

**SURVEY FOR ALACHLOR, ATRAZINE, METOLACHLOR AND  
NITRATE RESIDUES IN WELL WATER IN MERCED COUNTY AND  
THEIR RELATION TO SOIL AND WELL CHARACTERISTICS**



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**Environmental Hazards Assessment Program**

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Environmental Monitoring and Pest Management Branch  
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SURVEY FOR ALACHLOR, ATRAZINE, METOLACHLOR AND NITRATE RESIDUES  
IN WELL WATER IN MERCED COUNTY AND THEIR RELATION  
TO SOIL AND WELL CHARACTERISTICS

By

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ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

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## ABSTRACT

Alachlor and metolachlor have been found in ground water as the result of leaching after application to crops in other states. A well sampling survey was conducted to determine the presence of residues of alachlor, metolachlor, atrazine and nitrate in well water samples obtained from corn and dry bean production areas of California. The study was, in part, an extension of a previous survey, conducted in corn and dry bean cropped areas of the Sacramento Valley: similarly cropped areas were located in Merced County in the San Joaquin Valley and wells were sampled for the presence of herbicide residues. Analyses for atrazine and nitrate were included because atrazine has also been found in ground water as a result of use on corn and because nitrate has been proposed as an indicator for areas vulnerable to leaching. No confirmed residues of alachlor, metolachlor or atrazine were found. Nitrate was detected in 15 of 30 well samples: all 15 were above 10 ppm and 6 of the samples were above the 45 ppm EPA maximum contaminant level. Although dairies were located in 14 of the 19 sampled sections, residues were below the level of detection of 0.5 ppm in 5 of those sections. Nitrate was also detected in well water samples taken from sections where dairies were not located. Even though dairies could be a source of nitrogen for residues in well water, the results from this study were inconclusive and would require a larger study to determine the exact source of the contamination.

Of considerable interest was the relation of residues to geological and well construction features. As part of the study design, each section in the study area was assigned a value indicating potential for contamination by leaching through soil. The soil vulnerability rating was based on a previous study that related the occurrence of DBCP residues in well water to soil nomenclature at the family level of taxonomic organization. The data for nitrate indicated that the percentage of detections was not related to sectional vulnerability rating, but the mean value of positive samples appeared to increase as the vulnerability rating increased. Concentration, however, also appeared to be related to the depth of perforations in well casings: nitrate concentrations tended to be greater in shallower wells. When all data were analyzed, a regression model, predicting nitrate concentrations as a function of soil vulnerability and depth to perforations with the inclusion of an interaction term, was significant at  $p=0.05$  but it only had an  $R^2 = 25\%$ . Other explanatory variables, such as the exact input of nitrogen per acre, may be needed in order to improve the model. Since concentrations of nitrate appeared to be related to both soil vulnerability and to depth of the sampled aquifer, collection of data on well characteristics could aid in the interpretation of studies intended to relate surface land features with concentrations of agricultural chemicals detected in well water.

## ACKNOWLEDGMENTS

We greatly appreciate the cooperation from Bob Teso in supplying the soil contamination probabilities generated for Merced County.

## Disclaimer

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## INTRODUCTION

This study was an extension of a previous well survey conducted by the California Department of Food and Agriculture (CDFA) to determine whether residues of alachlor could be detected in well water in the Sacramento Valley (Welling and Nicosia, 1986). Alachlor is primarily used as a pre-emergent and early post-emergent herbicide for control of annual grasses in corn and dry beans. The potential for movement of alachlor through soils to ground water is considered high because it has been found in well water samples taken from corn production areas in Nebraska (Wehtje, et. al., 1984).

In California, alachlor residues have yet to be detected in ground water as a result of non-point source leaching through soils from agricultural applications (Ames, 1988). One well sampled in the Sacramento Valley had a confirmed positive residue for alachlor (Welling and Nicosia, 1986). However, the well was in disrepair and there was evidence of leakage of surface water directly into the wellhead; The detection was determined to be a point source and not the result of non-point source leaching.

The previous survey was conducted in 1985 in the Sacramento Valley which refers to the portion of the Central Valley that is north of the American River (Department of Water Resources, 1980). In order to provide data in other portions of California, corn and dry bean production areas were also identified in the San Joaquin Valley, the portion of the Central Valley south of the American River. For this study, well water samples were taken from corn and dry bean growing areas located in Merced County and they were analyzed for the presence of alachlor. In addition to alachlor, samples were also analyzed for atrazine, metolachlor and nitrate. Atrazine and metolachlor

were included because they are used on corn and dry beans and they also have a potential to leach through soils (Cohen, et al., 1984). Nitrate was included because concentrations in ground water have been shown to be associated with agricultural use (Canter, 1987) and with occurrence of pesticide residues (Libra, et al., 1987; Baker et al., 1989)

One other aspect of this study was the use of soil mapping units as a stratification variable in the sampling design. A previous study using data from Fresno County, California, 'sought to assess the utility of available soil and groundwater data bases in predicting groundwater contamination by pesticides' (Teso et al., 1988). Those results indicated a spatial association between wells with DBCP residues and soil nomenclature. For this study, areas where corn and dry beans were grown were stratified by a soil vulnerability rating that was based on the Fresno County analysis. Similar soils occurred in both counties. Regression analysis was used to explore possible relationships between concentrations of detected chemicals, the soil vulnerability rating, and depth to perforations, a well characteristic that indicates the depth of the aquifer from which ground water is obtained.

## MATERIALS AND METHODS

### Study Design

The identification of sampling sites was based on cropping patterns and on soil data. First, the corn and dry bean production areas of Merced County were identified on a sectional basis. A section, as defined by the United States Geographical Service's Public Survey Coordinate System (Foote and Davis, 1966), is a one square mile area of land. In each section, the crop production information was overlain with an index for vulnerability of associated soils to leaching. Vulnerability ratings were statistically generated from Teso et al. (1988) who determined the relationship between the occurrence of DBCP residues in well water and the nomenclature of soils within sections located in Fresno County. In that study, projected ratings were tested for sections in Merced County because soils of the same family existed in Merced County. The same sectional ratings derived in that previous study were used in this study to initially stratify the well sampling into 3 categories: 0-33%, 34-67% and 68-100% (Appendix I). A group of ten sections where corn or dry beans were grown were assigned to each probability range. One well was to be sampled per section. However, problems with well construction and with consent of well owners limited availability of wells for sampling. The number of sections and number of wells sampled in each section differed from original projections: ten wells in six sections were sampled in the 68-100% category, eleven wells in seven sections were sampled in the 34-67% category, and nine wells in six sections were sampled in the 0-33% category (Figure 1.).

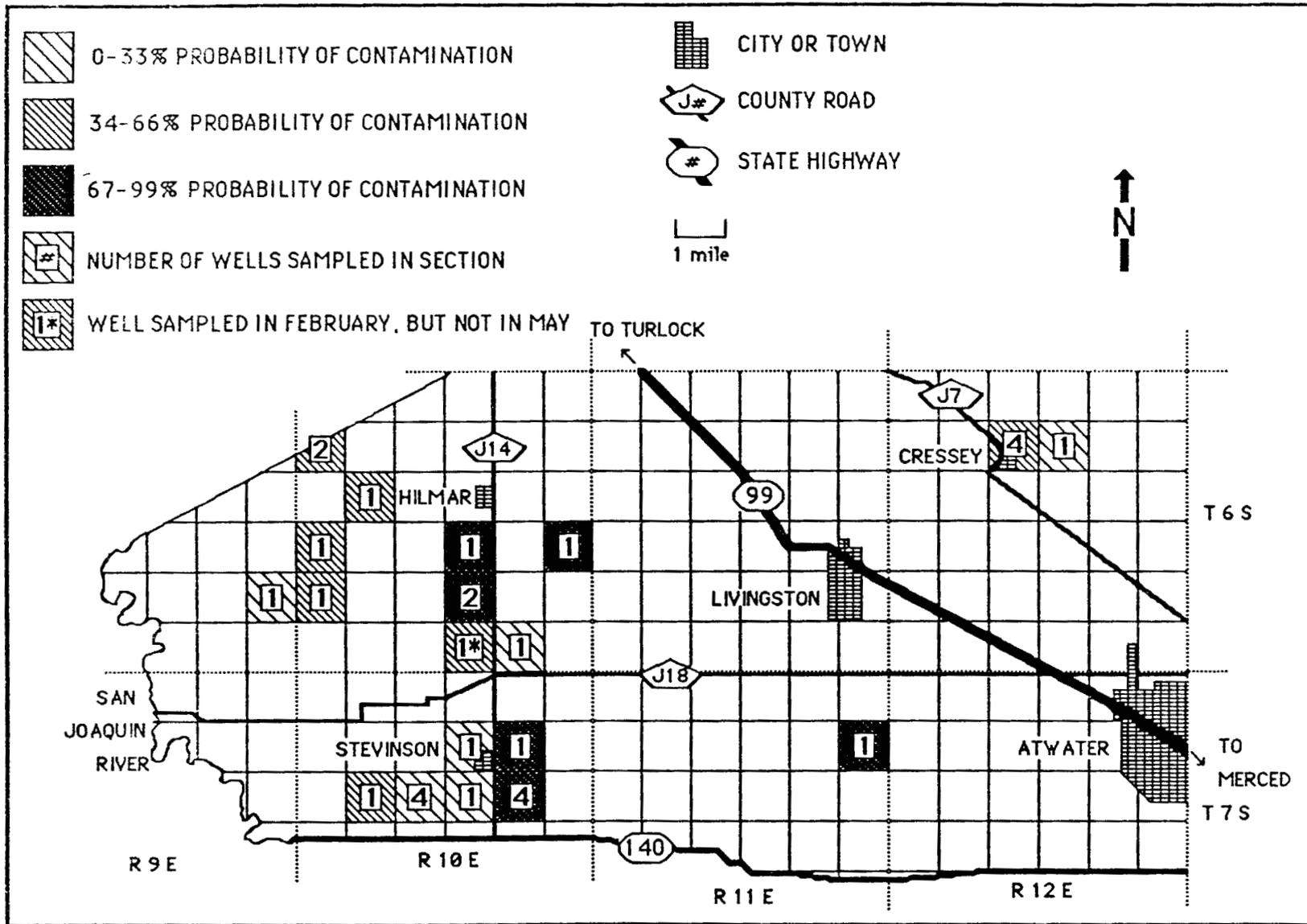


Figure 1. Well sampling area in northwest Merced County.

Samples were analyzed for the presence of alachlor, metolachlor, atrazine, and nitrate. Regression analysis was used to test for relationships between detected chemical residues and the projected ratings for soil vulnerability and depth to well perforations, a well characteristic that indicates the depth of the aquifer from which water was drawn. For completeness, both sequential (Type I) and partial (Type II) sums of squares are presented (SAS Institute Inc, 1986).

### **Sample Collection**

Well water samples were collected from 30 wells in February, 1987. Owing to conflicting results for atrazine and alachlor between the two analyzing laboratories during the first sampling, it was necessary to resample the original wells. However, only twenty-nine wells were resampled in May, 1987 because one owner refused permission for resampling. Samples from February were analyzed for pesticide and nitrate residues and samples from May were analyzed only for pesticide residues.

Prior to sampling, well logs were obtained for the area of interest. All wells selected for sampling had cement or bentonite sanitary seals and a sampling port located before any in-line filter systems. Shallow wells and wells with sampling ports between the well and tank were selected preferentially. Owners of selected wells were asked to grant permission to sample.

When possible, the well pumps were run for the amount of time needed to flush three times the amount of standing water from the casing. All samples were collected in one-liter amber glass bottles with aluminum foil-lined lids. Each bottle was rinsed and then filled with water from the sampling port. The

samples were stored on wet ice and kept refrigerated at 4° C until analysis. Well water pH and other pertinent sampling data were recorded on the accompanying chain of custody.

### Chemical Analyses

For the 30 well water samples collected in February, 1987, the primary analyses were conducted by Agricultural and Priority Pollutants, Laboratories, Inc. (APPL) in Fresno, California. Quality control analyses were conducted by the CDFA Chemistry Laboratory Services Branch in Sacramento, California.

Detection of alachlor, atrazine, and metolachlor residues was accomplished by: a methylene chloride extraction, extract concentration, solvent exchange (to hexane at APPL or ethyl acetate at CDFA), and analysis using gas chromatography. APPL laboratory used a Lachet Autoanalyzer to detect nitrate. Replicate analyses were used to confirm detected levels. The CDFA laboratory did not conduct nitrate analyses. A detailed description of analytical methods is presented in Appendix II.

Quality control procedures for pesticide analyses included the analysis of split samples and replicate samples (Appendix III). Samples from 6 wells were split into two portions; one portion was analyzed by APPL laboratory and the other portion by the CDFA laboratory. At each well, two replicate samples were collected for each pesticide analysis.

All positive detections found by the CDFA laboratory were subject to confirmation by a second column and detector on the gas chromatograph. A detailed description of quality control procedures used within each laboratory is presented in Appendix II.

For the 29 well water samples collected in May, 1987, the primary analyses were conducted by the CDFA laboratory and quality control analyses were conducted by APPL laboratory. Water samples were analyzed for alachlor, atrazine and metolachlor but not for nitrate. Analytical methods were identical to those used for the February sampling. The same quality control procedures were used with one exception, a field blank (a sample of pesticide-free deionized water) was prepared at each well site and submitted with the samples.

## RESULTS AND DISCUSSION

Information collected on sampled wells is presented in Table 1. Most were cased with PVC, sealed with bentonite and used for domestic purposes. During analysis of the data, it was discovered that one of the sections was originally misclassified so the actual number of wells sampled in each soil probability range was: 9 wells in the 0-33% range, 11 wells in the 34-67% range, and 10 wells in the 68-100% range. Also, the initial design was based on one well sample per section, but there were insufficient acceptable wells in the study area to fulfill this requirement so multiple samples were taken in a section.

### Pesticide Analysis

There were no confirmed residues of alachlor, metolachlor or atrazine in any of the water samples taken during the February or May sampling dates. Thus, no statistical test was possible between the occurrence of pesticide residues and the section soil probability ratings. Results for all analyses of samples, replicate samples and split samples between laboratory are given in Table 2. Since most analyses were negative (below the detection limits), data for quality control indicated good agreement between replicate samples and split laboratory samples. There were a few detections, but they could not be confirmed so they were considered false positives. More specifically, one sample initially tested positive for alachlor at 0.1 ug/L and two samples tested positive for atrazine at 0.07 and 0.1 ug/L. These results could not be confirmed.

Table 1. Data obtained from well logs describing the condition of the wells sampled.

Well Identification	Range in Perforations (feet)	Depth of the casing (feet)	Casing Material	Sealing Material	Use
A1 <sup>a</sup>	50 - 60	67	PVC	Bentonite	Domestic
A2	55 - 65	65	PVC	Bentonite	Domestic
A3	90 - 110	110	PVC	Bentonite	Domestic
A5	113 - 152	160	Steel	Cement	Irrigation
A6	85 - 105	105	Steel	Bentonite	Domestic
A7	250 - 290	290	PVC	Bentonite	Domestic
A8	65 - 85	85	PVC	Bentonite	Domestic
A9	45 - 65	65	PVC	Bentonite	Domestic
A10	54 - 64	64	PVC	Bentonite	Domestic
B1	105 - 125	125	PVC	Bentonite	Domestic
B2	115 - 115	115	PVC	Bentonite	Domestic
B3	105 - 125	125	PVC	Cement	Domestic
B4	98 - 148	148	PVC	Bentonite	Domestic
B5	44 - 62	62	PVC	Bentonite	Domestic
B6	110 - 140	140	PVC	Cement	Domestic
B7	154 - 164	164	PVC	Bentonite	Domestic
B8	180 - 200	200	PVC	Bentonite	Domestic
B9	140 - 180	180	PVC	Bentonite	Domestic
B10	63 - 83	83	PVC	Bentonite	Domestic
B11 <sup>b</sup>	85 - 100	100	PVC	Bentonite	Domestic
C1	75 - 85	85	PVC	Bentonite	Domestic
C2	85 - 100	100	PVC	Bentonite	Domestic
C3	120 - 140	140	PVC	Bentonite	Domestic
C4	50 - 80	80	PVC	Bentonite	Domestic
C5	106 - 116	116	PVC	Bentonite	Domestic
C6	87 - 107	107	PVC	Cement	Domestic
C7	137 - 157	157	PVC	Cement	Domestic
C8	70 - 90	90	Steel	Bentonite	Domestic
C9	115 - 135	135	PVC	Bentonite	Domestic
C10	110 - 130	130	PVC	Bentonite	Domestic

<sup>a</sup> A, B and C refers to soil sectional probability ranges of 0-33, 34-67 and 68-100%, respectively.

<sup>b</sup> This well was originally designated as A4 but subsequently assigned to the B range.

Table 2. Results of the Merced County sampling, February - March, 1987. Samples with no detectable amount are indicated by a < sign and the detection limit. APPL=Agricultural Priority Pollutants Laboratory, Fresno, California; CDFA=Laboratory Services, California Department of Food and Agriculture.

Well ID	Date sampled	Laboratory	Alachlor (ppb)	Metolachlor (ppb)	Atrazine (ppb)
A01	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	0.1	<0.2	0.1
	5/5/87	APPL	<0.1	<0.1	<0.1
		CDFA	<0.3	<0.3	<0.1
A02	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6
		CDFA	<0.3	<0.3	<0.1
A03	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
A05	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		APPL	<0.1	<0.1	<0.1
	5/5/87	APPL	<0.1	<0.1	<0.1
		CDFA	<0.3	<0.3	<0.1
A06	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
A07	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.1	<0.2	<0.05
	5/5/87	APPL	<0.1	<0.1	<0.1
		CDFA	<0.3	<0.3	<0.3
A08	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
A09	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
A10	2/5/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
B01	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.1	<0.2	<0.05
B02	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		APPL	<0.1	<0.1	<0.1
B03	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
B04	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
B05	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
B06	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
B07	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1
B08	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.1	<0.2	<0.05
	5/4/87	APPL	<0.1	<0.1	<0.1
		CDFA	<0.3	<0.3	<0.1
B09	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.3	<0.3	<0.1

Table 2. Continued....

Well ID	Date sampled	Laboratory	Alachlor (ppb)	Metolachlor (ppb)	Atrazine (ppb)
B10	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/6/87	CDFA	<0.3	<0.3	<0.1
B11	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6
	5/5/87	CDFA	<0.3	<0.3	<0.1
C01	2/3/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/5/87	CDFA	<0.3	<0.3	<0.1
C02	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/6/87	APPL	<0.3	<0.3	<0.1
C03	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/5/87	CDFA	<0.3	<0.3	<0.1
C04	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/6/87	CDFA	<0.3	<0.3	<0.1
C05	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/6/87	CDFA	<0.3	<0.3	<0.1
C06	2/4/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/4/87	CDFA	<0.3	<0.3	<0.1
C07	2/5/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/5/87	CDFA	<0.3	<0.3	<0.1
C08	2/5/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.1	<0.2	0.07
	5/5/87	APPL	<0.1	<0.1	<0.1
		CDFA	<0.3	<0.3	<0.1
C09	2/5/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
	5/4/87	CDFA	<0.3	<0.3	<0.1
C10	2/5/87	APPL	<0.05, <0.05	<0.5, <0.5	<0.6, <0.6
		CDFA	<0.1	<0.2	<0.05
	5/5/87	APPL	<0.1	<0.1	<0.1
		CDFA	<0.3	<0.3	<0.1

either in the replicate samples that were taken at the same time or in additional samples taken after the first sampling period. The MDL's for each herbicide were 0.05-0.3, 0.5-0.1, and 0.05-0.6 ug/L for alachlor, metolachlor and atrazine, respectively. Since the initial levels of detection were within the MDL ranges, they could have been measures of instrument baseline variation. Thus, these detections were considered false positives because of their low initial values and the inability to confirm in subsequent samples.

### **Nitrate Analysis**

Nitrates, at a minimum detection limit of 0.5 ppm, were detected in 15 of the 30 wells sampled in February (Table 3). The concentrations for all 15 samples were above 10 ppm with six wells above the 45 ppm EPA drinking water standard. Land use surveys were conducted for all sampled sections (Appendix IV). A total of 19 sections were surveyed of which 14 (76%) contained dairies (Table 4). In sections containing dairies, residues were detected in 9 (64%) sections: conversely, residues were below detection limits in 5 (36%) sections. A non-significant  $\chi^2$  test indicated that the probability for detection of nitrate was independent of the presence of dairies in a section. This observation should be considered preliminary because of the small number of sampled sections. Based on this sectional analysis, the source of nitrogen with respect to the presence of dairies was inconclusive.

Table 3. Nitrate concentrations measured in water samples and associated data on depth to perforations and sectional probability rating.

Well Identification	Vulnerability Rating (%)	Township-Range Section Location	Average Perforation (feet)	Nitrate Concentration (ppm)
A1	29	7S-10E-16	65	<0.5, <0.5 <sup>a</sup>
A2	29	7S-10E-16	60	<0.5, <0.5
A3	29	7S-10E-16	100	<0.5, <0.5
A5	18	6S-10E-35	133	<0.5, <0.5
A6	12	6S- 9E-25	95	<0.5, <0.5
A7	20	6S-12E-10	270	12.3, 12.3, 12.3
A8	14	7S-10E-15	75	<0.5, <0.5
A9	29	7S-10E-10	55	44.0, 44.0
A10	29	7S-10E-16	59	<0.5, <0.5
B1	65	6S-10E-34	115	13.4, 13.8, 13.6
B2	55	6S-10E-19	115	14.5, 17.2
B3	55	6S-10E-17	115	23.7, 24.6
B4	55	6S-10E- 7	123	66.4, 65.1
B5	45	7S-10E-17	53	<0.5, <0.5
B6	41	6S-12E- 9	125	46.2, 46.6
B7	41	6S-12E- 9	159	15.4, 12.3
B8	41	6S-12E- 9	190	22.0, 16.3
B9	41	6S-12E- 9	160	26.4, 26.0
B10	55	6S-10E- 7	73	55.0, 54.6
B11	42	6S-10E-30	92	28.6, 30.4
C1	72	7S-10E-14	80	<0.5, <0.5
C2	83	6S-10E-27	93	<0.5, <0.5
C3	72	7S-10E-14	130	<0.5, <0.5
C4	83	6S-10E-27	65	88.9, 88.9
C5	72	6S-10E-24	111	<0.5, <0.5
C6	72	7S-11E-12	97	52.3, 52.3
C7	72	7S-10E-14	147	<0.5, <0.5
C8	72	6S-10E-22	80	88.4, 88.4
C9	72	7S-10E-14	125	<0.5, <0.5
C10	72	7S-10E-11	120	<0.5, <0.5

<sup>a</sup> Values <0.5 ppm were less than the MDL. Values are from replicate samples.

Table 4. Contingency table for the number of sections classified as either negative or positive for detection of nitrate residues in sections where dairies were present or not. Values in parenthesis are expected values for that classification.

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		<u>Presence of Dairies</u>		
		No	Yes	Totals
Presence of Nitrate Residues	No	3 (2.1)	5 (5.9)	8
	Yes	2 (2.9)	9 (8.1)	11
Totals		5	14	19

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$\chi^2 = 1.097$  at 1 degree of freedom; non-significant at  $p < 0.05$

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Data were analyzed to relate the occurrence of residues to geographical location (soil vulnerability rating) and to a well characteristic (depth to perforations). The number of positive results in each category of soil vulnerability was 2 of 9 samples in the 0-33% soil probability range, 10 of 11 samples in the 34-67% soil probability range, and 3 of 10 samples in the 68-100% soil probability range. Although the occurrence in the intermediate group was high, the frequency of positives did not appear to follow a trend with respect to sectional probability rating. The mean concentration of positive results appeared to increase in relation to the vulnerability rating, especially at the highest range; means were 28.2 ppm in the 0-33% range, 31.0 ppm in the 34-67% range and 76.5 ppm in the 68-100% range.

A graphical inspection of the data indicated that nitrate values appeared to be higher at higher soil vulnerability ratings (Figure 2). However, nitrate values also appeared related to the depth of perforations in well casings: Nitrate values were higher in wells with shallower perforations (Figure 3). In regression analysis using both negative (values below the minimum detection limit of 0.5 ppm were treated as 0) and positive data, a model that included both factors and a term for their interaction was significant at  $p=0.05$  (Table 5). The  $R^2$  for that model was low at 25%.

Figure 2. Scatter plot of average nitrate concentration in well water and sectional soil vulnerability rating

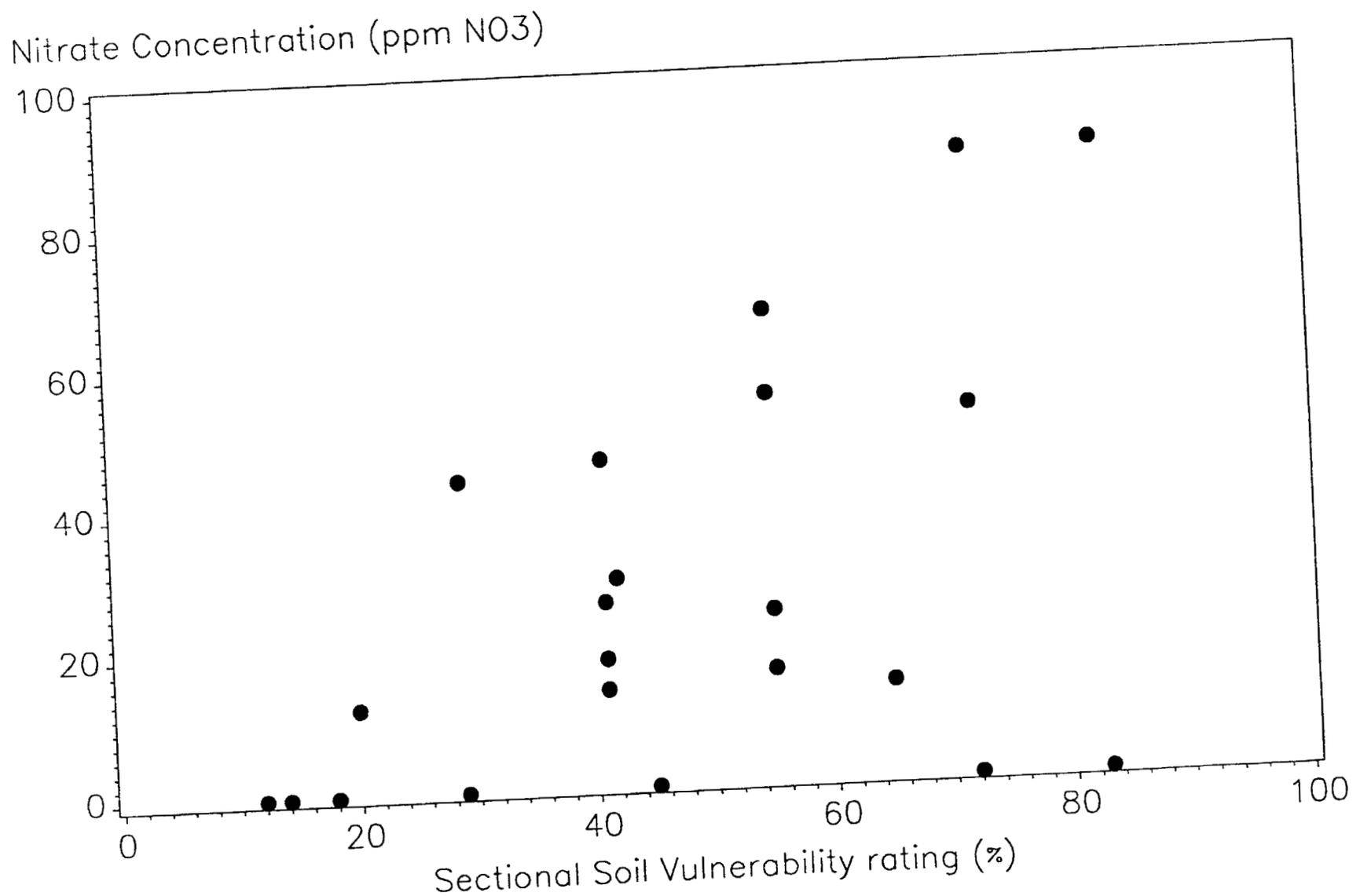


Figure 3. Scatter plot of average nitrate concentration in well water and average depth to perforations in well casings

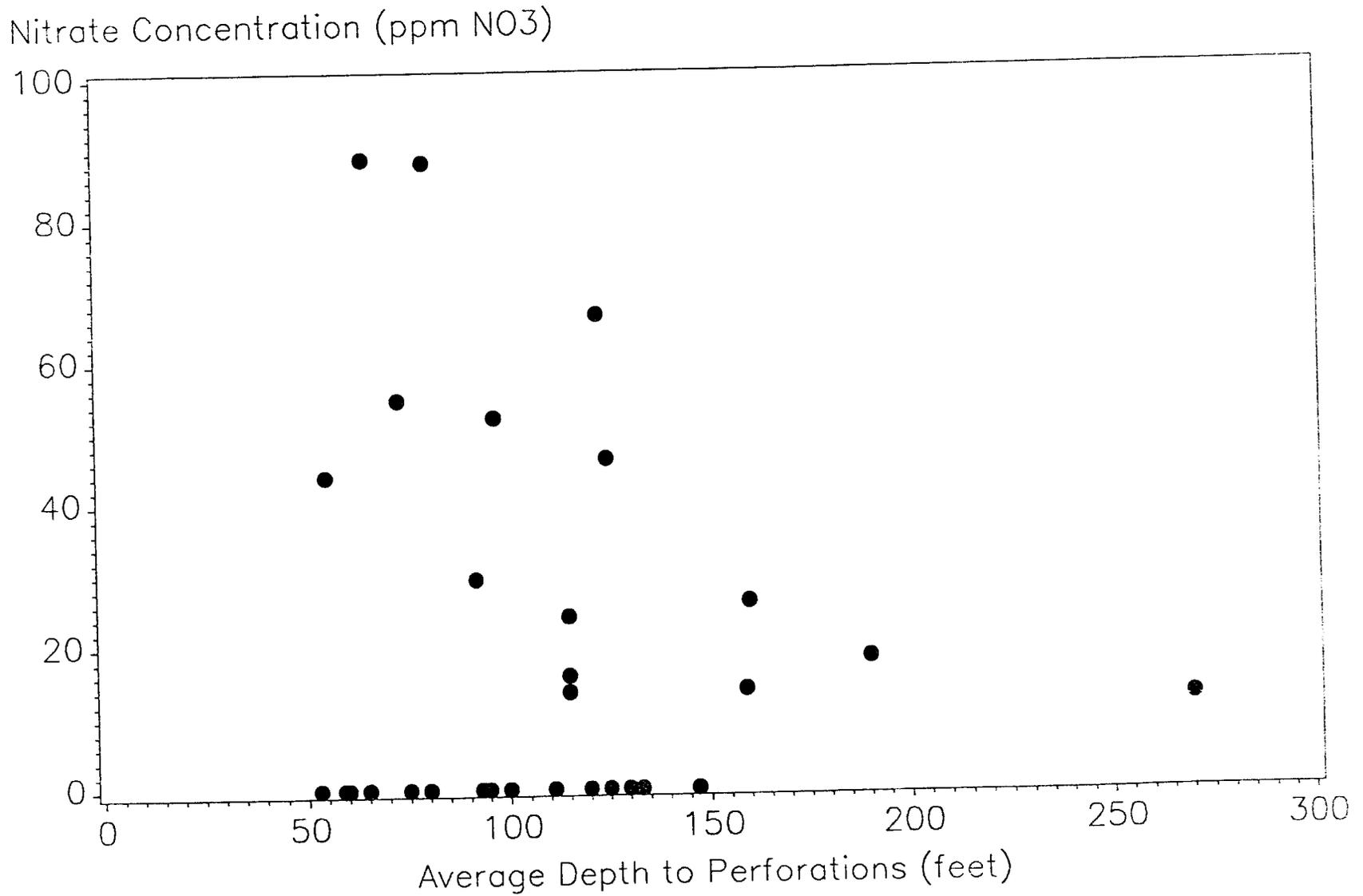


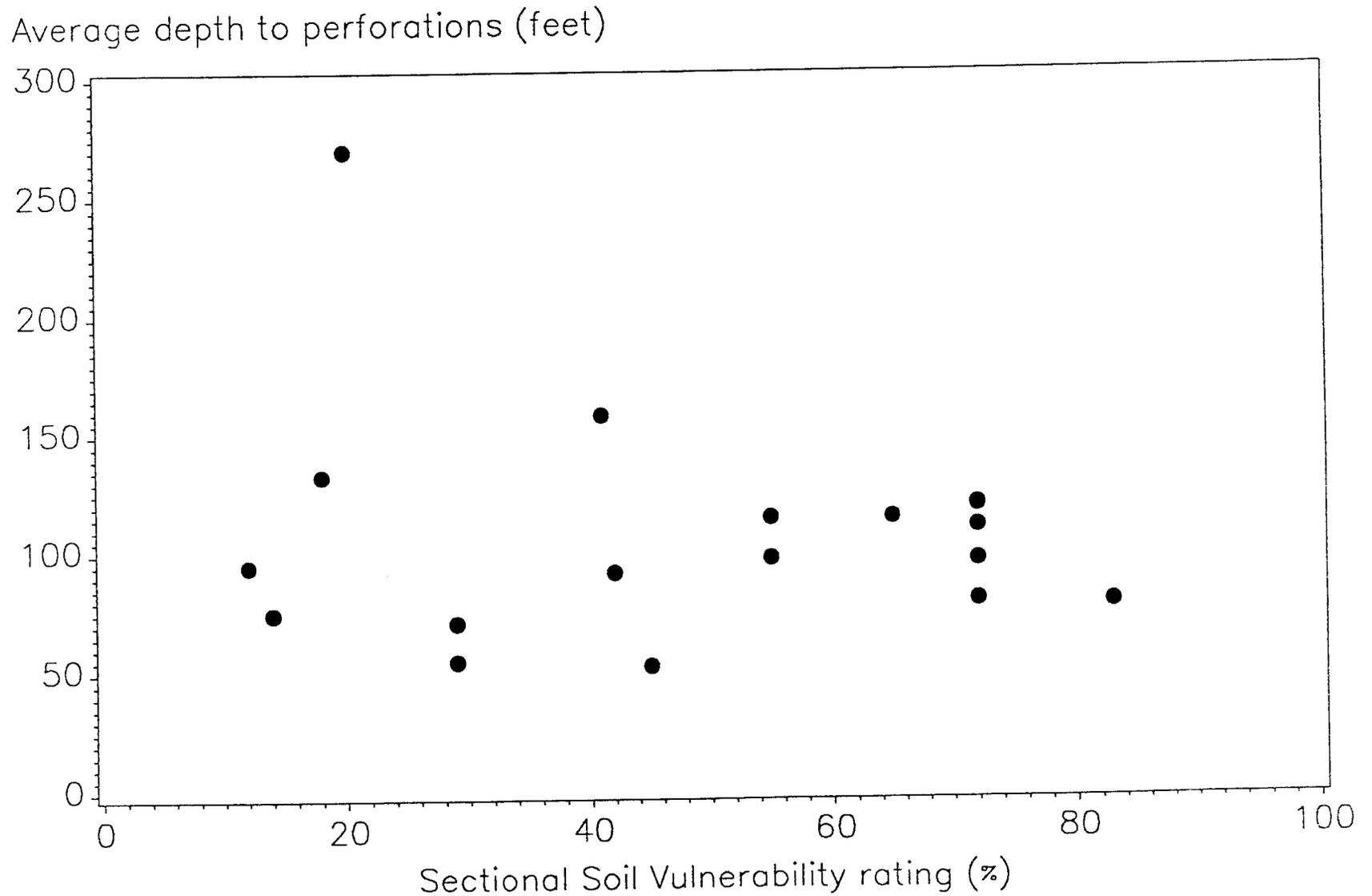
Table 5. Regression analysis of variance for the regression of nitrate concentration against vulnerability rating and mean depth to perforations in wells. V = Vulnerability rating and D = mean depth to perforations.

Source of Variation	Degrees of Freedom	Sums of Squares	F-Value	Probability of > F-value
Model	3	5381.10	2.90	0.0537
Error	26	16055.95		
<u>Type I Sums of Squares (Sequential)</u>				
V	1	1707.32	2.76	0.1084
D	1	240.15	0.39	0.5383
V*D	1	3433.63	5.56	0.0262
<u>Type II Sums of Squares (Regression)</u>				
V	1	4698.78	7.61	0.0105
D	1	2000.25	3.24	0.0835
V*D	1	3433.63	5.56	0.0262
Parameter	Estimate	T for H0=0	Pr > T	Std Error
Intercept	-37.4453	-1.44	0.1614	25.9796
V	1.7633	2.76	0.0105	0.6392
D	0.3921	1.80	0.0835	0.2179
V*D	-0.0137	-2.36	0.0262	0.0058

The significant interaction between soil vulnerability rating and depth to perforations indicated a dependence between these factors when predicting nitrate concentrations. A plot of depth to well perforations in relation to soil vulnerability rating indicated an uneven distribution in well depth across soil vulnerability index (Figure 4). Some wells sampled in soils with lower soil vulnerability ratings had perforations deeper than an average of 150 feet whereas no wells deeper than 150 feet were sampled in the higher soil vulnerability range. Thus, both factors may be important explanatory variables for the concentration of agricultural solutes in well water, but, because of the small sample size in this study, conclusions need to be validated over a greater area. Other geologic and agronomic factors, such as the input of nitrogen per acre, may be important in determining presence or absence of agricultural chemical residues in ground water and could be important in explaining more of the variability in results.

Although the vulnerability rating had been previously derived for a pesticide, DBCP, the goal of that study was to derive a geographic basis for distinguishing between areas sensitive to leaching (Teso et al., 1988). The application of these ratings to other pesticides or inorganic chemicals needs further investigation. However, under agricultural conditions solutes, whether organic or inorganic, leach to ground water as soluble constituents of deep percolating water (Green and Khan, 1987).

Figure 4. Scatter plot of average depth to perforations in well casings and sectional soil vulnerability rating



The extent of leaching will be a function of the reactions between soil components and the chemical, and of the rates at which chemicals are transformed (Rao and Davidson, 1980). These concepts are employed in complex models of solute transport (Otoma and Kuboi, 1985; Wagenet and Hutson, 1986). Thus, an index of geographical leaching vulnerability should be applicable to either pesticide or nutrient leaching. The relationship observed in this study between nitrate concentration and well depth has also been found in Iowa (Hallberg, 1987) and in Ohio (Baker et al., 1989): concentration of nitrate tended to be lower when deeper aquifers were sampled. Factors such as well depth may be important explanatory variables that could aid in interpretation of data from studies designed to relate surface land features with levels of detected ground water contaminants.

## CONCLUSIONS

1. No residues of alachlor, atrazine or metolachlor were found in well water sampled in corn and dry bean growing areas of Merced county, in the San Joaquin Valley. These results were similar to a previous study conducted in corn and dry bean growing areas in the Sacramento Valley.
2. Nitrate was detected in 15 of 30 well water samples. Concentrations of all 15 samples were above 10 ppm and 6 samples contained levels above the 45 ppm EPA Advisory level. Although dairies were located in 14 of the 19 sampled sections, residues were below the level of detection of 0.5 ppm in 5 of those sections. Nitrate was also detected in well water samples taken from sections where dairies were not located. Even though dairies could be a source of nitrogen for residues in well water, the results from this study were inconclusive and would require a larger study to determine the exact source of the contamination.
3. Nitrate concentration in wells were correlated with an index of soil vulnerability to leaching and to the depth of sampled wells. Collecting data on well characteristics could aid in the interpretation of studies intended to relate surface land features with the presence of agricultural chemicals in well water.

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**APPENDIX I**

**PROJECTED PROBABILITY OF CONTAMINATION FOR EACH SECTION  
IN THE MERCED STUDY AREA**

TABLE 16. DIMERFAM.FRB

LINE#	LOCATION	P(O)	P(U)
( 1)	T04S-R12E25	0.42138	0.57862
( 2)	T04S-R12E34	0.19966	0.80034
( 3)	T04S-R12E35	0.27728	0.72272
( 4)	T04S-R12E36	0.42138	0.57862
( 5)	T04S-R13E12	0.32136	0.67864
( 6)	T04S-R13E14	0.32136	0.67864
( 7)	T04S-R13E15	0.32136	0.67864
( 8)	T04S-R13E20	0.32136	0.67864
( 9)	T04S-R13E21	0.32136	0.67864
(10)	T04S-R13E22	0.42138	0.57862
(11)	T04S-R13E23	0.32136	0.67864
(12)	T04S-R13E24	0.32136	0.67864
(13)	T04S-R13E25	0.65522	0.34478
(14)	T04S-R13E26	0.43242	0.56758
(15)	T04S-R13E27	0.74507	0.25493
(16)	T04S-R13E28	0.42138	0.57862
(17)	T04S-R13E29	0.32136	0.67864
(18)	T04S-R13E30	0.32136	0.67864
(19)	T04S-R13E31	0.42138	0.57862
(20)	T04S-R13E32	0.32136	0.67864
(21)	T04S-R13E33	0.42138	0.57862
(22)	T04S-R13E34	0.50030	0.49970
(23)	T04S-R13E35	0.65522	0.34478
(24)	T04S-R13E36	0.32136	0.67864
(25)	T04S-R14E01	0.32136	0.67864
(26)	T04S-R14E02	0.32136	0.67864
(27)	T04S-R14E03	0.32136	0.67864
(28)	T04S-R14E04	0.32136	0.67864
(29)	T04S-R14E05	0.32136	0.67864
(30)	T04S-R14E07	0.32136	0.67864
(31)	T04S-R14E08	0.32136	0.67864
(32)	T04S-R14E09	0.42138	0.57862
(33)	T04S-R14E10	0.32136	0.67864
(34)	T04S-R14E11	0.32136	0.67864
(35)	T04S-R14E12	0.32136	0.67864
(36)	T04S-R14E13	0.32136	0.67864
(37)	T04S-R14E14	0.42138	0.57862
(38)	T04S-R14E15	0.32136	0.67864
(39)	T04S-R14E16	0.32136	0.67864
(40)	T04S-R14E17	0.32136	0.67864
(41)	T04S-R14E18	0.32136	0.67864
(42)	T04S-R14E19	0.53952	0.46048
(43)	T04S-R14E20	0.32136	0.67864
(44)	T04S-R14E21	0.32136	0.67864
(45)	T04S-R14E22	0.32136	0.67864
(46)	T04S-R14E23	0.32136	0.67864
(47)	T04S-R14E24	0.32136	0.67864
(48)	T04S-R14E25	0.19966	0.80034
(49)	T04S-R14E26	0.32136	0.67864
(50)	T04S-R14E27	0.42138	0.57862
(51)	T04S-R14E28	0.42138	0.57862
(52)	T04S-R14E29	0.53952	0.46048
(53)	T04S-R14E30	0.65522	0.34478
(54)	T04S-R14E31	0.64495	0.35505
(55)	T04S-R14E32	0.42138	0.57862
(56)	T04S-R14E33	0.32136	0.67864
(57)	T04S-R14E34	0.32136	0.67864

( 58)	T046-R14E35	0.32136	0.67864
( 59)	T046-R14E36	0.32136	0.67864
( 60)	T046-R15E07	0.32136	0.67864
( 61)	T046-R15E18	0.32136	0.67864
( 62)	T046-R15E19	0.32136	0.67864
( 63)	T046-R15E20	0.19966	0.80034
( 64)	T046-R15E23	0.19966	0.80034
( 65)	T046-R15E30	0.19966	0.80034
( 66)	T046-R15E31	0.32136	0.67864
( 67)	T046-R15E32	0.19966	0.80034
( 68)	T046-R15E33	0.32136	0.67864
( 69)	T055-R10E25	0.86283	0.13717
( 70)	T055-R10E34	0.71604	0.28396
( 71)	T055-R10E35	0.71604	0.28396
( 72)	T055-R10E36	0.86283	0.13717
( 73)	T055-R11E12	0.42138	0.57862
( 74)	T055-R11E13	0.27728	0.72272
( 75)	T055-R11E14	0.19966	0.80034
( 76)	T055-R11E15	0.32136	0.67864
( 77)	T055-R11E20	0.71604	0.28396
( 78)	T055-R11E21	0.79500	0.20500
( 79)	T055-R11E22	0.61615	0.38385
( 80)	T055-R11E23	0.72250	0.27750
( 81)	T055-R11E24	0.61806	0.38194
( 82)	T055-R11E25	0.83171	0.16829
( 83)	T055-R11E26	0.83171	0.16829
( 84)	T055-R11E27	0.51071	0.48929
( 85)	T055-R11E28	0.89130	0.10870
( 86)	T055-R11E29	0.91007	0.08993
( 87)	T055-R11E30	0.86283	0.13717
( 88)	T055-R11E31	0.86283	0.13717
( 89)	T055-R11E32	0.86283	0.13717
( 90)	T055-R11E33	0.86283	0.13717
( 91)	T055-R11E34	0.86283	0.13717
( 92)	T055-R11E35	0.86283	0.13717
( 93)	T055-R11E36	0.75440	0.24560
( 94)	T055-R12E01	0.27728	0.72272
( 95)	T055-R12E02	0.48901	0.51099
( 96)	T055-R12E03	0.48901	0.51099
( 97)	T055-R12E04	0.42138	0.57862
( 98)	T055-R12E05	0.42138	0.57862
( 99)	T055-R12E07	0.27728	0.72272
( 100)	T055-R12E08	0.27728	0.72272
( 101)	T055-R12E09	0.27728	0.72272
( 102)	T055-R12E10	0.60626	0.39374
( 103)	T055-R12E11	0.27728	0.72272
( 104)	T055-R12E12	0.27728	0.72272
( 105)	T055-R12E13	0.74507	0.25493
( 106)	T055-R12E14	0.64495	0.35505
( 107)	T055-R12E15	0.60626	0.39374
( 108)	T055-R12E16	0.60626	0.39374
( 109)	T055-R12E17	0.60626	0.39374
( 110)	T055-R12E18	0.19966	0.80034
( 111)	T055-R12E19	0.60626	0.39374
( 112)	T055-R12E20	0.60626	0.39374
( 113)	T055-R12E21	0.27728	0.72272
( 114)	T055-R12E22	0.27728	0.72272
( 115)	T055-R12E23	0.42138	0.57862
( 116)	T055-R12E24	0.66457	0.33543
( 117)	T055-R12E25	0.42391	0.57609

( 119)	T05S-R12E26	0.56229	0.46711
( 119)	T05S-R12E27	0.71326	0.28665
( 120)	T05S-R12E28	0.82529	0.17471
( 121)	T05S-R12E29	0.48901	0.51099
( 122)	T05S-R12E30	0.80016	0.19984
( 123)	T05S-R12E31	0.83171	0.16829
( 124)	T05S-R12E32	0.83372	0.11628
( 125)	T05S-R12E33	0.88372	0.11628
( 126)	T05S-R12E34	0.63693	0.36305
( 127)	T05S-R12E35	0.64732	0.35268
( 128)	T05S-R12E36	0.42391	0.57609
( 129)	T05S-R13E01	0.42138	0.57862
( 130)	T05S-R13E02	0.74507	0.25493
( 131)	T05S-R13E03	0.54154	0.45846
( 132)	T05S-R13E04	0.43242	0.56758
( 133)	T05S-R13E05	0.65522	0.34478
( 134)	T05S-R13E06	0.27728	0.72272
( 135)	T05S-R13E07	0.19966	0.80034
( 136)	T05S-R13E08	0.65522	0.34478
( 137)	T05S-R13E09	0.60626	0.39374
( 138)	T05S-R13E10	0.49161	0.50839
( 139)	T05S-R13E11	0.64732	0.35268
( 140)	T05S-R13E12	0.36381	0.63619
( 141)	T05S-R13E13	0.22056	0.77944
( 142)	T05S-R13E14	0.42391	0.57609
( 143)	T05S-R13E15	0.07901	0.92099
( 144)	T05S-R13E16	0.64732	0.35268
( 145)	T05S-R13E17	0.53087	0.46913
( 146)	T05S-R13E18	0.32136	0.67864
( 147)	T05S-R13E19	0.53289	0.46711
( 148)	T05S-R13E20	0.42391	0.57609
( 149)	T05S-R13E21	0.42391	0.57609
( 150)	T05S-R13E22	0.03193	0.96807
( 151)	T05S-R13E23	0.07901	0.92099
( 152)	T05S-R13E24	0.42391	0.57609
( 153)	T05S-R13E25	0.37540	0.62460
( 154)	T05S-R13E26	0.19417	0.80583
( 155)	T05S-R13E27	0.42391	0.57609
( 156)	T05S-R13E28	0.42391	0.57609
( 157)	T05S-R13E29	0.42391	0.57609
( 158)	T05S-R13E30	0.42391	0.57609
( 159)	T05S-R13E31	0.53289	0.46711
( 160)	T05S-R13E32	0.53289	0.46711
( 161)	T05S-R13E33	0.75440	0.24560
( 162)	T05S-R13E34	0.75440	0.24560
( 163)	T05S-R13E35	0.61806	0.38194
( 164)	T05S-R13E36	0.48901	0.51099
( 165)	T05S-R14E01	0.26223	0.73777
( 166)	T05S-R14E02	0.27108	0.72894
( 167)	T05S-R14E03	0.53087	0.46913
( 168)	T05S-R14E04	0.53087	0.46913
( 169)	T05S-R14E05	0.30321	0.69679
( 170)	T05S-R14E06	0.27728	0.72272
( 171)	T05S-R14E07	0.12974	0.87026
( 172)	T05S-R14E08	0.43242	0.56758
( 173)	T05S-R14E09	0.42391	0.57609
( 174)	T05S-R14E10	0.31382	0.68618
( 175)	T05S-R14E11	0.28642	0.71358
( 176)	T05S-R14E12	0.28642	0.71358
( 177)	T05S-R14E13	0.19966	0.80034

( 178)	T05S-R14E14	0.38359	0.61641
( 179)	T05S-R14E15	0.61806	0.38194
( 180)	T05S-R14E16	0.53087	0.46913
( 181)	T05S-R14E17	0.53087	0.46913
( 182)	T05S-R14E18	0.42391	0.57609
( 183)	T05S-R14E19	0.66457	0.33543
( 184)	T05S-R14E20	0.32136	0.67864
( 185)	T05S-R14E21	0.32136	0.67864
( 186)	T05S-R14E22	0.32136	0.67864
( 187)	T05S-R14E23	0.32136	0.67864
( 188)	T05S-R14E24	0.32136	0.67864
( 189)	T05S-R14E25	0.32136	0.67864
( 190)	T05S-R14E26	0.32136	0.67864
( 191)	T05S-R14E27	0.32136	0.67864
( 192)	T05S-R14E28	0.32136	0.67864
( 193)	T05S-R14E29	0.42138	0.57862
( 194)	T05S-R14E30	0.61806	0.38194
( 195)	T05S-R14E31	0.32136	0.67864
( 196)	T05S-R14E32	0.32136	0.67864
( 197)	T05S-R14E33	0.32136	0.67864
( 198)	T05S-R14E34	0.32136	0.67864
( 199)	T05S-R14E35	0.32136	0.67864
( 200)	T05S-R14E36	0.32136	0.67864
( 201)	T05S-R15E03	0.55185	0.44815
( 202)	T05S-R15E04	0.66457	0.33543
( 203)	T05S-R15E05	0.43242	0.56758
( 204)	T05S-R15E06	0.38359	0.61641
( 205)	T05S-R15E07	0.22056	0.77944
( 206)	T05S-R15E08	0.38359	0.61641
( 207)	T05S-R15E09	0.65522	0.34478
( 208)	T05S-R15E10	0.32136	0.67864
( 209)	T05S-R15E15	0.32136	0.67864
( 210)	T05S-R15E16	0.65522	0.34478
( 211)	T05S-R15E17	0.54154	0.45846
( 212)	T05S-R15E18	0.32136	0.67864
( 213)	T05S-R15E19	0.32136	0.67864
( 214)	T05S-R15E20	0.32136	0.67864
( 215)	T05S-R15E21	0.32136	0.67864
( 216)	T05S-R15E22	0.32136	0.67864
( 217)	T05S-R15E23	0.32136	0.67864
( 218)	T05S-R15E25	0.32136	0.67864
( 219)	T05S-R15E26	0.42138	0.57862
( 220)	T05S-R15E27	0.42138	0.57862
( 221)	T05S-R15E28	0.32136	0.67864
( 222)	T05S-R15E29	0.32136	0.67864
( 223)	T05S-R15E30	0.32136	0.67864
( 224)	T05S-R15E31	0.32136	0.67864
( 225)	T05S-R15E32	0.32136	0.67864
( 226)	T05S-R15E33	0.32136	0.67864
( 227)	T05S-R15E34	0.32136	0.67864
( 228)	T05S-R15E35	0.19966	0.80034
( 229)	T05S-R15E36	0.43242	0.56758
( 230)	T06S-R09E12	0.32136	0.67864
( 231)	T06S-R09E13	0.71604	0.28396
( 232)	T06S-R09E14	0.32136	0.67864
( 233)	T06S-R09E15	0.54154	0.45846
( 234)	T06S-R09E21	0.43242	0.56758
( 235)	T06S-R09E22	0.65522	0.34478
( 236)	T06S-R09E23	0.12104	0.87896
( 237)	T06S-R09E24	0.54154	0.45846

( 232 )	T06S-R09E25	0.12104	0.87586
( 239 )	T06S-R09E26	0.12104	0.87896
( 240 )	T06S-R09E27	0.28171	0.16829
( 241 )	T06S-R09E28	0.48242	0.56758
( 242 )	T06S-R09E33	0.32136	0.67864
( 243 )	T06S-R09E34	0.01159	0.98841
( 244 )	T06S-R09E35	0.02843	0.97157
( 245 )	T06S-R09E36	0.64732	0.35268
( 246 )	T06S-R10E01	0.55185	0.44815
( 247 )	T06S-R10E02	0.71604	0.28396
( 248 )	T06S-R10E03	0.71604	0.28396
( 249 )	T06S-R10E04	0.55185	0.44815
( 250 )	T06S-R10E05	0.71604	0.28396
( 251 )	T06S-R10E07	0.55185	0.44815
( 252 )	T06S-R10E08	0.71604	0.28396
( 253 )	T06S-R10E09	0.55185	0.44815
( 254 )	T06S-R10E10	0.55185	0.44815
( 255 )	T06S-R10E11	0.71604	0.28396
( 256 )	T06S-R10E12	0.71604	0.28396
( 257 )	T06S-R10E13	0.71604	0.28396
( 258 )	T06S-R10E14	0.86283	0.13717
( 259 )	T06S-R10E15	0.71604	0.28396
( 260 )	T06S-R10E16	0.71604	0.28396
( 261 )	T06S-R10E17	0.55185	0.44815
( 262 )	T06S-R10E18	0.71604	0.28396
( 263 )	T06S-R10E19	0.55185	0.44815
( 264 )	T06S-R10E20	0.71604	0.28396
( 265 )	T06S-R10E21	0.71604	0.28396
( 266 )	T06S-R10E22	0.71604	0.28396
( 267 )	T06S-R10E23	0.71604	0.28396
( 268 )	T06S-R10E24	0.71604	0.28396
( 269 )	T06S-R10E25	0.60109	0.39891
( 270 )	T06S-R10E26	0.64732	0.35268
( 271 )	T06S-R10E27	0.83171	0.16829
( 272 )	T06S-R10E28	0.86283	0.13717
( 273 )	T06S-R10E29	0.86283	0.13717
( 274 )	T06S-R10E30	0.42306	0.57694
( 275 )	T06S-R10E31	0.17526	0.82374
( 276 )	T06S-R10E32	0.78986	0.21014
( 277 )	T06S-R10E33	0.64732	0.35268
( 278 )	T06S-R10E34	0.64732	0.35268
( 279 )	T06S-R10E35	0.17626	0.82374
( 280 )	T06S-R10E36	0.64732	0.35268
( 281 )	T06S-R11E01	0.75440	0.24560
( 282 )	T06S-R11E02	0.71604	0.28396
( 283 )	T06S-R11E03	0.71604	0.28396
( 284 )	T06S-R11E04	0.86283	0.13717
( 285 )	T06S-R11E05	0.86283	0.13717
( 286 )	T06S-R11E06	0.71604	0.28396
( 287 )	T06S-R11E07	0.71604	0.28396
( 288 )	T06S-R11E08	0.71604	0.28396
( 289 )	T06S-R11E09	0.71604	0.28396
( 290 )	T06S-R11E10	0.71604	0.28396
( 291 )	T06S-R11E11	0.70025	0.29975
( 292 )	T06S-R11E12	0.31382	0.68618
( 293 )	T06S-R11E13	0.64732	0.35268
( 294 )	T06S-R11E14	0.64732	0.35268
( 295 )	T06S-R11E15	0.48362	0.51638
( 296 )	T06S-R11E16	0.71604	0.28396
( 297 )	T06S-R11E17	0.71604	0.28396

( 298)	T06S-R11E18	0.71604	0.28396
( 299)	T06S-R11E19	0.15763	0.81237
( 300)	T06S-R11E20	0.07901	0.92099
( 301)	T06S-R11E21	0.14942	0.85058
( 302)	T06S-R11E22	0.64732	0.35268
( 303)	T06S-R11E23	0.31382	0.68618
( 304)	T06S-R11E24	0.55185	0.44815
( 305)	T06S-R11E25	0.86289	0.13717
( 306)	T06S-R11E26	0.71604	0.28396
( 307)	T06S-R11E27	0.11295	0.88705
( 308)	T06S-R11E28	0.14942	0.85058
( 309)	T06S-R11E29	0.42391	0.57609
( 310)	T06S-R11E30	0.72986	0.21014
( 311)	T06S-R11E31	0.55185	0.44815
( 312)	T06S-R11E32	0.55185	0.44815
( 313)	T06S-R11E33	0.71604	0.28396
( 314)	T06S-R11E34	0.71604	0.28396
( 315)	T06S-R11E35	0.71604	0.28396
( 316)	T06S-R11E36	0.86289	0.13717
( 317)	T06S-R12E01	0.53289	0.46711
( 318)	T06S-R12E02	0.39492	0.60508
( 319)	T06S-R12E03	0.20789	0.79261
( 320)	T06S-R12E04	0.64732	0.35268
( 321)	T06S-R12E05	0.83171	0.16829
( 322)	T06S-R12E06	0.75440	0.24560
( 323)	T06S-R12E07	0.53289	0.46711
( 324)	T06S-R12E08	0.64732	0.35268
( 325)	T06S-R12E09	0.41378	0.58622
( 326)	T06S-R12E10	0.20063	0.79937
( 327)	T06S-R12E11	0.28859	0.71141
( 328)	T06S-R12E12	0.75440	0.24560
( 329)	T06S-R12E13	0.54154	0.45846
( 330)	T06S-R12E14	0.54154	0.45846
( 331)	T06S-R12E15	0.54154	0.45846
( 332)	T06S-R12E16	0.54154	0.45846
( 333)	T06S-R12E17	0.75440	0.24560
( 334)	T06S-R12E18	0.53289	0.46711
( 335)	T06S-R12E19	0.75440	0.24560
( 336)	T06S-R12E20	0.75440	0.24560
( 337)	T06S-R12E21	0.54154	0.45846
( 338)	T06S-R12E22	0.54154	0.45846
( 339)	T06S-R12E23	0.54154	0.45846
( 340)	T06S-R12E24	0.54154	0.45846
( 341)	T06S-R12E25	0.54154	0.45846
( 342)	T06S-R12E26	0.54154	0.45846
( 343)	T06S-R12E27	0.54154	0.45846
( 344)	T06S-R12E28	0.54154	0.45846
( 345)	T06S-R12E29	0.75440	0.24560
( 346)	T06S-R12E30	0.75440	0.24560
( 347)	T06S-R12E31	0.75440	0.24560
( 348)	T06S-R12E32	0.75440	0.24560
( 349)	T06S-R12E33	0.75440	0.24560
( 350)	T06S-R12E34	0.54154	0.45846
( 351)	T06S-R12E35	0.54154	0.45846
( 352)	T06S-R12E36	0.54154	0.45846
( 353)	T06S-R13E01	0.32136	0.67864
( 354)	T06S-R13E02	0.42198	0.57862
( 355)	T06S-R13E03	0.74507	0.25499
( 356)	T06S-R13E04	0.82529	0.17471
( 357)	T06S-R13E05	0.75440	0.24560

( 359)	T06S-R13E07	0.51805	0.50134
( 360)	T06S-R13E08	0.48901	0.51099
( 361)	T06S-R13E09	0.64495	0.35505
( 362)	T06S-R13E10	0.74507	0.25493
( 363)	T06S-R13E11	0.42138	0.57862
( 364)	T06S-R13E12	0.32136	0.67864
( 365)	T06S-R13E13	0.42138	0.57862
( 366)	T06S-R13E14	0.42138	0.57862
( 367)	T06S-R13E15	0.42138	0.57862
( 368)	T06S-R13E16	0.19966	0.80034
( 369)	T06S-R13E17	0.27728	0.72272
( 370)	T06S-R13E18	0.48901	0.51099
( 371)	T06S-R13E19	0.38359	0.61641
( 372)	T06S-R13E20	0.19966	0.80034
( 373)	T06S-R13E21	0.27728	0.72272
( 374)	T06S-R13E22	0.27728	0.72272
( 375)	T06S-R13E23	0.48901	0.51099
( 376)	T06S-R13E24	0.27728	0.72272
( 377)	T06S-R13E25	0.19966	0.80034
( 378)	T06S-R13E26	0.48901	0.51099
( 379)	T06S-R13E27	0.19966	0.80034
( 380)	T06S-R13E28	0.19966	0.80034
( 381)	T06S-R13E29	0.19966	0.80034
( 382)	T06S-R13E30	0.38359	0.61641
( 383)	T06S-R13E31	0.54154	0.45846
( 384)	T06S-R13E33	0.38359	0.61641
( 385)	T06S-R13E34	0.19966	0.80034
( 386)	T06S-R13E35	0.38359	0.61641
( 387)	T06S-R13E36	0.38359	0.61641
( 388)	T06S-R14E01	0.32136	0.67864
( 389)	T06S-R14E02	0.32136	0.67864
( 390)	T06S-R14E03	0.32136	0.67864
( 391)	T06S-R14E04	0.32136	0.67864
( 392)	T06S-R14E05	0.32136	0.67864
( 393)	T06S-R14E06	0.32136	0.67864
( 394)	T06S-R14E07	0.32136	0.67864
( 395)	T06S-R14E08	0.32136	0.67864
( 396)	T06S-R14E09	0.32136	0.67864
( 397)	T06S-R14E10	0.32136	0.67864
( 398)	T06S-R14E11	0.32136	0.67864
( 399)	T06S-R14E12	0.32136	0.67864
( 400)	T06S-R14E13	0.32136	0.67864
( 401)	T06S-R14E14	0.32136	0.67864
( 402)	T06S-R14E15	0.32136	0.67864
( 403)	T06S-R14E16	0.32136	0.67864
( 404)	T06S-R14E17	0.32136	0.67864
( 405)	T06S-R14E18	0.32136	0.67864
( 406)	T06S-R14E19	0.19966	0.80034
( 407)	T06S-R14E20	0.19966	0.80034
( 408)	T06S-R14E21	0.32136	0.67864
( 409)	T06S-R14E22	0.32136	0.67864
( 410)	T06S-R14E23	0.32136	0.67864
( 411)	T06S-R14E24	0.32136	0.67864
( 412)	T06S-R14E25	0.32136	0.67864
( 413)	T06S-R14E26	0.32136	0.67864
( 414)	T06S-R14E27	0.32136	0.67864
( 415)	T06S-R14E28	0.32136	0.67864
( 416)	T06S-R14E29	0.19966	0.80034
( 417)	T06S-R14E30	0.19966	0.80034

( 418)	T06S-R14E31	0.19966	0.80034
( 419)	T06S-R14E32	0.32136	0.67864
( 420)	T06S-R14E33	0.32136	0.67864
( 421)	T06S-R14E34	0.32136	0.67864
( 422)	T06S-R14E35	0.42138	0.57862
( 423)	T06S-R14E36	0.32136	0.67864
( 424)	T06S-R15E01	0.43242	0.56758
( 425)	T06S-R15E02	0.32136	0.67864
( 426)	T06S-R15E03	0.32136	0.67864
( 427)	T06S-R15E04	0.32136	0.67864
( 428)	T06S-R15E05	0.32136	0.67864
( 429)	T06S-R15E06	0.32136	0.67864
( 430)	T06S-R15E07	0.32136	0.67864
( 431)	T06S-R15E08	0.32136	0.67864
( 432)	T06S-R15E09	0.32136	0.67864
( 433)	T06S-R15E10	0.32136	0.67864
( 434)	T06S-R15E11	0.32136	0.67864
( 435)	T06S-R15E12	0.32136	0.67864
( 436)	T06S-R15E13	0.32136	0.67864
( 437)	T06S-R15E14	0.32136	0.67864
( 438)	T06S-R15E15	0.32136	0.67864
( 439)	T06S-R15E16	0.32136	0.67864
( 440)	T06S-R15E17	0.32136	0.67864
( 441)	T06S-R15E18	0.32136	0.67864
( 442)	T06S-R15E19	0.32136	0.67864
( 443)	T06S-R15E20	0.32136	0.67864
( 444)	T06S-R15E21	0.32136	0.67864
( 445)	T06S-R15E22	0.54154	0.45846
( 446)	T06S-R15E23	0.32136	0.67864
( 447)	T06S-R15E24	0.43242	0.56758
( 448)	T06S-R15E25	0.28642	0.71358
( 449)	T06S-R15E26	0.19966	0.80034
( 450)	T06S-R15E27	0.38358	0.61641
( 451)	T06S-R15E28	0.32136	0.67864
( 452)	T06S-R15E29	0.32136	0.67864
( 453)	T06S-R15E30	0.32136	0.67864
( 454)	T06S-R15E31	0.32136	0.67864
( 455)	T06S-R15E32	0.32136	0.67864
( 456)	T06S-R15E33	0.32136	0.67864
( 457)	T06S-R15E34	0.32136	0.67864
( 458)	T06S-R15E35	0.28642	0.71358
( 459)	T06S-R15E36	0.28642	0.71358
( 460)	T06S-R16E19	0.43242	0.56758
( 461)	T06S-R16E29	0.32136	0.67864
( 462)	T06S-R16E30	0.32136	0.67864
( 463)	T06S-R16E31	0.32136	0.67864
( 464)	T06S-R16E32	0.43242	0.56758
( 465)	T07S-R09E01	0.41378	0.58622
( 466)	T07S-R09E02	0.41378	0.58622
( 467)	T07S-R09E03	0.22056	0.77944
( 468)	T07S-R09E10	0.41378	0.58622
( 469)	T07S-R09E11	0.30496	0.69504
( 470)	T07S-R09E12	0.11739	0.88261
( 471)	T07S-R09E13	0.29579	0.70421
( 472)	T07S-R09E14	0.32136	0.67864
( 473)	T07S-R09E24	0.14412	0.85588
( 474)	T07S-R10E01	0.86283	0.13717
( 475)	T07S-R10E02	0.86283	0.13717
( 476)	T07S-R10E03	0.64732	0.35268
( 477)	T07S-R10E04	0.17626	0.82374

( 478)	T07S-R10E05	0.42851	0.57609
( 479)	T07S-R10E06	0.42851	0.57609
( 480)	T07S-R10E07	0.20063	0.79937
( 481)	T07S-R10E08	0.01726	0.98274
( 482)	T07S-R10E09	0.01726	0.98274
( 483)	T07S-R10E10	0.28859	0.71141
( 484)	T07S-R10E11	0.71604	0.28396
( 485)	T07S-R10E12	0.71604	0.28396
( 486)	T07S-R10E13	0.71604	0.28396
( 487)	T07S-R10E14	0.71604	0.28396
( 488)	T07S-R10E15	0.14412	0.85588
( 489)	T07S-R10E16	0.28899	0.71141
( 490)	T07S-R10E17	0.45377	0.54623
( 491)	T07S-R10E18	0.69104	0.30896
( 492)	T07S-R10E19	0.47276	0.52724
( 493)	T07S-R10E20	0.24983	0.75017
( 494)	T07S-R10E21	0.14412	0.85588
( 495)	T07S-R10E22	0.32136	0.67864
( 496)	T07S-R10E23	0.55185	0.44815
( 497)	T07S-R10E24	0.71604	0.28396
( 498)	T07S-R10E25	0.55185	0.44815
( 499)	T07S-R10E26	0.55185	0.44815
( 500)	T07S-R10E27	0.32136	0.67864
( 501)	T07S-R10E28	0.32136	0.67864
( 502)	T07S-R10E29	0.32136	0.67864
( 503)	T07S-R10E30	0.32136	0.67864
( 504)	T07S-R10E31	0.32136	0.67864
( 505)	T07S-R10E32	0.32136	0.67864
( 506)	T07S-R10E33	0.32136	0.67864
( 507)	T07S-R10E34	0.32136	0.67864
( 508)	T07S-R10E35	0.32136	0.67864
( 509)	T07S-R10E36	0.32136	0.67864
( 510)	T07S-R11E01	0.71604	0.28396
( 511)	T07S-R11E02	0.71604	0.28396
( 512)	T07S-R11E03	0.71604	0.28396
( 513)	T07S-R11E04	0.71604	0.28396
( 514)	T07S-R11E05	0.71604	0.28396
( 515)	T07S-R11E06	0.71604	0.28396
( 516)	T07S-R11E07	0.71604	0.28396
( 517)	T07S-R11E08	0.71604	0.28396
( 518)	T07S-R11E09	0.71604	0.28396
( 519)	T07S-R11E10	0.71604	0.28396
( 520)	T07S-R11E11	0.71604	0.28396
( 521)	T07S-R11E12	0.71604	0.28396
( 522)	T07S-R11E13	0.55185	0.44815
( 523)	T07S-R11E14	0.71604	0.28396
( 524)	T07S-R11E15	0.71604	0.28396
( 525)	T07S-R11E16	0.71604	0.28396
( 526)	T07S-R11E17	0.71604	0.28396
( 527)	T07S-R11E18	0.71604	0.28396
( 528)	T07S-R11E19	0.86283	0.13717
( 529)	T07S-R11E20	0.71604	0.28396
( 530)	T07S-R11E21	0.71604	0.28396
( 531)	T07S-R11E22	0.86283	0.13717
( 532)	T07S-R11E23	0.86283	0.13717
( 533)	T07S-R11E24	0.71604	0.28396
( 534)	T07S-R11E25	0.86283	0.13717
( 535)	T07S-R11E26	0.86283	0.13717
( 536)	T07S-R11E27	0.91007	0.08993
( 537)	T07S-R11E28	0.70750	0.29250
( 538)	T07S-R11E29	0.86283	0.13717
( 539)	T07S-R11E30	0.86283	0.13717
( 540)	T07S-R11E31	0.55185	0.44815

( 539)	T07S-R11E33	0.71604	0.28396
( 540)	T07S-R11E34	0.70750	0.29250
( 541)	T07S-R11E35	0.55185	0.44815
( 542)	T07S-R11E36	0.55185	0.44815
( 543)	T07S-R12E01	0.54154	0.45846
( 544)	T07S-R12E02	0.54154	0.45846
( 545)	T07S-R12E03	0.54154	0.45846
( 546)	T07S-R12E04	0.75440	0.24560
( 547)	T07S-R12E05	0.75440	0.24560
( 548)	T07S-R12E06	0.86283	0.13717
( 549)	T07S-R12E07	0.86283	0.13717
( 550)	T07S-R12E08	0.86283	0.13717
( 551)	T07S-R12E09	0.75440	0.24560
( 552)	T07S-R12E10	0.54154	0.45846
( 553)	T07S-R12E11	0.54154	0.45846
( 554)	T07S-R12E12	0.75440	0.24560
( 555)	T07S-R12E13	0.75440	0.24560
( 556)	T07S-R12E14	0.54154	0.45846
( 557)	T07S-R12E15	0.54154	0.45846
( 558)	T07S-R12E16	0.86283	0.13717
( 559)	T07S-R12E17	0.86283	0.13717
( 560)	T07S-R12E18	0.75440	0.24560
( 561)	T07S-R12E19	0.71604	0.28396
( 562)	T07S-R12E20	0.86283	0.13717
( 563)	T07S-R12E21	0.71604	0.28396
( 564)	T07S-R12E22	0.75440	0.24560
( 565)	T07S-R12E23	0.54154	0.45846
( 566)	T07S-R12E24	0.54154	0.45846
( 567)	T07S-R12E25	0.54154	0.45846
( 568)	T07S-R12E26	0.54154	0.45846
( 569)	T07S-R12E27	0.86283	0.13717
( 570)	T07S-R12E28	0.55185	0.44815
( 571)	T07S-R12E29	0.71604	0.28396
( 572)	T07S-R12E30	0.71604	0.28396
( 573)	T07S-R12E31	0.71604	0.28396
( 574)	T07S-R12E32	0.71604	0.28396
( 575)	T07S-R12E33	0.55185	0.44815
( 576)	T07S-R12E34	0.75440	0.24560
( 577)	T07S-R12E35	0.75440	0.24560
( 578)	T07S-R12E36	0.54154	0.45846
( 579)	T07S-R13E01	0.19966	0.80034
( 580)	T07S-R13E02	0.19966	0.80034
( 581)	T07S-R13E03	0.38359	0.61641
( 582)	T07S-R13E04	0.38359	0.61641
( 583)	T07S-R13E05	0.54154	0.45846
( 584)	T07S-R13E06	0.54154	0.45846
( 585)	T07S-R13E07	0.75440	0.24560
( 586)	T07S-R13E08	0.54154	0.45846
( 587)	T07S-R13E09	0.54154	0.45846
( 588)	T07S-R13E10	0.38359	0.61641
( 589)	T07S-R13E11	0.19966	0.80034
( 590)	T07S-R13E12	0.28642	0.71358
( 591)	T07S-R13E13	0.28642	0.71358
( 592)	T07S-R13E14	0.19966	0.80034
( 593)	T07S-R13E15	0.38359	0.61641
( 594)	T07S-R13E16	0.54154	0.45846
( 595)	T07S-R13E17	0.75440	0.24560
( 596)	T07S-R13E18	0.75440	0.24560
( 597)	T07S-R13E19	0.54154	0.45846

**APPENDIX II**

**LABORATORY METHODS FOR DETECTION OF ALACHLOR,  
ATRAZINE, METOLACHLOR AND NITRATE**

## I. Sample Analysis

- A. Pour 1,000 mls of Sample into a 2-liter separatory funnel.
- B. Add 60mls of pesticide-grade methylene chloride and shake separatory funnel vigorously for one minute.
- C. Let methylene chloride layer settle to the bottom of the separatory funnel for at least one minute, and then drain the methylene chloride layer (the bottom layer) into a 500ml Kuderna-Danish (KD) apparatus with a 10ml receiver.
- D. Repeat steps "B" & "C" two more times
- E. Place a few boiling chips in the KD, then place the KD on a 100°C boiling water bath and boil until there is less than 5mls of methylene chloride left. Remove the KD from the water bath and let it cool for at least 5 minutes.
- F. Once the KD has cooled for five minutes, add approximately 100mls of pesticide-grade hexane. Place the KD on the water bath and wrap securely with an insulating blanket. Boil the hexane down until only about 5mls are left, then remove KD from the water bath and allow to cool for 5 minutes.
- G. Repeat "F" one more time.
- H. Once the final extraction has cooled, bring the extract up to a final volume of 10.0 mls using hexane.
- I. The extract is now ready for gas-chromatography.

## II. Quality Control

- A. For every extraction set (typically 10 samples) a solvent blank will be run.
- B. The initial methodology study consisted of 3 sets of matrix spikes (5 each) at 0.06/0.4; 0.6/4.0; and 6/40ppb alachlor/metolachlor.

## III. Chromatography

- A. The following chromatographic conditions will be in effect:
  1. Chromatograph: HP5880A
  2. Column: 1.5 $\mu$  SP2250/  
1.95 $\mu$  SP2401 on  
100/120 Supelcoport  
2mm ID \* 2meters  
Packed column  
Flow rate: 27mls/min
  3. Detector: Electron capture (Ni 63)
  4. Oven temperature: Isothermal @ 200°C
  5. Chart speed: 1.0cm/min @ 0.1 min  
0.5cm/min @ 5 min  
0.1cm/min @ 15 min
  6. Runtime stop: 20 minutes
  7. Attenuation: 2<sup>18</sup>
  8. Threshold: 4

Under the above conditions 0.06  $\mu$ g/ml alachlor and 0.4  $\mu$ g/ml metolachlor will elute at 3.38 and 4.25 minutes respectively, with approximate full scale responses



## TEST METHOD

### DETERMINATION OF SIMETRYN AND TERBUTRYN IN WASTEWATER

METHOD 619

#### Scope and Application

- 1.1 This method covers the determination of certain triazine pesticides. The following parameters can be determined by this method:

Parameter	STORET No.	CAS No.
Ametryn	--	834-12-8
Atracyn	--	1610-17-9
Atrazine	39033	1912-24-9
Prometon	39056	1610-18-0
Prometryn	39057	7297-19-6
Proquazone	39024	139-40-2
Seduroneton	--	26259-45-0
Simetryn	39054	1014-70-6
Simazine	39055	122-34-9
Terbutylazine	--	5915-41-3
Terbutryn	--	885-50-0

- 1.2 This is a gas chromatographic (GC) method applicable to the determination of the compounds listed above in industrial and municipal discharges as provided under 40 CFR 136.1. Any modification of this method beyond those expressly permitted, shall be considered a major modification subject to application and approval of alternate test procedures under 40 CFR 136.4 and 136.5.
- 1.3 The estimated method detection limit (MDL, defined in Section 15) for each parameter is listed in Table 1. The MDL for a specific wastewater may differ from those listed, depending upon the nature of interferences in the sample matrix.
- 1.4 The sample extraction and concentration steps in this method are essentially the same as several others in the 500-method series. Thus, a single sample may be extracted to measure the parameters included in the scope of each of these methods. When cleanup is required, the concentration levels must be high enough to permit selecting aliquots, as necessary, in order to apply appropriate cleanup procedures. Under Gas Chromatography, the analyst is allowed the latitude to select chromatographic conditions

Furnace at 400°C for 15 to 30 min. Do not heat volumetric ware. Thermally stable materials such as PCBs, might not be eliminated by this treatment. Thorough rinsing with acetone and pesticide quality hexane may be substituted for the heating. After drying and cooling, seal and store glassware in a clean environment to prevent any accumulation of dust or other contaminants. Store inverted or capped with aluminum foil.

3.1.2 The use of high purity reagents and solvents helps to minimize interference problems. Purification of solvents by distillation in all-glass systems may be required.

3.2 Matrix interferences may be caused by contaminants that are co-extracted from the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature and diversity of the industrial complex or municipality sampled. The cleanup procedure in Section II can be used to overcome many of these interferences, but unique samples may require additional cleanup approaches to achieve the MDL listed in Table 1.

#### 4. Safety

4.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound must be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of material data handling sheets should also be made available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available and have been identified 5-1 for the information of the analyst.

#### 5. Apparatus and Materials

5.1 Sampling equipment, for discrete or composite sampling.

5.1.1 Grab sample bottle - Amber borosilicate or flint glass, 1-liter or 1-quart volume, fitted with screw caps lined with TFE-fluorocarbon. Aluminum foil may be substituted for TFE if the sample is not corrosive. If amber bottles are not available, protect samples from light. The container and cap liner must be washed, rinsed with acetone or methylene chloride, and dried before use to minimize contamination.

5.1.2 Automatic sampler (optional) - Must incorporate glass sample containers for the collection of a minimum of 250 mL. Sample containers must be kept refrigerated at 4°C and protected from light during compositing. If the sampler uses a peristaltic pump, a minimum length of compressible

Furnace at 400°C for 15 to 30 min. Do not heat volumetric ware. Thermally stable materials such as PCBs, might not be eliminated by this treatment. Thorough rinsing with acetone and pesticide quality hexane may be substituted for the heating. After drying and cooling, seal and store glassware in a clean environment to prevent any accumulation of dust or other contaminants. Store inverted or capped with aluminum foil.

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#### 5. Apparatus and Materials

5.1 Sampling equipment, for discrete or composite sampling.

5.1.1 Grab sample bottle - Amber borosilicate or flint glass, 1-liter or 1-quart volume, fitted with screw caps lined with TFE-fluorocarbon. Aluminum foil may be substituted for TFE if the sample is not corrosive. If amber bottles are not available, protect samples from light. The container and cap liner must be washed, rinsed with acetone or methylene chloride, and dried before use to minimize contamination.

5.1.2 Automatic sampler (optional) - Must incorporate glass sample containers for the collection of a minimum of 250 mL. Sample containers must be kept refrigerated at 4°C and protected from light during compositing. If the sampler uses a peristaltic pump, a minimum length of compressible

silicone rubber tubing may be used. Before use, however, the compressible tubing must be thoroughly rinsed with methanol, followed by repeated rinsings with reagent water to minimize the potential for contamination of the sample.

An integrating flow meter is required to collect flow proportional composites.

- 5.2 Glassware (All specifications are suggested. Catalog numbers are included for illustration only.)
  - 5.2.1 Separatory funnel - 2000-mL, with TFE-fluorocarbon stopcock, ground glass or TFE stopper.
  - 5.2.2 Drying column - Chromatographic column 400 mm long x 19 mm ID with coarse fritted disc.
  - 5.2.3 Chromatographic column - 400 mm long x 19 mm ID with coarse fritted disc at bottom and TFE-fluorocarbon stopcock (Kontes K-420540-0224 or equivalent).
  - 5.2.4 Concentrator tube, Kuderna-Danish - 10-mL, graduated (Kontes K-570050-1025 or equivalent). Calibration must be checked at the volumes employed in the test. Ground glass stopper is used to prevent evaporation of extracts.
  - 5.2.5 Evaporative flask, Kuderna-Danish - 500-mL (Kontes K-570001-0500 or equivalent). Attach to concentrator tube with springs.
  - 5.2.6 Snyder column, Kuderna-Danish - three-ball macro (Kontes K-503000-0121 or equivalent).
  - 5.2.7 Vials - Amber glass, 10 to 15 mL capacity with TFE-fluorocarbon lined screw cap.
- 5.3 Boiling chips - approximately 10/40 mesh. Heat at 400°C for 30 min or Soxhlet extract with methylene chloride.
- 5.4 Water bath - Heated, with concentric ring cover, capable of temperature control ( $\pm 2^\circ\text{C}$ ). The bath should be used in a hood.
- 5.5 Balance - Analytical, capable of accurately weighing to the nearest 0.0001 g.
- 5.6 Gas chromatograph - Analytical system complete with gas chromatograph suitable for on-column injection and all required accessories including syringes, analytical columns, gases, detector and strip-chart recorder. A data system is recommended for measuring peak areas.
  - 5.6.1 Column 1 - 180 cm long x 2 mm ID glass, packed with 5% Carbowax 20M-TPA on Supelcoport (80/100 mesh) or

equivalent. This column was used to develop the method performance statements in Section 15. Alternative columns may be used in accordance with the provisions described in Section 12.1.

5.6.2 Column 2 - 180 cm long x 4 mm ID glass, packed with 1.0% Carbowax 20M on Gas Chrom Q (100/120 mesh) or equivalent.

5.6.3 Detector - Thermionic bead in the nitrogen mode. This detector has proven effective in the analysis of wastewaters for the parameters listed in the scope and was used to develop the method performance statements in Section 15. Alternative detectors, including a mass spectrometer, may be used in accordance with the provisions described in Section 12.1.

## 6. Reagents

6.1 Reagent water - Reagent water is defined as a water in which an interferent is not observed at the method detection limit of each parameter of interest.

6.2 Acetone, hexane, methylene chloride, methanol - Pesticide quality or equivalent.

6.3 Ethyl ether - Nanograde, redistilled in glass if necessary. Must be free of peroxides as indicated by EM Quant test strips. (Available from Scientific Products Co., Cat. No. P1125-8, and other suppliers.) Procedures recommended for removal of peroxides are provided with the test strips. After cleanup, 20 mL ethyl alcohol preservative must be added to each liter of ether.

6.4 Sodium sulfate - (ACS) Granular, anhydrous. Heat treat in a shallow tray at 400°C for a minimum of 4 h to remove phthalates and other interfering organic substances. Alternatively, heat 16 h at 450-500°C in a shallow tray or Soxhlet extract with methylene chloride for 48 h.

6.5 Florisil - PR grade (60/100 mesh). Purchase activated at 1250°F and store in dark in glass container with ground glass stopper or foil-lined screw cap. Before use activate each batch at least 16 h at 130°C in a foil covered glass container.

6.6 Stock standard solutions (1.00 µg/µL) - Stock standard solutions may be prepared from pure standard materials or purchased as certified solutions.

6.6.1 Prepare stock standard solutions by accurately weighing approximately 0.0100 g of pure material. Dissolve the material in pesticide quality hexane or other suitable solvent and dilute to volume in a 10-mL volumetric flask. Larger volumes may be used at the convenience of the

analyst. If compound purity is certified at 95% or greater, the weight may be used without correction to calculate the concentration of the stock standard. Commercially prepared stock standards may be used at any concentration if they are certified by the manufacturer or by an independent source.

- 6.6.2 Transfer the stock standard solutions into TFE-fluorocarbon sealed screw cap vials. Store at 4°C and protect from light. Frequently check stock standard solutions for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.
- 6.6.3 Stock standard solutions must be replaced after six months or sooner if comparison with check standards indicates a problem.

## 7. Calibration

7.1 Establish gas chromatographic operating parameters equivalent to those indicated in Table 1. The gas chromatographic system may be calibrated using either the external standard technique (Section 7.2) or the internal standard technique (Section 7.3).

7.2 External standard calibration procedure:

7.2.1 For each parameter of interest, prepare calibration standards at a minimum of three concentration levels by adding accurately measured volumes of one or more stock standards to a volumetric flask and diluting to volume with hexane or other suitable solvent. One of the external standards should be representative of a concentration near, but above, the method detection limit. The other concentrations should correspond to the range of concentrations expected in the sample concentrates or should define the working range of the detector.

7.2.2 Using injections of 1 to 5  $\mu\text{L}$  of each calibration standard, tabulate peak height or area responses against the mass injected. The results can be used to prepare a calibration curve for each parameter. Alternatively, the ratio of the response to the mass injected, defined as the calibration factor (CF), may be calculated for each parameter at each standard concentration. If the relative standard deviation of the calibration factor is less than 10% over the working range, the average calibration factor can be used in place of a calibration curve.

7.2.3 The working calibration curve or calibration factor must be verified on each working shift by the measurement of one or more calibration standards. If the response for any parameter varies from the predicted response by more than  $\pm 10\%$ ,

the test must be repeated using a fresh calibration standard. Alternatively, a new calibration curve or calibration factor must be prepared for that parameter.

7.3 Internal standard calibration procedure: To use this approach, the analyst must select one or more internal standards similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Due to these limitations, no internal standard applicable to all samples can be suggested.

7.3.1 Prepare calibration standards at a minimum of three concentration levels for each parameter of interest by adding volumes of one or more stock standards to a volumetric flask. To each calibration standard, add a known constant amount of one or more internal standards, and dilute to volume with hexane or other suitable solvent. One of the standards should be representative of a concentration near, but above, the method detection limit. The other concentrations should correspond to the range of concentrations expected in the sample concentrates, or should define the working range of the detector.

7.3.2 Using injections of 1 to 5  $\mu$ L of each calibration standard, tabulate the peak height or area responses against the concentration for each compound and internal standard. Calculate response factors (RF) for each compound as follows:

$$RF = (A_s C_{is}) / (A_{is} C_s)$$

where:

$A_s$  = Response for the parameter to be measured.  
 $A_{is}$  = Response for the internal standard.  
 $C_{is}$  = Concentration of the internal standard in  $\mu$ g/L.  
 $C_s$  = Concentration of the parameter to be measured in  $\mu$ g/L.

If the RF value over the working range is constant, less than 10% relative standard deviation, the RF can be assumed to be invariant and the average RF may be used for calculations. Alternatively, the results may be used to plot a calibration curve of response ratios,  $A_s/A_{is}$  against RF.

7.3.3 The working calibration curve or RF must be verified on each working shift by the measurement of one or more calibration standards. If the response for any parameter varies from the predicted response by more than  $\pm 10\%$ , the test must be repeated using a fresh calibration standard. Alternatively, a new calibration curve must be prepared for that compound.

7.4 The cleanup procedure in Section 11 utilizes Florisil chromatography. Florisil from different batches or sources may vary in adsorptive capacity. To standardize the amount of Florisil which

is used, the use of lauric acid value is suggested. This procedure<sup>6</sup> determines the adsorption from hexane solution of lauric acid, in mg, per g of Florisil. The amount of Florisil to be used for each column is calculated by dividing this factor into 110 and multiplying by 20 g.

- 7.5 Before using any cleanup procedure, the analyst must process a series of calibration standards through the procedure to validate elution patterns and the absence of interference from the reagents.

## 8. Quality Control

- 8.1 Each laboratory using this method is required to operate a formal quality control program. The minimum requirements of this program consist of an initial demonstration of laboratory capability and the analysis of spiked samples as a continuing check on performance. The laboratory is required to maintain performance records to define the quality of data that is generated.
  - 8.1.1 Before performing any analyses, the analyst must demonstrate the ability to generate acceptable accuracy and precision with this method. This ability is established as described in Section 6.2.
  - 8.1.2 In recognition of the rapid advances occurring in chromatography, the analyst is permitted certain options to improve the separations or lower the cost of measurements. Each time such modifications to the method are made, the analyst is required to repeat the procedure in Section 6.2.
  - 8.1.3 The laboratory must spike and analyze a minimum of 10% of all samples to monitor continuing laboratory performance. This procedure is described in Section 8.4.
- 8.2 To establish the ability to generate acceptable accuracy and precision, the analyst must perform the following operations.
  - 8.2.1 Select a representative spike concentration for each compound to be measured. Using stock standards, prepare a quality control check sample concentrate in acetone 1000 times more concentrated than the selected concentrations.
  - 8.2.2 Using a pipet, add 1.00 mL of the check sample concentrate to each of a minimum of four 1000-mL aliquots of reagent water. A representative wastewater may be used in place of the reagent water, but one or more additional aliquots must be analyzed to determine background levels, and the spike level must exceed twice the background level for the test to be valid. Analyze the aliquots according to the method beginning in Section 10.
  - 8.2.3 Calculate the average percent recovery (R), and the standard

deviation of the percent recovery ( $s$ ), for the results. Wastewater background corrections must be made before  $R$  and  $s$  calculations are performed.

- 8.2.4 Using the data from Table 2, estimate the recovery and single operator precision expected for the method, and compare these results to the values calculated in Section 8.2.3. If the data are not comparable, review potential problem areas and repeat the test.
- 8.3 The analyst must calculate method performance criteria and define the performance of the laboratory for each spike concentration and parameter being measured.
- 8.3.1 Calculate upper and lower control limits for method performance as follows:  
Upper Control Limit (UCL) =  $R + 3s$   
Lower Control Limit (LCL) =  $R - 3s$   
where  $R$  and  $s$  are calculated as in Section 8.2.3. The UCL and LCL can be used to construct control charts<sup>9</sup> that are useful in observing trends in performance.
- 8.3.2 The laboratory must develop and maintain separate accuracy statements of laboratory performance for wastewater samples. An accuracy statement for the method is defined as  $R \pm s$ . The accuracy statement should be developed by the analysis of four aliquots of wastewater as described in Section 8.2.2, followed by the calculation of  $R$  and  $s$ . Alternatively, the analyst may use four wastewater data points gathered through the requirement for continuing quality control in Section 8.4. The accuracy statements should be updated regularly.<sup>9</sup>
- 8.4 The laboratory is required to collect in duplicate a portion of their samples to monitor spike recoveries. The frequency of spiked sample analysis must be at least 10% of all samples or one spiked sample per month, whichever is greater. One aliquot of the sample must be spiked and analyzed as described in Section 8.2. If the recovery for a particular parameter does not fall within the control limits for method performance, the results reported for that parameter in all samples processed as part of the same set must be qualified as described in Section 13.3. The laboratory should monitor the frequency of data so qualified to ensure that it remains at or below 5%.
- 8.5 Before processing any samples, the analyst must demonstrate through the analysis of a 1-liter aliquot of reagent water that all glassware and reagents interferences are under control. Each time a set of samples is extracted or there is a change in reagents, a laboratory reagent blank must be processed as a safeguard against laboratory contamination.

8.6 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory and the nature of the samples. Field duplicates may be analyzed to monitor the precision of the sampling technique. When doubt exists over the identification of a peak on the chromatogram, confirmatory techniques such as gas chromatography with a dissimilar column, specific element detector, or mass spectrometer must be used. Whenever possible, the laboratory should perform analysis of quality control materials and participate in relevant performance evaluation studies.

## 9. Sample Collection, Preservation, and Handling

- 9.1 Grab samples must be collected in glass containers. Conventional sampling practices should be followed; however, the bottle must not be prerinsed with sample before collection. Composite samples should be collected in refrigerated glass containers in accordance with the requirements of the program. Automatic sampling equipment must be as free as possible of plastic and other potential sources of contamination.
- 9.2 The samples must be iced or refrigerated at 4°C from the time of collection until extraction.
- 9.3 All samples must be extracted within seven days and completely analyzed within 40 days of extraction.

## 10. Sample Extraction

- 10.1 Mark the water meniscus on the side of the sample bottle for later determination of sample volume. Pour the entire sample into a 2-liter separatory funnel.
- 10.2 Add 60 mL methylene chloride to the sample bottle, seal, and shake 30 s to rinse the inner walls. Transfer the solvent to the separatory funnel and extract the sample by shaking the funnel for 2 min with periodic venting to release excess pressure. Allow the organic layer to separate from the water phase for a minimum of 10 min. If the emulsion interface between layers is more than one third the volume of the solvent layer, the analyst must employ mechanical techniques to complete the phase separation. The optimum technique depends upon the sample, but may include stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods. Collect the methylene chloride extract in a 250-mL Erlenmeyer flask.
- 10.3 Add a second 60-mL volume of methylene chloride to the sample bottle and repeat the extraction procedure a second time, combining the extracts in the Erlenmeyer flask. Perform a third extraction in the same manner.

- 10.4 Assemble a Kuderna-Danish (K-D) concentrator by attaching a 10-mL concentrator tube to a 500-mL evaporative flask. Other concentration devices or techniques may be used in place of the K-D if the requirements of Section 8.2 are met.
- 10.5 Pour the combined extract through a drying column containing about 10 cm of anhydrous sodium sulfate, and collect the extract in the K-D concentrator. Rinse the Erlenmeyer flask and column with 20 to 30 mL of methylene chloride to complete the quantitative transfer.
- 10.6 Add 1 or 2 clean boiling chips to the evaporative flask and attach a three-ball Snyder column. Prewet the Snyder column by adding about 1 mL methylene chloride to the top. Place the K-D apparatus on a hot water bath, 60 to 65°C, so that the concentrator tube is partially immersed in the hot water, and the entire lower rounded surface of the flask is bathed with hot vapor. Adjust the vertical position of the apparatus and the water temperature as required to complete the concentration in 15 to 20 min. At the proper rate of distillation, the balls of the column will actively chatter but the chambers will not flood with condensed solvent. When the apparent volume of liquid reaches 1 mL, remove the K-D apparatus and allow it to drain and cool for at least 10 min.
- 10.7 Increase the temperature of the hot water bath to about 80°C. Momentarily remove the Snyder column, add 50 mL of hexane and a new boiling chip and reattach the Snyder column. Pour about 1 mL of hexane into the top of the Snyder column and concentrate the solvent extract as before. Elapsed time of concentration should be 5 to 10 min. When the apparent volume of liquid reaches 1 mL, remove the K-D apparatus and allow it to drain and cool for at least 10 min.
- 10.8 Remove the Snyder column and rinse the flask and its lower joint into the concentrator tube with 1 to 2 mL of hexane and adjust the volume to 10 mL. A 5-mL syringe is recommended for this operation. (Note: Precipitation of triazines in the hexane may occur if the concentration in the original sample exceeded 500 µg/L. If this occurs, redissolve the triazines in methylene chloride and analyze the extract using flame ionization gas chromatography.) Stopper the concentrator tube and store refrigerated if further processing will not be performed immediately. If the extracts will be stored longer than two days, they should be transferred to TFE-fluoro-carbon sealed screw-cap vials. If the sample extract requires no further cleanup, proceed with gas chromatographic analysis. If the sample requires cleanup, proceed to Section 11.
- 10.9 Determine the original sample volume by refilling the sample bottle to the mark and transferring the water to a 1000-mL graduated cylinder. Record the sample volume to the nearest 5 mL.

## 11. Cleanup and Separation

11.1 Cleanup procedures may not be necessary for a relatively clean sample matrix. The cleanup procedure recommended in this method has been used for the analysis of various industrial and municipal effluents. If particular circumstances demand the use of an alternative cleanup procedure, the analyst must determine the elution profile and demonstrate that the recovery of each compound of interest for the cleanup procedure is no less than 85%.

11.2 The following Florisil column cleanup procedure has been demonstrated to be applicable to the nine triazine pesticides listed in Table 3.

11.2.1 Add a weight of Florisil (nominally 20 g) predetermined by calibration (Section 7.4 and 7.5), to a chromatographic column. Settle the Florisil by tapping the column. Add anhydrous sodium sulfate to the top of the Florisil to form a layer 1 to 2 cm deep. Add 50 mL of hexane to wet and rinse the sodium sulfate and Florisil. Just prior to exposure of the sodium sulfate to air, stop the elution of the hexane by closing the stopcock on the chromatography column. Discard the eluate.

11.2.2 Adjust the sample extract volume to 10 mL with hexane and transfer it from the K-D concentrator tube to the Florisil column. Rinse the tube twice with 1 to 2 mL hexane, adding each rinse to the column.

11.2.3 Drain the column until the sodium sulfate layer is nearly exposed. Elute the column with 200 mL of 6% ethyl ether in hexane (V/V) (Fraction 1) using a drip rate of about 5 mL/min. This fraction may be discarded. Place a 500-mL K-D flask and clean concentrator tube under the chromatography column. Elute the column into the flask, using 200 mL of 15% ethyl ether in hexane (V/V) (Fraction 2). Perform a third elution using 200 mL of 50% ethyl ether in hexane (V/V) (Fraction 3), and a final elution with 200 mL of 100% ethyl ether (Fraction 4), into separate K-D flasks. The elution patterns for nine of the pesticides are shown in Table 3.

11.2.4 Concentrate the eluates by standard K-D techniques (Section 10.6), substituting hexane for the glassware rinses and using the water bath at about 85°C. Adjust final volume to 10 mL with hexane. Analyze by gas chromatography.

## 12. Gas Chromatography

12.1 Table 1 summarizes the recommended operating conditions for the gas chromatograph. Included in this table are estimated retention times and method detection limits that can be achieved by this

method. An example of the separation achieved by Column 1 is shown in Figure 1. Other packed columns, chromatographic conditions, or detectors may be used if the requirements of Section 8.2 are met. Capillary (open-tubular) columns may also be used if the relative standard deviations of responses for replicate injections are demonstrated to be less than 6% and the requirements of Section 8.2 are met.

12.2 Calibrate the system daily as described in Section 7.

12.3 If the internal standard approach is being used, add the internal standard to sample extracts immediately before injection into the instrument. Mix thoroughly.

12.4 Inject 1 to 5  $\mu\text{L}$  of the sample extract using the solvent-flush technique.<sup>11</sup> Record the volume injected to the nearest 0.05  $\mu\text{L}$ , and the resulting peak size in area or peak height units. An automated system that consistently injects a constant volume of extract may also be used.

12.5 The width of the retention time window used to make identifications should be based upon measurements of actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time can be used to calculate a suggested window size for a compound. However, the experience of the analyst should weigh heavily in the interpretation of chromatograms.

12.6 If the response for the peak exceeds the working range of the system, dilute the extract and reanalyze.

12.7 If the measurement of the peak response is prevented by the presence of interferences, further cleanup is required.

### 13. Calculations

13.1 Determine the concentration of individual compounds in the sample.

13.1.1 If the external standard calibration procedure is used, calculate the amount of material injected from the peak response using the calibration curve or calibration factor in Section 7.2.2. The concentration in the sample can be calculated as follows:

$$\text{Concentration, } \mu\text{g/L} = \frac{(A)(V_t)}{(V_i)(V_s)}$$

where:

- A = Amount of material injected, in nanograms.
- $V_i$  = Volume of extract injected in  $\mu\text{L}$ .
- $V_t$  = Volume of total extract in  $\mu\text{L}$ .
- $V_s$  = Volume of water extracted in mL.

13.1.2 If the internal standard calibration procedure was used, calculate the concentration in the sample using the response factor (RF) determined in Section 7.3.2 as follows:

$$\text{Concentration, } \mu\text{g/L} = \frac{(A_s)(I_s)}{(A_{is})(RF)(V_o)}$$

where:

- $A_s$  = Response for the parameter to be measured.
- $A_{is}$  = Response for the internal standard.
- $I_s$  = Amount of internal standard added to each extract in  $\mu\text{g}$ .
- $V_o$  = Volume of water extracted, in liters.

13.2 Report results in micrograms per liter without correction for recovery data. When duplicate and spiked samples are analyzed, report all data obtained with the sample results.

13.3 For samples processed as part of a set where the laboratory spiked sample recovery falls outside of the control limits in Section 8.3, data for the affected parameters must be labeled as suspect.

#### 14. GC/MS Confirmation

14.1 It is recommended that GC/MS techniques be judiciously employed to support qualitative compound identifications made with this method. The mass spectrometer should be capable of scanning the mass range from 35 amu to a mass 50 amu above the molecular weight of the compound. The instrument must be capable of scanning the mass range at a rate to produce at least 5 scans per peak but not to exceed 7 s per scan utilizing a 70 V (nominal) electron energy in the electron impact ionization mode. A GC to MS interface constructed of all-glass or glass-lined materials is recommended. A computer system should be interfaced to the mass spectrometer that allows the continuous acquisition and storage on machine readable media of all mass spectra obtained throughout the duration of the chromatographic program.

14.2 Gas chromatographic columns and conditions should be selected for optimum separation and performance. The conditions selected must be compatible with standard GC/MS operating practices. Chromatographic tailing factors of less than 5.0 must be achieved.<sup>12</sup>

14.3 At the beginning of each day that confirmatory analyses are to be performed, the GC/MS system must be checked to see that all decafluorotriphenyl phosphine (DFTPP) performance criteria are achieved.<sup>13</sup>

14.4 To confirm an identification of a compound, the background corrected mass spectrum of the compound must be obtained from the sample extract and compared with a mass spectrum from a stock or calibration standard analyzed under the same chromatographic

conditions. It is recommended that at least 25 nanograms of material be injected into the GC/MS. The criteria below must be met for qualitative confirmation.

14.4.1 All ions that are present above 10% relative abundance in the mass spectrum of the standard must be present in the mass spectrum of the sample with agreement to plus or minus 10%. For example, if the relative abundance of an ion is 30% in the mass spectrum of the standard, the allowable limits for the relative abundance of that ion in the mass spectrum for the sample would be 20% to 40%.

14.4.2 The retention time of the compound in the sample must be within 6 seconds of the same compound in the standard solution.

14.4.3 Compounds that have very similar mass spectra can be explicitly identified by GC/MS only on the basis of retention time data.

14.5 Where available, chemical ionization mass spectra may be employed to aid in the qualitative identification process.

14.6 Should these MS procedures fail to provide satisfactory results, additional steps may be taken before reanalysis. These may include the use of alternate packed or capillary GC columns or additional cleanup (Section 11).

## 15. Method Performance

15.1 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero.<sup>14</sup> The MDL concentrations listed in Table 1 were estimated from the response of the thermionic bead nitrogen detector to each compound. The estimate is based upon the amount of material required to yield a signal five times the GC background noise, assuming a 5- $\mu$ L injection from a 10-mL final extract of a 1-liter sample.

15.2 In a single laboratory (either West Cost Technical Services, Inc. or Midwest Research Institute), using effluents from pesticide manufacturers and publicly owned treatment works (POTW), the average recoveries presented in Table 2 were obtained after Florisil cleanup.<sup>1,2</sup> The standard deviations of the percent recoveries of these measurements are also included in Table 2.

## References

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15. "Determination of Triazine in Industrial and Municipal Wastewater," Method 619, EPA No. 600/4-82-007, NTIS No. PB82-156019, January 1982, National Technical Information Center, 5285 Port Royal Road, Springfield, VA, 22165.

TABLE 1  
CHROMATOGRAPHIC CONDITIONS AND METHOD DETECTION LIMITS

Parameter	Retention Time (min.)		Method Detection Limit (ug/L)
	Column 1	Column 2	
Prometon	6.9	4.9	0.03
Atraton	--	6.3	ND
Propazine	9.2	6.7	0.03
Terbutylazine	10.2	7.3	0.03
Secbumeton	--	8.3	ND
Atrazine	12.4	9.4	0.05
Prometryn	13.8	10.3	0.06
Terbutryn	15.4	--	0.05
Simazine	16.3	12.7	0.06
Ametryn	17.7	14.0	0.06
Simetryn	23.0	--	0.07

ND = Not determined

Column 1 conditions: Supelcoport (80/100 mesh) coated with 5% Carbowax 2CM-TPA packed in a 1.8 m long x 2 mm ID glass column with helium carrier gas at a flow rate of 30 mL/min. Column temperature, isothermal at 200°C. A thermionic bead detector was used with this column to determine the MDL.

Column 2 conditions: Gas Chrom Q (100/120 mesh) coated with 1.0% Carbowax 20 M packed in a 1.8 m long x 4 mm ID glass column with helium carrier gas at 80 mL/min flow rate. Column temperature, isothermal at 155°C.

TABLE 2  
SINGLE LABORATORY ACCURACY AND PRECISION

Parameter	Sample Type*	Spike (ug/L)	Number of Replicates	Mean Recovery (%)	Standard Deviation (%)
Ametryn	3	4,000	2	104	--
	3	2,000	2	118	--
Atrazine	3	300	2	108	--
	1	1,000	7	177	15.2
Prometon	1	130	7	67	3.9
	2	250	7	51	3.0
Prometryn	3	2,000	2	76	--
	3	50	2	110	--
Propazine	1	516	7	54	6.5
	3	15	2	116	--
Simetryn	3	30	2	183	--
	3	15	2	182	--
Simazine	1	115	7	152	24.3
	3	10	2	99	--
Terbuthylazine	3	100	2	114	--
	3	15	2	100	--
Terbutryn	1	968	7	83	10.0
	2	169	7	89	24.0

\*Sample Type

- 1 - Industrial process water
- 2 - Industrial effluent
- 3 - 80% Industrial process water/20% industrial effluent

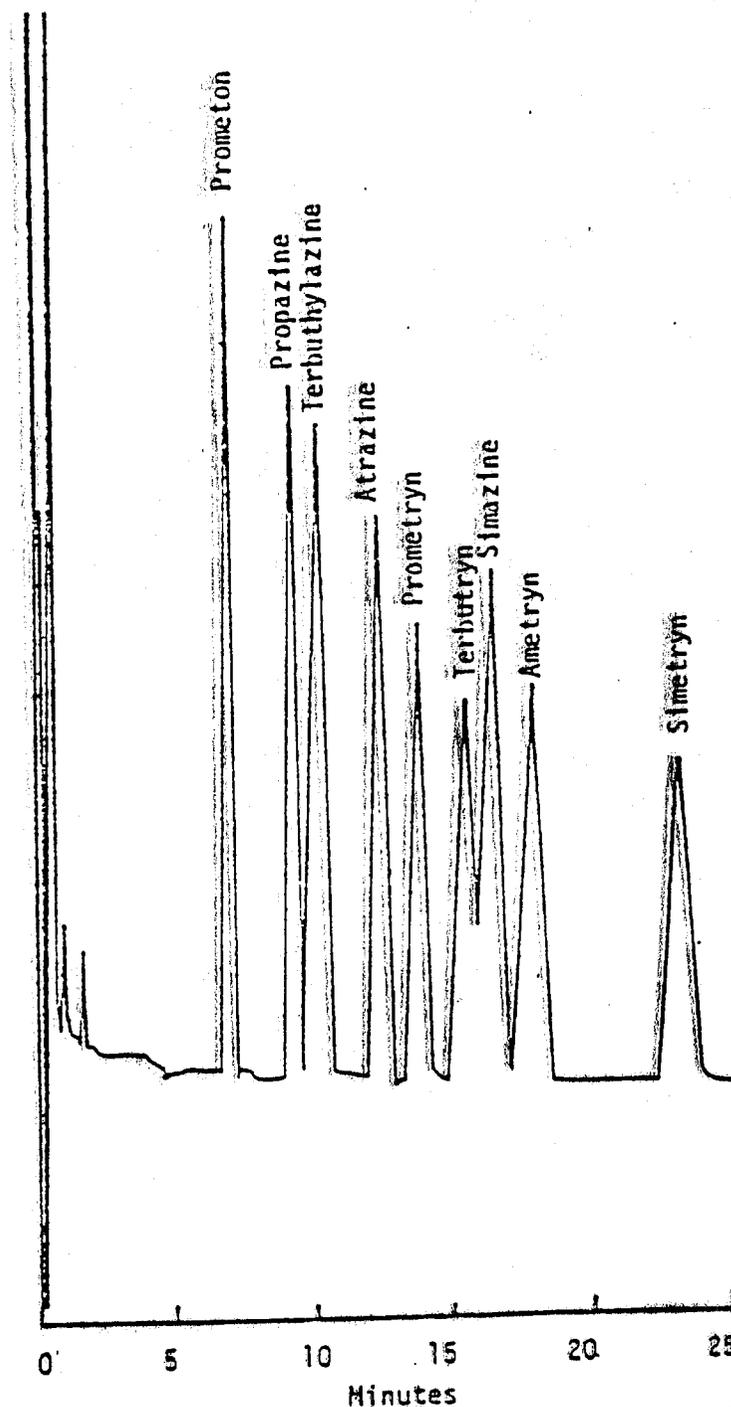


Figure 1. Gas chromatogram of triazine pesticides on Column 1. For conditions, see Table 1.

CALIFORNIA DEPT. OF FOOD & AGRIC.  
CHEMISTRY LABORATORY SERVICES  
ENVIRONMENTAL MONITORING SECTION  
3292 Meadowview Road  
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(916)+427-4998/4999

Original Date:??  
Supercedes: NEW  
Current Date:1/28/88  
Method #:

### Alachlor, Atrazine and Metolachlor in Water

#### SCOPE:

This method is for the extraction and analysis of Alachlor, Atrazine and Metolachlor in water.

#### PRINCIPLE:

Alachlor, Atrazine and Metolachlor are extracted from water with methylene chloride and the extracts are analyzed by gas chromatography.

#### REAGENTS AND EQUIPMENT:

Ethyl acetate, ACS certified or equivalent  
Methylene chloride, ACS certified or equivalent  
Sodium sulfate, anhydrous

Separatory funnels, 1000 ml  
Glass wool  
Boiling flasks, 500 ml  
Rotary evaporator (Buchi-Brinkman, R110)  
Pasteur pipettes, disposable  
Test tubes, 15 ml graduated  
Water bath (temperature = 37°C)  
Funnels, glass-stemmed  
Graduated cylinders, 1000 ml

#### ANALYSIS:

1. Measure 800 ml of well-mixed water into a separatory funnel.
2. Add 100 ml of methylene chloride, shake for 5 minutes and allow 15 minutes for phase separation.
3. Filter the lower methylene chloride layer through glass wool and sodium sulfate into a 500 ml round bottom flask.
4. Repeat the extraction twice more.
5. Combine the three extracts into the 500 ml evaporating flask and rinse the sodium sulfate with 25 ml methylene chloride.
6. Rotary evaporate the methylene chloride just to dryness.

7. Dissolve the residue in the flask with ethyl acetate and transfer quantitatively to a graduated test tube.
8. Reduce the volume to 5 ml on a water bath under a stream of nitrogen.
9. Analyze by gas chromatography.

## EQUIPMENT CONDITIONS:

1. Varian 3700 gas chromatograph with Hewlett-Packard 7672 Autosampler and Hewlett-Packard 3388A Data System; TSD Detector; Column: Methyl silicone megabore, 0.53 mm x 10 m; Column conditions: Temperature(initial)=140°C hold for one minute, Temperature(final)=163°C, hold for three minutes; Rate: 5°C/minute; Carrier gas : Helium; Carrier gas flow: 10 ml/minute; Injector temperature=210°C; Grob injection; Detector temperature: 275°C.
2. Varian Vista 6000 gas chromatograph with autosampler and Varian 604 Data System; TSD Detector; Column: 50% Phenyl methyl Silicone Megabore, 0.53 mm x 10 m; Column conditions: Temperature (initial)=150°C; Temperature (final)=195°C; Rate: 6°C/minute; Carrier gas: Helium; Carrier gas flow: 12 ml/minute; Injector temperature=220°C, Grob injection; Detector temperature: 275°C.

## CALCULATIONS:

ppb (Atrazine, Alachlor or Metolachlor) =

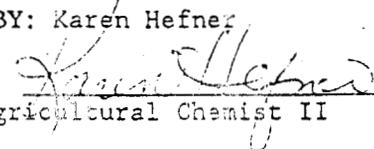
Sample peak height	ng standard injected	sample final volume (ml)
----- X	----- X	-----
Standard peak height	volume sample injected (ml)	g sample (in aliquot)

## REFERENCES:

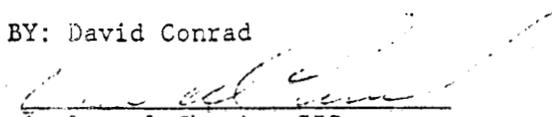
Lauer, R., Horner, L. M. and Klein, A. J., *Determination of Alachlor and Eight Other Pesticides in Raw Surface Water Using Capillary Gas Chromatography*

United States Environmental Protection Agency, Water and Waste Management, *Determination of Alachlor, Butachlor, and Propachlor in Waste Water, Method 102*, January 1983.

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TITLE: Agricultural Chemist II

APPROVED BY: David Conrad

  
TITLE: Agricultural Chemist III

## WATER NITRATES: AUTOANALYZER METHOD

**EQUIPMENT:** Lachat Autoanalyzer System with nitrate module  
Tubing, Blue, Size 0.065 mm id for Ammonium Chloride  
Tubing, Red, Size 0.045 mm id for Color Reagent  
Cadium reduction tube  
Standard Laboratory Glassware

### **REAGENTS:**

1. Deionized water, DI.
2. Ammonium Chloride Solution: Dissolve 40 g of ammonium chloride and 400 mg of disodium EDTA in distilled water and dilute to 4 liters in a brown bottle. Adjust the pH to 8.5 with concentrated ammonium hydroxide. Store in the refrigerator.
3. Color Reagent: Place 2800 ml of DI water in a beaker and carefully add 400 ml concentrated phosphoric acid,  $H_3PO_4$ . Add 4.0 g of N-1-naphthylethylenediamine dihydrochloride. Mix well and dilute to 4 liters. Store in a brown bottle in the refrigerator.
4. Nitrate-N Stock Standard, 1000 ppm: Weigh 7.216 g potassium nitrate,  $KNO_3$ , (dried at 100°C overnight), into a 1 liter volumetric flask. Dilute to the mark with DI water. (Stable 1 year).

Prepare a 100 ppm intermediate stock solution from the 1000 ppm stock using the DI water as the diluent.

Prepare working standard of 1,2,5, and 10 ppm Nitrate-N from the 100 ppm intermediate standard using the DI water as the diluent.

### **PROCEDURE:**

1. Set up the Lachat Autoanalyzer with the nitrate module including cadmium column according to the instrument instructions with the proper reagents, cycle time and sampling time.

2. Fill the autosampler vials with the filtered sample solutions and with the working standard, 0,1,2,5 and 10 ppm.
3. Place the carriage on the autosampler and run the samples through the autoanalyzer.
4. If samples peaks go off scale on the recorder, dilute the sample with 1N KCl solution and rerun through the autoanalyzer. (Keep track of all dilutions on the worksheet).
9. Calculations:
  - A. Measure the height of the peaks on the chart paper. Using the calculator linear regression program, enter the standards as 0,5,10,25, and 50 ppm to account for the dilution factor.
  - B. Check the linear regression coefficient and write it on the worksheet. Enter the height values for the samples and write the results on the worksheets. Multiply by the appropriate dilutions if any were made.
10. Submit the results for approval ASAP.

**APPENDIX III**

**QUALITY CONTROL DATA FOR BLANK AND SPLIT SAMPLES**

Table III-1. Recovery results for blank and spiked sample analyses conducted by Chemistry Services, California Department of Food and Agriculture (CDFA), Sacramento, California and Agricultural Priority Pollutants Laboratory (APPL), Fresno, California.

Pesticide	CDFA		APPL	
	Amount Added	Recovery	Amount Added	Recovery
	-----ppb-----	---%---	-----ppb-----	---%---
Atrazine	1.5	92	1.2	76.3
	5.0	104	1.2	71.4
	6.6	107	1.2	80.3
	6.6	104	1.2	92.1
	6.6	100	12.0	119.0
	9.0	113	12.0	108.0
			12.0	115.0
		12.0	83.5	
Alachlor	2.6	109	0.06	66.7
	5.0	81	0.06	71.5
	5.9	99	0.06	70.0
	5.9	109	0.06	100.7
	5.9	109	0.06	60.8
	8.0	88	0.6	82.0
			0.6	73.1
			0.6	91.6
			0.6	93.0
			0.6	95.4
			6.0	87.1
			6.0	68.3
			6.0	89.5
			6.0	85.7
		6.0	83.9	
Metolachlor	3.0	88	0.4	70.7
	5.0	75	0.4	82.8
	6.6	87	0.4	89.9
	6.6	86	0.4	113.5
	6.6	83	0.4	117.9
	9.0	80	4.0	77.6
			4.0	77.0
			4.0	77.5
			4.0	76.4
			4.0	79.4
			40.0	74.5
			40.0	67.5
			40.0	72.0
			40.0	72.8
		40.0	72.9	

**APPENDIX IV**

**LAND USE SURVEY CONDUCTED FOR EACH SECTION**

LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY

INFORMATION ON EACH SAMPLED SECTION INCLUDE:

TOWNSHIP, RANGE, AND SECTION.

CODES OF THE WELL(S) SAMPLED IN THE SECTION.

CROPS AND OTHER LAND USES ARE APPROXIMATIONS LISTED BY PERCENT OF SECTION COVERED.

SUMMER 1987 USES ARE ESTIMATES BASED ON DWR LAND USE MAPS.

WINTER 1987 USES ARE ESTIMATES BASED ON EHAP LAND USE SURVEYS.

IRRIGATION TYPES WERE RECORDED DURING THE EHAP SURVEY, IF NO TYPE IS LISTED IT IS PROBABLY FLOOD IRRIGATION.

LENGTH OF RIVERS, CANALS & DITCHES, AND ROADS ARE APPROXIMATIONS BASED ON USGS QUADRANGLE MAPS, AND EHAP SURVEYS.

NUMBER OF WELLS ARE A ROUGH NUMBER OF WELLS WHICH WERE EASILY SEEN DURING THE EHAP SURVEY.

FOR EACH SAMPLED WELL THE NEAREST CROP(S) OR USES ARE LISTED.

DIFFERENCES BETWEEN 1987 LAND USE AND 1989 LAND USE MAY BE DUE TO MANY FACTORS, INCLUDING:

- CHANGES IN CROPPING PATTERNS,
- SEASONAL CROPPING PATTERNS (GRAIN IN THE WINTER/CORN IN THE SUMMER),
- DIFFERENCES IN SURVEYING TECHNIQUES,
- ETC.

**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/9E-25**

**WELLS IN SECTION: A6**

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
ALFALFA	17	ALFALFA	24
CORN	75	DAIRY	7
DAIRY	6	GRAIN	64
MIXED PASTURE	2	IDLE	3
		MIXED PASTURE	2

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 1 MILE  
**ROADS:** 4 MILES  
**DOMESTIC WELLS:** 6  
**IRRIGATION WELLS:** 1  
**OTHER FEATURES:**  
 A06 IN GRAIN/ CORN AREA.  
 ND,ND

65

607-XLS  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-07**

**WELLS IN SECTION: B04,B10**

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
ALFALFA	22	ALFALFA	10
ALMONDS	6	DAIRY	13
CORN	5	DECIDUOUS	7 flood
DAIRY	6	GRAIN	57
IDLE	4	IDLE	11
MIXED PASTURE	9	MIXED PASTURE	2
NATIVE VEGETATION	1		

**ADDITIONAL INFORMATION:** 1987 PERCENTAGES INCLUDE ONLY THE 53% IN MERCED COUNTY

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 3 MILES  
**ROADS:** 6 MILES  
**DOMESTIC WELLS:** 21  
**IRRIGATION WELLS:** 0  
**OTHER FEATURES:**

B04 IN ALFALFA NEAR GRAIN/CORN AND IDLE LAND.  
 66.4, 65.1 ppm  
 B10 IN GRAIN AREA FORMERLY ALFALFA.  
 55.0, 54.6 ppm

DAIRY HOLDING POND

**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-17**

**WELLS IN SECTION: B3**

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
ALFALFA	14	ALFALFA	1
ALMONDS	21	DAIRY	11
CORN	49	DECIDUOUS	24 flood
DAIRY	9	GRAIN	50
MIXED PASTURE	1	IDLE	4
NATIVE VEGETATION	1	MIXED PASTURE	7
NURSERY	4	NURSERY	3
PEACHES	1		

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 1.5 MILES  
**ROADS:** 5 MILES  
**DOMESTIC WELLS:** 13  
**IRRIGATION WELLS:** 1  
**OTHER FEATURES:**

B03 IN DAIRY.  
 23.7, 24.6 ppm

DAIRY HOLDING POND  
 CHRISTMAS TREE FARM

S19 X16  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-19**

**WELLS IN SECTION: B2**

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
ALFALFA	2	DAIRY	15
CORN	62	GRAIN	64
DAIRY	14	IDLE	8
MIXED PASTURE	21	MIXED PASTURE	13
NATIVE VEGETATION	1		

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 2.5 MILES  
**ROADS:** 5 MILES  
**DOMESTIC WELLS:** 12  
**IRRIGATION WELLS:** 0  
**OTHER FEATURES:**

B02 IN GRAIN/CORN AREA.  
 14.5,17.2 ppm

DAIRY HOLDING POND

629-X16  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-22**

**WELLS IN SECTION: C8**

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
ALFALFA	4	ALFALFA	15
ALMONDS	18	DAIRY	11
CORN	43	DECIDUOUS	20 flood & sprinkler
DAIRY	9	GRAIN	33
GRAPES	10	IDLE	2
IDLE	1	MIXED PASTURE	5
MIXED PASTURE	1	PARK-LAWN AREA	3
PARK-LAWN AREA	4	RESIDENTIAL	11
RESIDENTIAL	9		
WALNUTS	1		

69

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 1.5 MILES  
**ROADS:** 6 MILES  
**DOMESTIC WELLS:** 10 + TOWN WELLS  
**IRRIGATION WELLS:** 0  
**OTHER FEATURES:**

CO8 NEAR ALMONDS AND GRAIN/CORN AREA - AREA WAS GRAPES.  
 88.4, 88.4 ppm

624 XLS  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-24**

**WELLS IN SECTION: C5**

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
ALFALFA	3	ALFALFA	4
ALMONDS	59	DECIDUOUS	63 sprinkler & flood
GRAIN	7	GRAIN	21
IDLE	13	IDLE	6
MIXED PASTURE	5	MIXED PASTURE	6
NATIVE VEGETATION	5		
POTATOES	8		

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILES  
**CANALS & DITCHES:** 0.8 MILE  
**ROADS:** 4.5 MILES  
**DOMESTIC WELLS:** 16  
**IRRIGATION WELLS:** 2  
**OTHER FEATURES:**

C05 NEAR ALMONDS , GRAIN, AND IDLE LAND.  
 ND,ND

PACKING SHED

**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-27**

**WELLS IN SECTION: C2,C4**

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
ALFALFA	32	ALFALFA	11
ALMONDS	16	DAIRY	6
CORN	39	DECIDUOUS	22 sprinkler & flood
DAIRY	5	GRAIN	43
IDLE	4	IDLE	13
MIXED PASTURE	3	MIXED PASTURE	5
WALNUTS	1		

71

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 2 MILES  
**ROADS:** 4.5 MILES  
**DOMESTIC WELLS:** 21  
**IRRIGATION WELLS:** 0  
**OTHER FEATURES:**

C02 IN GRAIN/CORN AREA  
 ND, ND

CO4 NEAR ORCHARD AND GRAIN/CORN AREA  
 88.9,88.9 ppm

**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-30**

**WELLS IN SECTION: B11**

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
ALFALFA	1	ALFALFA	23
CORN	88	GRAIN	71
MIXED PASTURE	7	IDLE	6
NATIVE VEGETATION	4		

**ADDITIONAL INFORMATION:**

**RIVERS: 0 MILE**  
**CANALS & DITCHES: 2.5 MILES**  
**ROADS: 4.5 MILE**  
**DOMESTIC WELLS: 1**  
**IRRIGATION WELLS: 0**  
**OTHER FEATURES:**

B11 IN GRAIN/CORN AREA .  
 28.6, 30.4 ppm

**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-34**  
**WELLS IN SECTION: B1**

<b>SUMMER 1987</b>		<b>WINTER 1990</b>	
<b>USE</b>	<b>% of section</b>	<b>USE</b>	<b>% of section</b>
ALFALFA	5	DAIRY	9
ALMONDS	13	DECIDUOUS	34 flood
CORN	25	GRAIN	21
DAIRY	8	GRAPES	9 sprinkler & flood
GRAPES	11	IDLE	11
IDLE	1	MIXED PASTURE	13
MIXED PASTURE	4	NATIVE VEGETATION	3
NATIVE VEGETATION	6		
PEPPERS	2		
WALNUTS	25		

**ADDITIONAL INFORMATION:**

**RIVERS:** 0.5 MILE  
**CANALS & DITCHES:** 2 MILES  
**ROADS:** 3.5 MILES  
**DOMESTIC WELLS:** 13  
**IRRIGATION WELLS:** 2  
**OTHER FEATURES:**  
 B01 IN WALNUTS  
 13.4,13.8,13.6 ppm

73

**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/10E-35**

**WELLS IN SECTION: A5**

<b>SUMMER 1987</b>		<b>WINTER 1990</b>	
<b>USE</b>	<b>% of section</b>	<b>USE</b>	<b>% of section</b>
ALMONDS	11	DECIDUOUS	18 sprinkler & flood
GRAPES	58	GRAIN	7
MANUFACTURING	1	GRAPES	56 sprinkler & flood
MIXED PASTURE	2	MIXED PASTURE	3
NATIVE VEGETATION	21	NATIVE VEGETATION	13
PARK-LAWN AREA	2	PARK-LAWN AREA	3 sprinkler
WALNUTS	5		

**ADDITIONAL INFORMATION:**

**RIVERS:** 1.5 miles  
**CANALS & DITCHES:** 0.5 mile  
**ROADS:** 4 miles  
**DOMESTIC WELLS:** 5  
**IRRIGATION WELLS:** 2  
**OTHER FEATURES:**  
 A05 IN PARK  
 ND, ND

7L

506 X16  
LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY

SECTION: 6S/12E-09

WELLS IN SECTION: B6,B7,B8,B9

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
ALFALFA	8	ALFALFA	11
ALMONDS	26	DAIRY	2
CORN	12	DECIDUOUS	43 flood & sprinkler
DAIRY	2	GRAIN	17
MIXED PASTURE	6	MIXED PASTURE	9
NATIVE VEGETATION	16	NATIVE VEGETATION	11
PEACHES	3	POULTRY FEEDLOT	1
RESIDENTIAL	6	RESIDENTIAL	6
SUDAN	4		
WALNUTS	17		

**ADDITIONAL INFORMATION:**

RIVERS: 1 MILE  
 CANALS & DITCHES: 2 MILE  
 ROADS: 3 MILE  
 DOMESTIC WELLS: 3 + TOWN WELLS  
 IRRIGATION WELLS: 0  
 OTHER FEATURES:

B06 IN RESIDENTIAL AREA.  
 46.2,46.6 ppm  
 B07 IN RESIDENTIAL AREA  
 15.4,12.3 ppm  
 B08 IN ALMONDS.  
 22.0,16.3 ppm  
 B09 IN RESIDENTIAL AREA.  
 26.4,26.0 ppm

6S10.XLS  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 6S/12E-10**

**WELLS IN SECTION: A7**

<b>SUMMER 1987</b>		<b>WINTER 1990</b>	
<b>USE</b>	<b>% of section</b>	<b>USE</b>	<b>% of section</b>
ALMONDS	12	ALFALFA	6
DAIRY	15	DAIRY	20
MISC. DECIDUOUS	3	DECIDUOUS	25 sprinkler
MIXED PASTURE	49	MIXED PASTURE	46
NATIVE VEGETATION	14	NATIVE VEGETATION	3
PEACHES	4		
SUDAN	6		
WALNUTS	3		

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 3 MILES  
**ROADS:** 2.5 MILES  
**DOMESTIC WELLS:** 4  
**IRRIGATION WELLS:** 0  
**OTHER FEATURES:**

A07 IN ALMONDS NEAR DAIRY.  
 12.3,12.3,12.3ppm

TRUCKING COMPANY  
 POWER STATION  
 RADIO TOWERS

**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 7S/10E-10**  
**WELLS IN SECTION: A9**

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
DAIRY	4	DAIRY	5
MIXED PASTURE	80	GRAIN	10
NATIVE VEGETATION	5	IDLE	15
POTATOES	9	MIXED PASTURE	70
SUDAN	2		

**ADDITIONAL INFORMATION:**

**RIVERS: 0 MILE**  
**CANALS & DITCHES: 3.5 MILE**  
**ROADS: 2 MILES**  
**DOMESTIC WELLS: 6**  
**IRRIGATION WELLS: 0**  
**OTHER FEATURES:**

**A09 NEAR MIXED PASTURE & FORMER SUDAN FIELD.**  
**44.0, 44.0 ppm**

LL

611 X 16  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 7S/10E-11**

**WELLS IN SECTION: C10**

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
FEEDLOTS	3	POULTRY FEEDLOTS	3
IDLE	3	GRAIN	8
MIXED PASTURE	66	GRAPES	8 sprinkler
NATIVE VEGETATION	7	IDLE	14
RESIDENTIAL	2	MIXED PASTURE	64
SWEET POTATOES	19		

**ADDITIONAL INFORMATION:**

**RIVERS: 0 MILE**  
**CANALS & DITCHES: 2.5 MILES**  
**ROADS: 5 MILES**  
**DOMESTIC WELLS: 27**  
**IRRIGATION WELLS: 2**  
**OTHER FEATURES:**

C10 IN MIXED PASTURE NEAR IDLE LAND.  
 ND,ND

\$14 X 16  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION:** 7S/10E-14  
**WELLS IN SECTION:** C1,C3,C7,C9

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
CORN	3	GRAIN	8
MIXED PASTURE	71	IDLE	19
NATIVE VEGETATION	19	MIXED PASTURE	68
RESIDENTIAL	7	RESIDENTIAL	5

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 3 MILES  
**ROADS:** 5 MILES  
**DOMESTIC WELLS:** 12 + TOWN WELLS  
**IRRIGATION WELLS:** 1  
**OTHER FEATURES:**

C01 IN RESIDENTIAL AREA NEAR MIXED PASTURE.  
 ND, ND  
 C03 IN MIXED PASTURE/NATIVE VEGETATION.  
 ND,ND  
 C07 NEAR MIXED PASTURE AND GRAIN AREA.  
 ND,ND  
 C09 IN MIXED PASTURE AREA.  
 ND,ND

S15-X16  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION:** 7S/10E-15  
**WELLS IN SECTION:** A8

<b>USE</b>	<b>SUMMER 1987 % of section</b>	<b>USE</b>	<b>WINTER 1990 % of section</b>
ALFALFA	7	AIRSTRIP	1
DAIRY	2	ALFALFA	7
FEEDLOTS	4	DAIRY	2
IDLE	5	GRAIN	6
MIXED PASTURE	74	IDLE	4
RESIDENTIAL	3	MIXED PASTURE	69
SUDAN	5	POULTRY FEEDLOTS	6
		RESIDENTIAL	5

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILE  
**CANALS & DITCHES:** 1.5 MILES  
**ROADS:** 5 MILES  
**DOMESTIC WELLS:** 7  
**IRRIGATION WELLS:** 2  
**OTHER FEATURES:**

A08 IN RESIDENTIAL AREA NEAR MIXED PASTURE AND GRAIN.  
 ND, ND

AIRSTRIP  
 DAIRY SETTLING PONDS

LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY

SECTION: 7S/10E-16  
 WELLS IN SECTION: A1,A2,A3,A10

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
CORN	5	ALFALFA	5
DAIRY	1	CATTLE FEEDLOTS	2
MIXED PASTURE	93	IDLE	7
RESIDENTIAL	1	MIXED PASTURE	86

**ADDITIONAL INFORMATION:**

RIVERS: 0 MILE  
 CANALS & DITCHES: 4 MILES  
 ROADS: 3.5 MILES  
 DOMESTIC WELLS: 20  
 IRRIGATION WELLS: 1  
 OTHER FEATURES:

A1 IN MIXED PASTURE NEAR IDLE LAND.  
 ND,ND  
 A2 IN MIXED PASTURE.  
 ND,ND  
 A3 IN MIXED PASTURE.  
 ND,ND  
 A10 NEAR MIXED PASTURE, CATTLE FEEDLOT, AND IDLE/CORN AREA.  
 ND,ND

617 X16  
**LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY**

**SECTION: 7S/10E-17**

**WELLS IN SECTION: B5**

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
CORN	2	ALFALFA	4
DAIRY	2	DAIRY	2
IDLE	2	IDLE	9
MIXED PASTURE	87	MIXED PASTURE	83
NATIVE VEGETATION	7	STABLE	2

**ADDITIONAL INFORMATION:**

**RIVERS:** 0 MILES  
**CANALS & DITCHES:** 3.5 MILES  
**ROADS:** 4.5 MILES  
**DOMESTIC WELLS:** 11  
**IRRIGATION WELLS:** 0  
**OTHER FEATURES:**

BO5 IN MIXED PASTURE.  
 ND,ND

## LAND USE IN SAMPLED SECTIONS OF MERCED COUNTY

SECTION: 7S/11E-12

WELLS IN SECTION: C6

USE	SUMMER 1987 % of section	USE	WINTER 1990 % of section
ALMONDS	69	DECIDUOUS	67 sprinkler & flood
GRAIN	1	GRAIN	15
GRAPES	3	GRAPES	3 flood
IDLE	3	IDLE	10
MIXED PASTURE	10	MIXED PASTURE	5
NATIVE VEGETATION	28		
SUDAN	6		
SWEET POTATOES	4		

## ADDITIONAL INFORMATION:

RIVERS: 0 MILE  
 CANALS & DITCHES: 1 MILE  
 ROADS: 5 MILES  
 DOMESTIC WELLS: 17  
 IRRIGATION WELLS: 0  
 OTHER FEATURES:

C06 NEAR GRAIN AND ALMONDS. WAS IN MIXED PASTURE .  
 52.3, 52.3 ppm