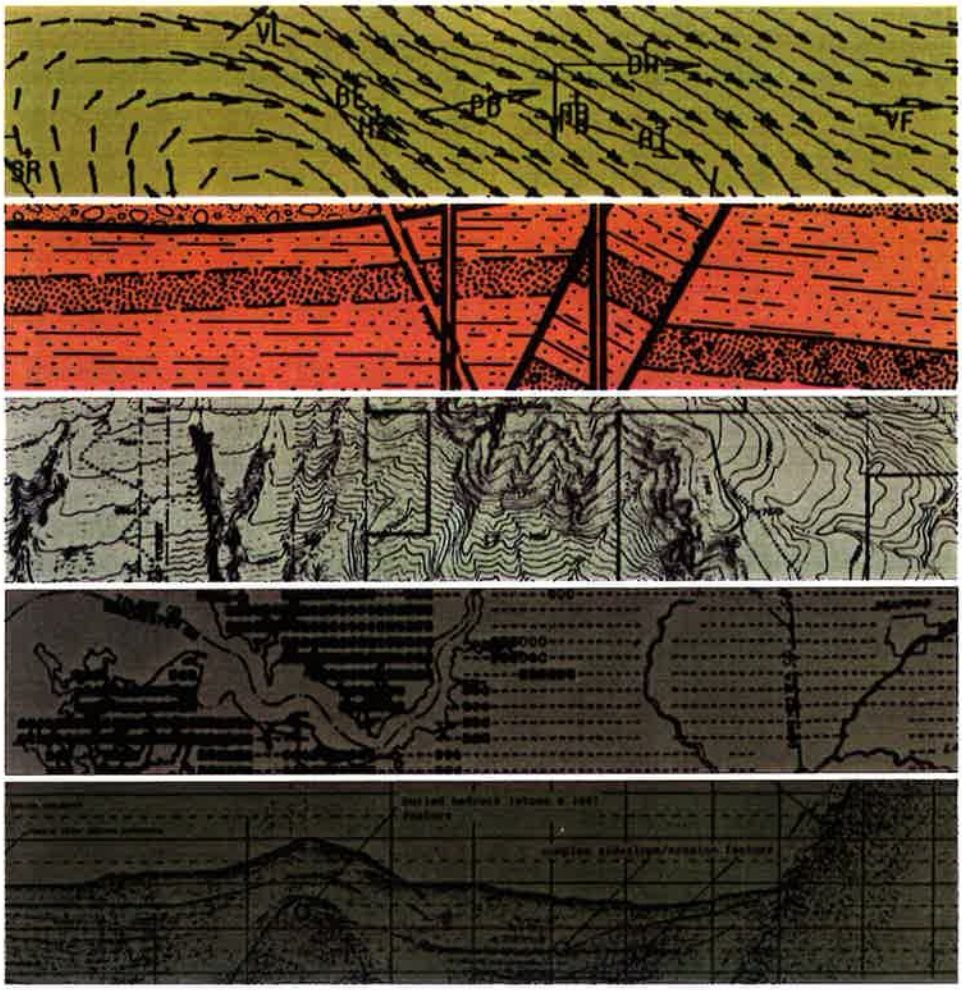

EVALUATION OF POTENTIAL NITRATE AND
HEXAVALENT CHROMIUM SOURCES IN THE
VICINITY OF THE UCD LEHR FACILITY
FOR
UNIVERSITY OF CALIFORNIA, DAVIS

DAMES & MOORE

EVALUATION OF POTENTIAL NITRATE AND HEXAVALENT CHROMIUM SOURCES IN THE VICINITY OF THE UCD LEHR FACILITY FOR UNIVERSITY OF CALIFORNIA, DAVIS

DAMES & MOORE

November 1990
Job No. 00234-213-044

DAMES & MOORE A PROFESSIONAL LIMITED PARTNERSHIP
9300 TECH CENTER DRIVE, SUITE 100, SACRAMENTO, CALIFORNIA 95826 (916) 364-8698

November 30, 1990

University of California
Office of Environmental Health and Safety
Davis, California 95616

Attention: Ms. Carolyn Owen

Re: Nitrate Report
UCD LEHR
Job No. 00234-213-044

Dear Ms. Owen:

Enclosed are three copies of our report titled "Evaluation of Potential Nitrate and Hexavalent Chromium Sources in the Vicinity of the UCD LEHR Facility for University of California, Davis." This report includes comments made by your staff on the Final Draft Report dated November 1990. These comments were made in a letter dated November 20, 1990.

Should you have any questions regarding this report please call either of the undersigned at (916) 364-8698.

Sincerely,

DAMES & MOORE

Joe Niland
Project Manager

Andy Kopania, R.G.
Project Hydrologist

JN:AK:sdm

Enclosures

UCD3.033
DAMES & MOORE

EVALUATION OF POTENTIAL NITRATE AND
HEXAVALENT CHROMIUM SOURCES IN THE
VICINITY OF THE UCD LEHR FACILITY
FOR
UNIVERSITY OF CALIFORNIA, DAVIS

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

TABLES

FIGURES

EVALUATION OF POTENTIAL NITRATE AND HEXAVALENT CHROMIUM SOURCES IN THE VICINITY OF THE UCD LEHR FACILITY FOR UNIVERSITY OF CALIFORNIA, DAVIS

1.0 INTRODUCTION

The Laboratory for Energy-Related Health Research (LEHR) has been operated by the University of California, Davis (UCD) for the U.S. Department of Energy (DOE) for 30 years to conduct studies on the long-term biological effects of low-level radiation. Over 1,000 beagles were studied during this time. The beagles were originally housed in indoor cages during the initial phase of the study. When the dogs' excretory material reached acceptable levels of radioactivity, the animals were moved to outdoor pens. Also located beneath and adjacent to LEHR is the old campus sanitary landfill, which was closed in 1966, and UCD and DOE low-level radioactive waste disposal sites, which were closed in 1974.

Due to the potential environmental impacts of LEHR and the landfills, water samples were collected from eight private wells in the site vicinity in October 1989 by UCD staff. The wells which were sampled are shown on Figure 1. Chemical analyses of these samples indicated that the Maximum Contaminant Level (MCL) drinking water standard for nitrate was exceeded in four wells (Table 1). In addition, hexavalent chromium was reported at concentrations at, or in excess of, the MCL in three of these same four wells. The MCL for nitrate is 10 milligrams per liter (mg/l) if reported as nitrogen (N). The MCL for hexavalent chromium is 0.05 mg/l. In response to these findings, UCD requested Dames & Moore to perform an investigation of the potential causes of the elevated levels of nitrate and chromium.

The draft of this report was circulated to UCD, regulatory agencies, and local landowners in March 1990. Comments received on the draft report are included in Appendix A of this report. Also included in Appendix A is a response by UCD to one landowner's comments. Where appropriate to the scope of this evaluation, comments have been incorporated into this report.

2.0 OBJECTIVE

The goal of this investigation was to review existing information and collect new data to evaluate whether the nitrate and hexavalent chromium detected in the nearby private wells was more likely to have originated from LEHR or from other sources. Other potential nitrate sources identified in the region include agricultural use of fertilizers, domestic septic systems, large concentrations of confined animals, and wastewater treatment plant outfalls. Other potential sources for hexavalent chromium include geochemical mobilization from natural soil material derived from weathering of the Coast Ranges, wood preservatives, fungicides, industrial wastewater effluent, or metallic fixtures in domestic and irrigation well and pump installations. The data used in the assessment of other potential sources was for comparative purposes only and does not constitute a detailed analysis of these sources.

3.0 SCOPE OF WORK

In order to meet the goals of this project, a phased investigation was recommended by Dames & Moore. These phases consisted of the following:

Task 1 - Verification Sampling of Domestic Wells

- Resampling of the domestic wells which contained nitrate levels in excess of the MCL (Miller, I. Hamel, O. Hamel, and Roth domestic wells) in order to verify the October results;
- Collection of water samples from the Nishi irrigation and domestic wells;
- Collection of water samples from the UCD sewage outfall upstream of LEHR; and
- Analyses of collected samples for nitrate and hexavalent chromium.

Task 2 - Review of Existing Data

- Review of off-site private domestic and irrigation well chemical data;
- Review of existing data regarding groundwater gradients and regional nitrate distribution;
- Review of available private supply well construction data; and
- A comparitive assessment of other potential sources of nitrate and hexavalent chromium, such as the UCD wastewater treatment plant outfall into Putah Creek, domestic septic systems, natural concentrations in soils, and residues of agricultural activities.

Task 3 - Interpretation of Data and Report Preparation

- Prepare a written report at the conclusion of Tasks 1 and 2 to present the data, summarize the findings, and draw conclusions.

4.0 RESULTS OF VERIFICATION SAMPLING

4.1 PRIVATE WELLS

In December 1989, five of the initial eight wells were resampled for the purpose of verifying the October 1989 analytical data. The wells which were re-sampled were the Rust, I. Hamel, Roth, O. Hamel and Miller wells. The analytical results from these samples verified the earlier analytical results (Table 1). In addition, the Nishi irrigation and domestic wells were sampled in October 1989 and January 1990, respectively.

The location of the sampled wells and the maximum detected nitrate values are shown on Figure 2. The Roth and Miller wells, located approximately 1,500 feet south-southwest of LEHR, and the South Fork of Putah Creek, had maximum nitrate levels of 35 mg/l as N and 20.0 mg/l as N, respectively. The Nishi irrigation well, located approximately 1,000 feet east of LEHR and north of the South Fork of Putah Creek, had a maximum nitrate level of 5.2 mg/l as N. The I. Hamel and the O. Hamel wells are about 8,000 feet and 10,000 feet to the northeast, respectively, and close to the North Fork of Putah Creek. These wells had maximum nitrate concentrations of 20.0 mg/l as N and 12.0 mg/l as N, respectively. The Nishi domestic well, about 6,000 feet north-northeast of LEHR, had 30 mg/l nitrate as N in the January 1990 water sample. The Martinelli domestic and irrigation wells are located approximately 3,000 feet east of LEHR and 2,000 and 400 feet south of Putah Creek, respectively. In October 1989 they had nitrate levels of 5.1 mg/l as N and 1.6 mg/l as N, respectively.

4.2 UCD WASTEWATER TREATMENT PLANT OUTFALL

In January 1990 a sample was collected from the UCD Wastewater Treatment Plant outfall to Putah Creek, just upstream of LEHR (Figure 1). This sample contained 12.5 mg/l nitrate as N, which exceeds the MCL. Hexavalent chromium was not detected in this sample. A verification sample was collected in March 1990 from the outfall and analyzed for nitrate only. This analysis indicated the presence of nitrate at 11.6 mg/l as N. Nitrate levels in the outfall are not normally measured, so it is uncertain how representative these values are of historical concentrations.

In January 1990, a water sample was collected and analyzed from Putah Creek downstream of the UCD wastewater treatment plant outfall. Water analyzed from this sample had a reported concentration of nitrate as nitrogen of 4.4 mg/l. Hexavalent chromium was reported at 0.01 mg/l.

5.0 REVIEW OF EXISTING DATA

5.1 GROUNDWATER LEVEL ELEVATIONS

Groundwater level elevations from wells south of the City of Davis were obtained from the California Department of Water Resources (DWR). These elevations were used to estimate the regional groundwater gradient around the LEHR facility. Data from both domestic and irrigation wells were used. Well depths for the files which contained groundwater level elevations, varied from 134 to 393 feet below ground surface. The shallowest screened interval is from 100 to 120 feet below ground surface, while the deepest is from 312 to 324 feet, implying that the contours represent a composite of depths and not a single discrete depth zone (Figures 3-5).

Three separate groundwater contour maps were plotted from the DWR data collected (Figures 3 - 5). Each map shows seasonal changes in groundwater levels reflecting the beginning (Spring levels) and end (Autumn levels) of the irrigation season. Three separate years were chosen to determine possible changes in groundwater flow over time. The years plotted represent the extreme conditions of drought (1977, Figure 3), wet years (1983, Figure 4), and recent time (1989, Figure 5).

Although the figures show that groundwater levels vary greatly over time, the general direction of flow from west to east is consistent in all three years. The direction of flow appears to be preserved from season to season and from year to year. Only during the Fall of 1977 (Figure 3) do water levels reflect a localized change in flow direction. Contours of groundwater levels east of Davis for Fall 1977 suggest a southerly flow direction, which may be the result of low groundwater levels and heavy pumping south of that area.

Spring groundwater levels seem to show an influence from Putah Creek, suggesting significant recharge of groundwater from the creek south and east of LEHR. Isolated lows seen in the Spring of 1977 and 1983 may be the result of pumping effects from irrigation wells.

The west-to-east direction of flow is important in relation to the location of LEHR and the private wells which were sampled for nitrate and hexavalent chromium. These wells are located south, east, and northeast of the facility (Figure 1). For groundwater to flow towards all of these wells from LEHR, a

reversal in the groundwater gradient would be required or a groundwater mound would need to exist under the site. However, as shown on Figures 3 through 5, a west to east groundwater flow direction is predominant and reversals in regional groundwater flow are not apparent.

5.2 NITRATE DISTRIBUTION

Historic nitrate data compiled from government agencies, including the Solano County Health Department, the University of California at Davis, the DWR, and the United States Geological Survey (USGS), are plotted on Figure 2. Much of the data are more than 20 years old, especially from DWR, and were collected from a variety of well depths (Tables 2A and 2B). However, some trends can be inferred from the data shown.

Nitrate levels seem to decrease with depth. This is seen in wells 8N/2E-13F1, F2, and F3, with the shallowest well showing the highest levels of nitrate.

Areas of elevated concentrations of nitrate in groundwater occur throughout the area. Approximately one mile north of the Highway 113/I-80 interchange, three UCD wells show nitrate as N above 10 mg/l (Figure 2). However, well construction information for these wells was not available from DWR, so it was not possible to determine what zone these wells are screened over and, hence, what is the likely source of nitrate present in the groundwater. The area around well 8N/2E-13F1, south of I-80 and approximately one mile west of Mace Boulevard, showed a reported high value of nitrate in a shallow well (41.0 mg/l nitrate as N).

5.3 HEXAVALENT CHROMIUM DISTRIBUTION

Hexavalent chromium was detected in all private wells which were sampled (Table 1). Reported concentrations in the I. Hamel, O. Hamel, Miller, and Nishi domestic wells were at or slightly in excess of the 0.05 mg/l MCL. As discussed in Section 5.1, and shown on Figures 3, 4, and 5, these four wells are not directly downgradient from LEHR.

Regional data on hexavalent chromium concentrations in groundwater were not available from any of the public agencies identified in this report. U.S. Geological Survey investigations of groundwater quality in Yolo and Solano Counties have detected total chromium levels between zero and 0.04 mg/l (Evenson, 1985). The highest concentration was observed in a well located just to the southwest of Davis, upgradient of LEHR. It is possible that biogeochemical reactions in nitrate-rich subsurface environments could result in the oxidation of chromium occurring naturally in soils to hexavalent chromium (Sims et. al., 1986).

5.4 LAND USE

The area around LEHR is predominantly agricultural. Information from the Solano County Department of Agriculture Commissioner's office shows a variety of crops grown in this area, including tomatoes, wheat, oats, barley, corn, and safflower (Figure 6).

Recommended fertilizer application rates in the LEHR area range from 60 pounds of nitrogen per acre for oats to 240 pounds of nitrogen per acre for corn (Table 3). Actual rates may vary depending on the grower. Crops grown adjacent to the LEHR facility from 1986 to 1989 are shown on Figure 6. According to information provided by the Solano County Department of Agriculture, 899 acres within the areas outlined on Figure 6 were actively farmed during this period. Based on the crops grown and the recommended application rates, approximately 424,000 pounds of nitrogen were applied to these fields between 1986 and 1989.

Research by the University of California, Division of Agricultural Sciences was conducted in 1980 to determine the amount of nitrate that may reach groundwater from agricultural fertilizers. This research indicated that, for corn, if fertilizer is applied at a rate equal to 100% of the plant's nitrogen requirement, up to 32% of the nitrogen is lost either by conversion to nitrogen gas or by leaching of nitrate to groundwater (University of California, 1980). In addition, if over-fertilization occurs, over 50% of the fertilizer nitrogen can be lost in the same manner. Similar results were also inferred for wheat, cotton, and tomatoes. Assuming that over-fertilization did not occur and one-half of the 32% nitrogen loss reaches the groundwater in the form of nitrate, then approximately 16,960 pounds of nitrate as N per year could be available to potentially reach groundwater from normal agricultural practices conducted in the areas outlined in Figure 6.

In order to estimate the potential nitrate release to groundwater from the beagles which were housed at LEHR, UCD small animal specialist Jim Morris, was consulted. Mr. Morris estimated that a beagle would consume 300 grams of food per day, 60 grams of which would be protein. Of the protein, about 10 grams would be nitrogen. Furthermore, nearly all of the nitrogen would be excreted, and not retained by the dog.

If it is assumed that a beagle has an average life span of 10 years, then one dog would take in 36,500 grams of nitrogen, equivalent to 80.3 pounds of nitrogen, during its life. Over 30 years, approximately 1,000 beagles were studied at LEHR, implying that 80,300 pounds of nitrogen may have been released. This is equivalent to about 2,700 pounds of nitrogen per year. It is likely that 50% to 75% of this nitrogen may be lost to the air or taken up by plants, leaving only 675 to 1,350 pounds of nitrate as N per year available to potentially migrate to groundwater.

Other sources of nitrate in the area surrounding LEHR include animal pens and corrals, domestic septic systems, and the UCD sewage outfall into Putah Creek. The average nitrate concentration in the sewage effluent has been about 12 mg/l as N based, on samples analyzed in January and March 1990. The minimum average flow rate from the sewage treatment plant has been 1,000,000 gallons per day. Therefore, the outfall could contribute approximately 100 pounds of nitrogen per day, or over 36,500 pounds per year to Putah Creek, which could potentially reach groundwater.

Public agency files were checked for quantitative information on animal pens and domestic septic systems. Reliable information which could be used to assess nitrate loading from these potential sources could not be located.

5.5 PRIVATE WELL INFORMATION

The DWR keeps records for wells drilled in the State of California. Well logs normally contain well construction information including the screened interval and the presence of a sanitary seal. A well log search was conducted for the five domestic wells located near LEHR which had nitrate levels in excess of the MCL (Miller, Roth, Nishi, O. Hamel and I. Hamel). The information found is summarized in Table 4. A log was found for the Miller and Roth irrigation wells, but none were found for the

domestic wells on these same properties. Two logs, which seem to correspond to the Nishi domestic and irrigation wells, were found, and logs for wells which correspond to locations at the O. Hamel and I. Hamel properties were also found. However, it was difficult to accurately associate these wells with the proper well log. In addition, information on the logs was incomplete. Also, many existing wells typically have no file on record with the DWR.

According to available well logs, the depth of the wells sampled varies from approximately 260 to 400 feet below ground surface with screened intervals ranging from about 100 to 340 feet below ground surface (Table 4). The Miller domestic well was reported to be 85 feet deep; however, no well log was available to verify this. Only the log for the Nishi domestic well, drilled in 1971, mentioned that it had no sanitary seal. The other logs had no information regarding the presence or absence of sanitary seals.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The private supply wells with reported levels of nitrate and hexavalent chromium levels in excess of MCLs are located southwest, east, and northeast of LEHR. These wells are in areas which can be considered hydraulically upgradient, sidegradient, and downgradient of the LEHR site. In addition, the Martinelli wells and the Nishi irrigation well, which are located just downgradient of the site (Figure 1), did not exhibit nitrate and hexavalent chromium levels in excess of the respective MCLs (Table 1).

Hexavalent chromium was detected in all of the sampled private wells and in the South Fork of Putah Creek. The variation in concentrations between these wells is much smaller than the variation in nitrate concentrations. Hexavalent chromium could be derived naturally from sediments which have come from the Coast Ranges to the west. Processes of geochemical mobilization, which may be present in the nitrate-rich aquifers, may cause locally elevated levels of hexavalent chromium to exist naturally. Other sources of hexavalent chromium include incinerator ash and metal plating wastes. However, sufficient regional data does not exist to completely evaluate the source or sources of hexavalent chromium.

If the regionally elevated nitrate concentrations result from major distinct point sources, then the groundwater containing elevated levels of nitrate should exist as distinct plumes containing high nitrate concentrations which are surrounded by areas with very low or nondetectable nitrate levels. However, the distribution of elevated nitrate concentrations in wells (Figure 2) compared to regional groundwater gradients (Figures 3, 4, and 5) does not indicate the presence of localized plumes emanating from specific sources, such as LEHR. The pattern is more suggestive of large areas which have been impacted by numerous point sources or diffuse areal (nonpoint) sources.

Details regarding the construction and completion of the private wells can not be well documented because of the lack of reliable and accurate well logs, construction details, and pump rate data available from DWR. In addition, at least one of the domestic supply wells does not have a sanitary seal. These factors make it difficult to evaluate and exclude the possibility that nitrate could be channeled down the well casings from shallow surface sources such as agricultural fertilizers, animal pens, or domestic septic leach fields near the domestic and irrigation wells.

A 1988 State Water Resources Control Board paper titled "Nitrate in Drinking Water Report to the Legislature" (1988) reviewed nitrate contamination in groundwater. This report found fertilizer use along with individual waste disposal systems and large concentrations of confined animals to be significant sources for nitrate in groundwater. All of these potential sources are found in the vicinity of LEHR and may be contributing to elevated nitrate concentrations.

The critical factors in determining the contribution from potential nitrate sources are the source magnitude and source location. Mass loading calculations, based on public agency data, indicate that nitrate available from normal agricultural practices in the area could be contributing 16,960 pounds, versus 1,350 pounds available from LEHR on an annual basis. Furthermore, the UCD wastewater treatment plant outfall could contribute 36,500 pounds of nitrate per year to Putah Creek, which could potentially reach groundwater. The wells which are directly downgradient of LEHR (Nishi irrigation, Martinelli domestic and irrigation) had some of the lowest nitrate levels measured in the private wells. The wells which had the highest nitrate levels (Nishi domestic, Miller, Roth, I. Hamel) are located in areas which are not directly downgradient of LEHR. This is especially significant with regards to the Miller and Roth wells.

These factors imply that the LEHR site is not the likely sole source for elevated nitrate levels observed in private wells in the area and may not even be a major source. Other potential sources include domestic septic systems, the UCD wastewater treatment plant outfall to Putah Creek, agricultural fertilizer application, and past or current domestic animal enclosures. Overall, it appears that the elevated nitrate levels in the domestic wells are part of a regional pattern.

No definite conclusions can be drawn concerning hexavalent chromium due to the lack of regional data.

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State Water Resources Control Board, 1988, Nitrate in Drinking Water Report to the Legislature, Report No. 88-11WQ, Division of Water Quality, 53 pgs.

Tchobanoglous, G. and E. D. Schroeder, 1987, Water Quality, Addison-Wesley, Reading, Massachusetts, 768 pgs.

University of California, Division of Agricultural Sciences, 1980, Nitrate losses from irrigated croplands, leaflet.

TABLE 1

NITRATE AND HEXAVALENT CHROMIUM CONCENTRATIONS IN SOME PRIVATE WELLS IN THE VICINITY OF UCD LEHR

	October 1989 Sampling Round		December 1989 Sampling Round		
Well	Nitrate as N (mg/l)	Cr VI (mg/l)	Nitrate as N (mg/l)	CR VI (mg/l)	Location
Rust	2.1	0.02	2.7	0.02	~1 mile NE of LEHR
I. Hamel	20.0	0.06	16.5	0.06	~1 mile NE of LEHR
Roth	35.0(18.5)(D)	0.04	18.2	0.04	South of Putah Creek, SW of LEHR
O. Hamel	12.0	0.05	11.2(10.5)(D)	0.04(0.05)(D)	~1 mile NE of LEHR
Martinelli (Dom.)	5.1	0.03	NS	NS	South of Putah Creek
Martinelli (Irr.)	1.6	0.02	NS	NS	South of Putah Creek - .9 miles East of Old Davis Rd.
Miller	17.0(20.0)(D)	0.05	17.6(17.6)(D)	0.05(0.05)(D)	South of Putah Creek, South of LEHR
Nishi (Irr.)	NS	NS	5.2	0.04	Adjacent to eastern University property line, NE of UCD-10
Nishi (Dom).	NS	NS	30(A)	0.06(A)	~1 mile NE of LEHR

NOTES:

NA - Not sampled
(A) - sampled January 1990
(D) - duplicate analysis in parenthesis

TABLE 2A - SUMMARY OF NITRATE DATA FROM USGS AND DWR

Well	Depth (feet)	Screened Interval (feet)	Nitrate as N (mg/l)	Date Sampled
8N/2E-13E2	120		0.2 13.9	5/53 10/55
8N/2E-13F1	100		5.2	2/55
8N/2E-13F2	300	280-300	0.86 0.80 0.84 0.98 1.1 0.77 0.77 0.86	7/50 6/57 7/58 8/59 7/60 7/61 7/62 7/65
8N/2E-13F3	57		41.0	6/56
8N/2E-13H2	148		1.9 3.6 5.9	8/69 7/79 8/85
8N/2E-14M3	204		3.0 1.3	9/70 7/80
8N/2#-15B1		312-324	0.68	7/31
8N/2E-15J2	150		1.1	8/31
8N/2E-15M2	322		0.23 0.68 0.91	6/31 7/31 9/31
8N/2E-15P1[1]			1.2	1/85
8N/2E-16A1	352		2.0	6/50
8N/2E-16M1	137	126-137	0.68 0.91	6/31 7/31
8N/2E-16N1	268	262-268	0.68	6/31
8N/2E-16Q1	1,450		5.2	1/53
8N/2E-18C1[1]			7.4	1/85
8N/2E-18R2	494		2.5	7/50
8N/2E-19BX1	120	100-120	1.1	7/31
8N/2E-20B1[1]			5.5	1/85
8N/2E-21B2[1]			0.45	1/85
8N/2E-21G2	123		1.4	7/52
8N/2E-21K1	1,400		0.20 0.14	11/71 8/82
8N/2E-24H1	1,030		4.5	11/50
8N/2E-24J3[1]			1.6	1/85
8N/2E-27Q1	144		1.8	7/52
8N/2E-29G[1]			0.97	1/85
8N/2E-35B1[1]			ND	1/85
8N/2E-35E1	226	212-220	0.23	8/31
8N/2E-35G2	93		2.5	10/52

NOTES: [1] - Data from USGS WRI 84-4244, (1986)
ND - Not Detected

TABLE 2B

SUMMARY OF NITRATE DATA FROM UNIVERSITY OF CALIFORNIA DAVIS CAMPUS IRRIGATION WELLS AND SOLANO COUNTY HEALTH DEPARTMENT

Well[1]	Nitrate as N (mg/l)	Date Sampled
A1	5.9	6/27/88
B6-NORTH	3.6	6/27/88
B6-SOUTH	4.1	6/27/88
C2H	6.8	6/27/88
C2F	4.1	6/27/88
DGA	2.5	6/27/88
E2A	7.3	6/27/88
E3B	10.0	6/27/88
E3D	8.0	6/27/88
E4A	11.6	6/27/88
E5	14.8	6/27/88
E8	6.1	6/27/88
F1	5.5	6/27/88
G6	5.9	6/27/88
A[2]	9.1	1985
A[2]	2.8	1984

NOTES:

[1] - No well construction information available
[2] - Data from Solano County Health Department

TABLE 3

FERTILIZER APPLICATION RATES FOR VARIOUS CROPS IN THE VICINITY OF UCD LEHR

CROP	LBS OF N/ACRE
Barley	80-100
Beans	80
Corn	240
Oats	60
Tomatoes	120
Wheat	120

NOTE:

Values reported are in pounds of nitrogen per acre independent of form of fertilizer. One pound of nitrogen is equivalent to 4.4 pounds of nitrate or one pound of nitrate "as nitrogen". One pound is equal to 453,592 mg.

Recommended application rates based on information supplied by the Solano County Department of Agriculture.

TABLE 4

CONSTRUCTION DETAILS OF AVAILABLE PRIVATE WELL LOGS[3]

OWNER	DEPTH (ft)	SCREENED INTERVAL (ft)	SANITARY SEAL	USE	YEAR DRILLED
Roth[1]	260	100-160	--	Irr	1979
Miller[1]	265	198-265	--	Irr	1979
I. Hamel	340	105-340	--	--	1938
O. Hamel	403	--	--	--	--
Nishi (Dom)	308	184-188	NONE	Irr[2]	1971
Nishi (Irr)	281	70-286	--	--	--

NOTES:

- Not recorded on log
[1] Log does not correspond with sampled well of same name
[2] Use on log does not correspond to use reported to UCD
[3] Based on information available from Department of Water Resources

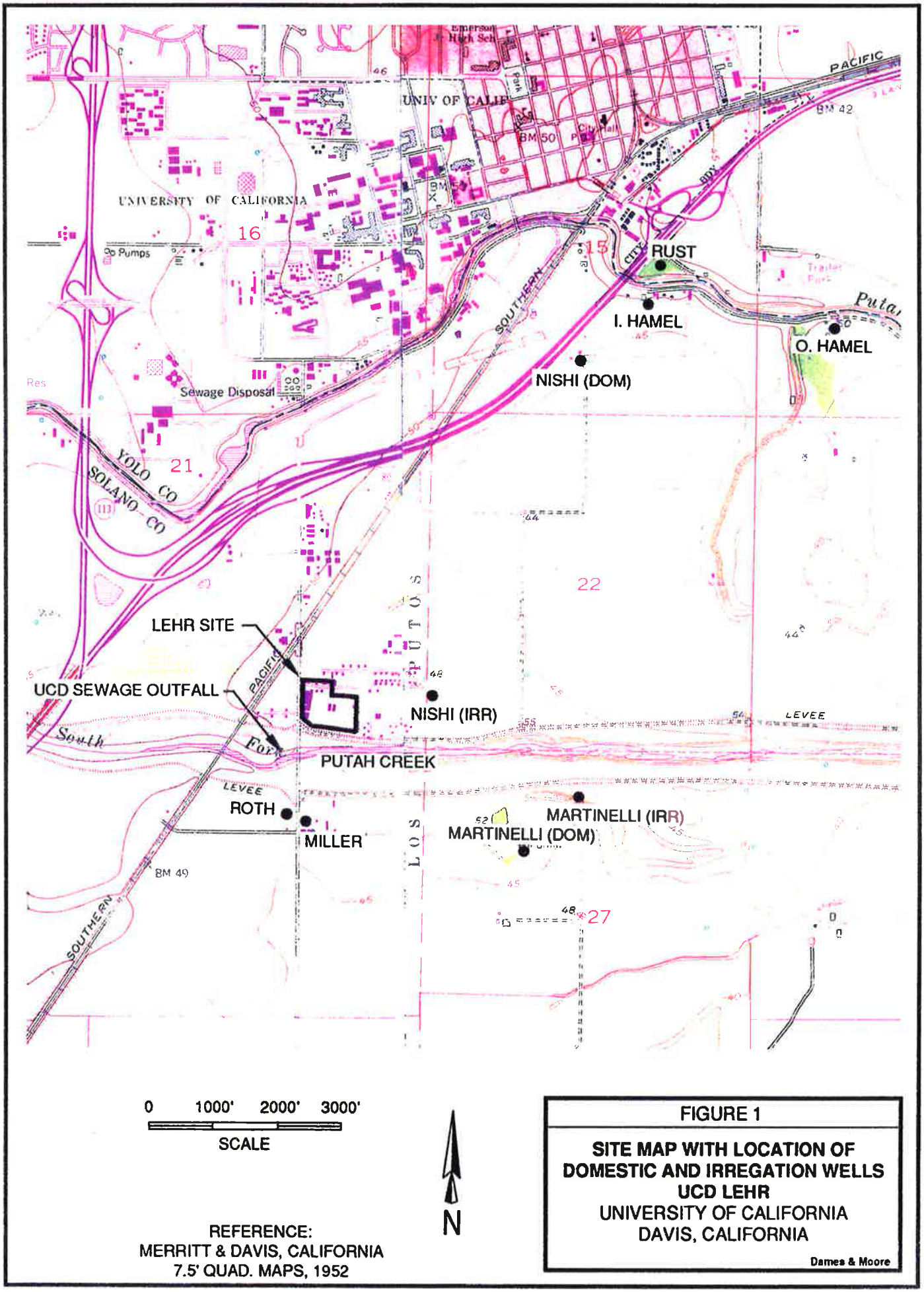


FIGURE 1

SITE MAP WITH LOCATION OF DOMESTIC AND IRREGATION WELLS
UCD LEHR
UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

Dames & Moore

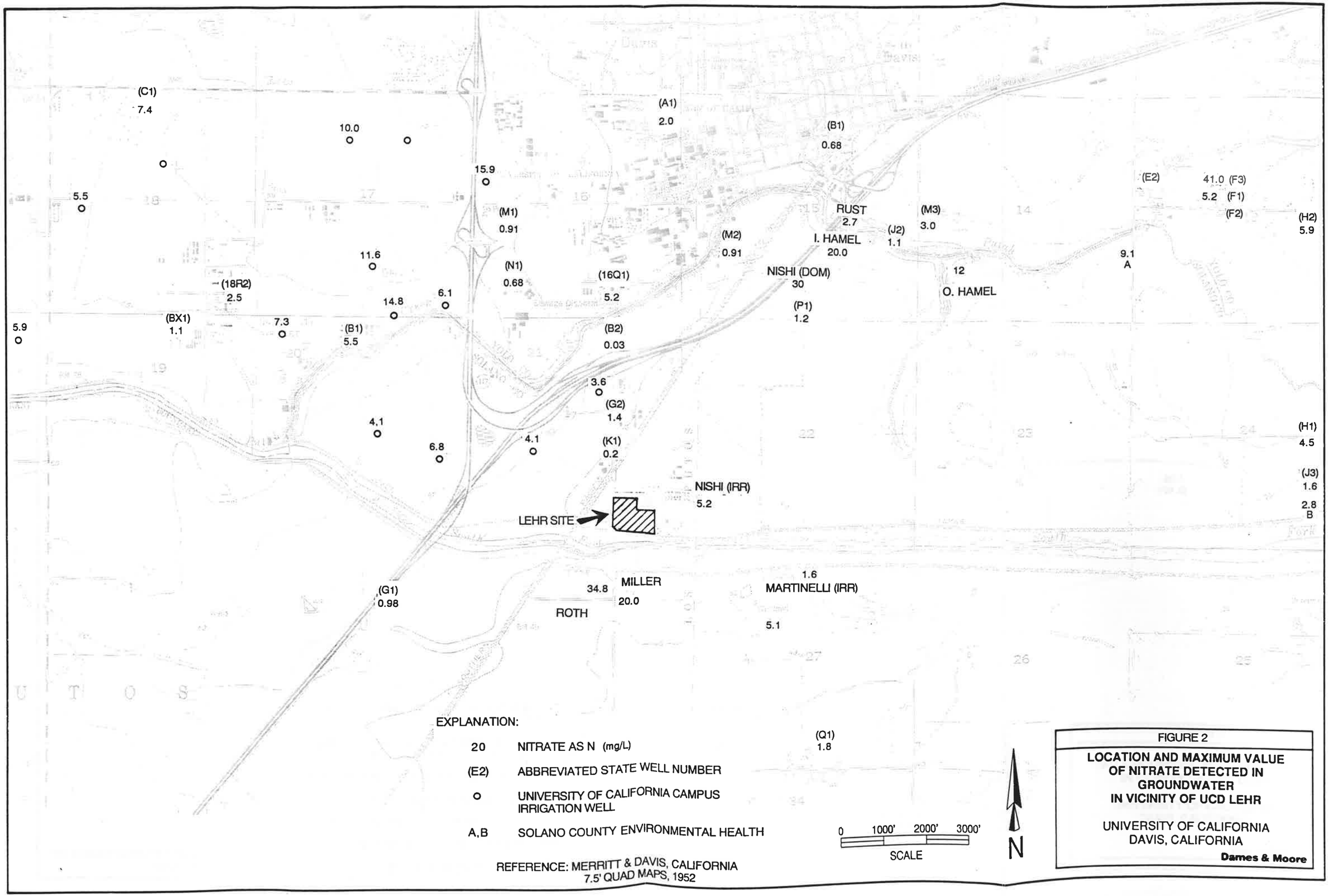
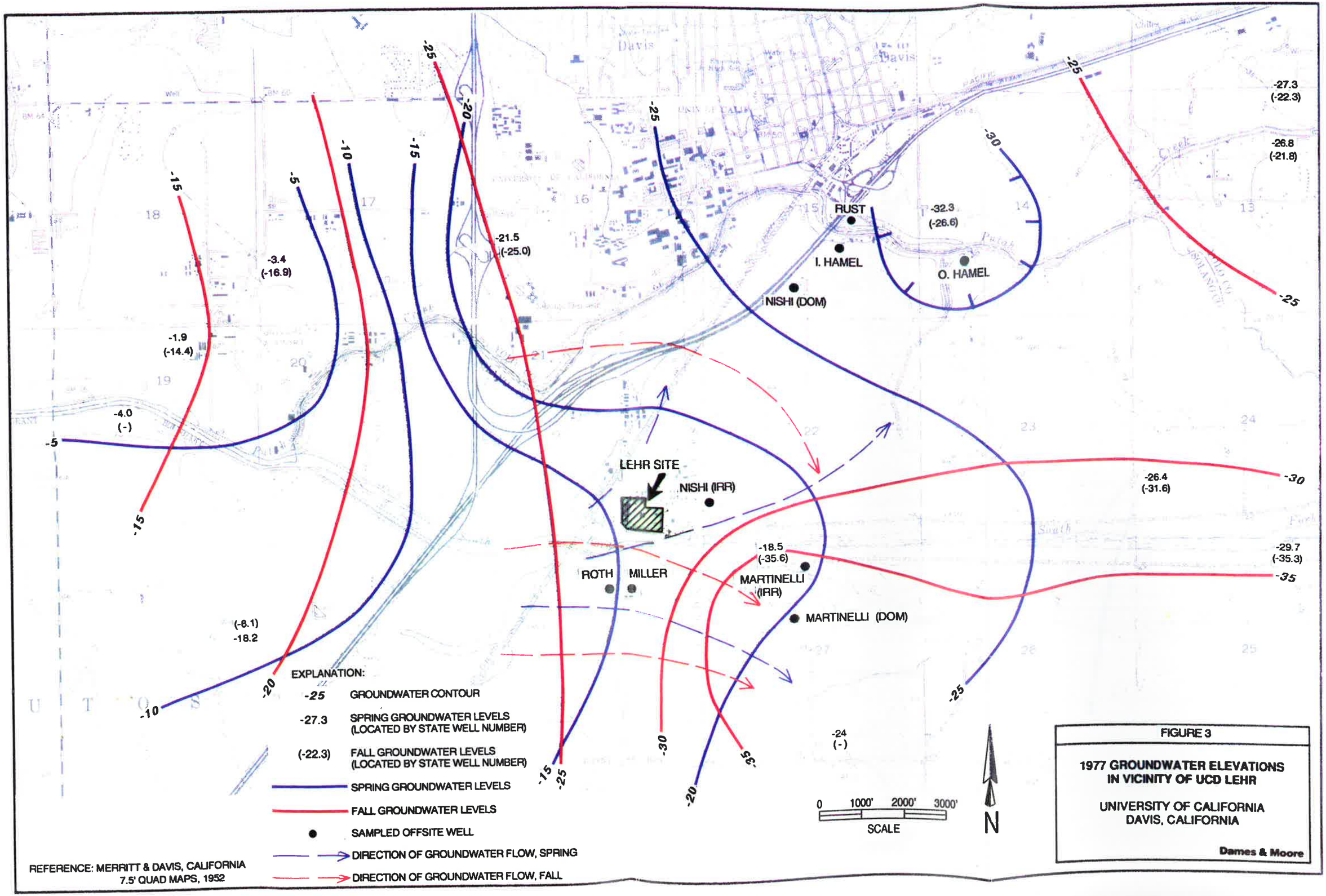


FIGURE 2

LOCATION AND MAXIMUM VALUE OF NITRATE DETECTED IN GROUNDWATER IN VICINITY OF UCD LEHR

UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

Dames & Moore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-20
-15
-10
-5
-30
-21.5
(-25.0)
-3.4
(-16.9)
-1.9
(-14.4)
-4.0
(-)
(-8.1)
-18.2
-27.3
(-22.3)
-26.8
(-21.8)
-32.3
(-26.6)
-26.4
(-31.6)
-18.5
(-35.6)
-29.7
(-35.3)
-24
(-)
RUST
I. HAMEL
O. HAMEL
NISHI (DOM)
LEHR SITE
NISHI (IRR)
ROTH
MILLER
MARTINELLI
(IRR)
MARTINELLI (DOM)
Davis
EXPLANATION:
-25 GROUNDWATER CONTOUR
-27.3 SPRING GROUNDWATER LEVELS (LOCATED BY STATE WELL NUMBER)
(-22.3) FALL GROUNDWATER LEVELS (LOCATED BY STATE WELL NUMBER)
SPRING GROUNDWATER LEVELS
FALL GROUNDWATER LEVELS
SAMPLED OFFSITE WELL
DIRECTION OF GROUNDWATER FLOW, SPRING
DIRECTION OF GROUNDWATER FLOW, FALL
REFERENCE: MERRITT & DAVIS, CALIFORNIA 7.5' QUAD MAPS, 1952
0 1000' 2000' 3000'
SCALE
N
FIGURE 3
1977 GROUNDWATER ELEVATIONS IN VICINITY OF UCD LEHR
UNIVERSITY OF CALIFORNIA DAVIS, CALIFORNIA
Dames & Moore

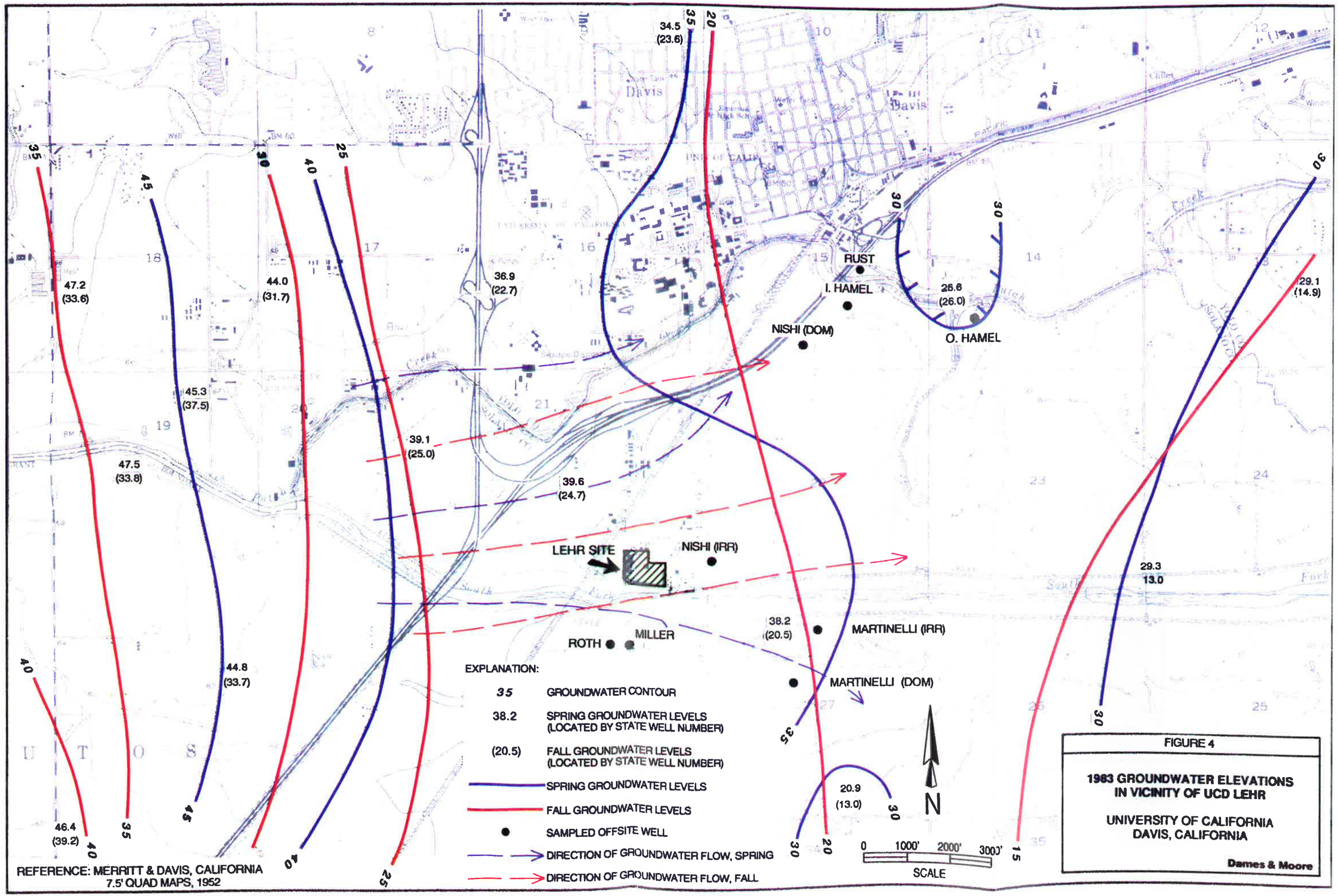

FIGURE 4

1983 GROUNDWATER ELEVATIONS IN VICINITY OF UCD LEHR

UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

Dames & Moore

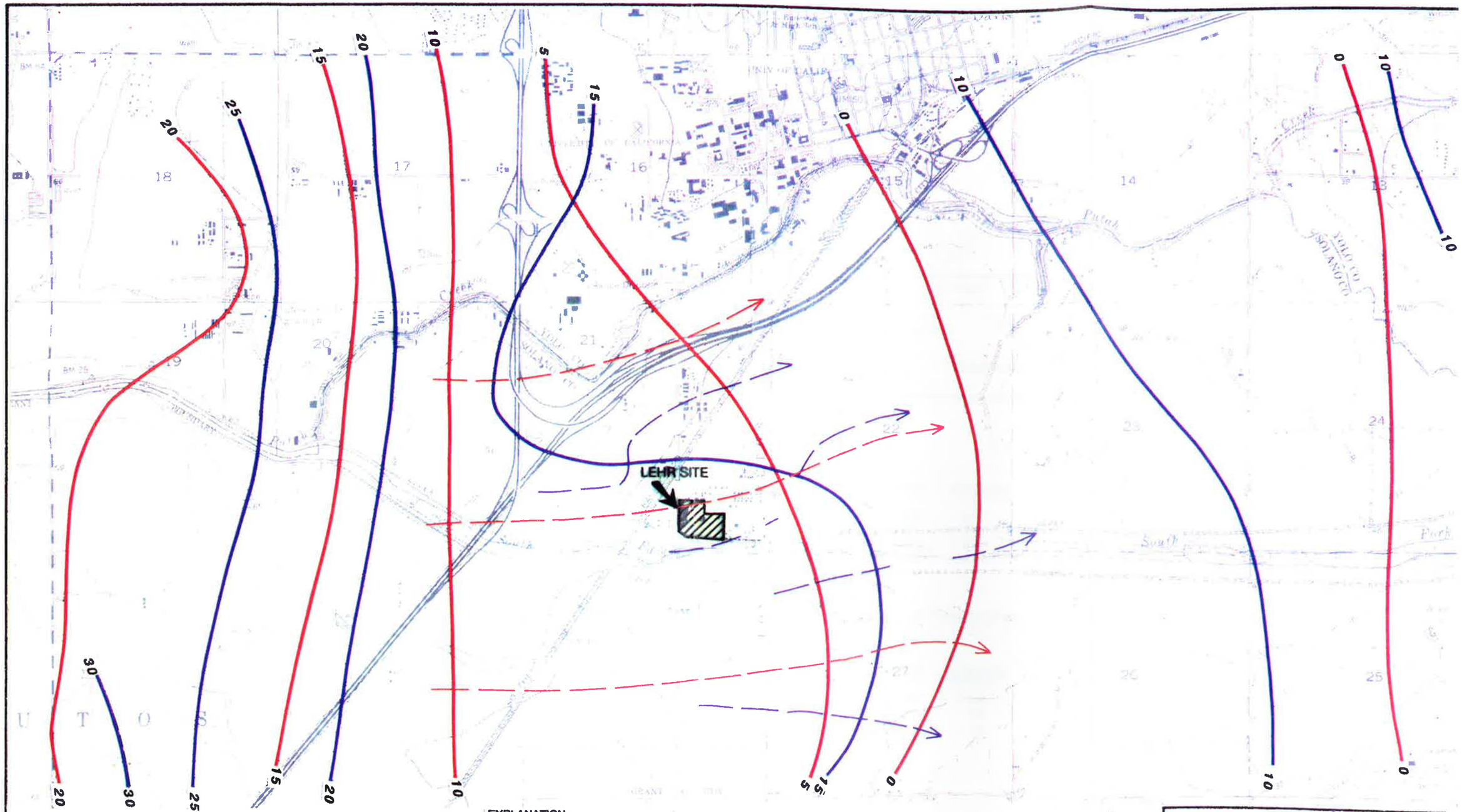

FIGURE 5

1989 GROUNDWATER ELEVATIONS IN VICINITY OF UCD LEHR

UNIVERSITY OF CALIFORNIA DAVIS, CALIFORNIA

Dames & Moore

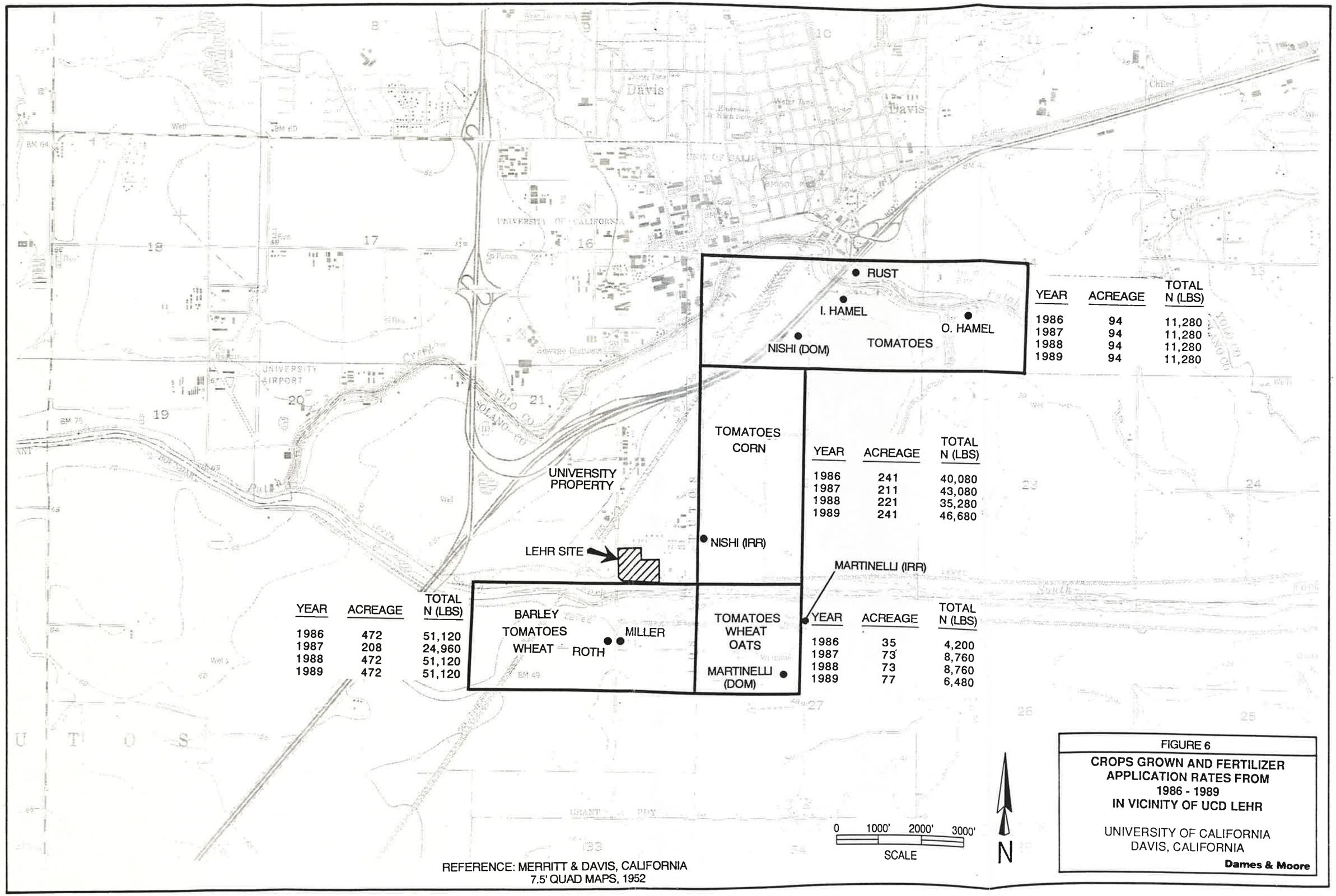

FIGURE 6

CROPS GROWN AND FERTILIZER APPLICATION RATES FROM 1986 - 1989 IN VICINITY OF UCD LEHR

UNIVERSITY OF CALIFORNIA
DAVIS, CALIFORNIA

Dames & Moore

APPENDIX A

June 11, 1990

University of California, Davis
Env. Health & Safety
Davis, Ca. 95616

Attn. Carolyn Owens, Radiation Safety Officer

Dear Carolyn:

I am responding to your request for recommendations or suggestions to the Dames and Moore draft report. My objections to the report are that (1) the study is limited in it's scope,(2) it's limited in its sources of information and(3) it lacks any definite conclusions.

The study did not consider the historic background of Putal Creek. This channel was dug by local farmers and does not have the same bottom as an ancient stream bed. Flooding was not mentioned in this report. What happens when this area is flooded or when the water remains flooded for months next to the LEHR site? How many times has the LEHR site had water on it? Have the levees always been in their present locations? How does the flooding effect the radiation burial site, the chemical dump site? What is the history of the site?

Drought.. What influences does the disposal of waste from UCD have on Putah Creek area when the area goes dry or there is little flow? Are more nitrates put into the ground at the discharge site and not dispersed by the flow? How does that effect the ground water?

The Dames and Moore report limited its sources of information to public information and as far as I could determine did not ask for any imput from the land owners or local people who have current, accurate and historic information.

The report on page 11 states "The dept of the wells sampled varies from approximately 260 to 400 feet below ground with screened intervals ranging from about 100 to 340 feet below ground surface (Table4)." Mariane Miller stated her domestic well is 85ft. This information was available if they had asked. Does 85ft make a difference?

The crop reports did not accurately reflect all crops grown in the area nor did Dames and Moore ask for the farmer's records. I understand some of the

farmers have accurate records of plants, fertilizers and etc. Is a generalization good enough or should the report be accurate? Danes and Moore made generalized conclusions based on inaccurate information.

The objective of the report was to collect new data to evaluate whether the nitrate and hexavalent chromium detected in nearby private wells was more likely to have originated from LEHR or from other sources. I found this report missed its mark. The conclusions on page 13 and 14 are riddled with words such as imply, likely, may not, may be, potential, and difficult to evaluate. I feel the report failed its objectives and raised more questions by the information not included. I feel until the various scenarios are fully addressed that this report lacks crediabilty.

Sincerely,

Julie Roth

Julie Roth

UNIVERSITY OF CALIFORNIA, DAVIS

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OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY DAVIS, CALIFORNIA 95616
TB 30

July 26, 1990

Julie Roth
Route 2, Box 2879
Davis, CA 95616

Re: Your comments on the Nitrate/Chromium Off-site Evaluation Report.

Dear Mrs. Roth:

Thank you for your comments on the Nitrate/Chromium Off-site Evaluation Report. All comments received will be incorporated in the body of the final report. We have consulted with several ground water hydrology experts in an effort to answer the points you have raised. I will attempt to summarize their answers.

Point: The study did not consider the historical background of Putah Creek.

The fact that Putah Creek is not in its original channel does not effect the issue of ground-water pollution migration.

Point: What are the effects of Putah Creek flooding?

When the area floods, the subsurface contaminant migration pathways are not significantly changed. The history on the site has never indicated flooding that has exceeded the height of the berm nor is there any history of water pooling on the LEHR property. There is also no indication of "water boils" ever occurring on the LEHR property during periods of high water tables.

Point: What influence does the effluent from UCD have on Putah Creek when the area is under drought conditions? How does this effect groundwater and soil?

Putah Creek does recharge the groundwater table and in times of drought, it would be expected that the water quality would change with less dilution. The University is pursuing this issue to determine the effect of the effluent discharge on Putah Creek.

Point: Technical information from the landowners need to be included.

This information will be incorporated.

Point: The conclusions given were not conclusive.

Although it is always desirable to be able to reach firm conclusions, it is difficult, at best, in most groundwater studies to take that position without studying the site for a prolonged period of time.

The report did help the University though, by clarifying which issues we could reach agreement on and which required further study. The report clearly did not resolve all of the issues but it did help narrow the list.

Thanks again for taking the time to provide us with your comments.

Sincerely,

Carolyn Owen
Radiation Safety Officer

CO/dg

cc: Groundwater Committee

\bp\co\off-site

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OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY
TB 30

DAVIS, CALIFORNIA 95616

June 18, 1990

Joe Niland
Dames and Moore
9300 TechCenter Drive, Suite 380
Sacramento, CA 95826

RE: Albert Martinelli's Comments on Draft Nitrate/Chromium Report

Unfortunately, Albert Martinelli was unable to give written comments to the Draft Nitrate/Chromium report. Dawn Mitchell took notes from her telephone conversation with him.

To paraphrase, he stated that fertilizer is only applied to tomatoes every other year. Corn receives fertilizer on an as-needed basis. Legumes produce nitrogen, there is no human control over that.

Sincerely,

Steve Eckberg
Health Physicist
University of California at Davis

se/la

cc: Carolyn Owen
Alice Tackett
Dawn Mitchell
Salem Attiga

File: NO_3/Cr Neighbors' Comments

sp/se/fertiliz.ls

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OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY
TB 30

DAVIS, CALIFORNIA 95616

June 15, 1990

Joe Niland
Dames and Moore
9300 Technical Center Drive, Suite 380
Sacramento, CA 95826

Re: Owen Hamel's Comments on the Draft Nitrate/Chromium Report

Unfortunately, Owen Hamel was unable to give written comments to the Draft Nitrate/Chromium Report. Leslie Arthur took notes from her phone conversation with him.

To paraphrase, he stated that he plants only alfalfa and oat hay for his beef cattle, without fertilizer. He also noted that legumes produce nitrogen. Lastly, he reiterated a rumor that one individual is removing up to 8,000 gallons per minute from Putah Creek up near Winters, California.

Sincerely,

Steve Eckberg

se/la

cc: Carolyn Owen
Alice Tackett
Dawn Mitchell
Salem Attiga

File: NO3/Cr - Neighbor's Comments

sp\se\hamel.com

STATE OF CALIFORNIA

GEORGE DEUKMEJIAN, *Governor*

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
CENTRAL VALLEY REGION
'3 ROUTIER ROAD
,RAMENTO, CA 95827-3098

13 April 1990

Ms. Carolyn Owen
Radiation Safety Officer
University of California, Davis
Davis, CA 95616

DRAFT REPORT FOR POTENTIAL NITRATE AND CHROMIUM SOURCES - LEHR SITE, SOLANO COUNTY

We have reviewed the Dames and Moore report, dated 29 March 1990. The report evaluated the potential nitrate and hexavalent chromium sources in the LEHR site vicinity. We see no evidence that the LEHR site has impacted or contaminated any of the offsite private wells or irrigation wells with nitrates or hexavalent chromium. In fact, the closest downgradient well to the site has one of the lowest nitrate levels of all the offsite wells sampled.

We believe UC Davis's efforts are best concentrated on completing investigations of the LEHR site. If additional site investigations indicate the spread of pollutants in the direction of private wells, then detailed investigation of those wells will be warranted.

If you have any questions, please call me at (916) 361-5669.

JAMES B. MAUGHAN

Area Engineer

JBM:jbm

cc: Department of Energy, Livermore
Department of Health Services, Radiological Division, Sacramento
Solano County Environmental Health, Fairfield
Dames and Moore, Sacramento