LOS AMIGOS RANCH PUD
FILINGS 6 THROUGH 10
INDIVIDUAL WASTEWATER TREATMENT SYSTEMS
SUPPLEMENTAL DOCUMENTATION

Prepared By:

Resource Engineering, Inc.
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May 13, 1998

RESOURCE
ENGINEERING INC.

Los Amigos Ranch Partnership
c/o Mr. Greg Boecker, Ranch Manager
2929 County Road 114
Glenwood Springs, CO 81601

May 13, 1998

RE: Los Amigos Ranch PUD Filings 6 - 10 Individual Wastewater Treatment Systems

Dear Greg:

This letter is provided as supplemental information to previous letters by Resource Engineering, Inc. (Resource) related to ISDS systems for the Los Amigos Ranch PUD Filings 6 - 10 (LAR). Those letters are addressed to Los Amigos Ranch Partnership and are dated April 6, 1998[1] and April 23, 1998. The April 23 letter is attached hereto as Exhibit A. The purposes of this letter are:

1) To place the Los Amigos Ranch PUD Filings 6 - 10 into perspective. This is brief overview of our letter of April 23rd and the reader is directed to that letter for further detail.

2) To summarize and comment briefly on the professional opinions that have been made related to the proposed Los Amigos Ranch ISDS systems, both those in favor of the ISDS systems and those opposed to ISDS systems.

3) To reiterate and further support the opinion of Resource Engineering, Inc. that properly designed, installed and maintained ISDS systems will not present adverse health and environmental impacts and are a suitable method of wastewater treatment for the Los Amigos Ranch PUD Filings 6 - 10

LOS AMIGOS ISDS SYSTEMS IN PERSPECTIVE

- Los Amigos Ranch PUD proposes 168 ISDS systems on 1,700 acres. This is a density of 1 unit per 10 acres. The development is linear in nature, extending approximately 2.5 miles from the entrance to Filing 6 to the northwest corner of Filing 9.

- The minimum distance between a proposed ISDS system and a drinking water supply is approximately 2,200 feet(Spring Valley Wells) and 2,500 feet (County Rd. 114 - Hwy 82 wells).

- The depth to the regional groundwater in the Los Amigos Ranch Development area is great based upon available well data: ranging from 60 feet (apparent perched water table) to possibly more than 800 feet.

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[1]The April 6th letter was previously introduced to the Garfield County Board of Commissioners as an exhibit at the hearing on April 13, 1998.

- Other subdivisions we have reviewed in Garfield and Eagle Counties in generally similar geologic settings have no nitrate contamination problems in their drinking water supplies. The five subdivisions reviewed (Wooden Deer, Panorama Ranches, Kings Row, Red Table Acres and Aspen Mesa Estates) are underlain by basalt, utilize predominantly ISDS systems (some systems are evaporative where leach fields were inappropriate), and have public water system wells within the developments. The highest nitrate level reported in any of these four subdivisions is 2.3 mg/liter, less than ¼ the State and EPA drinking water standard. The drinking water wells in all these developments are much closer than 2,200 feet from the nearest ISDS system. Please refer to the April 23 letter for additional detail.

- A study conducted in the mountain residential areas of Jefferson County, Colorado[2] (fractured bedrock conditions) found a strong correlation between nitrate levels in drinking water wells and the setback distance from potential contaminant sources such as leach fields. The study found that,

  > *"In particular, zones of nitrate contamination greater than 10 mg/liter were found to be associated with housing densities greater than one dwelling unit per acre and with well protective distances of 100 feet or less."*

  The study further concluded that,

  > *"Statistical analysis of the study data indicates that, for similar mountainous terrain, residential development that provides for well protective distance of only 100 feet face a 21.8% probability of exceeding the NO_3-N health standard; whereas, the probability with a well protective distance of 200 feet is 9.4%. Thus a minimum protective distance of 200 feet is more reasonable than 100 feet in preventing nitrate health hazards.[1]"*

  This study establishes a 200 foot well protective distance as more reasonable than a 100 foot distance for protection from nitrate contamination. This compares with a 2,200+ foot setback from drinking water supplies in the Los

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[2] *"Mountain Residential Development Minimum Well Protective Distances, Well Water Quality*, Ford, Schott and Keefe, Journal of Environmental Health, Vol. 43, No. 3, November/December, 1980.

Amigos Ranch PUD. The reader is again referred to our April 23rd letter for additional detail.

SUMMARY OF OPINIONS PRESENTED

1) Resource letter of February 28, 1998[3]. This letter presented our initial opinion that groundwater flow in the LAR development area is toward the Roaring Fork River and not toward Spring Valley. It concluded that it is unlikely that LAR ISDS systems will contaminate the regional groundwater system (where contamination is defined as nitrate levels at or above the State and EPA drinking water standard of 10 mg/liter). This opinion was arrived at based on the geology and hydrogeology of the site, information on wells in the LAR, Spring Valley and HWY 82 - County Rd. 114 area, and a mass balance approach using reasonable engineering assumptions.

   This letter resulted in a Planning and Zoning Commission condition of approval for LAR stating:

   > *"That prior to the approval of the Board of County Commissioners of the Preliminary Plan for Los Amigos Filings 6-10, the applicant shall develop a groundwater quality monitoring plan and mitigation plan, or in the alternative, develop a new proposal that eliminates the need for a monitoring and mitigation plan, to be reviewed and recommended for approval by the County's consulting engineer."*

2) Resource letter dated April 6, 1998. This letter was prepared to present a new proposal as required by P&Z. The new proposal included the utilization of properly designed, properly constructed and properly maintained individual wastewater treatment systems. In order to ensure this, Los Amigos Ranch Partnership agreed to implement Design Standards and a Management Plan for individual wastewater treatment systems. These included:

   a) Use of septic tank effluent filters. These eliminate the deposition of nitrogen rich bio-solids from septic tanks to leaching fields.

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[3]This letter was previously introduced to the Board of County Commissioners at the hearing on April 13, 1998 where it was included as an attachment to the Resource letter dated April 6, 1998.

b) Use of leach field dosing systems. Dosing systems, by intermittently discharging slugs of effluent to the leach field, promote even distribution of effluent throughout the leach field. This eliminates the consistently saturated zones commonly found in "traditional" septic tank leach field systems. Dosing also promotes the cyclical aerobic / anaerobic conditions needed for the nitrification - denitrification process.

c) Annual individual wastewater system inspections performed under the authority of the homeowners association. These inspections will ensure proper system maintenance and identify failing systems so repairs can be made.

The new proposal was based on the opinion of Resource Engineering, Inc. that:

> *"there is no risk of groundwater contamination[4] as a result of properly designed, installed and maintained individual sewage treatment systems in Los Amigos Ranch. There is a possibility that the nitrate level in the groundwater down gradient of Los Amigos Ranch in the vicinity of County Road 114 and Hwy 82 will increase slightly as a result of the individual sewage treatment systems. We have calculated that nitrate levels may increase by a factor ranging from 0.16 mg/liter to 0.60 mg/liter. This compares to existing groundwater nitrate levels in the County Road 114 - Hwy 82 vicinity ranging from 0.0 mg/liter to 3.5 mg/liter. The possible increased nitrate levels will not result in groundwater contamination."*

3) Wright Water Engineers (WWE) letter dated April 13, 1998 to Mr. Mark Bean. In response to the April 6 Resource letter, Michael Erion of WWE as the County's consultant, prepared a letter regarding Los Amigos Preliminary Plan - ISDS impact. The letter concludes:

> *"... the total, cumulative and diluted, concentration of constituents in the regional groundwater aquifer is estimated to be less than State and EPA drinking water*

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[4]Groundwater contamination for purposes of this opinion is defined as an increase in the nitrate level of the groundwater underlying Los Amigos Ranch and surrounding properties to a level above the drinking water standard of 10 mg/liter as established by the Colorado Department of Public Health and Environment and the U.S. Environmental Protection Agency.

standards."

The letter then states:

> *"We recommend the Design Standards and Management Plan presented in Attachment B of the Resource Engineering April 6, 1998 letter be included in any approvals for this project."*

The letter then lists several recommended minor modifications to the Design Standards and Management Plan which were acceptable to LAR.

4) McLaughlin Water Engineers, Ltd. (MWE) report of April 10, 1998 titled "Los Amigos Ranch P.U.D, Potential Impacts on Groundwater Flow and Quality Due to the Use of Individual Septic Systems for Domestic Wastewater Treatment and Disposal". This report was prepared by John Kaufman of MWE for Ms. Sherry Caloia who represents a party or parties opposed to the use of ISDS in Los Amigos Ranch.

The bulk of this report is a reiteration of Robert Kirkham's[5] description of the site specific geology. The report provides a conceptual groundwater contour map for the LAR / Spring Valley region and then concludes:

> *"Ground-water contamination due to nitrate loading will likely occur if individual septic systems are used in the planned residential development. In localized areas, the nitrate concentration as nitrogen of shallow ground water may significantly exceed 10 mg/l, the primary drinking water standard."* (Cover letter)

While the report concludes that nitrate levels may exceed the primary drinking water standards in some areas (e.g. immediately adjacent to a leach field) it does not state nor conclude that there will be contamination exceeding the primary drinking water standards at any drinking water wells.

The MWE groundwater contour map concludes (by Resource count) that, conservatively, only 15 of the 168 lots in the LAR development area are tributary to the Spring Valley wells with the nearest being 2,900 feet away

[5]Kirkham, R. M., et al. Kirkham in his capacity with the Colorado Geological Survey has extensively studied the geology in the Glenwood Springs and Cattle Creek quadrangle area.

from the nearest Los Amigos well. If this map is correct, the effluent from 15 ISDS systems located over ½ mile away is a very small component of the groundwater flowing to the wells and will not create a nitrate contamination problem at the Los Amigos of CMC wells. It is our opinion that this map is not correct and that no LAR ISDS systems are tributary to Spring Valley.

It is our opinion the groundwater contour map prepared by MWE is a flawed interpretation of the groundwater regime as it does not account for available well data that is clearly contrary to the map. MWE concludes that there is a significant groundwater mound centered to the northeast of the LAR proposed development area. The apex of the mound is mapped showing the water table approximately 100 feet below the ground surface. This discounts 7 wells in the area, ranging in depth from 300 to over 800 feet, only one of which encountered water and that at a reported depth of 320 feet. Refer to Attachment A to the Resource letter of April 23, 1998 for a map of these wells.

In our opinion when this well data is considered, the MWE map is shown to be clearly incorrect. If a groundwater mound does exist, the apex of the mound has to be within, or very near the edge of Spring Valley and not centered on the mesa above Los Amigos as suggested by MWE.

5) Addendum No. 1 to MWE report in (4) above. This report was prepared by Mr. John Kaufman in rebuttal to comments made at the Garfield County Board of County Commissioners hearing on April 13, 1998.

Mr. Kaufman states:

> *"MWE has examined additional well data as presented by Resource Engineering, Inc. and has amended the water table map accordingly in Figures 1 and 2. As these figures show, the ground-water mound is present with an even greater peak elevation."*

This remapping appears to be based on, and follow, more consistently than previous MWE mapping, the topographic land surface. The mapping does reduce the number of ISDS lots tributary to the Spring Valley wells from 15 to 8 ± (by Resource count). However the mapping continues to discount the available well information which clearly shows a much greater depth to groundwater. The discounted well information is either deemed incorrect where information in the State's files contradicts the MWE opinion or invalid where the limited information in the State's files has been supplemented with information

from the driller's files. Mr Kaufman states:

> *"So-called dry wells referenced by Resource Engineering, Inc. (Wells No. 31, 32 and 41; Permits No. 188402, 188403, and 188404 for Kindall Ranch) are shown on these two figures. Review of the well completion and test reports indicates that the static water- level data were not reported and the geologic logs were vague. To presume these boreholes are dry based on this lack of information is premature."*

Mr. Kaufman further states:

> *"The reported static level after drilling Well No. 46 (Permit No. 119503) was 300 feet. This water level is inconsistent with other nearby wells and is believed to be incorrect."*

In Mr. Kaufman's oral testimony before the Board of Commissioners on April 13, 1998 he stated:

> *"I have researched every legally drilled well or bore hole, test hole, out there ... at the State Engineer's Office. I'm not aware of a number of holes referenced in the other consultant's report. That raises a serous question about the lawfulness of those boreholes to begin with."*

The status of these wells has been thoroughly documented in the Resource letter dated April 23, 1998. In our opinion continuing to discount this important well information is a serious flaw in the MWE analysis. When these wells are considered one must arrive at a different interpretation of the groundwater regime than that presented by MWE.

Finally, it should be noted again that the MWE addendum does not conclude that there will be contamination exceeding the primary drinking water standards at any drinking water wells.

6) Jerome Gamba and Associates, Inc. letter dated April 21, 1998. This is a one page letter prepared by Jerome Gamba, PE for Colorado Mountain College. Mr. Gamba provided a review of the April 10, 1998 MWE report.

Mr. Gamba concludes:

> *"Every effort should be made to convince the Garfield County Board of Commissioners that any waste water discharged to the* (Spring Valley) *aquifer, from this time forward, must first receive tertiary treatment so that the discharged effluent can virtually meet drinking water standards."*

What Mr. Gamba does not say is very important. Mr. Gamba does not conclude or infer that any of the LAR ISDS systems are tributary to the Spring Valley aquifer. He does not state or infer that there is any possibility of contaminating the Spring Valley aquifer from ISDS systems in Los Amigos Ranch. In fact, Mr. Gamba does not mention Los Amigos Ranch ISDS systems at all.

7) Bishop Brogden and Associates letter dated April 23, 1998 (attached hereto as Exhibit B[6]). Mr. Brogden was retained by LAR to review and comment on the work and opinions prepared by Resource and MWE. Mr. Brogden prepared a groundwater contour map including the well data dismissed by MWE and concluded the following:

1. *"The direction of groundwater flow is not towards a group of wells that provides or will provide the water supply for the Los Amigos Ranch development and the Colorado Mountain College."*

2. *"Return flows from the filings 6 through 10 in the Los Amigos development will not migrate towards the wells; instead the return flows will move southwest towards the Roaring Fork River."*

Mr Brogden states in summary:

> *"In summary, our mapping of the ground water system in Spring Valley shows that the direction of flow is southwest towards the Roaring Fork River."*

8) Letter of WWE dated April 27, 1998. This letter was prepared by Michael Erion of WWE prior to the Garfield County Board of County Commissioners hearing of April 27, 1998. With respect to ISDS systems for LAR Mr. Erion concludes:

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[6]Mr. Brogden's resume is also included as an attachment to his letter.

"Based on available data and current regulations, properly designed and installed ISDS systems (conventional, mounded, or other engineered system) appear feasible for the project."

"Impacts to groundwater quality will result from the use of ISDS systems and can be generally quantified in terms of change in concentration of nitrate in the groundwater. Based on the engineering analyses by Resource Engineering and McLaughlin Water Engineers, and other available data, we believe the cumulative concentration of constituents in the local groundwater will be less than State and EPA drinking water standards.

9) Letter of Mr. Bruce Collins, Ph.D., dated May 8, 1998 (Attached hereto as Exhibit C[7]). Mr. Collins was retained by LAR to review the reports and testimony before the Board of County Commissioners including that from Resource MWE and Bishop - Brogden Associates. Mr. Collins through site investigation, review of the work by Kirkham and personal communication with Kirkham provides a detailed description of the geologic setting at LAR. His description differs somewhat from that presented by Kaufman (MWE).

In conclusion Collins states:

"Considering all of the above I concur with the conclusions of Resource Engineering, Inc., as augmented by Robert Brogden, of Bishop Brogden Associates, Inc. in his letter report dated April 23, 1998, wherein it is concluded that groundwater in the Los Amigos Ranch area is deep and that flow is southwesterly from the highlands east of Spring Valley toward the Roaring Fork River. The general geology of the area suggests that leach field effluent will migrate essentially vertically through the basalt cap of the mesa and then through the Maroon Formation to the water table, where it will join the general flow toward the Roaring Fork River."

[7]Mr. Collin's resume is also included as an attachment to his letter.

May 13, 1998

CONCLUSIONS AND OPINION OF RESOURCE ENGINEERING, INC.

- None of the technical reports provided by consultants, both those representing LAR ISDS proponents and those representing LAR ISDS opponents, indicates that ISDS systems in Los Amigos Ranch PUD Filings 6 - 10 will result in groundwater nitrate concentrations in drinking water supplies that exceed State and EPA drinking water standards. No consultant involved in these proceedings has concluded otherwise.

- In our opinion the MWE analysis of the groundwater regime in the Los Amigos Ranch vicinity is flawed as it discounts available groundwater data that is contrary to their opinion. While MWE concludes that somewhere between 5% and 9% of the 168 lots in filings 6 - 10 are tributary to Spring Valley we continue to be of the opinion, based on our analysis and supported by Brogden and Collins, that none of the lots proposed for ISDS systems are tributary to Spring Valley, the Los Amigos Ranch water supply and the CMC water supply.

- In our opinion, properly designed, installed and maintained ISDS systems are an appropriate and effective method of wastewater treatment for the Los Amigos Ranch PUD filings 6 - 10.

Sincerely,

RESOURCE ENGINEERING, INC.

John M. Currier, PE
Water Resources Engineer

JMC/jmc
File 707-1.0 file 707\losamigos4.W.D.

cc: Mr. Tim Thulson
Mr. Bruce Collins, Phd
Mr. Robert Brogden, PE
Mr. Michael Erion, PE

attachments: Exhibit A: Resource Engineering, Inc. letter dated April 23, 1998.
Exhibit B: Bishop - Brogden and Associates letter dated April 23, 1998.
Exhibit C: Bruce A. Collins, Ph.d. letter dated May 8, 1998.

EXHIBIT A

Resource Engineering, Inc.
Letter Dated April 23, 1998

RESOURCE
ENGINEERING INC.

Los Amigos Ranch Partnership
c/o Greg Boecker, Ranch Manager
2929 County Road 114
Glenwood Springs, CO 81601

April 23, 1998

RE: Los Amigos Ranch PUD Filings 6-10 Individual Wastewater Treatment Systems

Dear Greg:

This letter is provided as supplemental information to our previous correspondence regarding the proposed Los Amigos Ranch PUD individual wastewater treatment systems (ISDS). That correspondence is contained in a report dated April 6, 1998 titled *Los Amigos Ranch PUD Individual Wastewater Treatment Systems Groundwater Impact*.

In the past few weeks the discussion surrounding the use of ISDS systems at Los Amigos Ranch PUD has been elevated to a theoretical, academic plane in which there has been much discussion about hydrogeology and contaminant transport in complex geologic systems. Much of the theoretical discussion has been presented by Mr. John Kaufman of McLaughlin Water Engineers, Ltd. from his experience in other regions and in his reiteration and interpretation of work by Kirkham and others. While some of Mr Kaufman's points are relevant, we are concerned that by moving the focus of the discussion toward theory, we are ignoring the actual conditions observed at Los Amigos and thus losing sight of the impact of the project.

A recap of the project and the site conditions is appropriate:

1) There are 168 ISDS systems proposed for 1,700 acres. This is a density one unit to 10 acres.

2) The minimum distance between the proposed ISDS systems and a drinking water supply is approximately 2,000 feet (Spring Valley wells) to 2,500 feet (County Rd. 114 - Hwy 82 wells).

3) The depth to the regional groundwater is great: ranging from 60 feet (perched water table conditions) to possibly as much as 800 feet.

The site setting fits well with my professional understanding of what is generally thought of as an acceptable location for ISDS systems. The conditions (depth to groundwater and distance from significant water supplies) suggests that this may be one of the better locations and project configurations for ISDS in Garfield County.

The balance of this letter is presents information emphasizing the reasonableness of the ISDS proposal that has been made. Information presented in this letter covers four general areas:

1) Confirmation of well data available for the Los Amigos development area.
2) Groundwater impacts from other subdivisions in Garfield and Eagle Counties that utilize ISDS systems and that are located in geologically similar settings.
3) Groundwater mixing and implications for drinking water quality.
4) Discussion of leachfield - well setback distances and the implications for water quality.

The information included in this letter does not, nor is it intended to provide additional Los Amigos groundwater data above and beyond that previously disclosed. The information is provided to support our previous conclusion that individual sewage treatment systems at Los Amigos will not adversely impact groundwater quality[1]. We stand by our previous conclusion and assert that properly designed, installed and maintained individual septic tank - leachfield treatment systems are a reasonable and prudent manner of sewage treatment for Los Amigos Ranch PUD Filings 6 - 10.

Confirmation of Well Data

Attachment A to this letter provides supplemental data regarding the status of wells in the Los Amigos development area. Included is Figure 1 that was attached to our Feb. 28, 1998 letter. The figure has been modified to include the State Engineer's well permit numbers under which the wells were drilled except where otherwise noted. Also included in Attachment A are printouts from the State's well data base in support of the map. Additional information provided by Shelton Drilling on several of the wells constructed by Shelton Drilling is also included.

Two wells noted on Figure 1 indicate the possible presence of localized perched water table conditions at separate locations. This is seen by two wells reporting relatively shallow depths to water (118 feet and 60 feet) as compared to the other much deeper dry holes. These wells appear to be hydraulically connected to nearby small springs that discharge from the base of the basalt on the southwest side of the development. The springs nearby wells are the only known springs on the Los Amigos Ranch property.

The well information supports a finding that the regional groundwater table in the Los Amigos Ranch vicinity is very deep and trends westerly or southwesterly toward the Roaring Fork River and is controlled, ultimately, by the Roaring Fork River. It also supports a finding that there are two localized perched water tables defined by the localized geology in the immediate vicinity of the springs and two shallow wells.

Groundwater Quality in Water Wells Serving Other Subdivisions

Attachment B includes water quality information for four subdivisions on Missouri Heights that use ISDS systems and have community drinking water wells located within the subdivisions. A map (Figure 2) is also included showing the general location of these subdivisions. While the specific densities within these subdivisions in unknown, it is my

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[1]Groundwater contamination for purposes of this opinion is defined as an increase in the nitrate level of the regional groundwater underlying Los Amigos Ranch and surrounding properties to a level above the drinking water standard of 10 mg/liter as established by the Colorado Department of Public Health and Environment and the U.S. Environmental Protection Agency.

understanding that the densities range from several acres per lot to less than one acre per lot. Plats were not reviewed for this analysis to determine the specific density.

As can be seen in the attached water quality data none of the four subdivisions report elevated nitrate levels that would be of concern. The highest level of nitrate reported in any of these four subdivisions is 2.3 mg / liter.

The four subdivisions were chosen as they are underlain by basalt formations and they have public water systems for which water quality data is available from the Colorado Department of Health. The basalt formation also makes them somewhat analogous to the Los Amigos geologic setting.

The lack of groundwater contamination immediately under these four subdivisions with ISDS systems suggests that it is improbable for Los Amigos to adversely impact groundwater several thousand feet away.

This analysis is not rigorous, nor is it intended to be. It does however, show examples of similar situations in which ISDS systems have had no apparent negative impacts on groundwater quality.

Groundwater Mixing in the Vicinity of a Well

Speculation was raised by John Kaufman of McLaughlin Water Engineers that zones of groundwater with concentrated nitrates may exist in the groundwater under or adjacent to Los Amigos as a result of poor mixing in the groundwater. We agree that mixing may not be immediate or uniform. However knowledge of groundwater behavior in the vicinity of wells indicates that mixing will increase and become more and more complete as groundwater is drawn towards a well. Complete mixing will occur, certainly, within a pumped well.

As groundwater is drawn towards a well the gradient of the water table increases (steepens) and the velocity of the groundwater moving through the aquifer increases (more water moves through less space). As the velocity increases more and more mixing will occur and complete mixing will occur in the well. It is unlikely that discrete components of the groundwater flow having high nitrates could result in high nitrates at a well as a result of unmixed flow. This is particularly true for existing producing wells.

In summary, while it is possible to have areas within the groundwater regime of higher nitrate concentrations, mixing will occur within the radius of influence of a pumped well. Therefore we believe our previous assumption that there is complete mixing of the groundwater is valid for determining the impacts to other drinking water supplies.

Discussion of Leachfield - Well Setback Distances.

A study conducted in Jefferson County, Colorado published in 1980 reviewed water well contamination as a function of separation from contaminant sources (leachfields). The

study, entitled *"Mountain Residential Development Minimum Well Protective Distances, Well Water Quality"* (hereafter, Ford report) inspected wells in the mountainous region of western Jefferson County where leachfields overlie fractured metamorphic and granite intrusions.

The study found a strong correlation between nitrate levels and the horizontal separation between the well and leachfield. In this study 40% of the wells located ≤ 60 feet from leachfields were found to have nitrates greater than 10 mg / liter. At a distance ≤ 210 feet only one well out of 13 sampled had a nitrate level greater than 10 mg / liter. The study found a strong correlation between nitrate concentration and well protective distance where well protective distance is the distance a well is separated from a leachfield.

While not absolute, the probability of nitrate contamination decreases as wells are moved further and further horizontally from leachfields or other possible contaminant sources. The study concludes:

> *"When nitrate concentrations for the study area were spot mapped, the localities of excessive nitrate contamination were seen to be associated with increased housing density. In particular, zones of nitrate contamination greater than 10 mg/liter were found to associated with housing densities greater than one dwelling unit per acre and with well protective distances of 100 feet or less."*
>
> *"Statistical analysis of the study data indicates that, for similar mountainous terrain, residential development that provides for well protective distance of only 100 feet face a 21.8% probability of exceeding the NO_3-N health standard; whereas, the probability with a well protective distance of 200 feet is 9.4%. Thus a minimum protective distance of 200 feet is more reasonable than 100 feet in preventing nitrate health hazards."*

In Los Amigos, the minimum drinking water wells separation from ISDS systems will be approximately 2,000 feet (Spring Valley wells) to 2,500 feet (Cty Rd 114 - Hwy 82 wells). The findings outlined in the Ford report, together with the physical separation at Los Amigos suggests that the possibility of nitrate contamination at Los Amigos is very slight.

Summary

In summary it is the opinion of Resource Engineering, Inc. that individual septic disposal systems that are properly designed, properly installed and properly maintained are appropriate for Los Amigos and will not result in contamination of groundwater drinking supplies as defined herein. Therefore we recommend approval of ISDS systems.

April 23, 1998

If you have any questions please give me a call.

Sincerely,

RESOURCE ENGINEERING, INC.

John M. Currier, PE
Water Resources Engineer

JMC/jmc
File 707-1.0 file 707\losamigos3.wpd

attachments: A: Well data
B: Groundwater Quality in Other Subdivisions
C: Ford Report, *"Mountain Residential Development Minimum Well Protective Distances, Well Water Quality"*

cc: Tim Thulson, Esq.
Ed Church, PE
Dean Gordon, PE

ATTACHMENT A
LOS AMIGOS PUD

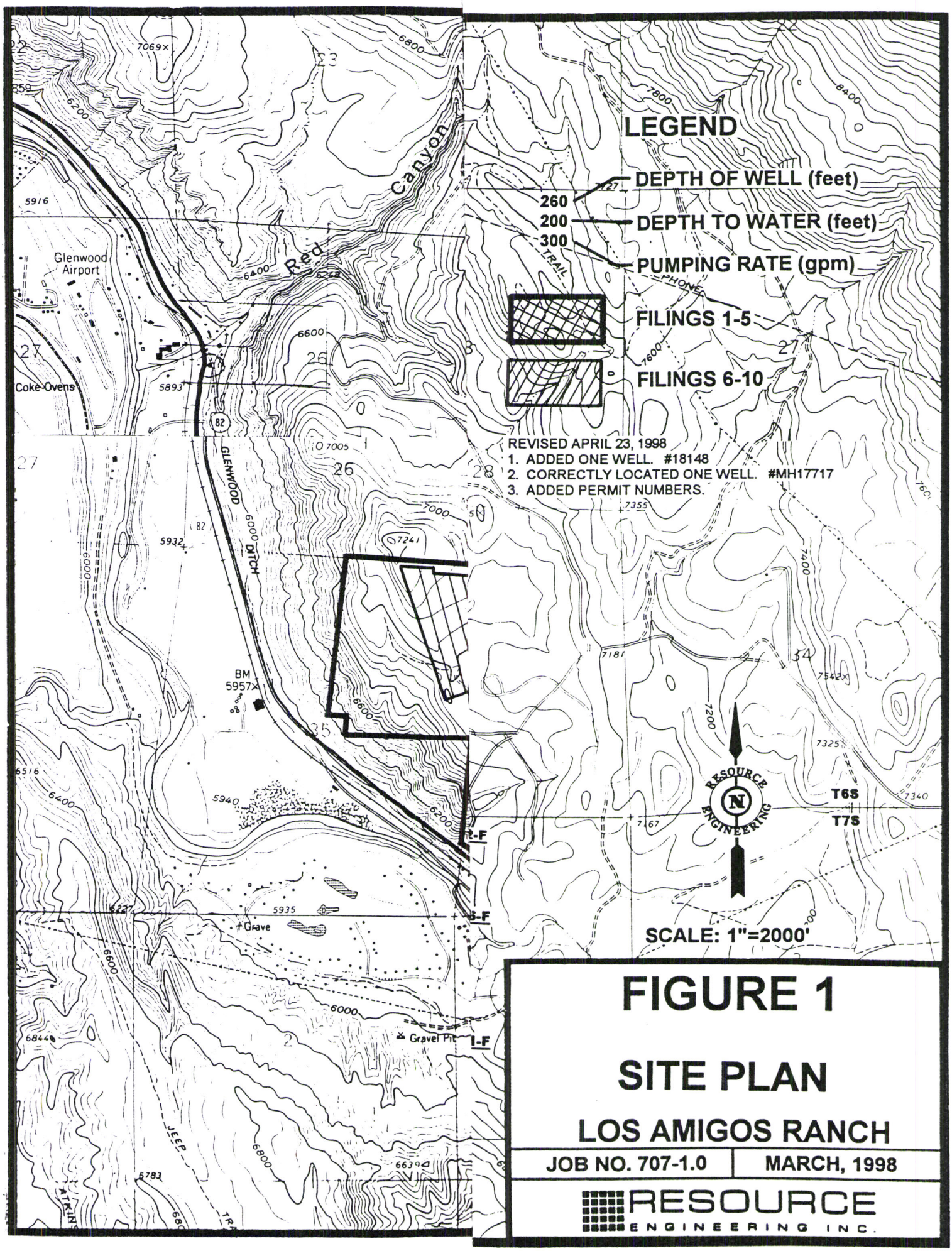


FIGURE 1

SITE PLAN

LOS AMIGOS RANCH

JOB NO. 707-1.0	MARCH, 1998

RESOURCE ENGINEERING INC.

Courtesy of Shelton Drilling Corp.
(970) 927-4182

Information Concerning Subdivision

PERMIT#	NAME	YIELD	DEPTH	STATIC	LEGAL DESCRIPTION	DATE
114980	Manchester	0	400	0	SE NW Sec 32 T6S R89W	9/20/82
MH-17717	Hood	0	500	0	NE NE Sec 25 T6S R89W	7/30/91
188402	Kindall (1)	0	300	0	NW SE Sec 25 T6S R89W	8/24/95
188404	Kindall (3)	0	460	0	SE NE Sec 31 T6S R88W	9/8/95
188403	Kindall (2-A)	0	810	0	NE SE Sec 25 T6S R89W	6/17/96
	5	0.0	494			

APR-21-95 10:2 3:40 PM SHELTON DRILLING 30 FAX NO. 3702370001

RECEIVED APR 2 1 1995

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER

FOR OFFICE USE ONLY

1. **WELL PERMIT NUMBER** 188402

2. Owner Name(s) : Kindall Ranch
Mailing Address : 6336 State Hwy 133
City, St. Zip : Carbondale, Co. 81623
Phone (970) 963-3879

APPROVAL # GWS31-91-03

3. WELL LOCATION AS DRILLED: NW 1/4 SE 1/4 Sec. 25 Twp. 6S Range 89W
DISTANCES FROM SEC. LINES:
2000 ft. from South Sec. line. and 1339 ft. from East Sec. line. OR
SUBDIVISION : LOT BLOCK FILING(UNIT)
STREET ADDRESS AT WELL LOCATION :

4. GROUND SURFACE ELEVATION ft. DRILLING METHOD Air Rotary
DATE COMPLETED 08/24/95 TOTAL DEPTH 300 ft. DEPTH COMPLETED ft.

5. GEOLOGIC LOG :

Depth	Type of Material (Size, Color, and Type)
000-120	Volcanics, Flows
120-300	Maroon Formation

6. HOLE DIAM. (in)	FROM (ft)	TO (ft)
9.0	0.0	30
6.5	30	300

7. PLAIN CASING

OD (in)	Kind	Wall Size	From (ft)	To (ft)
		0		
		0		
		0		
		0		

PERF. CASING : Screen Slot Size :

8. Filter Pack
Material :
Size :
Interval :

9. Packer Placement
Type :
Depth :

WATER LOCATED :

REMARKS : Hole is to be abandoned by client.

10. GROUTING RECORD :

Material	Amount	Density	Interval	Placement

11. DISINFECTION : Type : HTH Amt. Used : oz.

12. WELL TEST DATA : [ ] Check Box If Test Data is Submitted On Supplemental Form.
TESTING METHOD : Air Compressor
Static Level : 0 ft. Date/Time Measured : 08/24/95 Production Rate : 0 gpm.
Pumping Level : Total ft. Date/Time Measured : 08/24/95 Test Length : 2 hrs.
Remarks :

13. I have read the statements made herein and know the contents thereof, and that they are true to my knowledge. (Pursuant to Section 24-4-104 (13)(a) CRS, the making of false statements constitutes perjury in the second degree and is punishable as a class 1 misdemeanor.)

CONTRACTOR : Shelton Drilling Corp. Phone : (970) 927-4182
Mailing Address : P.O. Box 1059 Basalt, CO. 81621 Lic. No. 1095

Name / Title (Please Type or Print)	Signature	Date
Wayne Shelton / President		09/21/95

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER

FOR OFFICE USE ONLY

WELL PERMIT NUMBER 188403

2. Owner Name(s) : Kindall Ranch
Mailing Address : 6336 State Hwy 133
City, St. Zip : Carbondale, Co. 81623
Phone (970) 963-3879

APPROVAL # GWS31-91-03

3. WELL LOCATION AS DRILLED: NE 1/4 SE 1/4 Sec. 25 Twp. 6S Range 89W
DISTANCES FROM SEC. LINES:
1675 ft. from South Sec. line. and 146 ft. from East Sec. line. OR
SUBDIVISION : LOT BLOCK FILING(UNIT)
STREET ADDRESS AT WELL LOCATION :

4. GROUND SURFACE ELEVATION ft. DRILLING METHOD Air Rotary
DATE COMPLETED 08/25/95 TOTAL DEPTH 300 ft. DEPTH COMPLETED ft.

5. GEOLOGIC LOG :

Depth	Type of Material (Size, Color, and Type)
000-160	Volcanics. Flows
160-300	Maroon Formation

6. HOLE DIAM. (in)	FROM (ft)	TO (ft)
9.0	0.0	30
6.5	30	300

7. PLAIN CASING

OD (in)	Kind	Wall Size	From (ft)	To (ft)
		0		
		0		
		0		
		0		

PERF. CASING : Screen Slot Size :

8. Filter Pack
Material :
Size :
Interval :

9. Packer Placement
Type :
Depth :

WATER LOCATED :

REMARKS : Hole is to be abandoned by client.

10. GROUTING RECORD :

Material	Amount	Density	Interval	Placement

Amt. Used : oz.

11. DISINFECTION : Type : HTH

12. WELL TEST DATA : [ ] Check Box If Test Data is Submitted On Supplemental Form.
TESTING METHOD : Air Compressor
Static Level : 0 ft. Date/Time Measured : 08/25/95 Production Rate : 0 gpm.
Pumping Level : Total ft. Date/Time Measured : 08/25/95 Test Length : 2 hrs.
Remarks :

13. I have read the statements made herein and know the contents thereof, and that they are true to my knowledge. (Pursuant to Section 24-4-104 (13)(a) CRS, the making of false statements constitutes perjury in the second degree and is punishable as a class 1 misdemeanor.)

CONTRACTOR : Shelton Drilling Corp. Phone : (970) 927-4182
Mailing Address : P.O. Box 1059 Basalt, CO. 81621 Lic. No. 1095

Name / Title (Please Type or Print)	Signature	Date
Wayne Shelton / President		09/21/95

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER

FOR OFFICE USE ONLY

WELL PERMIT NUMBER 188404

2. Owner Name(s) : Kindall Ranch
Mailing Address : 6336 State Hwy 133
City, St. Zip : Carbondale, Co. 81623
Phone (970) 963-3879

APPROVAL # GWS31-91-03

3. WELL LOCATION AS DRILLED: SE 1/4 NE 1/4 Sec. 31 Twp. 6S Range 89W
DISTANCES FROM SEC. LINES:
2355 ft. from North Sec. line. and 591 ft. from East Sec. line. OR
SUBDIVISION : LOT BLOCK FILING(UNIT)
STREET ADDRESS AT WELL LOCATION :

4. GROUND SURFACE ELEVATION ft. DRILLING METHOD Air Rotary
DATE COMPLETED 09/08/95 TOTAL DEPTH 500 ft. DEPTH COMPLETED ft.

5. GEOLOGIC LOG :

Depth	Type of Material (Size, Color, and Type)
000-180	Volcanics, Flows
160-500	Maroon Formation

6. HOLE DIAM. (in)	FROM (ft)	TO (ft)
9.0	0.0	30
6.5	30	500

7. PLAIN CASING

OD (in)	Kind	Wall Size	From (ft)	To (ft)
		0		
		0		
		0		
		0		

PERF. CASING : Screen Slot Size :

8. Filter Pack
Material :
Size :
Interval :

9. Packer Placement
Type :
Depth :

WATER LOCATED :

REMARKS : Hole is to be abandoned by client.

10. GROUTING RECORD :

Material	Amount	Density	Interval	Placement

11. DISINFECTION : Type : HTH Amt. Used : oz.

12. WELL TEST DATA : [ ] Check Box If Test Data is Submitted On Supplemental Form.
TESTING METHOD : Air Compressor
Static Level : 0 ft. Date/Time Measured : 09/08/95 Production Rate : 0 gpm.
Pumping Level : Total ft. Date/Time Measured : 09/08/95 Test Length : 2 hrs.
Remarks :

13. I have read the statements made herein and know the contents thereof, and that they are true to my knowledge. (Pursuant to Section 24-4-104 (13)(a) CRS, the making of false statements constitutes perjury in the second degree and is punishable as a class 1 misdemeanor.)

CONTRACTOR : Shelton Drilling Corp. Phone : (970) 927-4182
Mailing Address : P.O. Box 1059 Basalt, CO. 81621 Lic. No. 1095

Name / Title (Please Type or Print)	Signature	Date
Wayne Shelton / President		09/21/95

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
9113590	/ /	/ /	/ /	000000	CD	CD	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	11896 F	38	99	00	COLORADO MOUNTAIN COLLEGE

ADDRESS	ADDRESS2	CITY	ST
		GLNWD SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
00000	0000	( ) -		NW	SW	4	7	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	2			N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP DATE	REPT -- PUMP -- COMP DATE
	/ /	/ /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	05/02/67	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		220	300.00	120			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S) (1)	(2)	OWNER DESIGNEE
/ /	( )							

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
9113648	/ /	/ /	/ /	000000	CD	CD	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	15801 F	38	99	00	COLORADO MOUNTAIN COLLEGE

ADDRESS	ADDRESS2	CITY	ST
WEST CAMPUS		GLNWD SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
00000	0000	( ) -		NW	SW	4	7	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	O			N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP DATE	REPT -- PUMP -- COMP DATE
	/ /	/ /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	05/08/67	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		300	400.00	80			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S) (1)	(2)	OWNER DESIGNEE
/ /	( )							

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
9113649	/ /	/ /	/ /	000000	CD	CD	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	15802 F	38	99	00	COLORADO MOUNTAIN COLLEGE

ADDRESS	ADDRESS2	CITY	ST
WEST CAMPUS		GLNWD SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
00000	0000	( ) -		NW	SW	4	7	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	O			N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP DATE	REPT -- PUMP -- COMP DATE
	/ /	/ /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	03/04/67	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		300	40.00	76			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S) (1)	(2)	OWNER DESIGNEE
/ /	( )							

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS CD	ACTIV CD	STAT CD
9113688	/ /	/ /	/ /	000000			

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	18147	38	99	00	CHATMAS ROBERT W & JOHNSON JAMES

ADDRESS	ADDRESS2	CITY	ST
PO DRAWER 2030		GLENW SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81601	0000	( ) -		NE	SE	5	7	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	8			N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP DATE	REPT -- PUMP -- COMP DATE
	/ /	/ /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	08/22/63	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REC
		260	300.00	200			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S) (1)	(2)	OWNER DESIGNEE
/ /	( )							

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
385185D	05/10/95	/ /	07/14/95		CD WA	CD NP	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	188404	38	00	00	KINDALL RANCH

ADDRESS	ADDRESS2	CITY	ST
6336 STATE HWY 133		CARBONDALE	CO

ZIP - EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81623	(303)963-3879		SE	NE	31	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	8 L	1095		N/S 2355 N	E/W 591 E			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	10/30/95 DATE 09/08/95	/ / DATE / /

COMMENTS	ENG USER
DRY HOLE	NLH

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		500					

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
07/14/97	(6023)	00000				(1) GW (2)	#4

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
205113D	06/18/80	04/22/96	07/09/80		CD OC	CD NP	CD OC

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	114977	38	00	00	KINDALL WILMER HAROLD VIRGIL

ADDRESS	ADDRESS2	CITY	ST
6315 STATE HWY 133	KINDALL CAROLYN & MURR L	CARBONDALE	CO

ZIP - EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81623	(970)963-3879		SW	NE	32	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----	LOT	BLK	FLG
	8	530		N/S 2300 N E/W 1700 E			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	01/25/82 DATE 11/01/81	/ / DATE / /

COMMENTS	ENG USER
	NLH

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
	20 120	120	11.00	62			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
/ /	( )	00000				(1)GW (2)	

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
229081	08/16/82	09/23/82	10/12/82	000000	CD	CD NP	CD AR

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	114980 A	38	00	00	MANCHESTER M

ADDRESS	ADDRESS2	CITY	ST
		ASPEN	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81612	0000	( ) -		SE	NW	32	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	8	894		N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	/ / DATE / /	/ / DATE / /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S) (1)	(2)	OWNER DESIGNEE
/ /	( )							

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS CD AB	ACTIV CD NP	STAT CD AB
278754	08/06/87	09/14/90	08/27/87	000000			

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	149180	38	00	00	GERMANN RONALD

ADDRESS	ADDRESS2	CITY	ST
		GLENWOOD SPRING	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81601	0000	( ) -		NW	SW	29	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	8	LR		N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	/ / DATE / /	/ / DATE / /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		15	15.00				

EXPIRE DATE	STATUTE	ID	ACRE IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
/ /	( )		1.00		(1) GW (2)	

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
310878	03/14/90	/ /	03/26/90	149180	CD	CD NP	CD

DIV	CO	FILE NUMBER		WD	BAS	MD	NAME
5	49	149180	A	38	00	00	ANDERSON JOHN

ADDRESS	ADDRESS2	CITY	ST
1332 CO RD 119		GLENWOOD SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81601	0000	( ) -		NW	SW	29	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----	LOT	BLK	FLG
	8	1095		N/S 1900 S E/W 1300 W			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	/ / DATE / /	/ / DATE / /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
/ /	( )	00000				(1) GW (2)	

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
205113B	06/18/80	05/25/96	07/09/80	195298	CD CA	CD NP	CD CA

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	114979	38	00	00	OULD W G

ADDRESS	ADDRESS2	CITY	ST
		GREENACRES	WA

ZIP - EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
99016	( ) -		SE	NE	30	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	8	697	1196	N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	/ / DATE / /	01/03/92 DATE 08/06/91

COMMENTS	ENG USER
	JLV

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		50	1.00	6			

EXPIRE DATE	STATUTE	ID	ACRE IR	QUAL	AQUIFER (S)		OWNER DESIGNEE
					(1)	(2)	
/ /	( )	00000					

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS CD PI	ACTIV CD NP	STAT CD
399573	04/19/96	/ /	05/28/96				

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	195298	38	00	00	PALMER DAN & NANCY

ADDRESS	ADDRESS2	CITY	ST
1150 GARFIELD CTY RD 119		GLENWOOD SPRGS	CO

ZIP - EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81601	(970)928-9231		SE	NE	30	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----			LOT	BLK	FLG
	H	1095	1196	N/S 2100 N	E/W	50 E			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	06/05/96 DATE 05/01/96	10/07/96 DATE 05/06/96

COMMENTS	ENG	USER
ONLY WELL;16+AC,CNTY EXEMPTION,EX A;CANCEL 114979;MH-27972;96VE146	TLC	NLH

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER	LOG	ABAND REQ
	76 100	100	15.00	7		N	N	N

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
05/28/98	(6023)	00000				(1) GW (2)	

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
339293A	05/26/92	03/17/94	06/30/92	000000	CD SA	CD NP	CD SA

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	41374 F	38	00	00	CHRISTELEIT PETER & LINDA

ADDRESS	ADDRESS2	CITY	ST
P O BOX 681		GLENWOOS SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81602	0000	(303)984-2265		NE	NW	30	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----	LOT	BLK	FLG
	8	634		N/S 4850 S E/W 3400 E	A		

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
CHRISTELEIT	11/16/92 DATE 09/22/92	08/23/93 DATE 10/19/92

COMMENTS	ENG	USER
PARCEL A	DWM	SMJ

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	08/23/93	05/22/93	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
	120 160	160	15.00	80			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
/ /	( )	00000				(1) GW (2)	#1

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS CD NP	ACTIV CD NP	STAT CD
339293B	05/26/92	/ /	06/30/92	018217MH			

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	41375 F	38	00	00	CHRISTELEIT PETER & LINDA

ADDRESS	ADDRESS2	CITY	ST
P O BOX 681		GLENWOOS SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP	RANGE	PM
81602	0000	( ) -		NE	NW	30	6 S	88 W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----	LOT	BLK	FLG
	8	426		N/S 4300 S E/W 3100 E	B		

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
CHRISTELEIT	12/04/91 DATE 10/22/91	/ / DATE / /

COMMENTS	ENG USER
PARCEL B	DWM

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

CRE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REC
	110 200	225	15.00	110			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
/ /	( )	00000				(1) GW (2)	#2

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
350791	03/29/93	05/21/93	07/23/93	041375F	CD SP	CD NP	CD AR

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	42574 F	38	00	00	CHRISTELEIT HOMEOWNERS ASSOC

ADDRESS	ADDRESS2	CITY	ST
% 4954 214 ROAD		NEW CASTLE	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81647	0000	(303)984-2265		NE	NW	30	6	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----	LOT	BLK	FLG
	80	634		N/S 4300 S E/W 3100 E	B		

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
CHRISTELEIT	/ / DATE / /	07/27/94 DATE 07/30/93

COMMENTS	ENG	USER
12 SF, IRR OF 34,000 FT SQ LAWN, DOMESTIC ANIMALS, BASALT CONTRACT	JD2	SMJ

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	07/19/94	/ /	/ /	/ /	/ /

-RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER	LOG	ABAND	REQ
		126	27.00	62		Y	N	N	

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
07/23/94	(1372)	00000				(1) GW (2)	#2

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
385185B	05/10/95	/ /	07/14/95		CD WA	CD NP	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	188403	38	00	00	KINDALL RANCH

ADDRESS	ADDRESS2	CITY	ST
6336 STATE HEY 133		CARBONDALE	CO

ZIP - EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81623	(303)963-3879		NE	SE	25	6	S	89	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----	LOT	BLK	FLG
	8 L	1095		N/S 1675 S E/W 146 E			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	10/30/95 DATE 08/25/95	/ / DATE / /

COMMENTS	ENG	USER
CRITICAL, 3SFD, 1AR IR, DOM ANIMALS, 38.66 ACRES DRY HOLE	SGA	NLH

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		300					

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
07/14/97	(6023)	00000				(1) GW (2)	

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
385185A	05/10/95	/ /	07/14/95		CD WA	CD NP	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	188402	38	00	00	KINDALL RANCH

ADDRESS	ADDRESS2	CITY	ST
6336 STATE HEY 133		CARBONDALE	CO

ZIP - EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP	RANGE	PM
81623	(303)963-3879		NW	SE	25	6 S	89 W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----	LOT	BLK	FLG
	8 L	1095		N/S 2000 S E/W 1339 E			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	10/30/95 DATE 08/24/95	/ / DATE / /

COMMENTS	ENG	USER
CRITICAL, 3SFD, 1AR IR, DOM ANIMALS, 43.78 ACRES DRY HOLE	SGA	NLH

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

RE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		300					

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
07/14/97	(6023)	00000				(1) GW (2)	

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
17717	06/19/91	/ /	/ /	000000	CD MH	CD MH	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	17717 MH	38	00	00	HOOD ART

ADDRESS	ADDRESS2	CITY	ST
C/O P O BOX 1059		BASALT	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81621	0000	( ) -		NE	NE	25	6	S	89	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	O	LIC		N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP	REPT -- PUMP -- COMP
	/ / DATE / /	/ / DATE / /

COMMENTS ENG USER

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	/ /	/ /	/ /	/ /

CRE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ

EXPIRE DATE	STATUTE	ID	ACRE IR	QUAL	AQUIFER (S)	OWNER DESIGNEE
/ /	( )	00000			(1) GW (2)	

RECEIPT	APP DATE	STAT DATE	NP DATE	WELL-X-REFER	TRANS	ACTIV	STAT
9113690	/ /	/ /	/ /	000000	CD	CD	CD

DIV	CO	FILE NUMBER	WD	BAS	MD	NAME
5	23	18148	38	99	00	CHATMAS ROBERT W & JOHNSON JAMES

ADDRESS	ADDRESS2	CITY	ST
PO DRAWER		GLENW SPGS	CO

ZIP	- EXT	PHONE	Q10	Q40	Q160	SEC	TWNSHP		RANGE		PM
81601	0000	( ) -		SE	SW	5	7	S	88	W	S

CASE NUM	USES	DRLR	PUMP INST	----- COORDINATES -----		LOT	BLK	FLG
	8			N/S	E/W			

SUBDIVISION	REPT -- WELL -- COMP DATE	REPT -- PUMP -- COMP DATE	ENG USER
	/ /	/ /	

COMMENTS

NWC RECD --DATE--	NBU RECD --DATE--	SBU RECD --DATE--	BENEF USE --DATE--	AMENDED --DATE--	RECD -ABAND-- --DATE--	COMP --DATE
/ /	/ /	/ /	09/03/63	/ /	/ /	/ /

CRE-FT	TOP/PERF/BOT	DEPTH	YIELD	LEVEL	ELEV	METER LOG	ABAND REQ
		160	20.00	118			

EXPIRE DATE	STATUTE	ID	ACRE	IR	QUAL	AQUIFER (S) (1)	(2)	OWNER DESIGNEE
/ /	( )							

ATTACHMENT B
LOS AMIGOS PUD

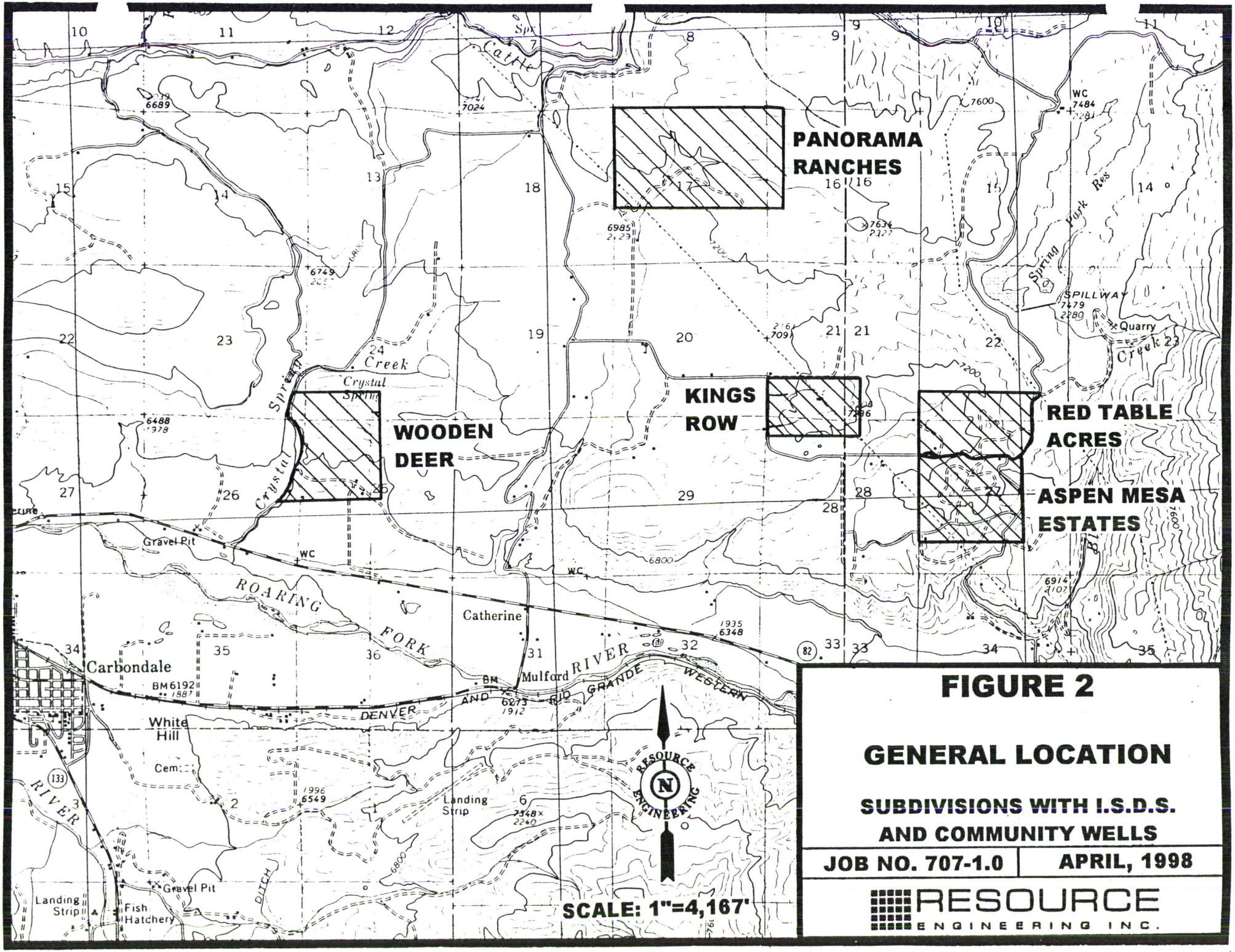


FIGURE 2

GENERAL LOCATION

SUBDIVISIONS WITH I.S.D.S. AND COMMUNITY WELLS

JOB NO. 707-1.0	APRIL, 1998

RESOURCE ENGINEERING INC.

Report Date: 04/17/98

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
Compliance Monitoring and Data Management Unit - WQCD

RESOURCE ENGINEERING INC.

Note: Computer data is always subject to error. If data appears unusual or questionable, please confirm the validity with the Drinking Water Program at (303) 692-3500.

WATER QUALITY DATA FOR ID 119125 - Aspen Mesa Estates
ATTN: EPC - Scott Leslie
PO Box 493
Snowmass, CO 81654

Contact: Leslie, Scott
Contact Phone: (970)945-6069
Operator: Leslie, Scott
Operator Phone: (970)945-6069
Resident Population: 165
Non-Transient Population: 0
Transient Population: 0
Service Connections: 26

County: Eagle
Active Status: Active
Activation Date: 0/
System Begin Date: 0/
System Type: Community
System Source Type: Ground Water
Open Year Around

Disinfection Waiver ? No
Bacts Required: 1
Bact Cycle: Monthly
Nitrate Schedule: 3rd Quarter
Chemical Schedule Group: 1
Inorganic Schedule: 3rd Quarter
Radiological Schedule: 3rd Quarter
Organic Schedule: Routine - 4 Quarters

********** SOURCE INFORMATION **********

se_id	srcnum	src	se_rec_type	se_code	avail	sampoint	seller_id	totaldepth	aquifer
001	Tnk01	Aspen Mesa Tank	P	R	P	.T.			
002	W01	Well #1	S	G	P	.F.		340	Roaring Fork
003	W02	Well #2	S	G	P	.F.		360	Roaring Fork
004	W03	Well #3	S	G	E	.F.		430	Roaring Fork

********** RECENT BACTERIOLOGICAL **********
*** s = Safe ***** U = Unsafe ***** N = Invalid ****

samp_date	type	testmeth	quantity	tc_pres	fe_pres	invalid
01/27/97	r	m	1	s		
02/21/97	r	m	1	s		
03/27/97	r	m	1	s		
04/29/97	r	m	1	s		
05/28/97	r	m	1	s		
06/26/97	r	m	1	s		
07/25/97	r	m	1	s		
08/26/97	r	m	1	s		
09/03/97	r	m	1	s		
10/30/97	r	m	1	s		
11/19/97	r	m	1	s		
12/18/97	r	m	1	s		
01/29/98	r	m	1	s		
02/25/98	r	m	1	s		
03/26/98	r	m	1	s		

********** ORIGINAL INORGANICS **********
****** all results and MCLs expressed in mg/l or ppm *******

** MCLs are	0.05	2	0.005	0.1	4.0	na	0.002	0.05	na	na					
IPLEDATE	ARSENIC	BARIUM	CADMIUM	CHROMIUM	FLUORIDE	LEAD	MERCURY	SELENIUM	SILVER	SODIUM	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID
10/29/82	0.000	0.000	0.00000	0.0000	0.780	0.0000	0.00000	0.000	0.0000	27	001				
07/26/88	0.000	0.000	0.00000	0.0000	0.710	0.0000	0.00000	0.000	0.0000	27	001				
03/09/95	0.000	0.01	0.0000	0.000	0.70	0.001	0.0000	0.001	NT	33.0	001				

********** NEW INORGANIC PARAMETERS **********
****** all results expressed in mg/l or ppm **********
********** TESTING BEGAN JAN 1, 1993 **********
MCLs are 0.006 0.004 0.2 0.1 na 0.002

SAMPLEDATE	ANTIMONY	BERYLLIUM	CYANIDE	NICKEL	SULFATE	THALLIUM	COMPOSITED	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID_5
03/09/95	0.000	0.000	0.000	0.000	28	0.000	.F.	001				

********** NITRATE/NITRITE **********
****** all results expressed in mg/l or ppm **********
** MCLs are 10.0 1.0 10.0

sampledate	nitrate_n	nitrite_n	no3_no2_n	se_id_1	se_id_2	se_id_3	se_id_4	se_id_5
10/29/82	0.00		NT	001				
07/26/88	1.20		NT	001				
03/18/93	0.833	0.000	NT	001				
06/29/94	0.93	BDL	0.93	001				
03/09/95	0.87	0.00	0.87	001				
09/30/96	1.27	0.00	1.27	001				
09/24/97	1.62	0.00	1.62	001				

********** LEAD/COPPER TAP MONITORING DATA **********
***** levels are 90th percentile levels expressed in mg/l *****

beg_compli	end_compli	pb_90th	cu_90th
07/01/93	12/31/93	0.001	0.18
01/01/94	06/30/94	0.001	0.16
01/01/95	12/31/95	0.002	0.40
01/01/98	12/31/98		

********** RADIOLOGICAL **********
**** all results expressed in pCi/l, except TS in mg/l ****

PLANTNUMBR	SAMPLEDATE	SAMTYPE	ALPHA	ADJ_ALPHA	BETA	RA226	RA228	RA226_228	URANIUM	TS	RADON_222
1	05/16/84		0.0	0.0	0.0	0.00	0.00	0.00	0.0	0	
1	02/28/89	G	0.0	0.0	0.0	0.00	0.00	0.00	0.0	500	
Tnk01	03/09/95		3	NT	<8	NT	NT	NT	NT	480	NT
Tnk01	09/24/97		2.2	NT	2.5	NT	NT	NT	NT	NT	NT

*** There was no corrosivity data found. ***

*** There was no trihalomethane data found. Required for community systems serving 10,000 or more only. ***

********** Phase I VOC'S **********

Note: Included as part of Phase II/V organics as of 1/1/93.
Refer to file for information on detects.

plantnumbr	plantname	sampledate	detected
1	Aspen Mesa	03/06/91	1 voc detected-B

********** REGULATED PHASE I/II/V ORGANICS **********

Sources: 001 06/27/97 Composited: F

*** There were no regulated detects in this sample. ***

********** UNREGULATED PHASE I/II/V ORGANICS **********

Note: Detections of Trihalomethanes are not printed.
Monitoring is required. No standards have been set.

Sources: 001 06/27/97 Composited: F

*** There were no unregulated detects in this sample. ***

********** CHECK SAMPLE TRACKING INFO **********

Parameter: O-Dichlorobenzene 95-50-1 2968

No check sample results were found in the tracking database

Source: 001 Tnk01 Combination of wells at tank

Check sample letter date: 07/18/97

Original sample date: 06/27/97 Result: 0.037 ug/l

Was presence of contaminant confirmed ?

*** There were no bacteriological or turbidity violations found. ***

********** CHEMICAL VIOLATIONS **********

beg_compli	end_compli	viol_type	contaminat	reqsamples	valid_sam	result	mcl_violat	enf_date	type_letr	epa_code	delete
07/01/97	12/31/97	03	4xxx	1	0			12/22/97		SFJ	
07/01/97	12/31/97	03	1038	1	0			12/22/97		SFJ	

*** There were no additional chemical enforcement actions found. ***

*** There are no outstanding enforcement orders. ***

Please Note:

NT = Not Tested
ND = None Detected
BDL = Below Detection Limit
< symbol for less than
na = Not Applicable

GW = ground water
SW = surface water
GWUISW = ground water under the influence of surface water
MCL = maximum contaminant level
VOC = volatile organic chemical
SWTR = surface water treatment rule

Report Date: 04/17/98

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
Compliance Monitoring and Data Management Unit - WQCD

Note: Computer data is always subject to error. If data appears unusual or questionable, please confirm the validity with the Drinking Water Program at (303) 692-3500.

WATER QUALITY DATA FOR ID 123860 - Wooden Deer Subd
ATTN: Davis Farrar
0165 Basalt Mtn Dr
Carbondale, CO 81623

Contact: Farrar, Davis
Contact Phone: (970)963-1670
Operator: Farrar, Davis
Operator Phone: (970)963-1670
Resident Population: 36
Non-Transient Population: 0
Transient Population: 0
Service Connections: 8

County: Garfield
Active Status: Active
Activation Date: 01/97
System Begin Date: 01/97
System Type: Community
System Source Type: Ground Water
Open Year Around

Disinfection Waiver ? No
Bacts Required: 1
Bact Cycle: Monthly
Nitrate Schedule: 2nd Quarter
Chemical Schedule Group: 1
Inorganic Schedule: 2nd Quarter
Radiological Schedule: 2nd Quarter
Organic Schedule: 2nd Quarter

********** SOURCE INFORMATION **********

se_id	srcnum	src	se_rec_type	se_code	avail	sampoint	seller_id	totaldepth	aquifer
001	W01	Well #1	S	G	P	.F.		350	

********** RECENT BACTERIOLOGICAL **********
** s = Safe ***** U = Unsafe ***** N = Invalid ****

samp_date	type	testmeth	quantity	tc_pres	fe_pres	invalid
03/17/97	r	m	1	s		
04/02/97	r	m	1	s		
05/12/97	r	m	1	s		
06/02/97	r	m	1	s		
07/14/97	r	m	1	s		
08/05/97	r	m	1	N		T
08/25/97	S	m	1	s		
09/02/97	r	m	1	s		
10/01/97	r	m	1	s		
11/03/97	r	m	1	s		
12/01/97	r	m	1	s		
01/26/98	r	m	1	s		
02/10/98	r	m	1	s		
03/09/98	r	m	1	s		

********** ORIGINAL INORGANICS **********
****** all results and MCLs expressed in mg/l or ppm *******

** MCLs are	0.05	2	0.005	0.1	4.0	na	0.002	0.05	na	na					
SAMPLEDATE	ARSENIC	BARIUM	CADMIUM	CHROMIUM	FLUORIDE	LEAD	MERCURY	SELENIUM	SILVER	SODIUM	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID
05/12/97	0.003	0.048	<0.00025	<0.010	0.57	<0.001	<0.0002	0.001	NT	21	001				

********** NEW INORGANIC PARAMETERS **********
****** all results expressed in mg/l or ppm **********
********** TESTING BEGAN JAN 1, 1993 **********

** MCLs are	0.006	0.004	0.2	0.1	na	0.002					
SAMPLEDATE	ANTIMONY	BERYLLIUM	CYANIDE	NICKEL	SULFATE	THALLIUM	COMPOSITED	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID_5

05/12/97 <0.001 <0.001 NT <0.020 62 <0.001 .F. 001

********** NITRATE/NITRITE **********
***** all results expressed in mg/l or ppm **********
** MCLs are 10.0 1.0 10.0
sampledate nitrate_n nitrite_n no3_no2_n se_id_1 se_id_2 se_id_3 se_id_4 se_id_5
05/12/97 NT NT 2.3 001
08/25/97 NT <0.02 NT 001

********** LEAD/COPPER TAP MONITORING DATA **********
***** levels are 90th percentile levels expressed in mg/l *****
beg_compli end_compli pb_90th cu_90th
01/01/97 06/30/97 0.002 0.84
07/01/97 12/31/97 0.005 0.81
01/01/98 12/31/98

********** RADIOLOGICAL **********
**** all results expressed in pCi/l, except TS in mg/l ****
PLANTNUMBR SAMPLEDATE SAMTYPE ALPHA ADJ_ALPHA BETA RA226 RA228 RA226_228 URANIUM TS RADON_222
W01 05/12/97 5 NT 8 NT NT NT NT 640 NT

*** There was no corrosivity data found. ***

*** There was no trihalomethane data found. Required for community systems serving 10,000 or more only. ***

** There was no Phase I VOC data found. ***

*** There was no regulated organics data found. ***

*** There was no unregulated organics data found. ***

*** There were no chemical check sample tracking records found. ***

*** There were no bacteriological or turbidity violations found. ***

*** There were no chemical violations found. ***

*** There were no additional chemical enforcement actions found. ***

*** There are no outstanding enforcement orders. ***

Please Note:
NT = Not Tested
ND = None Detected
BDL = Below Detection Limit
< symbol for less than
na = Not Applicable

GW = ground water
SW = surface water
GWUISW = ground water under the influence of surface water
MCL = maximum contaminant level
VOC = volatile organic chemical
SWTR = surface water treatment rule

Report Date: 04/17/98

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
Compliance Monitoring and Data Management Unit - WQCD

Note: Computer data is always subject to error. If data appears unusual or questionable, please confirm the validity with the Drinking Water Program at (303) 692-3500.

WATER QUALITY DATA FOR ID 123595 - Panorama Ranches HOA
0165 Basalt Mtn Dr
Carbondale, CO 81623

Contact: Farrar, Davis
Contact Phone: (970)963-1670
Operator: Farrar, Davis
Operator Phone: (970)963-1670
Resident Population: 80
Non-Transient Population: 0
Transient Population: 0
Service Connections: 27

County: Garfield
Active Status: Active
Activation Date: 1/89
System Begin Date: 0/
System Type: Community
System Source Type: Ground Water
Open Year Around

Disinfection Waiver ? No
Bacts Required: 1
Bact Cycle: Monthly
Nitrate Schedule: 3rd Quarter
Chemical Schedule Group: 1
Inorganic Schedule: 3rd Quarter
Radiological Schedule: 3rd Quarter
Organic Schedule: Routine - 4 Quarters

********** SOURCE INFORMATION **********

se_id	srcnum	src	se_rec_type	se_code	avail	sampoint	seller_id	totaldepth	aquifer
001	GWTP01	Cl2 for wells	P	T	P	.T.			
002	W01	well #1	S	G	P	.F.		320	
003	W02	Well #2	S	G	P	.F.		320	

********** RECENT BACTERIOLOGICAL **********
*** s = Safe ***** U = Unsafe ***** N = Invalid ****

samp_date	type	testmeth	quantity	tc_pres	fe_pres	invalid
01/27/97	r	m	1	s		
02/03/97	r	m	1	s		
03/11/97	r	m	1	s		
04/02/97	r	m	1	s		
05/06/97	r	m	1	s		
06/02/97	r	m	1	s		
07/08/97	r	m	1	s		
08/05/97	r	m	1	s		
09/02/97	r	m	1	s		
10/01/97	r	m	1	s		
11/03/97	r	m	1	s		
12/01/97	r	m	1	s		
01/26/98	r	m	1	s		
02/09/98	r	m	1	s		
03/09/98	r	m	1	s		

********** ORIGINAL INORGANICS **********
****** all results and MCLs expressed in mg/l or ppm *******

** MCLs are	0.05	2	0.005	0.1	4.0	na	0.002	0.05	na	na				
SAMPLEDATE	ARSENIC	BARIUM	CADMIUM	CHROMIUM	FLUORIDE	LEAD	MERCURY	SELENIUM	SILVER	SODIUM	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID
09/13/88	0.000	0.000	0.00000	0.0000	0.300	0.0070	0.00000	0.005	0.0000	28	001				
/04/91	ND	0.045	ND	ND	0.31	ND	ND	0.006	ND	27	001				
08/08/95	0.003	0.043	<0.00025	<0.01	0.36	<0.001	<0.0002	0.005	NT	26	001				

********** NEW INORGANIC PARAMETERS **********

****** all results expressed in mg/l or ppm **********
********** TESTING BEGAN JAN 1, 1993 **********
** MCLs are 0.006 0.004 0.2 0.1 na 0.002

MPLEDATE	ANTIMONY	BERYLLIUM	CYANIDE	NICKEL	SULFATE	THALLIUM	COMPOSITED	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID_5
_/08/95	<0.001	<0.001	MT	<0.02	58	<0.001	.F.	001				

********** NITRATE/NITRITE **********
****** all results expressed in mg/l or ppm **********
** MCLs are 10.0 1.0 10.0

sampledate	nitrate_n	nitrite_n	no3_no2_n	se_id_1	se_id_2	se_id_3	se_id_4	se_id_5
09/13/88	0.57		NT	001				
08/04/91	0.68		NT	001				
07/27/94	NT	NT	0.61	001				
08/08/95	NT	<0.02	0.7	001				
09/10/96	NT	NT	0.7	001				
07/01/97	NT	NT	0.7	001				

********** LEAD/COPPER TAP MONITORING DATA **********
***** levels are 90th percentile levels expressed in mg/l *****

beg_compli	end_compli	pb_90th	cu_90th
07/01/93	12/31/93	0.005	0.30
01/01/94	06/30/94	0.005	0.32
01/01/95	12/31/95	0.004	0.32
01/01/98	12/31/98		

********** RADIOLOGICAL **********
**** all results expressed in pCi/l, except TS in mg/l ****

ANTNUMBR	SAMPLEDATE	SAMTYPE	ALPHA	ADJ_ALPHA	BETA	RA226	RA228	RA226_228	URANIUM	TS	RADON_222
1	01/10/90	G	0.0	0.0	8.0	0.00	0.00	0.00	0.0	510	
WTP01	07/27/94	3	NT	<8	NT	NT	NT	NT	510	NT	
GWTP01	07/01/97	3	NT	<8	NT	NT	NT	NT	590	NT	

********** CORROSIVITY **********
***** all units are mg/l except Langlier, pH, and temp ****

sampledate	langlier	tot_alk	ca_hard	ph	tds	water_temp	chloride	sulfate
08/04/91	0.15	150	100	8.1		57.5F		

*** There was no trihalomethane data found. Required for community systems serving 10,000 or more only. ***

********** Phase I VOC'S **********

Note: Included as part of Phase II/V organics as of 1/1/93.
Refer to file for information on detects.

plantnumbr	plantname	sampledate	detected
1	Panorama Ranches Subdivision	03/20/91	No voc's detected.

********** REGULATED PHASE I/II/V ORGANICS **********

Sources: 001 10/01/97 Composited: F *** There were no regulated detects in this sample. ***

********** UNREGULATED PHASE I/II/V ORGANICS **********

Note: Detections of Trihalomethanes are not printed.
Monitoring is required. No standards have been set.

Sources: 001 10/01/97 Composited: F

*** There were no unregulated detects in this sample. ***

*** There were no chemical check sample tracking records found. ***

** There were no bacteriological or turbidity violations found. ***

********** CHEMICAL VIOLATIONS **********

beg_compli	end_compli	viol_type	contaminat	reqsamples	valid_sam	result	mcl_violat	enf_date	type_letr	epa_code	delete
01/01/93	12/31/93	03	1040	1	0	0.00000000	0.00000000	03/06/95	1	SO6	

********** ENFORCEMENT ACTIONS for CHEMS **********

**** SFJ = violation letter - SOX = now in compliance ****

enf_date	epa_code	type_letr	comments
07/27/94	SOX		

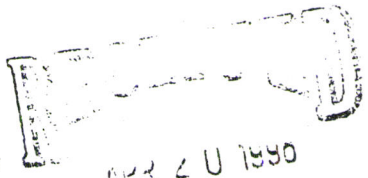
*** There are no outstanding enforcement orders. ***

Please Note:

NT = Not Tested
ND = None Detected
BDL = Below Detection Limit
< symbol for less than
na = Not Applicable

GW = ground water
SW = surface water
GWUISW = ground water under the influence of surface water
MCL = maximum contaminant level
VOC = volatile organic chemical
SWTR = surface water treatment rule

Report Date: 04/17/98



COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
Compliance Monitoring and Data Management Unit - WQCD

Note: Computer data is always subject to error. If data appears unusual or questionable, please confirm the validity with the Drinking Water Program at (303) 692-3500.

WATER QUALITY DATA FOR ID 123443 - Kings Row Subd
ATTN: EPC - Scott Leslie
PO Box 493
Snowmass, CO 81654

Contact: Leslie, Scott u274
Contact Phone: (970)945-9121
Operator: Leslie, Scott u274
Operator Phone: (970)945-6069
Resident Population: 40
Non-Transient Population: 0
Transient Population: 0
Service Connections: 11

County: Garfield
Active Status: Active
Activation Date: 0/
System Begin Date: 0/
System Type: Community
System Source Type: Ground Water
Open Year Around

Disinfection Waiver ? No
Bacts Required: 1
Bact Cycle: Monthly
Nitrate Schedule: 3rd Quarter
Chemical Schedule Group: 1
Inorganic Schedule: 3rd Quarter
Radiological Schedule: 3rd Quarter
Organic Schedule: Routine - 4 Quarters

********** SOURCE INFORMATION **********

se_id	srcnum	src	se_rec_type	se_code	avail	sampoint	seller_id	totaldepth	aquifer
001	W01	Well #1	S	G	P	.F.		360	
002	W02	Well #2	S	G	P	.F.		410	
003	GWTP01	Cl2 for wells	P	T	P	.T.			

********** RECENT BACTERIOLOGICAL **********
*** s = Safe ***** U = Unsafe ***** N = Invalid ****

samp_date	type	testmeth	quantity	tc_pres	fe_pres	invalid
01/27/97	r	m	1	s		
02/25/97	r	m	1	s		
03/27/97	r	m	1	s		
04/29/97	r	m	1	s		
05/28/97	r	m	1	s		
06/26/97	r	m	1	s		
07/23/97	r	m	1	s		
08/26/97	r	m	1	s		
09/30/97	r	m	1	s		
10/30/97	r	m	1	s		
11/19/97	r	m	1	s		
12/18/97	r	m	1	s		
01/29/98	r	m	1	s		
02/25/98	r	m	1	s		
03/26/98	r	m	1	s		

********** ORIGINAL INORGANICS **********
****** all results and MCLs expressed in mg/l or ppm *******

** MCLs are	0.05	2	0.005	0.1	4.0	na	0.002	0.05	na	na					
SAMPLEDATE	ARSENIC	BARIUM	CADMIUM	CHROMIUM	FLUORIDE	LEAD	MERCURY	SELENIUM	SILVER	SODIUM	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID
7/19/87	0.000	0.000	0.00000	0.0000	0.270	0.0000	0.00000	0.000	0.0000	25	001				
09/18/90	0.000	0.000	0.00000	0.0000	0.460	0.0000	0.00000	0.002	0.0005	30	001				
03/09/95	0.000	0.00	0.0000	0.000	0.59	0.000	0.0000	0.001	NT	34.2	003				

********** NEW INORGANIC PARAMETERS **********
****** all results expressed in mg/l or ppm **********
********** TESTING BEGAN JAN 1, 1993 **********

MCLs are	0.006	0.004	0.2	0.1	na	0.002						
MPLEDATE	ANTIMONY	BERYLLIUM	CYANIDE	NICKEL	SULFATE	THALLIUM	COMPOSITED	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID_5
03/09/95	0.000	0.000	0.000	0.000	28	0.000	.F.	003				

********** NITRATE/NITRITE **********
****** all results expressed in mg/l or ppm **********

** MCLs are	10.0	1.0	10.0				
sampledate	nitrate_n	nitrite_n	no3_no2_n	se_id_1	se_id_2	se_id_3	se_id_4	se_id_5
07/19/87	1.30		NT	001			
09/18/90	1.27		NT	001			
03/18/93	1.28	0.00	NT	001			
12/29/94	1.35	BDL	1.35	003			
03/09/95	1.32	0.00	1.32	003			
09/30/96	1.78	0.00	1.78	003			
09/24/97	1.45	0.00	1.45	003			

********** LEAD/COPPER TAP MONITORING DATA **********
***** levels are 90th percentile levels expressed in mg/l *****

beg_compli	end_compli	pb_90th	cu_90th
07/01/93	12/31/93	0.002	0.16
01/01/94	06/30/94	0.002	0.39
01/01/95	12/31/95	0.013	0.17
01/01/98	12/31/98		

********** RADIOLOGICAL **********
**** all results expressed in pCi/l, except TS in mg/l ****

PLANTNUMBR	SAMPLEDATE	SAMTYPE	ALPHA	ADJ_ALPHA	BETA	RA226	RA228	RA226_228	URANIUM	TS	RADON_222
1	02/01/84		0.0	0.0	0.0	0.00	0.00	0.00	0.0	0	
1	02/28/89	G	0.0	0.0	0.0	0.00	0.00	0.00	4.0	560	
WTP01	12/29/94		4.9	NT	4.6	NT	NT	NT	NT	272	NT
W01	09/24/97		2.7	NT	1.4	NT	NT	NT	NT	NT	NT

********** CORROSIVITY **********
***** all units are mg/l except Langlier, pH, and temp ****

sampledate	langlier	tot_alk	ca_hard	ph	tds	water_temp	chloride	sulfate
09/18/90	+.247	224	94.6	7.8	383	25 C		

*** There was no trihalomethane data found. Required for community systems serving 10,000 or more only. ***

********** Phase I VOC'S **********

Note: Included as part of Phase II/V organics as of 1/1/93.
Refer to file for information on detects.

plantnumbr	plantname	sampledate	detected
1	Kings Row	03/06/91	2 voc's detected.

********** REGULATED PHASE I/II/V ORGANICS **********

Sources: 003 06/27/97 Composited: F *** There were no regulated detects in this sample. ***

********** UNREGULATED PHASE I/II/V ORGANICS **********

Note: Detections of Trihalomethanes are not printed.
Monitoring is required. No standards have been set.

Sources: 003 06/27/97 Composited: F

*** There were no unregulated detects in this sample. ***

*** There were no chemical check sample tracking records found. ***

*** There were no bacteriological or turbidity violations found. ***

********** CHEMICAL VIOLATIONS **********

beg_compli	end_compli	viol_type	contaminat	reqsamples	valid_sam	result	mcl_violat	enf_date	type_letr	epa_code	delete
07/01/97	12/31/97	03	4xxx	1	0			12/22/97		SFJ	
07/01/97	12/31/97	03	1038	1	0			12/22/97		SFJ	

*** There were no additional chemical enforcement actions found. ***

*** There are no outstanding enforcement orders. ***

Please Note:
NT = Not Tested
ND = None Detected
BDL = Below Detection Limit
< symbol for less than
na = Not Applicable

GW = ground water
SW = surface water
GWUISW = ground water under the influence of surface water
MCL = maximum contaminant level
VOC = volatile organic chemical
SWTR = surface water treatment rule

Report Date: 04/21/98

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
Compliance Monitoring and Data Management Unit - WQCD

Note: Computer data is always subject to error. If data appears unusual or questionable, please confirm the validity with the Drinking Water Program at (303) 692-3500.

WATER QUALITY DATA FOR ID 119672 - Red Table Acres HOA
ATTN: EPC - Scott Leslie
PO Box 493
Snowmass, CO 81654

Contact: Leslie, Scott u106
Contact Phone: (970)945-9121/FAX#
Operator: Leslie, Scott u106
Operator Phone: (970)945-6069
Resident Population: 100
Non-Transient Population: 0
Transient Population: 0
Service Connections: 35

County: Eagle
Active Status: Active
Activation Date: 0/
System Begin Date: 0/
System Type: Community
System Source Type: Ground Water
Open Year Around

Disinfection Waiver ? No
Bacts Required: 1
Bact Cycle: Monthly
Nitrate Schedule: 3rd Quarter
Chemical Schedule Group: 1
Inorganic Schedule: 3rd Quarter
Radiological Schedule: 3rd Quarter
Organic Schedule: Routine - 4 Quarters

********** SOURCE INFORMATION **********

se_id	srcnum	src	se_rec_type	se_code	avail	sampoint	seller_id	totaldepth	aquifer
001	W01	well	S	G	P	.F.		350	
002	W02	Well	S	G	P	.F.		400	
003	GWTP01	RTA WTP/Pumphouse and CL2	P	T	P	.T.			

********** RECENT BACTERIOLOGICAL **********
*** s = Safe ***** U = Unsafe ***** N = Invalid ****

samp_date	type	testmeth	quantity	tc_pres	fe_pres	invalid
01/27/97	r	m	1	s		
02/25/97	r	m	1	s		
03/27/97	r	m	1	s		
04/29/97	r	m	1	s		
05/28/97	r	m	1	s		
06/26/97	r	m	1	s		
07/25/97	r	m	1	s		
08/26/97	r	m	1	s		
09/30/97	r	m	1	s		
10/30/97	r	m	1	s		
11/19/97	r	m	1	s		
12/18/97	r	m	1	s		
01/29/98	r	m	1	s		
02/25/98	r	m	1	s		
03/26/98	r	m	1	s		

********** ORIGINAL INORGANICS **********
****** all results and MCLs expressed in mg/l or ppm *******

** MCLs are	0.05	2	0.005	0.1	4.0	na	0.002	0.05	na	na					
^AMPLEDATE	ARSENIC	BARIUM	CADMIUM	CHROMIUM	FLUORIDE	LEAD	MERCURY	SELENIUM	SILVER	SODIUM	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID
/23/84	0.000	0.000	0.00000	0.0000	0.660	0.0000	0.00000	0.000	0.0000	12	001				
07/26/88	0.000	0.000	0.00000	0.0000	0.730	0.0000	0.00000	0.000	0.0000	12	001				
03/09/95	0.000	0.00	0.0003	0.000	0.66	0.000	0.0000	0.000	NT	15.9	003				

********** NEW INORGANIC PARAMETERS **********
****** all results expressed in mg/l or ppm **********
********** TESTING BEGAN JAN 1, 1993 **********

MCLs are	0.006	0.004	0.2	0.1	na	0.002					
SAMPLEDATE	ANTIMONY	BERYLLIUM	CYANIDE	NICKEL	SULFATE	THALLIUM	COMPOSITED	SE_ID_1	SE_ID_2	SE_ID_3	SE_ID_4	SE_ID_5
03/09/95	0.000	0.000	0.000	0.000	25	0.000	.F.	003				

********** NITRATE/NITRITE **********
****** all results expressed in mg/l or ppm **********

** MCLs are	10.0	1.0	10.0					
sampledate	nitrate_n	nitrite_n	no3_no2_n	se_id_1	se_id_2	se_id_3	se_id_4	se_id_5
07/23/84	0.00		NT	001				
07/26/88	0.83		NT	001				
03/18/93	0.915	0.00	NT	001				
06/29/94	0.85	BDL	0.85	001				
03/09/95	1.17	0.00	1.17	003				
09/30/96	0.82	0.00	0.82	003				
09/24/97	1.18	0.00	1.18	003				

********** LEAD/COPPER TAP MONITORING DATA **********
***** levels are 90th percentile levels expressed in mg/l *****

beg_compli	end_compli	pb_90th	cu_90th
07/01/93	12/31/93	0.001	0.14
01/01/94	06/30/94	0.003	0.15
01/01/95	12/31/95	0.001	0.37
01/01/98	12/31/98		

********** RADIOLOGICAL **********
**** all results expressed in pCi/l, except TS in mg/l ****

PLANTNUMBR	SAMPLEDATE	SAMTYPE	ALPHA	ADJ_ALPHA	BETA	RA226	RA228	RA226_228	URANIUM	TS	RADON_222
1	02/16/84		0.0	0.0	0.0	0.00	0.00	0.00	5.7	0	
1	02/28/89	G	0.0	0.0	0.0	0.00	0.00	0.00	6.0	660	
W01	12/29/94		7.9	NT	6.9	NT	NT	NT	NT	336	NT
GWTP01	09/24/97		7.9	NT	3.1	NT	NT	NT	NT	NT	NT

*** There was no corrosivity data found. ***

*** There was no trihalomethane data found. Required for community systems serving 10,000 or more only. ***

********** Phase I VOC'S **********

Note: Included as part of Phase II/V organics as of 1/1/93. Refer to file for information on detects.

plantnumbr	plantname	sampledate	detected
1	Red Table Acres	03/06/91	No voc's detected.

********** REGULATED PHASE I/II/V ORGANICS **********

Sources: 003 06/27/97 Composited: F

*** There were no regulated detects in this sample. ***

********** UNREGULATED PHASE I/II/V ORGANICS **********

Note: Detections of Trihalomethanes are not printed.
Monitoring is required. No standards have been set.

Sources: 003 06/27/97 Composited: F

*** There were no unregulated detects in this sample. ***

*** There were no chemical check sample tracking records found. ***

*** There were no bacteriological or turbidity violations found. ***

********** CHEMICAL VIOLATIONS **********

beg_compli	end_compli	viol_type	contaminat	reqsamples	valid_sam	result	mcl_violat	enf_date	type_letr	epa_code	delete
01/01/97	12/31/97	03	1038	1	0			12/22/97		SFJ	
07/01/97	12/31/97	03	4xxx	1	0			12/22/97		SFJ	

*** There were no additional chemical enforcement actions found. ***

*** There are no outstanding enforcement orders. ***

Please Note:

NT = Not Tested
ND = None Detected
BDL = Below Detection Limit
< symbol for less than
na = Not Applicable

GW = ground water
SW = surface water
GWUISW = ground water under the influence of surface water
MCL = maximum contaminant level
VOC = volatile organic chemical
SWTR = surface water treatment rule

ATTACHMENT C
LOS AMIGOS PUD

Mountain Residential Development Minimum Well Protective Distances Well Water Quality

Karl L. Ford, Julia H. Schott, and Thomas J. Keefe, Ph.D.

Abstract

The purpose of this study was to identify factors important to wellwater contamination associated with onsite wastewater disposal systems. The study site is a mountainous portion of Jefferson County, west of Denver, Colo. Contamination of well waters was indicated by concentration of nitrates and coliform bacteria in excess of the Environmental Protection Agency's drinking water standards. Statistical analysis of the wellwater data in this study indicate that a well protective distance of 100 ft. has a probability of nitrate-nitrogen contamination of 21.8%; whereas, a 200 ft. distance has a probability of nitrate-nitrogen contamination of 9.4%.

Most local environmental health agencies regulate the siting and installation of onsite wastewater disposal systems. Unless properly located and installed, these systems may be a source of coliform or pathogenic microorganisms and toxic products such as nitrates. In order to prevent contamination of water supplies and the creation of health hazards, these agencies may employ regulatory measures such as control of well construction, subdivision lot size, well depth, and horizontal well protective distance requirements. These distance requirements normally specify the minimum distance from the well to all wastewater disposal systems. A study was made to evaluate the relative importance of these factors with respect to well water contamination.

Journal of Environmental Health, V. 43 (3) 130-133.

Karl L. Ford, Health Science Department, California State University, Northridge, CA 91330; Julia H. Schott, Jefferson County Health Dept., 260 S. Kipling, Lakewood, CO 80226; and Thomas J. Keefe, Ph.D., Institute of Rural Environmental Health, Colorado State University, Spruce Hall, Ft. Collins, CO 80523.

The Study Area

The study area, approximately 300 square miles in size, includes most of the mountainous area of Jefferson County, Colorado. Much of the area, which lies within commuting distance of the Denver metropolitan area, has experienced rapid growth; the population of the area doubled from 1960 to 1970 and is increasing at approximately the same rate of growth. Of the approximately 20,000 year-round residents of the study area, nearly 12,000 are using individual wells and onsite wastewater disposal systems (6).

Metamorphic rocks and granite intrusions comprise most of the bedrock, and the rock contains numerous faults and fractures. Fractured bedrock constitutes the principle aquifer in the mountains. The porosity of the aquifer is low and water availability is correspondingly low with yields of 1 gpm common (7). Sand and gravel deposits occur in the valleys and form the second most important source of groundwater in the area. The alluvial wells are characterized by higher storage capacity and more stable water levels than wells drilled in bedrock.

Soils throughout the study area are quite thin (superficial), normally reflecting an average topsoil depth of 12 to 24 inches, and are underlain with decomposed bedrock of varying density and thickness; this intermediate zone from soil to bedrock ranges from 0 to over 20 feet. Most soils in the study area are not suitable for conventional soil absorption wastewater disposal systems. Not only are the soils too thin, but the fracture zones allow rapid movement of the wastewater effluent. Under continuing pressure for development, Jefferson County has allowed subsurface sand filters and ripped base disposal fields that have been installed in accordance with the design of a professional engineer.

Methodology

Wellwater samples were collected as an indicator of the quality of the groundwater being used for human consumption. The 164 wells utilized in the study were not selected at random. The wellwater samples were taken by the staff of the Jefferson County Health Department from wells subjected to a sanitary survey during the years 1975-1977. On the basis of sanitary surveys, previous

samples, or owner complaints, some of the wells were known or suspected to be contaminated. Despite this, only 20.7% of the wells selected for the study actually exceeded the Environmental Protection Agency's (EPA) standards of 10 mg/l for NO_3-N (3).

The wells were sampled and analyzed for coliform bacteria and NO_3-N in accordance with the APHA Standard Methods for the Examination of Water and Wastewater (2). A sanitary survey was conducted for each well in order to identify possible sources of contamination. Since well construction was thought to be an important factor influencing coliform contamination, the survey included a well inspection. The following criteria were utilized to classify wells of unapproved construction (5, 9):

1. lack of a watertight sanitary seal;
2. pit installation;
3. dug well or spring; and
4. inadequate formation seal.

Also investigated were site factors thought to be related to contamination:

1. well depth;
2. well protective distance;
3. geology (some data collected); and
4. lot size.

Domestic livestock was initially considered a factor contributing to the occurrence of contamination but, on the basis of the sanitary surveys, was eliminated as a source of contamination in most instances.

Well Construction and Depth

Based on the above criteria, wells were classified as either approved or unapproved construction. Coliforms were found in unapproved wells more frequently than approved wells, but nitrates were found equally in approved and unapproved wells (Table 1). Well construction was not found to be statistically related in nitrate contamination. Coliform contamination was found equally in shallow, unapproved wells as in deep-drilled, unapproved wells. Coliform contamination was not found to be related to lot size or distance.

Table 1

Comparison of coliform and nitrate (NO_3-N) contamination found in approved and unapproved constructed wells.

Well Construction	% Wells With Coliforms	% Wells NO_3-N>10mg/1	$\bar{X}$ NO_3-N Concentration
Approved	17.6	19.8	4.60
Unapproved	23.7	20.3	4.76

Table 2

Percent of sampled wells exceeding the nitrate-nitrogen standard for six well-distance groups.

Distance Group (Feet)	Number Sampled Wells	Mean Distance (Feet)	Number of Contaminated Wells[a]	P[b]	LP[c]
≤ 60	25	44.2	10	40.0	− .406
61-90	27	77.7	7	25.9	−1.051
91-120	43	103.3	9	20.9	−1.331
121-150	28	135.4	4	14.3	−1.791
151-210	28	195.5	3	10.7	−2.122
< 210	13	430.8	1	7.7	−2.369
Overall	164	137.1	34	20.7	−1.343

[a] For these purposes, a well was considered contaminated if the nitrogen-nitrate level (NO_3-N) exceeded the standard of 10 mg/liter.
[b] P denotes the percentage of wells exceeding the standard of 10 mg/liter.
[c] LP denotes the logit transform of P. $LP = \log_e (P/(100-P))$.

Protective Distance

Whereas coliforms were not expressly associated with the well protective distance, the nitrate concentrations were. In order to examine the relationship between well-distance and nitrate-nitrogen concentration, the wells were categorized both by well distance (six groups as shown in Table 2) and by contamination or noncontamination. A well was coded as contaminated if the nitrate-nitrogen level exceeded the health standard of 10 mg/1. As seen in Table 2, the percentage of wells exceeding the nitrate-nitrogen standard decreases sharply with increasing well distance. A weighted regression analysis showed a highly significant quadratic relationship between the logit transformation of the percentage of contaminated wells and the distance of the well from the nearest wastewater disposal system. The percentage variation explained by this regression analysis (i.e., R^2) was 98.5%. A plot of the predictive equation for the percentage of contaminated wells, along with an approximate 95% confidence band and the observed percentage of contaminated wells, is given in Figure 1. Calculated values of the estimated percentage of wells exceeding the nitrate-nitrogen standard are given in Table 3 for selected well distances. For example, the estimated percentage of contaminated wells with a well distance of 200 feet is 9.4% with an approximate 95% confidence interval of 8.2 to 10.8%.

Whereas the correlation between nitrate-nitrogen and well distance was statistically significant, the considerable variation of nitrate-nitrogen levels within the well distance categories indicated the potential for other explanatory sources of variation. The effects of other variables, such as well depth and lot size, on nitrate-nitrogen levels were statistically investigated via multiple regression analysis. However, the addition of these other variables did not contribute significantly to explaining the variation in the nitrate-nitrogen levels.

Geology

The subsurface geology of a given site was a factor that was beyond the scope of the study to properly evaluate. Some secondary data were compiled from USGS geological maps and other sources. Well logs were considered a potentially valuable source of geological data for further investigation.

Table 3

Regression estimates of the percent (P) of wells exceeding 10 mg/l NO_3-N of water, along with 95% confidence intervals, for selected well-distance (D).

D (Feet)	$\hat{P}$	Approximate 95% Confidence Interval for P	
0	56.1	52.4	59.8
50	35.8	32.4	39.3
100	21.8	19.3	24.4
150	13.7	12.0	15.6
200	9.4	8.2	10.8
250	7.2	6.3	8.3
300	6.3	5.4	7.2
350	6.2	5.3	7.0
400	6.9	6.0	7.9
450	8.7	7.6	10.0
500	12.3	10.8	14.0

Discussion

The well protective distance (and indirectly lot size) does not entirely explain or predict contamination, probably due to the geologic variable. Hofstra and Hall (4) emphasized not only the importance of well construction but also stressed the significance of geologic factors in explaining the occurrence of contamination in well waters. Geologic factors are difficult to deal with in mountainous environments due to the variation in the depth to bedrock, fracture direction, specific yield of the aquifer, and other factors that defy easy generalization. Geological considerations may also explain coliform contamination when well construction is adequate. Waltz (8) and Allen (1) have shown that the fractures in crystalline bedrock are not effective in filtering the bacteria associated with wastewater effluent. They have also shown that the orientation of the rock fractures does influence the direction and travel path of the contaminants. These studies confirm that simply locating the well topographically above the wastewater does not provide any assurances that leachfield effluent will not flow into the well.

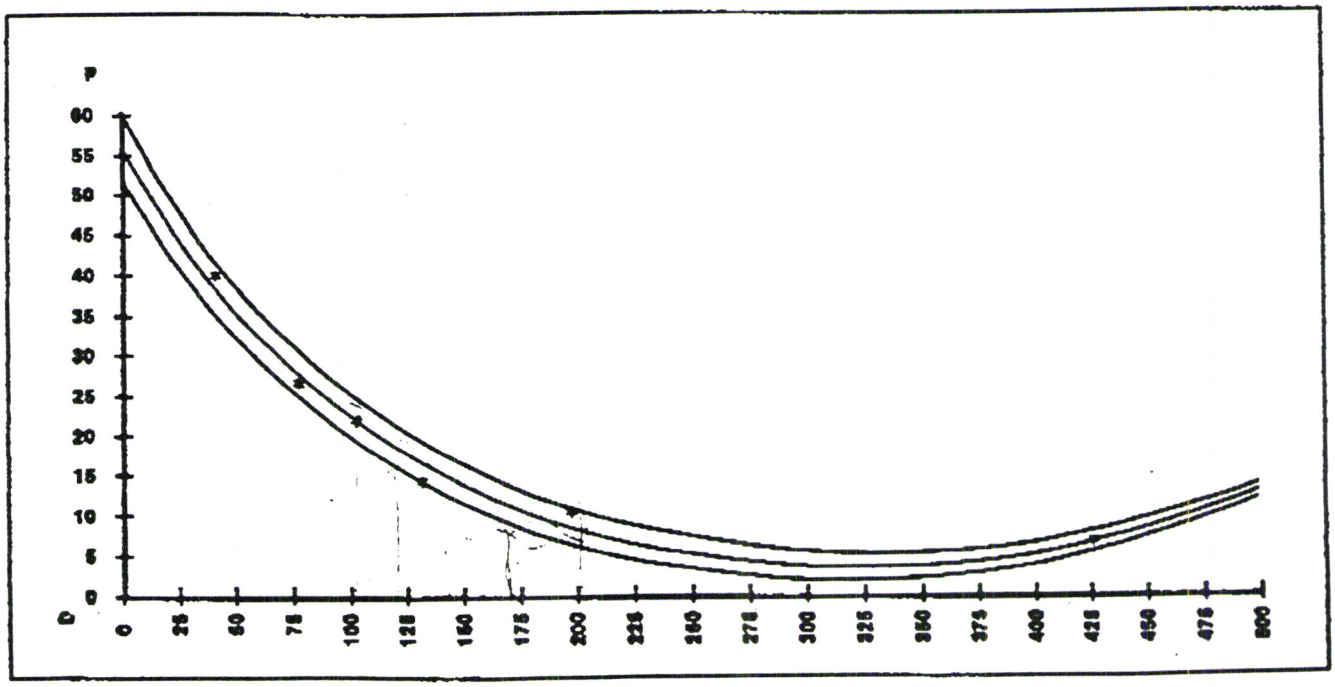
In regard to well construction, one reason that coliform contamination was found equally in shallow, unapproved wells as in deep-drilled, unapproved wells is that surface contamination-bearing coliforms may still enter the well head of a poorly protected well and flow down the casing into the well. For these reasons, the occurrence of coliforms in wellwaters may be considered a better indicator of improper well construction than of groundwater contamination.

Since the nitrate-nitrogen may be an indicator of wastewater contamination, it is important to consider how it is formed. Nitrate-nitrogen is formed from the nitrogenous wastes in percolating effluent under aerobic conditions, but unlike other effluent products, nitrates are water soluble and are not effectively removed by soil filtration. Consequently, nitrates tend to accumulate in the aquifer. Since the presence of nitrates was found to be statistically unrelated to well construction, nitrates may be a better indicator of well water contamination from wastewater disposal systems than are coliforms.

Lot size, as related to well water contamination, is an important consideration for land use planning. In fact, since the relative spacing of well

Figure 1

Plot of estimated percentage P of wells exceeding 10 mg NO_3-N per liter water as a function of distance D from the nearest wastewater effluent, along with approximate 95% confidence band and scatterplot of observed percentages.



and disposal systems largely determines the lot size requirements, lot size is closely related to the minimum protective distance requirements. When nitrate concentrations for the study area were spot-mapped, the localities of extensive nitrate contamination were seen to be associated with increased housing density. In particular, zones of nitrate contamination greater than 10 mg/l were found to be associated with housing densities greater than one dwelling unit per acre and with well protective distances of 100 feet or less.

Statistical analysis of the study data indicates that, for similar mountainous terrain, residential developments which provide for a well protective distance of only 100 feet face a 21.8% probability of exceeding the NO_3-N health standard; whereas, the probability with a well protective distance of 200 feet is 9.4%. Thus, a minimum protective distance of 200 feet is more reasonable than 100 feet in preventing nitrate health hazards in well water supplies. A 200-foot minimum protective distance requires two-acre minimum lot sizes and with adverse topography and full subdivision development, even two acres may be inadequate to maintain 200-foot minimum protective distances. Evidence of contamination suggests that water quality and health hazards may prove to be more significant limitations on mountain residential development than merely water quantity.

References

1. Allen, J., and S. M. Morrison (1973) Bacterial movement through fractured bedrock, *Ground Water* 11:6-10.
2. American Public Health Association, American Water Works Association and The Water Pollution Control Federation, eds. (1976), *Standard Methods for the Examination of Water and Wastewater*, Washington, D.C.
3. Environmental Protection Agency (1975), *National Interim Primary Drinking Water Regulations*, EPA publication #570/9-76-003, 5-7.
4. Hostra, T. and D. A. Hall (1975), *Geological Control of Supply and Quality of Water in the Mountainous Part of Jefferson County, Denver, Colorado*, Colorado Geological Survey, Bulletin 36:43-44.
5. Jones, E. (1974), Evaluating well construction, *J. Environ. Health* 36:556-560.
6. *Jefferson County Planning Department (1976), Mountain Area Population Estimates.*
7. *Snow, T. (1972), Mountain groundwater supplies, The Mountain Geologist*, 10:19-24.
8. Waltz, J. P. (1972), Methods of geologic evaluation of pollution potential at mountain homesites, *Ground Water* 10:42-47.
9. Whitsell, W. J. and G. D. Hutchison (1973), Seven danger signals for individual water supply, *Transactions of the ASAE* 16.

Stored Petroleum Vapors Regulated

EPA regulations to prevent vapors from petroleum storage tanks went into effect with publication in the April 4, 1980 Federal Register. They affect tanks on which construction was begun after May 18, 1978, that have storage capacity greater than 40,000 gallons and that contain petroleum liquids with a vapor pressure greater than 1.5 pounds per square inch. Exempted are those used at drilling sites to store crude oil or natural gas, but only if they have a storage capacity less than 420,000 gallons.

The regulations are issued under authority of Section 111 of the Clean Air Act protecting the public health or welfare. They require the use of improved emission control technology for storage tanks equipped with external floating roofs. They require two seals and minimizing the gaps between seals and tank walls. As an alternative to floating roofs, tank owners may install a vapor recovery process or any other system that reduces VOC emissions to the same degree as the roofs.

Radiation Book Out

Effluent and Environmental Radiation Surveillance is a new publication of the American Society for Testing and Materials, the outcome of the July 1978 Johnson Conference. It includes 30 papers that review methodologies, data and interpretations obtained from the monitoring of effluents from the environments surrounding nuclear facilities. The text specifically addresses the techniques used in measuring the radioactive effluent from facilities using nuclear materials and monitoring the environment in order to determine the impact of these materials on people and the environment. For information, contact ASTM Sales Service Dept., 1916 Race St., Philadelphia, PA 19103.

APPENDIX B

MINIMUM HORIZONTAL DISTANCES IN FEET BETWEEN COMPONENT OF A SEWAGE DISPOSAL SYSTEM AND PERTINENT GROUND FEATURES *

	BUILDING SEWER, SEPTIC TANK, TREATMENT PLANTS, EFFLUENT LINES	PRIVY VAULT OR VAULT	ABSORPTION TRENCH, SEEPAGE BED, SAND FILTER, PRIVY, UNLINED EVAPOTRANSPIRATION SYSTEM, UNLINED STABILIZATION POND, DISPERSAL SYSTEM OTHER THAN AEROSOL	LINED EVAPOTRANSPIRATION OR LINED STABILIZATION POND	ADVANCED TREATMENT SYSTEMS, GREY WATER ABSORPTION SYSTEMS	SEEPAGE PITS
WELLS, SPRINGS, SUCTION LINES	50	50	200 (A) (B)	60	100 (B)	200 (A) (B)
POTABLE WATER SUPPLY LINES	10	10	25	10	25	50
CISTERNS	25	10	25	25	25	25
DWELLING OR OCCUPIED BUILDING	5	15	20	15	20	20
PROPERTY LINES	10	10	10	10	10	25
SUBSOIL DRAINS	10 (C)	10	25	10	25	25
LAKE, WATER COURSE, STREAM	50 (C)	25	50	25	50	50
DRY GULCH	10 (C)	10	25	10	25	25

Note: When a geological or other conditions warrant, greater distance may be required.

A. Distance separations between 100 and 200 feet may be permitted if adequate geologic data, meeting the Boards' guidelines is submitted and approved. When geologically appropriate distance reductions shall affect components on the proposed building site rather than components on adjacent developed sites.

B. Add 8 feet additional distance for each 100 gallons per day design flow over 1000 gallons per day.

C Crossings may be permitted where pipelines are constructed of sufficient strength to contain flows under pressure.

EXHIBIT B

Bishop Brogden and Associates
Letter Dated April 23, 1998

Bishop-Brogden Associates, Inc.

Water Consultants

Robert E. Brogden Harold F. Bishop

Michael A. Sayler
Charles E. Scanzione

ACEC

333 West Hampden Avenue Ste. 1050 Englewood, CO 80110 (303) 806-8952 Fax (303) 806-8953

April 23, 1998

Mr. Greg Boecker
Ranch Manager
Los Amigos Ranch
2929 County Road 114
Glenwood Springs, CO 81601

Dear Mr. Boecker:

Mr. John Currier of Resource Engineering asked that we review interpretations by his firm and by Mr. John Kaufman of the ground water system in the Spring Valley area, and provide you with our written comments on those interpretations. We understand that some concern has been raised about the movement of nitrates from individual septic systems into the ground water system. We studied the reports prepared by both companies such as a letter from Resource Engineering dated February 28, 1998 and a report by Mr. John Kaufman with McLaughlin Water Engineers titled, "Los Amigos Ranch PUD, Potential Impacts on the Ground-Water Flow and Quality Due to the Use of Individual Septic Systems for Domestic Wastewater Treatment and Disposal", dated April 1998. Both reports examine the ground water system in the Spring Valley and both present water level information that can be used to describe the configuration of the upper water levels in the area.

Geology and Hydrology

The geology beneath Spring Valley is described as a series of basalts, interbedded with alluvial and lake-bed deposits that overlie the Maroon Formation. At the surface in Spring Valley are present-day alluvial and lake deposits that probably are similar to the deposits found at depth between individual basalt flows. Ground water is present in the area and can be found in the geologic units; its occurrence is controlled by several factors including:

1. The presence or absence of permeability in the geologic units;

2. Locations of discharge such as Red Canyon, Cattle Creek and the Roaring Fork River and their tributaries;

3. And, locations of recharge such as the upland areas north and east of Spring Valley.

Using these factors and water level data presented by Resource Engineering and McLaughlin Water Engineers, we constructed a map that shows the configuration of the ground water system in Spring Valley. This map is shown as Figure 1 and is attached to this letter. This map shows that the direction of ground water flow is southwest, largely controlled by the elevations of the Roaring Fork River. Probably the basalts, alluvial and lake deposits, and the Maroon Formation are mostly saturated in the upper right part of the map and only the Maroon is saturated in the lower left part of the map. The depth to ground water increases greatly near the bluffs overlooking the Roaring Fork valley as indicated by the numerous dry holes reported in the Resource Engineering report. Further, in this area, there probably are zones of perched ground water, or small areas where ground water can be found in some upper alluvial and lake deposits and is higher in elevation than the regional system.

Ground water is recharged throughout the area and is discharged into the Roaring Fork River and possibly Fisher Creek, a small tributary to Cattle Creek. The interpretation we show is similar to the interpretation by the U.S. Geological Survey in their 1976 report, "Availability and Chemical Characteristics of Ground Water in the Crystal River and Cattle Creek Drainage Basins near Glenwood Springs, West-Central Colorado". This report mapped the ground water system in the basalts between Cattle Creek and the Roaring Fork River and showed that the ground water system in the basalts is connected to the streams in the area, very much like our interpretation for Spring Valley. We note that the Los Amigos development will be located in the lower left part of Spring Valley area (Figure 2), generally over an area in which the depth to ground water is several hundred feet deep and the direction of flow is away from Spring Valley.

Our interpretation of the ground water system differs from Mr. Kaufman's interpretation in that he mapped a ground water mound in vicinity of Los Amigos. We believe that there is not a mound in this area, but instead an isolated zone or zones of perched ground water overlying a deep ground water system. This interpretation is supported by the numerous reported dry holes in the area, which indicate that the regional ground water is deep and a shallow ground water mound is not present.

From this effort, we can conclude the following:

1. The direction of ground water flow is not towards a group of wells that provides or will provide the water supply for the Los Amigos development and the Colorado Mountain College;

2. Return flows from filings 6 through 10 in the Los Amigos development will not migrate towards the wells; instead, the returns flows will move southwest towards the Roaring Fork River.

Summary

In summary, our mapping of the ground water system in Spring Valley shows that the direction of flow is southwest towards the Roaring Fork River. The area over which the Los Amigos development lies probably has some perched ground water, but for the most part, the depth to water is several hundred feet. The flow of ground water under the development is not towards the wells that will ultimately provide the water supply for the development.

Please feel free to give me a call if you have any questions.

Very truly yours,

BISHOP-BROGDEN ASSOCIATES, INC.

Robert E. Brogden

REB/skc
cc: John Currier (via Fax)
Ed Church (via Fax)
Tim Thulson/Larry Green (via Fax)
C9808.00

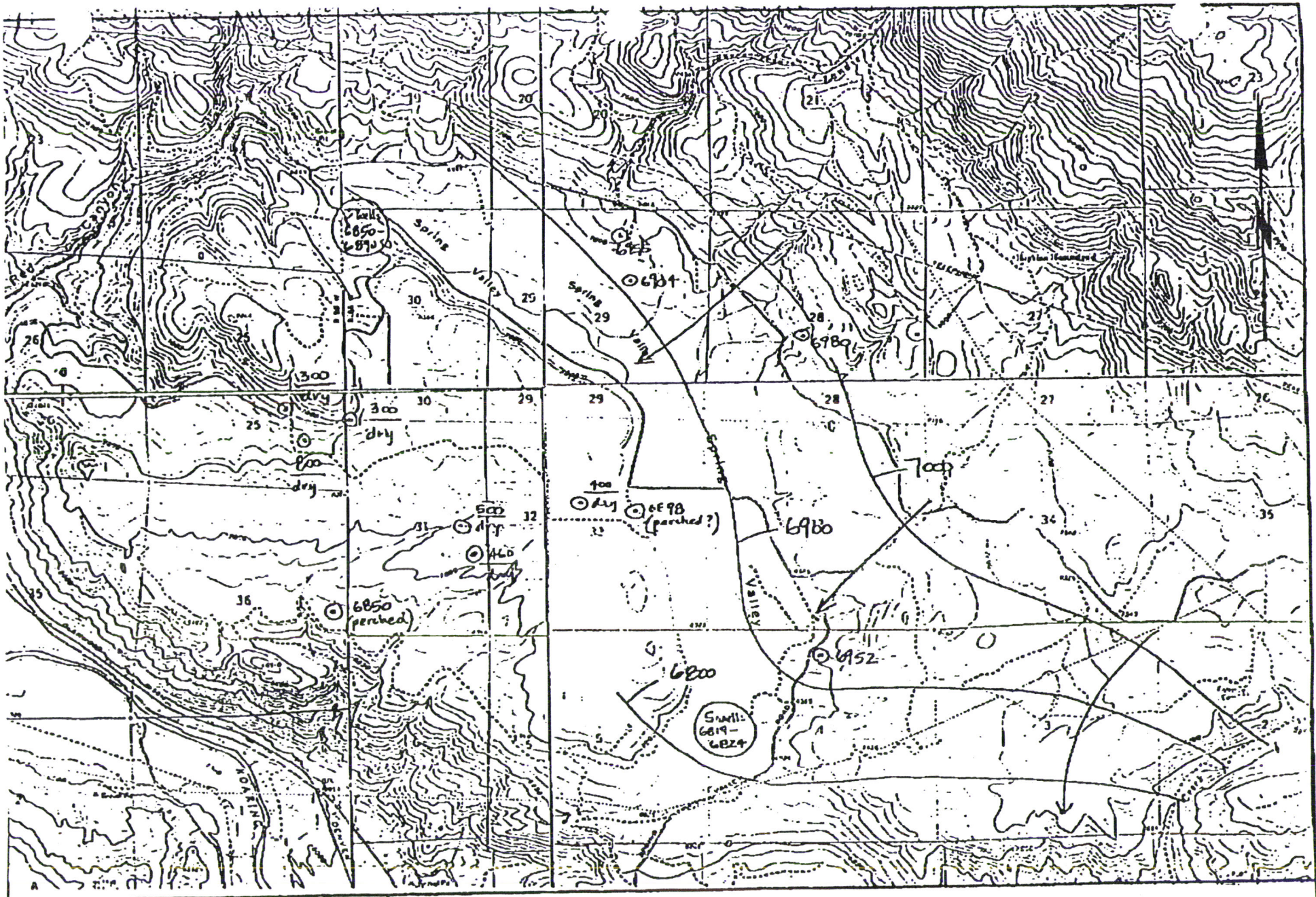


FIGURE 1
SPRING VALLEY WATER LEVEL CONFIGURATION

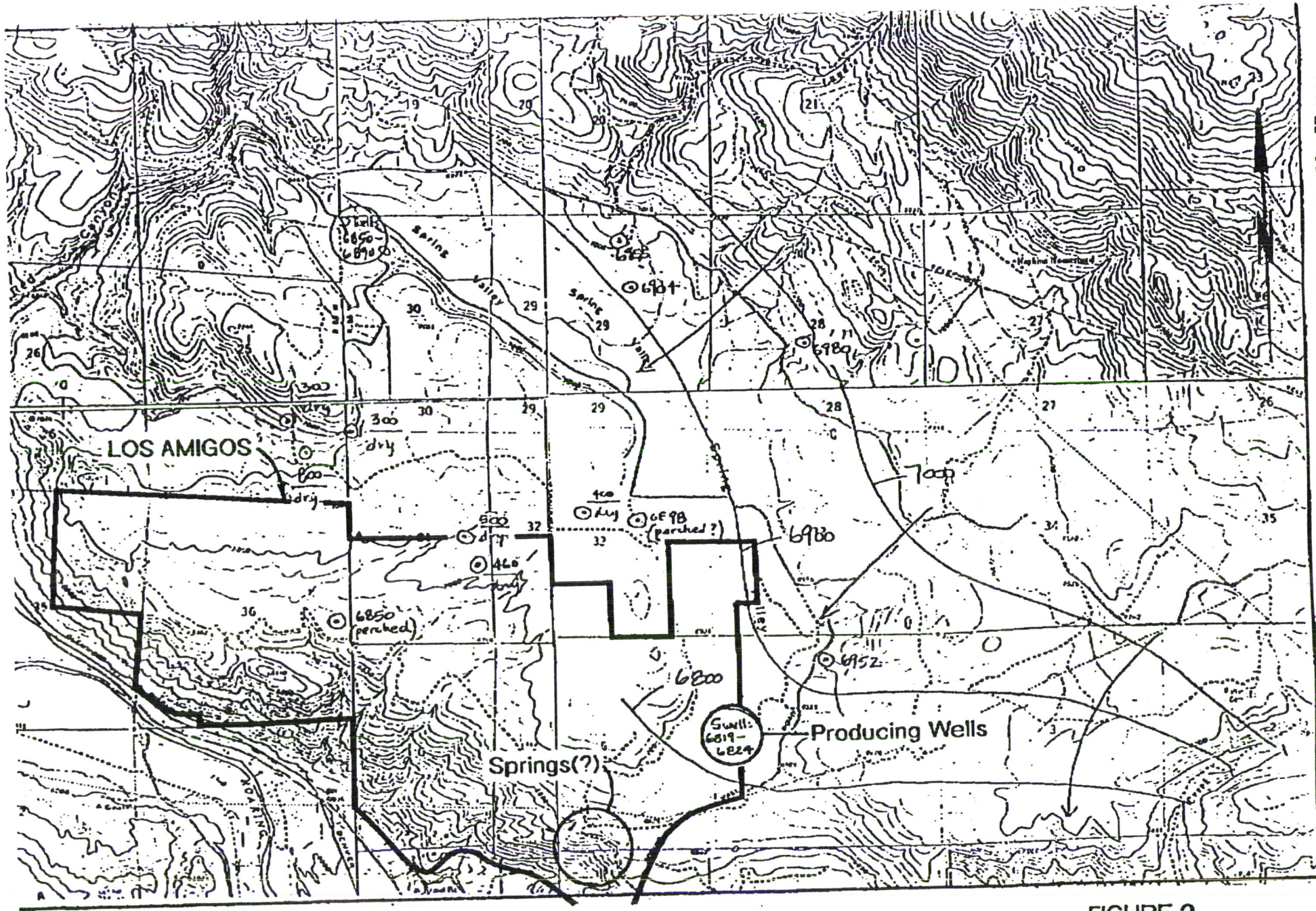


FIGURE 2
LOCATION OF LOS AMIGOS
AND PRODUCING WELLS

ROBERT E. BROGDEN

President

EDUCATION

B.S. in Geology, 1968, University of Nebraska
M.S. in Civil Engineering, 1972, University of Nebraska
U.S. Geological Survey short courses include:

1. Accelerated course in computer programming.
2. Ground water - surface water relationships.
3. Modelling of ground water flow.
4. Surface geophysics.

PROFESSIONAL

National Water Well Association
Colorado Ground Water Association
Wyoming Professional Geologist

EXPERIENCE RECORD

1980-Present — Bishop-Brogden Associates, Inc., Englewood, Colorado.
President, Hydrologist and Ground Water Geologist. In charge of ground and surface water project development, and surface and ground water investigations and water rights studies. Principal responsibilities include marketing, client contact, and supervision of technical staff. Technical activities include well design; analysis of aquifer quantity and quality capabilities: computer applications to surface and ground water issues; water rights analyses and appraisals; report preparation; and expert testimony.

Qualified as an expert in and has offered testimony in the fields of ground water geology, geology, computer model applications, surface and ground water relationships, water rights conflicts, augmentation plans, and water rights values. Testified as many as 50 times before District and Federal courts, Special Masters, Federal Commissions, State Hearing officers, and County Commissioners. Frequent speaker before interest groups, CLE conferences, County Commissions, and others.

1976-1980 — Leonard Rice Consulting Water Engineers, Inc., Denver, Colorado.
Ground Water Geologist and Executive Vice President. Supervised ground and surface water activities, and served as Project Manager for surface water and water rights investigations and provided expert testimony in court proceedings.

ROBERT E. BROGDEN - Continued

1975-1976 U.S. Geological Survey, Water Resources Division, Denver, Colorado.
Project Hydrologist. Supervised ground water studies throughout Colorado. Principal areas of investigation were the coal-rich areas on the west and northwest part of the state. Served as project chief on a Denver geologic basin study describing the availability of ground water in the Arapahoe aquifer. Involved as principal investigator with the Bureau of Land Management's EMRIA (Energy Minerals Rehabilitation Inventory and Analysis) Program.

1972-1975 Leonard Rice Consulting Water Engineers, Inc., Denver, Colorado.
Ground Water Geologist and Senior Hydrologist. Engaged in ground and surface water development projects including analysis of quantity and quality capabilities of individual aquifers, supervised test hole drilling programs, aquifer tests, water rights investigations and report preparations. Provided expert testimony in court proceedings.

1972 South Dakota Geological Survey, South Dakota.
Research Geologist. Worked in the county program mapping surficial Pleistocene deposits and identifying aquifers; responsible for interpretation of geologic and hydrologic data in program and supervised drilling operations, electric logging, and other field investigations in project area.

1971-1972 Graduate School, University of Nebraska, College of Civil Engineering.

1969-1971 United States Army. Active duty.

1968-1969 University of Nebraska, Conservation and Survey Division.
Hydrogeologist. Participated in state's county ground water program. Principal responsibilities included collection and interpretation of basic geologic and hydrologic data and preparation of reports describing the occurrence of ground and surface water supplies throughout the state.

1965-1968 U.S. Geological Survey, Water Resources Division and University of Nebraska Conservation Survey Division.
Part-time employment. Work included geologic logging of drill cuttings; stream gaging; inventorying irrigation and industrial wells; collection of water samples for regional ground water studies; and drafting of maps, figures and graphs for report publication.

PUBLICATIONS

"Water Resources of the Lower Platte Valley", report for Lincoln and Omaha, Nebraska, University of Nebraska, 1971.

"Availability and Chemical Quality of Ground Water in the Crystal River and Cattle Creek Drainage Basins near Glenwood Springs, West-Central Colorado", U.S. Geological Survey, Water Resources Investigation 76-70.

ROBERT E. BROGDEN - Continued

"Availability and Chemical Characteristics of Ground Water in Central La Plata County, Colorado", U.S. Geological Survey, Water Resources Investigation 76-69.

"Water Resources of Pierre County, Nebraska", Nebraska Water Survey Paper, University of Nebraska, 1976.

"Reconnaissance of Ground Water Resources in a Part of the Yampa River Basin Between Craig and Steamboat Springs, Moffat and Routt Counties, Colorado", U.S. Geological Survey, Water Resources Investigation 77-4.

"Hydrology of the Arapahoe Aquifer in the Englewood-Castle Rock Area South of Denver, Denver Basin, Colorado", U.S. Geological Survey, Miscellaneous Investigation Map, Map I-1043.

"Availability and Chemical Characteristics of Ground Water on the Southern Ute Indian Reservation, Southwestern Colorado", U.S. Geological Survey, Water Supply Paper 1576-J.

"Water Quality Data of Ground and Surface Water, Southern Ute Indian Reservations, Southwestern Colorado", U.S. Geological Survey, Open-File Report 76-16.

"Selected Hydrologic Data, Yampa River Basin and Parts of the White River Basin, Northwestern Colorado and South Central Wyoming", U.S. Geological Survey, Open-File Report 78-23.

"Geohydrologic Effects of Strip Mining on the Water Resources of the Yampa River Basin", U.S. Geological Survey, presented at Geological Society of America, Denver, Colorado.

"Basic Water Quality Data in Part of the Eagle River Valley Between Eagle and Vail, Colorado", U.S. Geological Survey, Open-File Report 76-812.

Frequent lecturer for Continuing Legal Education in Colorado and other groups; topics include: Denver Basin ground water issues, water rights, consumptive use, hazardous waste, water values, expert witness testimony, and others. Titles for CLE and other papers include: "Denver Basin Aquifers (The Good News and Not-so-Good News)", "Hydrogeologic Impacts of Typical Water Supply Projects", "Speculating on the Denver Basin", "Hydrogeology of the Denver Basin", "Challenges in Developing and Presenting Data to Support a Ground Water Rights Case, and "Data, Correspondence, Reports, and Exhibits for Ground Water Rights Cases".

ROBERT E. BROGDEN - Continued

TESTIMONY PROVIDED IN THESE CASES IN THE LAST FOUR YEARS

Case No.	Case Name	Jurisdiction	Year
93-K-322	Franklin L. Haney vs Castle Meadows & Resolution Trust Corp.	Federal Court Colorado District	1994
89CW235	Perry Park WSD	District Court of Water Division 1	1994
93CW148	Yale Investments	District Court of Water Division 1	1994
91CW16 & 93CW85	Donala WSD A/K/S Gleneagle WSD	District Court of Water Division 2	1995
____	Diamond Shamrock Pipeline Applicaton	El Paso County	1995
____	Diamond Shamrock Pipeline Application	Elbert County	1996
89CW136	Stonegate Developments, Inc. Lincoln Park Metro Dist. & Stonegate Village Metro. Dist.	District Court of Water Division 1	1996
96CV11745-S	Lafayette vs New Anderson Ditch	District Court Boulder, Colorado	1998

EXHIBIT C

Bruce A. Collins, Phd
Letter Dated May 8, 1998

BRUCE A. COLLINS, PH.D.
NATURAL RESOURCE CONSULTANT
P.O. BOX 23 • 1116 MINEOTA DRIVE
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EXPLORATION
MINING, AND
ENVIRONMENTAL
GEOLOGY

May 8, 1998

Mr. Greg Boecker
Ranch Manager
Los Amigos Ranch
2929 County Road 114
Glenwood Springs, Colorado 81601

Dear Mr. Boecker:

This report is essentially a slight refinement of the submittal dated April 27, 1998. It contains a few minor corrections, revisions, and amplifications, as well as definitions of technical terms that were omitted from the first report due to time constraints. Definitions are themselves simplified to the extent possible to avoid having to further define terms used therein. For precise technical definitions I refer you to the *Dictionary of Mining, Mineral, and Related Terms* (2nd ed., U.S. Bureau of Mines, 1996), or the *Glossary of Geology and Related Sciences* (American Geological Institute, 1997).

Mr. John Currier of Resource Engineering Inc., and Mr. Tim Thulson, of Delaney & Balcomb, have requested that I prepare a brief summary of the geology of the Los Amigos Ranch area; review reports and testimony before the Board of Commissioners of Garfield County by Mr. Currier and by Mr. John Kaufman of McLaughlin Water Engineers; and provide you with my opinion regarding the differing groundwater regimes in the Los Amigos — upper Spring Valley area proposed by Messrs. Currier and Kaufman in light of the geology of the area. In preparing this letter I have studied the reports prepared by Mr. Currier and Mr. Kaufman, as well as pertinent sections of the Hepworth-Pawlak Geotechnical report that accompanied the original PUD application, and have utilized the following technical references:

BASS, N.W., AND NORTHROP, S.A., 1963, Geology of Glenwood Springs quadrangle and vicinity, northwestern Colorado: U.S. Geol. Survey Bull. 1142-J, 74 p.

KIRKHAM, R.M., STREUFERT, R.K., AND CAPPA, J.A., 1995a, Geologic map of the Glenwood Springs quadrangle, Garfield County, Colorado: Colo. Geol. Survey Open File Rept. 95-3.

KIRKHAM, R.M., STREUFERT, R.K., AND CAPPA, J.A., 1995b, Geologic map of the Shoshone quadrangle, Garfield County, Colorado: Colo. Geol. Survey Open File Rept. 95-4.

KIRKHAM, R.M., STREUFERT, R.K., HEMBORG, T.H., and STELLING, P.L., 1996, Geologic map of the Cattle Creek quadrangle, Garfield County, Colorado: Colo. Geol. Survey Open File Rept. 96-1.

KIRKHAM, R.M., AND WIDMANN, B.L., 1997, Geologic map of the Carbondale quadrangle, Garfield County, Colorado: Colo. Geol. Survey Open File Rept. 97-3.

OLANDER, H.C., LAMM, N.B., AND FLORQUIST, B.A., 1974, Roaring Fork and Crystal valleys: an environmental and engineering geology study, Eagle, Garfield, Gunnison and Pitkin counties, Colorado: Colo. Geol. Survey Environ. Geol. No. 8.

I have also relied heavily on personal communications with Robert Kirkham, of the Colorado Geological Survey, who has several years of experience in detailed mapping of the geology of the Roaring Fork Valley area, as well as on my own knowledge of the area, where I have lived and worked intermittently since 1968.

The Los Amigos Ranch occupies roughly the southwestern half of the northwest-southwest-trending oval mesa delineated by Red Canyon on the north, Spring Valley along the eastern and southeastern side, the Spring Valley road on the south, and the Roaring Fork River on the west and southwest. The gently-rolling top of the mesa, which slopes to the southwest, makes up about two-thirds of the property, with the remainder consisting of ledges, cliffs, and steep slopes that drop away to the Roaring Fork River. The mesa top is covered with soils and other unconsolidated materials that are generally thin, varying from two to rarely more than ten feet in thickness. Bedrock is well-exposed only along the steep southwestern slopes of the property, and much more poorly along the northeastern slopes above Spring Valley, off the property to the northeast.

Rocks in the vicinity of the property vary from Precambrian[1] granites[2] and gneisses[3] up to two billion years old, exposed in Glenwood Canyon, to the basalt[4] flows of Miocene age (from about 10.0 to 7.7 million years old) that form the uppermost ledges along the southwest side and floor the mesa top of the property. The entire Paleozoic sequence as dramatically exposed in Glenwood Canyon only a few

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[1] One of the four great divisions of geologic time. The time periods represented by these divisions are: Precambrian (Archean, approximately 4,600 to 2,500 million years ago (mya); Proterozoic, 2,500 to 570 mya); Paleozoic, 570 to 245 mya; Mesozoic, 245 to 66.4 mya; and Cenozoic, 66.4 mya to the present. A copy of the geologic time scale is attached to this report.

[2] Granite and "granitic" rocks (most commonly quartz monzonite or granodiorite) are *intrusive igneous* rocks containing more than 10% quartz (pure silica) and where potassium *feldspar* exceeds 10% of total feldspar (granite more than 67%, quartz monzonite 33% to 67%, granodiorite 10% to 33%).

Igneous rocks are those that solidified from molten or partly molten material, i.e. from a magma. Igneous rocks constitute one of the three main classes into which rocks are divided, the others being metamorphic and sedimentary.

Intrusive igneous rocks are those that consolidated from magma (molten rock) beneath the surface; especially, those that were forced into or between other rocks.

Feldspars are the most common of the basic rock-forming minerals, and consist of aluminum silicate with varying amounts of potassium (orthoclase, microcline) or sodium and calcium (plagioclase group).

[3] Gneiss is coarse-grained high-grade *metamorphic* rock in which granular minerals such as quartz and feldspar alternate with bands containing finer-grained minerals such as micas (hydrated potassium aluminum silicate with varying amounts of other elements), hornblende and other amphiboles, and pyroxenes (amphiboles and pyroxenes are mostly dark aluminum silicates containing varying amounts of iron, calcium, sodium, and magnesium).

Metamorphic rocks are consolidated rocks which have been altered in composition, texture, or internal structure, or various combinations thereof, by pressure, heat, or new chemical substances, usually all three and resulting from increasing depth of burial, proximity to intrusions of molten rock, or migration of mineralized solutions, and again most commonly combinations of these agents.

[4] A general term for usually-extrusive or shallow intrusive dark-colored igneous rocks rich in iron- and magnesium-containing minerals. As a rock type, basalt is generally dark purple or brown to black, fine-grained, contains less than 10% quartz, and calcium-rich plagioclase feldspar is greater than 67% of total feldspar.

miles north of the property is assumed to be present in the subsurface beneath the Los Amigos Ranch. This sequence includes from bottom (oldest) to top (youngest), the Sawatch Quartzite[5] (upper Cambrian, quartzitic sandstone[6]); the Dotsero Formation (upper Cambrian, dolomite[7] and limestone[8]); Manitou Dolomite (lower Ordovician); Chaffee Group (upper Devonian; Parting Formation, sandstone and shale[9]; Dyer Formation, limestone and dolomite; Gilman Sandstone); Leadville Limestone (lower Mississippian); Molas Formation (Mississippian-lower Pennsylvanian, soil and cave filling materials developed on and in the upper Leadville); Belden Formation (lower Pennsylvanian, petroliferous[10] limestone and shale, carbonaceous[11] shale, gypsiferous[12] shale); Eagle Valley Formation/Gothic (Minturn) Formation/Eagle Valley Evaporite[13] (middle-late Pennsylvanian, uppermost part may be lowest Permian, intertonguing complex of evaporite basin chemical rocks [mainly halite and gypsum], internal basin margin rocks [dolomite, dolomitic shales and sandstone, limestone, gypsiferous sediments], and outer basin margin sediments [mostly sandstone and siltstone] shed from the highlands that restricted circulation in the evaporite basin; Maroon Formation (lower Pennsylvanian to lower Permian, conglomeratic[14] sandstone, sandstone, siltstone, and shale); and

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[5] Quartzite is a sedimentary or metamorphic rock consisting of quartz grains cemented by silica. Level of metamorphism is indicated by the extent quartz grains are welded together and/or the degree to which grains have melted into the cement (recrystallization).

[6] Sandstone consisting mostly of quartz.

[7] As used herein dolomite is a *sedimentary* rock consisting of calcium magnesium carbonate which has been either precipitated directly from magnesium-rich seawater or produced chemically by the action of magnesium-rich solutions on *limestone*.

Sedimentary rocks are those composed of materials eroded from older rocks deposited at or near the earth's surface from water, ice, wind, or gravitational processes (sandstone, shale), chemically formed from or by the action of organisms (limestone, coal), or precipitated from chemically-saturated solutions (gypsum, salt).

[8] Rock consisting mostly or entirely of the mineral calcite (calcium carbonate). Most commonly consists of the skeletal or shell remains of calcite-secreting organisms, intact to crushed debris, cemented by calcite dissolved from the same materials. May also be precipitated from calcium carbonate-saturated solutions, such as may be found in tidal flats and at both cold- and hot-water springs.

[9] Shale is a textural term that refers to fine-grained sedimentary rocks that possess "fissility." Fissility in turn is a general term for the property possessed by some rocks of splitting easily into thin layers along closely spaced, roughly planar, and approximately parallel surfaces. "Shale" may thus be applied to fissile siltstone, mudstone, or claystone.

[10] Containing petroleum.

[11] Containing carbon, usually in the form of coalified plant debris or petroleum residue. Commonly used as a synonym for "coaly."

[12] Containing gypsum, hydrated calcium sulfate.

[13] As used here an evaporite is a sedimentary rock composed primarily of minerals produced from a saline solution as a result of extensive or total evaporation of water. Gypsum, halite (rock salt) and primary dolomite are the most common evaporites, and are frequently found mixed to some degree in evaporite deposits.

[14] Containing or consisting of conglomerate. A conglomerate is a coarse sedimentary or composite sedimentary/volcanic rock composed of rounded to subrounded pebbles, cobbles, boulders, or any mixture of the three, in a matrix of finer sand or silt, and commonly cemented by calcite, iron oxide, silica, or hardened clay. The consolidated equivalent of gravel. When the coarse fragments are angular or subangular, usually referred to as breccia.

unnamed basalt lava[15] flows interbedded with alluvial gravels and other sediments which are not common. Rocks exposed on and in the immediate subsurface beneath the Los Amigos Ranch consist of limited exposures of the Eagle Valley Formation and Eagle Valley Evaporite along the southern-southwestern boundary; the Maroon Formation, which forms the red cliffs above the Roaring Fork along the western-northwestern boundary; and the unnamed basalts, which form capping ledges along the southwest-northwest boundary and forms the bedrock beneath the soils of the rest of the ranch The upper Eagle Valley Formation and its equivalents, the Eagle Valley Evaporite and the lower Maroon Formation all intertongue in complex fashion around the edges of the Eagle basin, and are therefore equivalent in age.

Many varieties of semi- to unconsolidated surface materials of Pleistocene (100,000 to 2 million years old) and Holocene (present to 100,000 years) age are present in the area. These include stream channel, flood-plain, terrace, debris-flow, and sheet-wash deposits, or alluvium, deposited by flowing water; talus, landslide and other colluvium, materials deposited primarily by gravity; lacustrine (lake) deposits in the Spring Valley area immediately northeast of the property; and eolian (wind) deposits that form the basis for much of the soil of the upland areas. On the Los Amigos Ranch Quaternary deposits are limited to sheetwash, colluvium ranging in age from early Pleistocene to recent, talus, mixed alluvium and colluvium, and loess (fine-grained wind-blown material, mostly silt).

Detailed descriptions of all the units, bedrock and unconsolidated surficial deposits, are presented in the pamphlets that accompany the four recent geologic maps by Kirkham and others (1995a, 1995b, 1996, 1997) that include the Los Amigos Ranch area. Somewhat abbreviated versions of these descriptions are included in Mr. Kaufman's report dated April 10, 1998. In attempting to shorten the descriptions, certain words or phrases, sentences, and even whole paragraphs were omitted and in other cases sentences combined, resulting in subtle changes in meaning in some instances; for this reason I strongly recommend the original sources, as I do for my own definitions of technical terms.

The groundwater regime in the Spring Valley — Los Amigos Ranch area is influenced by bedding attitude,[16] fracturing,[17] and other factors governing porosity[18] and permeability,[19] of the Maroon

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[15] Fluid rock that has poured out onto the earth's surface, most commonly from a volcano.

[16] Most sedimentary rocks and extrusive volcanic rocks were originally deposited horizontally or nearly so, usually in "beds" that are bounded by color changes, mineralogical changes, surfaces of erosion and nondeposition, and so on. Bedding planes are formed when the rocks break along such changes. Bedding attitude refers to the strike and dip of beds which are not horizontal, either because they were deposited that way (sand dunes or lava falls for example) or more frequently because they have been tilted by the forces of mountain building. Attitude is most easily determined on bedding planes. Strike is the bearing of a horizontal line on the bedding plane and is perpendicular to the dip; dip is the angle of departure from horizontal of the bedding plane and is perpendicular to the strike.

[17] All rocks exposed at and near the surface are fractured to some degree. Fracturing is caused by many agents, including cooling, drying, the weight of overlying materials during burial, and mountain-building forces. Fractures that occur in more-or-less repeatable patterns are *joints*. Fractures where one side has moved relative to the other are *faults*.

[18] Most simply, the amount of open space in a rock. Connection of open spaces creates *permeability*.

[19] The degree to which a rock can transmit fluid.

Formation and the lava flows, as well as recharge area,[20] hydraulic head,[21] and other hydrologic controls. Two very important related factors in determining the direction of groundwater flow in the Los Amigos Ranch area that have not been sufficiently addressed in previous work that has been reviewed by the writer are the nature of the pre-lava flow surface of the Maroon Formation and the overall dip of the flows themselves. Unfortunately little is known concerning either of these factors, and evidence that can be derived from the Kirkham maps is somewhat ambiguous. Elevations of dated lava flows in Glenwood Canyon suggest that the Colorado River had cut a canyon 200 to 300 feet deep 7.7 million years ago but cut only an additional 300 to 400 feet over the next 4.4 million years (Kirkham, personal communication), so a young stream in roughly the same location would not be surprising, nor would be the presence of an ancestral Roaring Fork, prior to the first flows dated at 9.64 million years. Therefore a low-relief surface on the Maroon dipping from 1° to 5° generally northwesterly is proposed. In addition, the overlying lavas appear to dip as a sequence gently in a generally westerly direction from source areas thought to be in the Basalt Mountain area (Kirkham, personal communication; as of this date Mr. Kirkham wishes to emphasize that a Basalt Mountain area origin for *any* of the flows in the Spring Valley area has *not* been established with any degree of certainty), and it is normal for lava flows, which frequently have highly contorted internal structure, to dip as a sequence in the direction of the surface over which the original flow spread.

Along the southwest-center part of the property, from above the Highway 82 — Spring Valley Road intersection northwestward for about 1.25 miles, Kirkham and others map a deposit of alluvial gravel between the lower and upper lava flow sequences. These gravels were apparently deposited by an ancestral Roaring Fork River, again indicating a general westerly-dipping surface for the Maroon in the area toward this stream. The connection to the current Roaring Fork drainage area is supported by the presence in the gravels of rocks derived from features unique to the Elk and West Elk Mountains (Kirkham, personal communication).

A gentle westerly dip is further suggested by the distribution of the flows in the ridge between the cliff outcrops on the west side and the less-well-defined ledges to the east of the Los Amigos Ranch. The cliff top, which has been dated as belonging to the uppermost (youngest) flow (Kirkham, personal communication), occurs at approximately 6,800 feet, while the mapped basalt bedrock coincident with the top boulder ledge on the east side varies from 7,000 to 7,200 ft, producing an apparent westerly dip of less than 1° to 3° depending on location, decreasing from southeast to northwest. Finally, the flows are described by Kirkham and others (1995a, 1995b, 1996, 1997) as being a maximum of 300 feet thick but usually much thinner. The flow-gravel interval on the southwest rim of the mesa is approximately 350 to 400 ft thick, suggesting that the entire sequence is present. Drill hole logs for three holes on the plateau but just north of the property at elevations ranging from 6,960 ft to 7,020 ft indicate basalt thicknesses of 160 ft to 180 ft, suggesting either thinning or slight steepening in the dip in this area; it should be mentioned that the sequence does thin rapidly to the east to the extent of the thickness of the gravel beds described above, which Kirkham has advised do not occur elsewhere in the area (personal communication).

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[20] The area which feeds saturated rock through infiltration of surface water from precipitation, snowmelt, or other sources.

[21] Most simply, the total water pressure at a specific point in a saturated horizon.

To summarize, the Maroon Formation, which internally dips northeastward in the area of interest at from 20° to 60° as the result of an essentially-unknown combination of Laramide tectonic activity and later salt diapiric[22] movement, was eroded to a surface of low relief that dipped gently in a generally westerly direction toward an ancestral Roaring Fork River prior to the initiation of volcanic activity which spread basaltic lavas over the region in the late Miocene. The flows contain uncommon interbedded volcanic-related sediments that reflect the topography of the flows upon which they were deposited. A single alluvial gravel deposit between the two major flow sequences in the southeastern part of the property lends support to the concept of an ancestral Roaring Fork River and the development of a pediment-like[23] surface on the Maroon Formation east of the stream. Except where interrupted by more recent structural activities the orientation of the Maroon Formation surface and the upper and lower (and some internal) boundaries of the lava sequence remain essentially the same today, that is dipping gently in a generally westerly to northwesterly direction. The effect of the structure mapped as the Glenwood Springs syncline[24] by Kirkham and others on these surfaces is not known. Kirkham has advised that although he did extend identification of the structure south into the Los Amigos Ranch on the maps, it can be clearly defined in the field only as far south as Red Canyon, about a mile north of the ranch boundary.

While the local effects of salt diapirism in the Roaring Fork Valley area have been known for some time, new interpretations by Kirkham and Widmann (1997) suggest that the current geological structure and to a large extent surface topography of the entire Glenwood Springs — Carbondale region are governed to at least some extent by movement and dissolution of thick intervals of gypsum and halite in the Eagle Valley Evaporite, which underlies virtually the entire area. Of particular interest are collapse structures that vary from (apparently) only a few tens of feet in maximum dimension to several miles. Kirkham and others map one such structure along the southwest side of the property, between the main upper basalt ledge and the top of the Maroon cliffs to the southwest, and another on the west side of Spring Valley about a half-mile northeast of the property. Spring Valley itself, a certainly-anomalous structure, is likely the result of a larger collapse. The mapped structures trend generally northwest — southeast, parallel to the Roaring Fork Valley, itself at least partially such a structure; Spring Valley parallels this trend. The collapse structures influence groundwater flows in several ways, but principally by providing local sinks and by superimposing a fracture (joint) system of varying extent at least internally on any regional fracture system that may be present. Fracture mapping on the Los Amigos Ranch and immediately adjacent areas is difficult because of minimal exposures. Limited measurements on the basalt ledges along the southwest side of the property suggest two dominant fracture directions, approximate N 80° E and N 10° W; most of the more significant joints measured fell within five to ten degrees of these directions. These

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[22] Upward movement of salt as the result of squeezing of thick salt beds by depth-of-burial overloading, mountain-building forces, or a combination of these and other factors, which results in the upward folding and fracturing of overlying rocks. As used in this discussion, "salt" includes both halite and gypsum.

[23] A pediment is a broad, gently sloping rock-floored erosion surface or plain of low relief, typically developed by running water in an arid or semiarid region at the base of an abrupt and receding mountain front or plateau escarpment; underlain by bedrock that may be bare, but is more often partly covered with a thin discontinuous veneer of material derived from the adjacent uplands.

[24] A fold in which the rocks dip inward toward the axis; therefore the rocks become progressively younger toward the axis. Generally spoon- or trough-shaped.

fractures were spaced from about 2 feet to 10 feet or more, are open at the edge of the cliffs but appear to close in the direction of rock undisturbed by edge effects (virtually none of the observed rock can be said to have been free of edge effects), and are near-vertical. A third set of minor fractures, only a few of which were observed, are tighter and have a direction of N 60° to 70° E. Curiously no significant fracturing parallel to the axes of the mapped collapse structures was found, even directly adjacent to one of the features, where the N 80° E group was dominant. There is no indication of columnar jointing,[25] and Kirkham advises it is very rare in the region; the closest observed columnar jointing is in a flow exposed in the roadcut on the hill between El Jebel and Missouri Heights, several miles southeast of the property (personal communication). The fracture pattern in the underlying Maroon Formation is unknown, but is assumed to be similar (joint sets with similar bearings occur in pre-Miocene rocks throughout the Piceance basin immediately to the west and in fact throughout most of western Colorado and adjacent areas).

Some idea of the nature of the basalt cap can be had from the drilling that has occurred in the area. According to Wayne Shelton of Shelton Drilling, who with his father has been drilling in the area for over 40 years and who drilled the three holes closest to the property on the cap, virtually all holes on the south side of Spring Creek above the lake sediments have produced little or no water. Drilling conditions have been generally good, with only occasional lost-circulation[26] or similar problems. The basalt flows are solid and drill easily, and the occasional sediment interbeds, which he described mostly as tuff,[27] posed no unusual problems either. He described the Maroon as very hard. One hole was originally drilled to 500 ft, reentered the next year and extended to 800 feet. Mr. Shelton stated that the hole was reentered without difficulty (no hole collapse, debris at the bottom, etc.), and that it was completely dry.

The primary recharge area for groundwater in the Spring Valley region, including the plateau between Spring Valley and the Roaring Fork River, is the highlands to the east. Drilling information on and along the east side of the plateau indicates that there is no significant "mound" of water on the west side of Spring Valley. The almost total lack of springs along the down-dip contact between the lava flows and the underlying Maroon, from within the flows including the alluvial gravel described above, or the Maroon Formation above the Roaring Fork River suggests the absence of perched water or

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[25] More or less parallel, prismatic columns, almost always hexagonal in cross section, that occur occasionally in basaltic flows and other extrusive and intrusive rocks. It is formed as the result of contraction during cooling, and is dependant on cooling rate, thickness of the igneous body, nature of the contacts of the body with other rocks, and chemistry of the cooling material.

[26] In rotary drilling air or water, with or without a variety of additives such as foam or mud, is forced down the drill pipe, through the bit, and back up the hole. The primary purpose is to cool the drill bit, although the fluid also acts as a lubricant for the bit and rotating drill pipe. The fluid also carries rock fragments (*cuttings*) to the surface, where samples of the rock being drilled can be taken. "Lost circulation" (LC) refers to situations where return of the fluid and cuttings to the surface stops. The most common causes of LC include drilling through extremely porous beds, rock with abundant open fractures, or existing voids created by solution. Washing (or blowing) out of extremely soft, unconsolidated, or soluble rocks by the drilling fluid can also result in LC. LC can be serious, especially where the fluid is lost but the cuttings remain in the hole, where they can plug the bit and burn it off or bind the drill pipe. On the other hand, thousands of feet of hole have been drill with no circulation and no trouble.

[27] A rock formed of compacted volcanic fragments, generally smaller than coarse sand (4 mm). Essentially solidified volcanic ash.

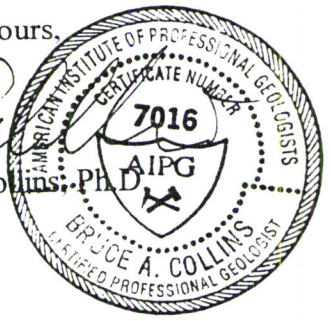
any significant water flow above the principal water table[28] that connects the Spring Valley aquifer[29] with the Roaring Fork River. Flow from the aquifer to the river is controlled by the two major subvertical fracture systems, N80E and N10W, in the basalts and the underlying Maroon Formation, the gently-westerly- to northwesterly-dipping flow sequence boundaries and the pre-flow Maroon surface, and more-steeply dipping bedding planes in the Maroon, which strike northwesterly, all of which suggest a generally westerly to southwesterly flow of groundwater under the Los Amigos Ranch.

Considering all of the above, I concur with the conclusions of Resource Engineering Inc., as augmented by Robert Brogdan, of Bishop-Brogdan Associates, Inc., in his letter report dated April 23, 1998, wherein it is concluded that groundwater in the Los Amigos Ranch area is deep and that flow is southwesterly from the highlands east of Spring Valley toward the Roaring Fork River. The general geology of the area suggests that leach field effluent will migrate essentially vertically through fractures in first the basalt cap of the mesa and then through the Maroon Formation to the water table, where it will join the general flow toward the Roaring Fork River. Such diversion from vertical movement as may occur will by governed by the gentle westerly dip of the lava bed sequence and the pre-flow erosional surface on the Maroon, and the northwest strike of the northeasterly-dipping beds of the Maroon Formation, all of which will tend to direct the water in a westerly to northerly direction away from the water supply wells to the east of the property.

If you have any questions or if I can be of any further assistance in this matter, please do hesitate to contact me.

Very truly yours,

Bruce A. Collins, Ph.D.



[28] The surface between unsaturated and saturated rock or other water-bearing material.

[29] An aquifer is an underground rock unit that will yield water in sufficient quantity to be of value as a source of supply.

Geologic Time Scale

EON	ERA	PERIOD		EPOCH	TIME SPAN (million years)	AGE of	
Phanerozoic	Cenozoic	Quaternary		Holocene	0-2		Humans
				Pleistocene			
		Tertiary	Neogene	Pliocene	2-5		
				Miocene	5-24	Mammals	Mammals develop and become dominant
			Paleogene	Oligocene	24-37		Extinction of dinosaurs (beginning of Paleocene)
				Eocene	37-58		
				Paleocene	58-66		
	Mesozoic	Cretaceous			66-144		Flowering plants, height of dinosaurs
		Jurassic			144-208	Reptiles	1st birds/mammals, abundant dinosaurs
		Triassic			208-245		First Dinosaurs
	Paleozoic	Permian			245-286		End of trilobites & other marine animals
		Carbon-iferous	Pennsylvanian		286-320	Amphibians	Abundant insects, first reptiles
			Mississippian		320-360		Large primitive trees
		Devonian			360-408	Fishes	First amphibians
		Silurian			408-438		First land plant fossils
		Ordovician			438-505	Marine Invertebrates	First Fish
		Cambrian			505-570		1st shelled organisms, trilobites dominant
Proterzoic					570-2,500		First Multicelled organisms
Archean		**Also known as Precambrian**			2,500-3,800		First one-celled organisms
Hadean					3,800-4,600		Approx age of oldest rocks (3800)

Taken from: **MODERN PHYSICAL GEOLOGY**, Graham R. Thompson Ph.D., Jonathan Turk Ph.D., Saunders College Publishing

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RÉSUMÉ

NATURAL RESOURCE CONSULTANT, PAONIA, GLENWOOD SPRINGS, AND SILT, COLORADO

Consultant to the western mining industry, conservation groups, and others. Preparation of exploration and reserve reports, Superfund site geological analysis, geologic hazard ("1041") reviews, and conservation easement, open space, and park minerals studies. Clients include Colorado State Parks, The Conservation Fund, Colorado Cattlemen's Association Agricultural Land Trust, The Nature Conservancy, Wyoming Fuel Company, Sunbelt Mining Company, Pitkin Iron Corporation, Bear Coal Company, Dorchester Coal Company, American Coal Investment Company, Boulder Exploration Group (BXG), Mid-Continent Resources, Inc., Grand Mesa Properties Company, American Coal Sales Company, Powderhorn Coal Company, Smuggler Consolidated Mines Corp., Chemical Lime Company, Crystal Valley Alabaster & Marble, Bowie Resources Limited, and Eagle Star and St. Paul Fire & Marine insurance companies (both for Smuggler-Durant Mining Company), various law and real estate firms, and individuals. Expert witness before the Mine Safety & Health Administration and the Colorado Water Quality Control Commission.

ASSISTANT TO THE PRESIDENT, MID-CONTINENT RESOURCES, INC., CARBONDALE, COLORADO

Personal assistant to the president of the company, primarily responsible for assisting him in all aspects of management and operations, and for operations administration. MCR was affiliated directly and indirectly with producers of limestone and screened coke, and with real estate developers. At its peak MCR employed approximately 600 people and produced in excess of 1.0 million tons of premium quality metallurgical coal with the most difficult underground mining conditions in the United States. Contract liaison officer for a U.S. Bureau of Mines research project. Responsible for geologic investigations, sampling, certain aspects of quality control, fee and Federal lease administration (with Bureau of Land Management), and certain aspects of permitting and environmental compliance (Colorado Mined Land Reclamation Division, U.S. Forest Service).

CREW SUPERVISOR AND FORMER SITE MANAGER, PITKIN IRON CORPORATION, CARBONDALE, COLORADO

Responsible for general supervision of Coal Basin Site maintenance and reclamation crew. Principal liaison between MCR (see above) and salvage, portal-sealing, and other contractors working at the site. Formerly responsible for the maintenance of the idle Dutch Creek Mine and associated operations of MCR. Responsible for Bureau of Land Management lease administration of Federal coal leases near Grand Junction.

DIRECTOR OF PROPERTY DEVELOPMENT, WESTERN ASSOCIATED COAL CORP., DENVER AND DELTA, COLORADO

Responsible for all aspects of WACC's acquisition program, including all phases of exploration, reserve determination, quality distribution, and property evaluation, as well as mine planning and economic analysis. Overall supervision of environmental coordinators and sampling and quality control at operating mines. Supervised drilling and geophysical exploration programs in Colorado and New Mexico. Administered Federal coal leases and private lands and mineral leases. Involved in construction contract negotiation and administration.

MINE SUPERINTENDENT, BLUE RIBBON MINE, NEAR PAONIA, COLORADO (PARTIALLY OWNED BY WESTERN ASSOCIATED COAL, SEE ABOVE)

Responsible for all aspects of operation of an underground coal mine. Retained many of the responsibilities described immediately above as well.

GEOLOGIST, MID-CONTINENT COAL & COKE COMPANY, CARBONDALE, COLORADO (PREDECESSOR OF MID-CONTINENT RESOURCES, SEE ABOVE)

Responsibilities included mine mapping and interpretation of faults, folds, and igneous intrusions in a geologically complex area; surface and subsurface exploration; mine planning and projection; and certain aspects of quality control and environmental compliance. Supervised exploration drilling programs in Wyoming and Colorado. Operations manager for a small limestone quarry. Evaluated numerous coal, metal, and industrial mineral properties. Involved in Federal and private lease and construction contract administration.

GEOLOGIST, EASTERN ASSOCIATED COAL CORP., PITTSBURGH, PENNSYLVANIA

Responsibilities included property evaluation in both Appalachian and western coal fields; examination of special problems in operating mines; mine planning and budgeting. Participated in numerous environmental and coal development policy meetings and public hearings, principally involving western coal. Supervised exploration drilling programs in Wyoming, New Mexico, and Tennessee.

MISCELLANEOUS

Mid-Continent Coal & Coke Company, Consolidation Coal Company, Colorado School of Mines, and U.S. Bureau of Mines, while attending graduate school full-time.

EDUCATION

UNDERGRADUATE: College of Wooster, Wooster, Ohio
Major: Chemistry Minor: History, German
Degree: Bachelor of Arts

GRADUATE: Colorado School of Mines, Golden, Colorado
Major: Geology Minor: Geochemistry, Mining Engineering
Degree: Master of Science
Doctor of Philosophy
Honors: Gulf Oil Corporation Fellowship in Geology, two years
Society of the Sigma Xi
Who's Who in the West, 1981-

ADDITIONAL CERTIFICATION AND TRAINING:

Registered Professional Geologist (Kentucky, No. 495)
Certified Professional Geologist (CPG No. 7016)
Certified Coal Mine Official (Mine Foreman, Colorado, No. 42-76)
MESA short course on remote sensing as applied to mine safety; various MSHA mine safety courses.
Various management training courses and other workshops and seminars.
IBM PC capabilities, including Lotus, WordPerfect, Windows, Excel, various technical programs, basic programming.

PROFESSIONAL MEMBERSHIP

American Institute of Professional Geologists
Society for Mining, Metallurgy and Geology (SME)
Geological Society of America
American Association of Petroleum Geologists
Rocky Mountain Association of Geologists
Colorado Coalition of Land Trusts
Colorado Cattlemen's Association Agricultural Land Trust
Rocky Mountain Coal Mining Institute
Society of the Sigma Xi

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