following this introduction, Chapter 2 gives a brief overview of the physical-mathematical basis and various functional relationships underlying the transport model. Chapter 3 explains the basic ideas behind the various solution schemes implemented in MT3DMS. Chapter 4 discusses the computer implementation of the numerical solution schemes. Chapter 5 describes the program structure and design of the MT3DMS code, which has been divided into a main program and a number of packages, each dealing with a single aspect of the transport simulation. Chapter 6 provides detailed model input instructions and discusses how to set up a simulation. Chapter 7 describes the benchmark and example problems that were used to test the MT3DMS code and illustrate its applications. The appendices include information on the iterative solver, the computer memory requirements of the MT3DMS model, the interface between MT3DMS and a flow model, several post-processing programs, and tables of abbreviated input instructions.

Acknowledgments

The original MT3D code was developed at S. S. Papadopulos & Associates, Inc. and documented for the U.S. Environmental Protection Agency. The contributions of Charles Andrews, Gordon Bennett and Stavros Papadopulos to the conception and development of MT3D are gratefully acknowledged. The current work was funded, in part, by the U.S. Army Corps of Engineers Waterways Experiment Station (WES) under contract DACA39-96-K-0016 to the University of Alabama. We are indebted to several WES scientists, including Mark Dortch, Mansour Zakikhani, Dave Richards, Jeff Holland and

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