

Memorandum

To : Don Weaver, Senior Environmental Research Scientist  
Environmental Monitoring and Pest Management

Date : August 7, 1995

Place : Sacramento

From : Department of Pesticide Regulation

John Troiano, Sr. Env. Research Scientist  
Craig Nordmark, Env. Research Asst.  
Environmental Hazards Assessment Program

Subject : Summary of Results for a Study to Identify Areas of Ground Water Contamination by Pesticides in California.

SCOPE OF THIS MEMORANDUM

The purpose of this memorandum is to provide results from the study entitled "Identifying Areas of Ground Water Contamination by Pesticides in California". Well sample data were collected from April 19 through September 29, 1994. This memorandum does not include an interpretation of the data.

INTRODUCTION

Having the ability to identify areas of land that are vulnerable to ground water contamination should facilitate the development of management and regulatory options that may be used on a regional scale. The prevalent approach to modelling land areas has been to identify contamination processes deductively and then construct theoretical models comprised of pertinent variables. Most models for pesticide contamination of ground water combine climatic, hydrogeologic, and/or soil variables in a manner that maximize discrimination in leaching potential between land areas. Furthermore, only simple percolation from the land surface is usually considered, movement in preferential flow paths is not described (National Research Council, 1993). In a recent conference on application of Geographic Information Systems technology to nonpoint source pollution problems, most reports identified areas vulnerable to simple-percolation leaching (Corwin and Wagenet, 1995).

A few well sampling studies have been conducted to test the relevance of land vulnerability indices (EPA, 1992; Balu and Paulsen, 1991; Holden et al., 1992, Kalinski et al., 1994; Roux et al., 1991). The success of these studies was limited by detections of residues in relatively invulnerable areas. In our experience, identifying simple percolation-leaching as the sole cause of positive detections in large retrospective well surveys has been problematic because of the strong possibility for other avenues of pesticide movement to ground water. Examples of other contamination processes from legal non-point source agricultural applications are movement of surface water into agricultural drainage wells (Braun and Hawkins, 1991; Roux et al., 1991), Karst formations (Hallberg, 1989), or cracks in clay soils (Graham et al., 1992). Measuring and modelling the movement of pesticide residues in macropore flow has recently gained more attention (Bergstrom et al., 1991; Chen et al., 1993).



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In a previous paper, we reported an empirical statistical approach to profiling areas of ground water contamination by pesticides. The method did not rely upon determining the level of vulnerability between land areas nor did it assume any particular pathway for ground water contamination (Troiano et al., 1994). Instead, sections of land where pesticide residues had been found in ground water and the detections were attributed to legal agricultural use, were designated as known contaminated (KC) sections. A section is a one square-mile area of land as described by the USGS Public Land Survey (Davis and Foote, 1966). Clustering methods were then used to identify groups of KC sections first, with respect to climatic variables and, then, with respect to soil variables. Based on rainfall amount, two climatic clusters were identified, one wet and one dry. Only five sections were located in the wet climate cluster and those were located in Del Norte and Humboldt Counties in the Northwestern portion of the state that annually receives over 60 inches of rainfall. The remaining 254 KC sections were members of a dry climate cluster where irrigation is mandatory because of very little rainfall. Two soil variables partitioned the KC sections in the dry climate cluster into five separate soil clusters. One soil variable was a measure of soil texture which was indicated by the percentage of particles passing a number 200 sieve. The average sectional value for soil texture of the five clusters ranged from coarse to fine (Table 1). The second variable indicated the absence or presence of a hardpan. That factor ranged from practically no soils in a section with a hardpan, as indicated by a zero weight, to potentially all soils in a section with a hardpan, as indicated by a weight of one (Table 1).

A classification method was developed to determine membership or non-membership of candidate sections that lacked positive detections or had no well sample data into KC soil clusters. The classification algorithm employed Principal Components Analysis (PCA classification algorithm) and it was applied to all sections in Fresno and Tulare counties with soil data. A plot of the section classifications indicated that the statistical clusters were associated with discrete geographical areas. A large area of coarse, sandy soil was located in the central portion of Fresno County (KC1 in Figure 1). Sections adjacent to the coarse soil sections on the east and extending down into Tulare County contained soil with a hardpan layer (KC2 in Figure 1). The clustering results appeared quite meaningful in relation to previous field studies which indicated different sources of contamination between the two cluster soil profiles. Pesticide residues detected in broad bands deep in sandy soils sampled in Fresno County appeared to result from leaching (Zailkin et al., 1984). In contrast, very little residue was detected deep in hardpan soil sampled in Tulare County (Welling et al., 1986). A subsequent study in Tulare County indicated that a probable route of nonpoint source contamination in these soils was movement of pesticide residues in runoff water into agricultural drainage wells (Braun and Hawkins, 1991).

In order to gain confidence in the classification method, a well sampling study was designed utilizing the groups produced by the PCA classification algorithm.

## MATERIALS AND METHODS

### Study Design

The well sampling study was conducted in Fresno and Tulare Counties, California. Sections of land with unknown ground water contamination status were denoted as Candidate Sections. Soil data from approximately 2,600 Candidate Sections were subjected to the PCA classification algorithm (Troiano et al., 1994). Sections for well sampling were selected from three groups: one group from the cluster with coarse soil texture and no hardpan (KC1); a second group from the cluster with coarse to medium soil texture and approximately 50% of the soils in a section containing a hardpan (KC2); and a third group from candidate sections that were not-classified into one of the KC soil clusters (Figure 1). The experimental unit was a section of land with one well sampled per section.

Candidate Sections were chosen with cropping and pesticide use patterns that were similar to KC sections in Fresno and Tulare counties, giving some assurance that pesticide use patterns in Candidate Sections were similar to those in KC sections. Selection criteria were based on data from the 1990 and 1991 California Department of Pesticide Regulation's pesticide use reports which are based on section coordinates. Reporting of all farm use of pesticides in California was mandated in 1990. In the KC1 cluster, combined use for both years of the known ground water contaminants, bromacil, diuron, and simazine, was greatest on grapes at 6,020 kg followed by oranges at 2,175 kg. In the KC2 cluster, use was greatest on oranges at 27,020 kg followed by grapes and olives at 2,530 and 1,880 kg, respectively. Thus, Candidate Sections were chosen as potential experimental units if use of a known ground water contaminant had been reported on citrus, grapes or olives in either 1990 or 1991. The number of potential Candidate Sections in each group was 385 in KC1, 406 in KC2, and 129 in not-classified sections.

The total amount of pesticide applied in a section had been employed as a selection criterion in previous well sampling studies. Theoretically, the probability of a detection would be positively correlated with pesticide use because the probability of a detection would be greater in sections with greater pesticide loading. This hypothesis was tested by including total pesticide use in a section as a second design factor. Each group, e.g. KC1, KC2, and the not-classified sections, were divided into high and low pesticide loading categories by determining the median combined total use of simazine, bromacil, and diuron in 1990 and 1991. Median use per section was 236 lbs for KC1, 419 lbs for KC2, and 151 lbs for not-classified sections. Within each group, low loading sections were those below the median, high loading sections were those above the median.

Initially, 60 Candidate Sections with one well sampled per section were to be randomly chosen from each of the two PCA classification groups, KC1 cluster and KC2 cluster, and from the not-classified sections. Due to the additional selection criteria of pesticide loading, 30 of the 60 sections were randomly chosen in each loading category. During sampling, some sections could not be sampled because: none of the wells in a section passed the selection criteria; the section was completely agricultural with no domiciles; owners could not be located; or

permission to sample was denied. Each classification group was repopulated by randomly choosing additional sections from the remaining pool of sections.

### **Well Selection and Sampling Procedures**

Surveys for potential sampling sites were conducted by visually searching for wells, residences, or occupied buildings in targeted sections. When possible, wells situated near vineyards, citrus, or olive orchards were preferentially sampled. If permission to sample a well was granted by the owner then the well was inspected for the following criteria:

1. In order to assure that the well was not a point source for entry of residues into ground water, the well was sampled only if it was sealed and the pad, and cap were in good condition.
2. The well was remotely located from any pesticide sprayer filling stations, wash down areas, or pesticide storage facilities;
3. A sample port, faucet, valve or stand pipe, was located prior to any storage tank.

Well water samples were collected in one-liter amber glass bottles with Teflon<sup>®</sup>-lined caps. Two separate sample-packs were prepared, one with four bottles and one with 6 bottles. From the four bottle pack, one bottle, labeled the primary sample, was analyzed for a multiherbicide screen. Two other backup samples were also taken for confirmation analysis of positive detections. From the six bottle pack, one bottle, labeled the primary sample, was analyzed for a dacthal screen. Four other backup samples were also taken for confirmation analysis of positive detections. An additional field blank was prepared at the sampling site from each bottle pack. Prior to sampling, the pump was run for at least 10 minutes to clear the casing of standing water and bring in fresh aquifer water. The sample bottles were rinsed and then filled with the well water and the field blank bottle was rinsed and filled with deionized water. The pH of the well water was measured in a separate sample taken during well sampling. The mean pH of samples was 7.2 with a range of 6.0 to 8.4. Bottles were transported on wet ice and stored in a refrigerator at 4° C.

### **Chemical Analyses**

Well water samples were analyzed for atrazine, bromacil, diuron, prometon, simazine, prometryn, cyanazine, metribuzin, hexazinone and the triazine breakdown products deethylatrazine (DEA) and deisopropylatrazine (DIPA). ALTA Analytical Laboratories conducted the multiherbicide screen on the primary samples. Backup and field blank samples were submitted to Quanterra Laboratories only to confirm a detection in the primary sample. Primary multiherbicide screen samples were extracted by the analyzing laboratory within 16 days of collection. Multiherbicide screen backup samples submitted for confirmation were extracted within 56 days of collection.

Well water samples were also analyzed for dacthal and the dacthal breakdown products monomethyl 2,3,5,6-tetrachloroterephthalate (MTP) and 2,3,5,6-tetrachloroterephthalic acid (TPA). Primary dacthal screen samples were submitted to the California Department of Food and

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Agriculture Laboratory. Backup and field blank samples were submitted to APPL, Inc. Laboratories only to confirm a detection in the primary sample.

Detection limits for each laboratory and chemical analyte, and method development data are given in Table 2. The laboratories had different detection limits for DEA and DIPA so a sample was considered positive only if residues were reported from both laboratories. No detectable levels of multiherbicide screen or dacthal screen chemicals were found in the field blanks. Levels detected in the backup samples were similar to the primary analyses indicating that degradation of pesticide residues was minimal during the holding period. Chemical and analytical procedures are available upon request and will be included in the final report.

## RESULTS AND DISCUSSION

Well water sampling for this study was completed in September 1994 and all chemical analytical results received by the end of October. The analytical results for all sections sampled are presented in Table 4. The results of both primary and backup sample tests are listed by county, township/range and section number. Unverified detections are indicated by a 'U'. Blanks indicate that the chemical was not detected in either laboratory's test. Wells in sections 14S/23E-28 and 17S/27E-29 were resampled to clarify multiherbicide screen results and only the resampling data are presented. The data from Table 4 are summarized in Tables 5 and 6.

There were 297 sections surveyed for suitable wells in Fresno and Tulare counties. From those sections 176 wells were sampled. Seven of the 14 pesticide analytes were detected in well water samples in this study: atrazine, DIPA, DEA, bromacil, diuron, simazine and TPA (Tables 4 and 5). Initially, residues were detected in 79 wells (45%) representing 79 separate sections, however, detections were verified in 76 wells (41%). A detection was verified when residues were found in both the primary and backup samples, each analyzed by a different laboratory. More than one pesticide residue was detected in 68% of the verified wells (Table 6). Simazine and DIPA accounted for most of these positive detections; simazine was verified in 63% and DIPA in 75% of positive sections. The detections reflected use patterns within these sections: Simazine and diuron were used on grapes, and simazine, diuron and bromacil were used on citrus.

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Figure 1. Township/Range-Section map of the Fresno and Tulare county areas showing the soil type clusters. Each small box represents a one square mile section. Sections are idealized for computer plotting, actual section sizes and locations may vary slightly.

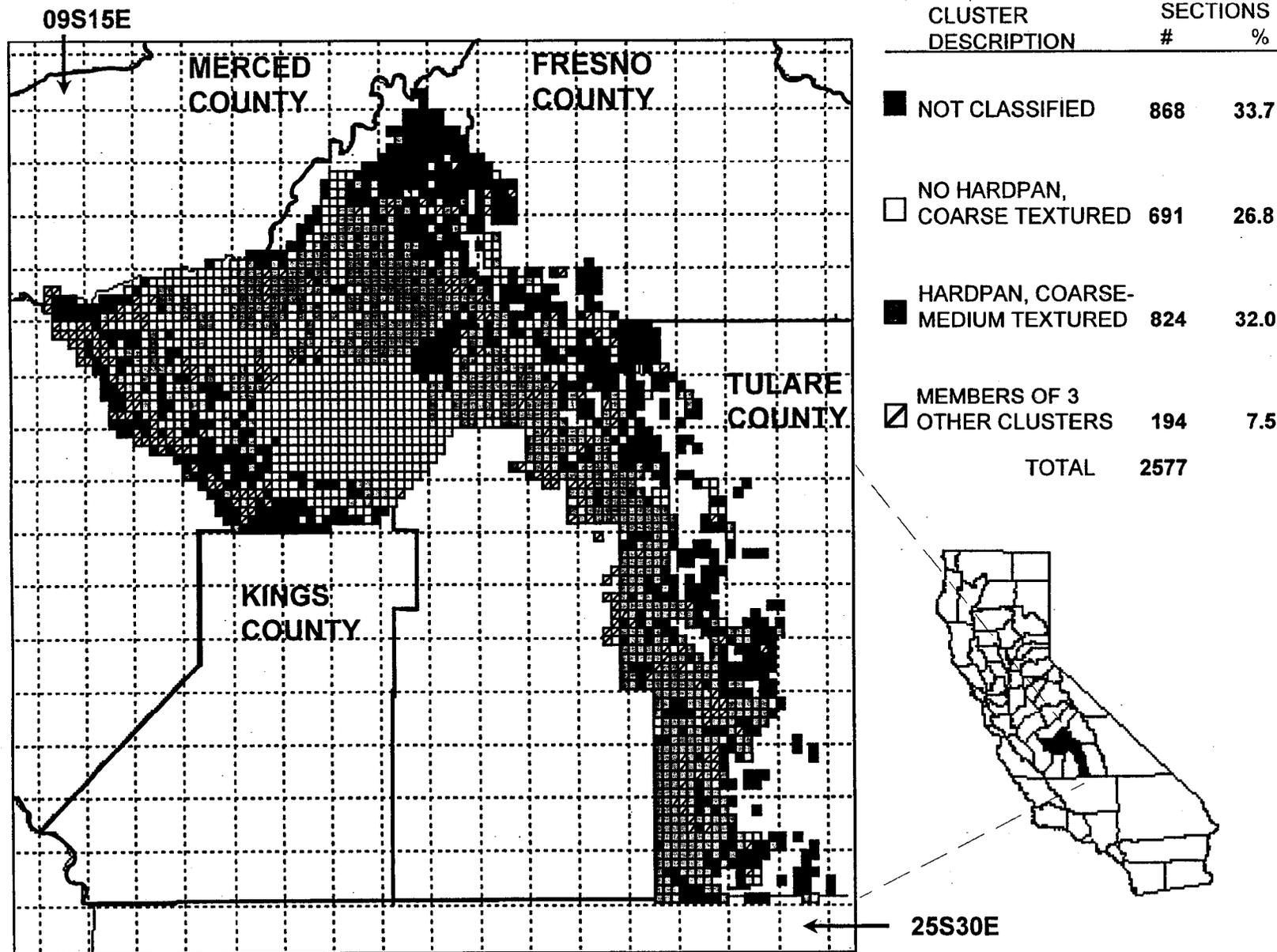


Table 1. Description and average±standard deviation (SD) sectional values for variables that reflect the presence of hardpan and % soil particles passing a No. 200 soil sieve in each of 5 clusters of sections with ground water contaminated by pesticides.

Cluster Description	# of KC Sections	Cluster Variables		Distribution of Pesticides <sup>1</sup>						
		Hardpan <sup>2</sup>	No. 200 Sieve <sup>3</sup>	Atra	Ben <sup>4</sup>	Bro	Diu	Pro	Sim	TPA
			-----%-----	-----# of Sections-----						
KC1. No Hardpan and Coarse Textured	72	0.08±0.11	36± 5.9	5	3	10	23	2	63	4
KC2. Hardpan and Coarse-Medium Textured	82	0.50±0.14	49± 7.7	4	6	36	56	3	67	1
KC3. No Hardpan and Medium Textured	26	0.01±0.03	60± 6.4	6	9	1	2	0	6	9
KC4. Hardpan and Medium Textured	26	0.94±0.13	62±10.1	2	4	12	16	3	20	0
KC5. No Hardpan and Fine Textured	48	0.03±0.10	82± 4.3	17	25	0	0	4	7	0

<sup>1</sup> Atra=Atrazine; Ben=Bentazon; Bro=Bromacil; Diu=Diuron; Pro=Prometon; Sim=Simazine; TPA=breakdown product of dacthal.

<sup>2</sup> Scale from 0-1 with a 0 value representing no soils in the section with hardpan and a 1 indicating all soils in that section with hardpan.

<sup>3</sup> Measured by the percentage by weight of soil particles that pass a No. 200 soil sieve. The smaller the percentage, the more coarse textured the soil.

<sup>4</sup> The results in this table are on a statewide basis. All chemicals shown, except bentazon, were used in the cropping patterns in Fresno and Tulare Counties and were examined in this well sampling study.

Table 2. Method detection limits (MDL), in parts per billion (ppb), and percent recovery data for well water sample analytes for the multiherbicide screen.

Chemical Analyte	Laboratory							
	ALTA Analytical				Quanterra			
	MDL	% Recovery <sup>1</sup>		UCL <sup>2</sup>	MDL	% Recovery <sup>1</sup>		UCL <sup>2</sup>
Mean	LCL <sup>2</sup>	UCL <sup>2</sup>	Mean		LCL <sup>2</sup>	UCL <sup>2</sup>		
Atrazine	0.05	94	85	102	0.05	89	83	95
Bromacil	0.05	103	87	119	0.05	89	75	103
DEA	0.10	89	71	107	0.05	104	77	131
DIPA	0.10	86	71	100	0.05	62 <sup>3</sup>	18	106
Diuron	0.05	98	88	109	0.05	101 <sup>3</sup>	91	111
Cynazine	0.05	111	98	124	0.05	102	95	109
Hexazinone	0.05	104	91	117	0.05	93	84	102
Metribuzin	0.05	94	79	109	0.05	92	80	104
Prometon	0.05	91	88	103	0.05	93	73	113
Prometryn	0.05	94	78	110	0.05	106	89	124
Simazine	0.05	99	81	116	0.05	98	87	109

<sup>1</sup> Percentage of spike levels

<sup>2</sup> LCL=Lower Control Limits and UCL=Upper Control Limits determined as the mean of the percent recovery±2 standard deviations.

<sup>3</sup> Five spiked replicates each at 0.1, 0.5, 2.0, and 10.0 ppb, spike levels for the rest were 0.05, 0.1 and 0.5 ppb.

Table 3. Method detection limits (MDL), in parts per billion (ppb), and percent recovery data for well water sample analytes for the dacthal screen.

Chemical Analyte	Laboratory							
	CDFA				APPL Inc.			
	MDL	% Recovery <sup>1</sup>		UCL <sup>2</sup>	MDL	% Recovery <sup>1</sup>		UCL <sup>2</sup>
Mean	LCL <sup>2</sup>	UCL <sup>2</sup>	Mean		LCL <sup>2</sup>	UCL <sup>2</sup>		
Dacthal	0.05	111 <sup>3</sup>	104	115	0.05	98 <sup>4</sup>	76	120
MTP	0.10	97 <sup>3</sup>	88	106	0.10	89 <sup>5</sup>	65	113
TPA	0.10	78 <sup>3</sup>	72	84	0.10	63 <sup>5</sup>	47	79

<sup>1</sup> Percentage of spike levels

<sup>2</sup> LCL=Lower Control Limits and UCL=Upper Control Limits determined as the mean of the percent recovery±2 standard deviations.

<sup>3</sup> Three spiked replicates each at 0.2, 0.5, and 1.0 ppb.

<sup>4</sup> Five spiked replicates each at 0.25, 2.5, and 25 ppb.

<sup>5</sup> Five spiked replicates each at 0.5, 5.0 and 50 ppb.

Table 4. Results of the Ground Water Vulnerability Study by county, township/range and section, April-September 1994. One well was sampled per section. Only chemicals that were detected are shown. For a verification a detection must be made in both the primary and the backup sample which was done by a separate laboratory.

COUNTY NO. 1	TOWNSHIP / RANGE	SECTION	SOIL CLUSTER <sup>2</sup>	Detection <sup>3</sup>	PRIMARY SAMPLE							BACKUP SAMPLE							
					Amounts Detected in Parts per Billion														
					atrazine	DIPA	DEA	bromacil	diuron	simazine	TPA	atrazine2	DIPA2	DEA2	bromacil2	diuron2	simazine2	TPA2	
10	12S20E	24	NC	Y		0.26		0.76	0.49					0.28		0.85	0.56		
10	12S21E	24	NC	N															
10	12S21E	25	H	Y		3.80			0.37	0.25			2.00				0.60	0.24	
10	12S22E	30	H	N															
10	13S16E	22	NC	N															
10	13S16E	25	S	N															
10	13S17E	23	H	Y		0.12							0.16						
10	13S17E	25	H	N															
10	13S17E	27	NC	N															
10	13S17E	28	S	N															
10	13S17E	33	S	N															
10	13S18E	08	S	N															
10	13S18E	13	H	N															
10	13S18E	27	S	N															
10	13S18E	28	S	N															
10	13S18E	29	H	N															
10	13S18E	30	H	N															
10	13S18E	31	H	N															
10	13S18E	33	H	N															
10	13S18E	34	H	N															
10	13S19E	16	H	N															
10	13S19E	22	H	N															
10	13S19E	27	H	Y		0.38				0.21			0.42					0.13	
10	13S20E	01	H	N															
10	13S21E	13	H	N															
10	13S21E	26	S	N															
10	13S22E	04	H	Y		0.13							0.13						
10	13S22E	23	NC	N															
10	13S22E	26	H	Y							6.88								5.90
10	13S22E	27	H	N															
10	13S22E	36	H	Y		0.42		0.33	0.42	0.07			0.40		0.21	0.32	0.08		
10	13S23E	24	H	Y		0.72		0.48	0.09	0.22			0.84		0.41	0.08	0.18		
10	13S23E	26	NC	Y		0.36		3.00	0.18	0.07			0.35		2.10	0.15	0.06		
10	13S23E	28	H	N															
10	13S23E	31	H	Y		0.84		0.05	0.40	0.15			0.92		0.07	0.39	0.13		
10	13S23E	32	H	Y		0.12	0.71	U <sup>+</sup>		0.16	0.23		0.11	0.61	0.05		0.18	0.20	
10	13S23E	34	NC	Y			0.28			0.18	0.17		0.25			0.14	0.14		
10	14S16E	12	NC	N															
10	14S17E	03	S	N															
10	14S17E	11	NC	N															
10	14S17E	16	H	N															
10	14S17E	23	NC	N															
10	14S17E	24	NC	N															
10	14S18E	02	S	Y					0.60	U						0.79	0.06		
10	14S18E	05	S	N															

Table 4 Continued

COUNTY NO. 1	TOWNSHIP / RANGE	SECTION	SOIL CLUSTER <sup>2</sup>	Detection <sup>3</sup>	PRIMARY SAMPLE								BACKUP SAMPLE							
					Amounts Detected in Parts per Billion															
					atrazine	DIPA	DEA	bromacil	diuron	simazine	TPA	atrazine2	DIPA2	DEA2	bromacil2	diuron2	simazine2	TPA2		
10	14S18E	14	S	N																
10	14S18E	18	S	N																
10	14S18E	34	H	N																
10	14S19E	07	S	N																
10	14S19E	11	S	N																
10	14S19E	19	S	Y					0.40		0.11						0.57		0.11	
10	14S20E	31	S	N																
10	14S20E	36	S	N																
10	14S21E	18	H	N																
10	14S22E	03	H	Y																
10	14S22E	13	NC	Y		U			0.05				0.10				0.07			
10	14S22E	13	NC	Y					0.12		0.11		0.11					0.09		
10	14S22E	16	H	Y					0.23				0.26							
10	14S22E	20	H	Y					0.15		0.10	0.30	0.15				0.07	0.23		
10	14S22E	24	NC	N																
10	14S22E	25	NC	N																
10	14S22E	33	S	Y		U							0.10			0.31	0.64	0.17		
10	14S22E	34	S	N																
10	14S22E	35	NC	Y					0.43		0.23		0.44					0.18		
10	14S23E	04	NC	N																
10	14S23E	15	NC	Y					0.90		0.29	1.20	0.22		1.00		0.30	1.50	0.19	
10	14S23E	18	NC	N																
10	14S23E	19	NC	N																
10	14S23E	26	H	Y					0.15		0.07		0.17					0.06		
10	14S23E	28	NC	Y					0.28		0.18		0.22					0.18		
10	14S23E	29	NC	N																
10	14S23E	31	NC	N																
10	14S23E	32	NC	Y		U					0.79		0.09					0.06		
10	14S23E	33	NC	N																
10	14S24E	04	H	N																
10	14S24E	27	H	Y					4.00		0.73	0.08		3.00			0.57	0.08		
10	14S24E	30	S	Y					0.41		0.14		0.35					0.11		
10	14S24E	35	H	Y					0.53		0.13	0.22		0.46			0.07	0.19		
10	15S18E	11	NC	N																
10	15S19E	21	NC	N																
10	15S19E	25	S	N																
10	15S19E	29	NC	N																
10	15S20E	02	S	N																
10	15S20E	04	S	N																
10	15S20E	05	S	N																
10	15S21E	20	S	Y					0.27		0.13		0.32					0.12		
10	15S21E	21	S	N																
10	15S21E	34	S	Y					0.38		0.17		0.39					0.15		
10	15S22E	03	S	Y					0.83		0.25		0.80					0.20		
10	15S22E	24	S	N																
10	15S22E	36	S	N																
10	15S23E	04	NC	N																
10	15S23E	09	NC	N																
10	15S23E	12	H	N																
10	15S23E	14	H	N																
10	15S23E	21	S	N																
10	15S23E	32	S	Y					0.17		0.08		0.16					0.06		
10	15S23E	36	H	N																
10	15S24E	12	H	Y					1.40		0.10	0.20		1.20			0.12	0.17		

Table 4 Continued

COUNTY NO. 1	TOWNSHIP / RANGE	SECTION	SOIL CLUSTER <sup>2</sup>	Detection <sup>3</sup>	PRIMARY SAMPLE								BACKUP SAMPLE							
					Amounts Detected in Parts per Billion															
					atrazine	DIPA	DEA	bromacil	diuron	simazine	TPA	atrazine2	DIPA2	DEA2	bromacil2	diuron2	simazine2	TPA2		
10	15S24E	13	H	Y		0.32			0.08	0.22				0.34	0.09	0.13	0.27			
10	15S24E	14	H	Y		1.40			0.14	0.32	0.10			0.89		0.08	U	0.11		
10	15S24E	23	H	Y		0.12				0.08				0.14			0.07			
10	15S24E	25	H	Y		0.11			0.39	0.15	0.06			0.14		0.57	0.13	U		
10	15S24E	36	H	Y		1.60			2.50	0.97	0.14			1.40		3.20	0.87	0.11		
54	15S25E	05	H	Y		3.30			0.80	1.20	0.21			3.90		0.63	1.00	0.19		
54	15S25E	08	H	Y		0.23				0.10				0.25			0.07			
54	15S25E	19	H	Y		0.67			1.40	0.53	0.10			1.00		1.10	0.56	0.09		
10	16S18E	15	NC	N																
10	16S18E	21	NC	Y					0.43	0.40						0.25	0.27			
10	16S18E	25	S	N																
10	16S18E	26	NC	N																
10	16S19E	02	S	Y		U				0.07				0.05				0.06		
10	16S19E	04	NC	N																
10	16S19E	12	NC	N																
10	16S19E	14	NC	Y		0.27				0.21				0.37				0.19		
10	16S19E	21	NC	N																
10	16S19E	23	NC	Y		0.20				0.17				0.29				0.16		
10	16S19E	26	NC	Y							0.10								U	
10	16S20E	04	S	N																
10	16S20E	12	S	Y		0.05	U						U	0.07						
10	16S20E	17	S	N																
10	16S20E	20	S	N																
10	16S20E	22	S	Y		0.22				0.22				0.32				0.16		
10	16S20E	27	S	Y		U								0.05						
10	16S20E	32	NC	N																
10	16S21E	04	S	Y		0.70				0.27				0.69				0.18		
10	16S21E	05	S	Y		U				0.05				0.09				0.05		
10	16S21E	07	S	Y		0.15				0.11				0.22				0.10		
10	16S21E	21	S	Y		0.35				0.27				0.34				0.14		
10	16S21E	33	S	Y		0.26				0.29				0.22				0.16		
10	16S21E	34	S	Y		U				0.15				0.06				0.14		
10	16S21E	36	S	Y		0.14								0.15						
10	16S22E	01	S	Y		0.86				0.10	0.42			0.79			0.08	0.29		
10	16S22E	02	S	Y		0.36								0.42						
10	16S22E	03	S	Y		0.35				0.12				0.25				0.11		
10	16S22E	09	S	N																
10	16S22E	17	S	N																
10	16S22E	21	S	Y		0.29								0.39						
10	16S22E	22	S	N																
10	16S22E	24	S	N																
10	16S22E	33	S	Y		U			0.12					0.06		0.10				
10	16S22E	34	S	Y		U				0.07	0.17			0.15			0.08	0.14		
10	16S23E	04	S	N																
54	16S25E	09	H	N																
54	16S25E	20	H	N																
54	16S25E	31	NC	Y		0.17								0.28						
54	16S26E	07	H	Y		3.80				0.13	0.28			4.80			0.15	0.28		
54	16S26E	35	H	Y		0.38				0.19	0.15			0.33			0.18	0.11		
10	17S19E	03	S	N																
10	17S19E	12	S	N																
10	17S19E	22	NC	Y						0.12							0.08			
10	17S21E	04	NC	N																



Table 5. Summary of analytical results by sections where residues were detected. There were 176 wells sampled, one well was sampled per section.							
	atrazine	DIPA	DEA	bromacil	diuron	simazine	TPA
Detections <sup>1</sup>	3	72	4	19	35	56	3
Verified <sup>2</sup>	2	59	2	19	32	50	2
Unverified <sup>3</sup>	1	13	2	0	3	6	1
No Detections <sup>4</sup>	173	104	172	157	141	120	173

<sup>1</sup> Wells where pesticide residue was detected.  
<sup>2</sup> Wells where the detected pesticide was verified by the backup laboratory.  
<sup>3</sup> Wells where pesticides were detected but not verified by the backup laboratory.  
<sup>4</sup> Wells where pesticide residues were not detected.

Table 6. Frequency of positive sections by numbers of residues detected in each well sample.		
Residues per Sample	Number of Sections	
	All Residues <sup>1</sup>	Unique Active Ingredients <sup>2</sup>
1	24	44
2	27	16
3	13	16
4	11	0
5	1	0

<sup>1</sup> All pesticide residues including breakdown products are counted.  
<sup>2</sup> Only unique active ingredients are counted. Atrazine and DEA are combined as are simazine and DIPA.