SAMPLING FOR PESTICIDE RESIDUES IN CALIFORNIA WELL WATER:

1987 UPDATE
WELL INVENTORY DATA BASE

SECOND ANNUAL REPORT TO THE LEGISLATURE,
STATE DEPARTMENT OF HEALTH SERVICES, AND
STATE WATER RESOURCES CONTROL BOARD

PURSUANT TO
THE PESTICIDE CONTAMINATION PREVENTION ACT

Dec. 1, 1987

Environmental Hazards Assessment Program

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EH 87-05

EXECUTIVE SUMMARY

The Pesticide Contamination Prevention Act (PCPA), Assembly Bill 2021, became law on January 1, 1986. The PCPA [Food and Agricultural Code, Chapter 2 of Division 7, Article 15, Section 13152 (e)] requires that the California Department of Food and Agriculture (CDFA), in consultation with the California Department of Health Services (CDHS) and the State Water Resources Control Board (SWRCB), report the following information annually to the Legislature, the CDHS, and the SWRCB: (1) the number of wells sampled for pesticide active ingredients, the location of the wells from where the samples were taken, the well numbers, if available, and the agencies responsible for drawing and analyzing the samples; (2) the number of well samples with detectable levels of pesticide ingredients, the location of the wells from which the samples were taken, the well numbers, if available, and the agencies responsible for drawing and analyzing the samples; and (3) an analysis of the results of well sampling described above in (1) and (2), to determine the probable source of the residues, as well as a consideration of factors such as the physical and chemical characteristics of the pesticide active ingredient, volume of use, method of application, irrigation practices, and types of soil in areas where the pesticide active ingredient is applied. This annual report is compiled as the single data base which contains reports of all sources (agricultural and non-agricultural, point and non-point) of pesticide active ingredient residues in ground water. The requirements for this report are the only part of the PCPA that address non-agricultural point source residues in ground water. Those detections that are due to point source are referred to other appropriate agencies for further investigation. The first annual report (Brown, et al., 1986) contains sampling results from 1975 through August, 1986. (Copies are available upon request from the CDFA Environmental Monitoring and Pest Management Branch.) This second annual report presents information on results which were submitted between September 1, 1986 and August 31, 1987 to the CDFA, although the well sampling may have occurred at an earlier time.

Part I includes information which describes the number of wells sampled, the number of wells with detectable levels of pesticide residues for each county, and factors contributing to ground water contamination by pesticides used in agriculture.

The 1987 update to the well inventory data base includes well sampling results from the following agencies: U. S. Bureau of Land Management; U. S. Geological Survey; U. S. Department of Agriculture - Forest Service; CDFA; CDHS; SWRCB; Regional Water Quality Control Board (RWQCB) - Region 1; and Kern and Marin Counties' Departments of Health. Of the data submitted by the CDHS from the Assembly Bill 1803 (small systems) sampling survey, only positive results were available for this report.

As of December 1, 1986, all data submitted for inclusion in the data base must meet minimum well sampling reporting requirements jointly established in Spring, 1986, by the CDFA, CDHS, and SWRCB pursuant to Section 13152 (d) of the PCPA. In keeping with these requirements, the following data fields are included for each record in the well inventory:

1. state well number (township/range/section/tract/sequence number/base and meridian)
2. county
3. date of sample
4. chemical analyzed
5. sample concentration, in parts per billion
6. minimum detectable limit, in parts per billion
7. sampling agency
8. analyzing laboratory
9. type of sample (e.g., initial or confirmation)
10. date of analysis
11. well type
12. street name and number of well location.

With the passage of the PCPA, sampling data received from 1986 and thereafter is to be included in the data base regardless of the source (point or nonpoint) of contamination. For example, the sources for the pesticides detected through monitoring of large drinking water systems mandated by Assembly Bill 1803, which now constitute the bulk of the data base, are largely unknown.

Highlights of the 1987 update to the data base:

1. A total of 4,193 confirmed samples taken from 530 wells are recorded in this year's data base.
2. Samples were collected and analyzed for pesticide residues in 19 of California's 58 counties.
3. Pesticide residues from all sources have been detected in wells in 14 of the 19 counties sampled.
4. Collectively, 82 pesticide active ingredients and related chemicals (breakdown products and isomers) were sampled for, but no wells were tested for all 82 pesticides.
5. DBCP was the pesticide most frequently sampled for and detected. It was detected in 138 wells, or 73% of all wells with positive samples.
6. Sampling in Kern County accounted for 41% of all the wells sampled and 47% of the samples taken for pesticides.
7. Wells in Fresno County were sampled for the largest number of pesticides (83%), while all other counties were sampled for fewer than 12% of the 82 pesticides which were detected this year.
8. Based on the data submitted and confirmed to date, the CDFA has determined that 16 pesticide active ingredients and related compounds were detected in well water. Eight were present in well water as a result of non-agricultural point sources: alachlor, chlorothalonil, diazinon, 1,3-dichloropropene (1,3-D), endrin, paradichlorobenzene, tetrachloroethylene, and xylene. These detections have been referred to or are under investigation by the State Water Resources Control Board. Eight were present in well water as a result of non-point source agricultural use: aldicarb, atrazine, bromacil, dibromochloropropane (DBCP), 1,2-dichloropropane (1,2-D), diuron, ethylene dibromide (EDB), and simazine. Four of the eight agricultural use pesticides are no longer registered or have had their use suspended. The remaining four

occur in ground water at levels considered safe by the California Department of Health Services[1] and are being processed under the mandate of the Pesticide Contamination Prevent Act. (Refer to page 10 for a summary of the status of the 16 pesticides.)

In brief, this report fulfills the requirements of the PCPA and is the only part of this Act which addresses non-agricultural point source residues of pesticide active ingredients in ground water. This report has been compiled as the single data base which can be used to prevent further occurrence of pesticide active ingredient residues in ground water. When residues are determined to be present due to point source, these detections are referred to other appropriate agencies for further investigation.

A list of numerical highlights in the 1986 data base (Brown, et al., 1986) which includes data from 1975 to August 31, 1986, in the 1987 update (sampling results submitted between September 1, 1986 and August 31, 1987) to the 1986 data base, and the cumulative total of these highlights is shown in Table 1.

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1. H. H. Russell, R. J. Jackson, D. P. Spath and S. A. Book. 1987. Chemical contamination of California drinking water. Western Journal of Medicine, 147(5): 615-622.

Table 1. A summary of numerical highlights contained in the 1986 data base (consists of samples taken between 1975 and August 31, 1986, Brown, et al., 1986), in the 1987 update (consists of sampling results submitted by various agencies between September 1, 1986 and August 31, 1987) to the 1986 data base, and the cumulative total of these highlights. [Note: for the 1987 update to the 1986 data base, data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

Numerical Highlights	1986 Data Base	1987 Update	Cumulative Total
Total number of samples	71,963	4,193	76,156
Number of positive samples	5,104	1,055	6,159
Total number of wells sampled	8,376	530	--*
Number of wells with positive samples	2,303	190	2,472**
Number of counties sampled	53	19	54**
Number of counties with positive samples	23	14	25**
Number of pesticides and related compounds sampled for	164	82	175**
Number of pesticides and related compounds detected	16	16	23**
Number of pesticides present as a result of nonpoint source agricultural use	9	8	10**

* Unavailable.

** In these cases, the cumulative total is not the sum of results recorded in the 1986 data base plus the results recorded in the 1987 update, e.g. wells with positive results in the 1986 data base may have been resampled with positive results and included in the 1987 update, but these wells are not counted again in the cumulative total.

Limitations on interpretation of the data:

1. Pesticide residue detections in the well inventory do not represent a complete survey of ground water contamination in the state. The pesticides detected are limited to those for which the sample was specifically analyzed. Therefore, the data indicate which pesticides are present in California well water among those pesticides for which analyses were carried out, but not among all pesticides used statewide.
2. Sampling by agencies other than the CDFA is not necessarily related to suspected agricultural non-point sources of contamination. Therefore, it should not be assumed that all submitted results indicate the leaching potential of pesticides used in agriculture.
3. Most sampling has been carried out in densely populated areas of the San Joaquin Valley. In comparison, very little sampling has been done in coastal counties or in rural areas where wells are more likely to be in close proximity to agricultural fields. Because the amount of sampling varies widely from one area to the next, it is not appropriate to conclude that certain areas are more sensitive to leaching than others based solely on information in the data base.

Despite these limitations, sampling information contained in the well inventory data base has several applications including: modeling; displaying the geographic distribution of wells sampled; displaying the geographic distribution of known pesticide contamination in wells; identifying areas potentially sensitive to pesticide leaching or areas sampled intensively for certain pesticides; and designing protocols for future sampling studies.

In order to effectively maintain use of pesticides for the agricultural community and to prevent residues from entering well water as a result of agricultural use, understanding factors that contribute to ground water contamination by pesticides is important. However, scientific knowledge of how pesticides move to ground water is incomplete. Some factors that contribute to ground water contamination by pesticides used in agriculture discussed in this report include use and method of application, irrigation practices, pesticide physical and chemical characteristics, soil type and climate. The roles these factors play in the contamination process are not fully understood.

Part II describes the actions the CDFA has taken to prevent pesticides from migrating to ground water in California. The CDFA Environmental Hazards Assessment Program (EHAP) conducts environmental studies to identify actual and potential ground water contamination by agricultural pesticides. The CDFA Ground Water Protection Plan, established by the department in 1984, seeks to improve regulatory decisions by providing estimates of the potential of a pesticide to enter ground water within specific geographical areas. The original well inventory data base (Cardozo, et al., 1985) was the first project of the Plan. In addition to considering potential for ground water contamination in its ongoing pesticide registration and evaluation process, the CDFA has also begun implementing the PCPA and has issued proposed regulations.

The SWRCB has implemented or participates in several programs to identify, correct and prevent pesticide contamination of California ground water. These programs are described in Part III. They include the Ground Water

Protection Strategy, the Pesticide Registration and Evaluation Program, Toxic Substances Monitoring, the Priority Chemicals Program, and Assembly Bill 1803 Follow-Up Program. Regional Water Quality Control Boards have investigated and mitigated a number of ground water contamination incidents originating from point sources. In addition, the State and Regional Boards work with the CDFA and County Agricultural Commissioners to mitigate problems of ground water contamination with pesticides resulting from non-point source agricultural use.

In summary, this report includes results submitted to the CDFA between 1986 and 1987. Eight pesticide active ingredients were detected in ground water due to legal agricultural use: DBCP, simazine, 1,2-D, diuron, EDB, atrazine, aldicarb and bromacil. All of these pesticides, except bromacil, were already reported as detected due to legal agricultural use in last year's report.

PREFACE

This report fulfills the requirements contained in Section 13152 (e) of the Pesticide Contamination Prevention Act (Chapter 1298, Statutes of 1985). The Act directs the California Department of Food and Agriculture (CDFA) to report specified information on sampling for pesticide residues in California ground water to the Legislature, the California Department of Health Services (CDHS), and the State Water Resources Control Board (SWRCB) by December 1, 1986, and annually thereafter.

This report is an update of last year's report (Brown, et al., 1986) which summarized results of well water sampling for agricultural pesticide residues from 1975 to 1986. This year's report includes well water sampling results which were submitted to the CDFA between September 1, 1986 and August 31, 1987.

Locations of sampling results are summarized in this report by county. In the data base, results are specified by state well number, if available. The state well number signifies township, range and section of the well sampled, locating it within one square mile units. However, due to the number of records contained in the data base for this year's report (4,193), a listing of individual results by township, range and section is not possible here.

Parts I and II of this report were written by the CDFA staff; the SWRCB contributed Part III. As specified in the PCPA, the following items are addressed:

PART I:

* The number of wells sampled for pesticide active ingredients, the location of wells from which the samples were taken, and agencies responsible for drawing and analyzing the samples.

* The number of well samples with detectable levels of pesticide active ingredients, the location of the wells from which the samples were taken, and the agencies responsible for drawing and analyzing the samples.

* An analysis of the probable source of residues, considering factors such as the physical and chemical characteristics of the economic poison, volume of use, method of application, irrigation practices related to use, and types of soil in areas where the economic poison was applied.

PART II:

* Actions taken by the CDFA to prevent economic poisons from migrating to ground waters of the state.

PART III:

* Actions taken by the SWRCB to prevent economic poisons from migrating to ground waters of the state.

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Finally, we thank the many individuals contributing their time and data whose efforts made this data base and report possible.

DISCLAIMER

The mention of commercial products, their source or their use in connection with material reported herein is not to be construed as either an actual or implied endorsement of such product.

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I.

WELL INVENTORY DATA BASE

A. INTRODUCTION

The California Department of Food and Agriculture (CDFA) is required by the Pesticide Contamination Prevention Act (PCPA), effective January 1, 1986, to develop and maintain a central data base of sampling results for pesticides in California well water collected by state and local agencies. The PCPA also requires that data submitted on the number and locations of wells sampled, and wells with detectable levels of pesticides be reported annually by the CDFA to the State Legislature, the State Water Resources Control Board (SWRCB), and the California Department of Health Services (CDHS).

This is the second annual report to fulfill these reporting requirements. The 1987 report is an update of the 1986 report entitled Sampling for Pesticide Residues in California Well Water, 1986 Well Inventory Data Base (Brown, et al., 1986). As in the 1986 report, results are presented for the number of wells sampled and the number of wells in which pesticides were detected for each county. Discussed in this report are data submitted between September 1, 1986 and August 31, 1987, which include some sampling results from studies conducted prior to September 1, 1986. General factors influencing pesticide movement through the soil to ground water are also discussed.

The CDFA began developing the well inventory data base in the winter of 1983, prior to enactment of the PCPA. At that time, the data base included only those results of sampling for pesticides in well water suspected of originating from agricultural nonpoint sources. To meet the requirements of the PCPA, both point and non-point source sampling results are now included in the data base, although the majority of data submitted are still from agricultural non-point sources.

B. MATERIALS AND METHODS

DATA COLLECTION

The PCPA requires all agencies that sample wells for pesticides to submit their pesticide sampling data to the CDFA for inclusion into the data base. In August, 1986, the CDFA notified federal and state agencies which sample well water for pesticide residues of this new state law, and requested them to submit required data either on a suggested reporting form, on a form of their own, or on magnetic tape. Agencies which contributed data to the 1987 update are:

(1) Federal: U.S. Bureau of Land Management, U.S. Geological Survey, U.S. Department of Agriculture - Forest Service;

(2) State: California Department of Food and Agriculture - both the Worker Health and Safety Branch and Environmental Monitoring and Pest Management Branch, California Department of Health Services - Sanitary Engineering Branch, State Water Resources Control Board, and the Regional Water Quality Control Board - Region 1;

(3) County: The Kern and Marin Counties' Departments of Health.

Data collection required a significant amount of inter-agency cooperation. Agencies supplied the data as either published reports, raw laboratory results, or retrievals of information from another data base transferred to magnetic tape. The CDFA staff also traveled to other agency offices to obtain photocopies of data, or to transcribe information directly onto computer coding sheets. In the past, the amount of data contributed by the Sanitary Engineering Branch of the CDHS has been a significant portion of the data base. However, because of unforeseen computer difficulties this year, only the positive results from the second phase (small systems) of the statewide monitoring study required by Assembly Bill 1803 were available for

inclusion into the data base in time for the results to be summarized in this year's report. The negative results will be presented in the 1988 report.

DATA EVALUATION

Sample results were first evaluated to determine if they met the following necessary criteria for inclusion in the well inventory data base:

a. Sample results had to be for analyses of pesticides and related compounds ("related compounds" means breakdown products such as endrin aldehyde or isomers of lindane).
b. Samples had to be associated with ground water, i.e., taken from a well.
c. Samples had to be taken as close to the well head as possible.
d. Samples had to be obtained from an untreated and unfiltered system, because filtration or treatment could reduce or eliminate a chemical residue and, therefore, mask the possible presence of the chemical in the supplying aquifer or ground water.
e. Location of each well sampled had to be identified at least by township/range/section according to the U.S. Geological Survey's Public Lands Survey Coordinate system. This requirement was necessary to count the number of individual wells in the data base, as well as to evaluate ground water contamination by pesticides using other spatially-distributed data sets.
f. The data must not have been entered previously.

Published reports were evaluated to determine if the data met these criteria, or, in the case of unpublished laboratory results, verbal confirmation was requested from appropriate agency staff. Data that met the criteria were then coded into the standard well inventory data base format.

The PCPA also requires that the CDFA, SWRCB and CDHS jointly agree on minimum well sampling requirements for all results submitted to the CDFA. The three agencies agreed upon minimum well sampling reporting requirements, in an effort to standardize at least the types of well sampling information reported, instead of setting standard sampling requirements which could possibly limit the amount of data received. The following minimum reporting

requirements were effective as of December 1, 1986, and are applicable only to samples taken after that date:

1. state well number (township/range/section/tract/sequence number/base and meridian)
2. county
3. date of sample (month/day/year)
4. chemical analyzed
5. individual sample concentration, in parts per billion
6. minimum detectable limit, in parts per billion
7. sampling agency
8. analyzing laboratory
9. street name and number of well location
10. well type
11. sample type (e.g., initial or confirmation)
12. date of analysis (month/day/year).

Optional information to be included when available:

1. method of analysis
2. well depth (in feet)
3. depths of top and bottom perforations of the well (in feet)
4. depth of standing water in the well at time of sampling (in feet)
5. year the well was drilled
6. whether a driller's log was located
7. known or suspected source of contamination.

These items are explained in Appendices A and B. Complete lists of the various codes used in the data base (e.g., chemical, sampling agency, laboratory) are included.

In an effort to increase the integrity and usefulness of the data, "confirmed" positive samples were distinguished from "unconfirmed" positive samples. The minimum reporting requirement that a sample be identified as either an initial or confirmed sample helped make this distinction possible. The document entitled "Contamination and Analytical Method Verification -- Definitions" (Appendix C), served as the basis for coding a sample as

confirmed or not. The coding system that describes as specifically as possible what procedures were used, if any, to confirm a sample is explained in the "Well Inventory Data Base: Format and Codes" (Appendices A and B).

DATA ENTRY

Once data were coded into the appropriate format, they were keypunched into the PDP 11/23+ minicomputer in Riverside, CA. The data were proofread against the coding sheets, and edited as necessary. Next, the data files were transferred from the PDP to a PRIME computer (9750 model) at the CDFA headquarters in Sacramento. After the new files were checked with computer verification programs, the data were entered into the Scientific Information Retrieval (SIR) Data Base Management System, where the generation of tables was performed.

Computer-driven verification programs have been developed by the CDFA staff that are used to increase the accuracy of the data. Verification is performed on all new data before inclusion into the main file to check for:

(1) Township/range/section (T/R/S) verification:
The townships, ranges, and sections in each county were coded and entered into a computer file. A program was written that compares this file to well sampling records to be included in the data base. Errors, such as an incorrect township for a county, were noted and corrected.

(2) Column verification:
A computer program was written that compares all allowed values for each column to the actual entered values in each column and notes any errors for each line. For example, the column for township can only be "N" or "S"; any other digit would be an error. These errors were inspected and corrected.

The purpose of the original data base was to determine where sampling for pesticides used in agriculture had occurred and where pesticide residues in ground water due to agricultural use were present. The objective was enlarged with the PCPA to also provide an absolute count of the number of contaminated versus non-contaminated wells. This new requirement introduced the need for identifying individual wells from which samples were taken, as opposed to a simple recording of all sampling results. To meet this need,

complete state well numbers have since been required. The Department of Water Resources (DWR) is responsible for assigning these numbers.

FORMAT OF THE DATA BASE

Each chemical analysis for a pesticide residue or related chemical in a well water sample constitutes one record in the data base. Each record contains 132 columns of data. The data base format is explained in Appendix A.

C. RESULTS

1987 DATA

The primary unit of analysis in the well inventory data base is a record. All records in the data base now have unique identification, and well numbers, enabling 1987 results to be summarized by record, or by well. The 1987 update to the well inventory data base includes only those sampling results that:

1) represent pesticide residue analyses from well water samples;
2) have been submitted from cooperating public agencies, including the CDFA, from September 1, 1986 through August 31, 1987. However, many of the data submitted were the results of well sampling conducted prior to September 1, 1986;
3) met the CDFA evaluation criteria as previously disscussed in the Materials and Methods section.

Appendix D lists the studies included in the 1987 update to the data base.

For the past two years, results from the CDHS statewide well monitoring program, required by Assembly Bill 1803, have been added to the data base. However, because of technical problems in obtaining the data this year, only the positive results from the second phase (small systems) of this survey could be included in the data base. Also, we have been notified by other agencies of sampling studies that were conducted this year, but the results were not submitted in time to meet our data entry deadline; these will be included in the 1988 update to the data base.

Data presented in the first portion of the Results section (Tables 2-8, Figures 1 and 2, and Appendix E) include:

1) results for all well water samples in which pesticide residues were not detected, and
2) results for well water samples in which a particular pesticide residue was detected in two or more discrete samples taken from the same well, during the time period of a single monitoring study.

Data presented in the second portion of the Results section (Tables 9-10) include results for which a particular pesticide was detected in only one sample, either because no other samples were taken or because no other subsequent samples contained detectable residues. These samples are referred to as single sample detections (SSDs) and are presented under the heading "Results for Single Sample Detections."

Results presented in the 1987 report are summarized in two ways: (1) by pesticide active ingredient, showing which pesticides were sampled for and which were detected; and (2) by county, indicating where sampling occurred and where pesticides were detected.

RESULTS BY PESTICIDE ACTIVE INGREDIENT:

Summary of Detected Pesticides and their Status

Information on 82 pesticide active ingredients and related chemicals analyzed in 4,193 samples taken from 530 wells is included in this 1987 update to the 1986 well inventory data base. Sixteen of these 82 active ingredients were detected in well water. Table 2 lists these pesticides, their sources and summarizes their status in the PCPA process. (For more detailed information, refer to the Status of Detected Pesticides section on pages 33 to 40.)

Sampling Distribution

Among the 82 pesticide active ingredients sampled for, there was great variability in the number of counties in which sampling occurred and in the number of wells sampled for each pesticide. Table 3 summarizes the number of counties with positive results and the total number of counties sampled for each of the 82 pesticides. Table 4 displays the number of positive, negative and total number of results per well and samples for these pesticides.

Well water was sampled most extensively for DBCP (304 wells in eight counties). Several pesticides have been sampled in nearly as many counties as DBCP but in fewer wells. For example, 1,2-D was sampled in seven

Table 2. A list of the 16 detected pesticides summarizing their status in the PCPA process from results reported 9/86 through 8/87 by various agencies. (For a more detailed explanation of these detections, see pages 33-40, Status of Detected Pesticides section.)

Detected Pesticide	Source(s)	Status in the PCPA Response Process
DBCP	Not applicable	Exempt from the PCPA process because use was suspended in 1979.
simazine	Non-point (agricultural)	Legal agricultural use determined on 8/4/1986; regulations are currently being written.
1,2-D	Non-point (agricultural); unknown; potential point	Exempt from the PCPA process because it is no longer registered as an active ingredient.
diuron	Non-point (agricultural)	Legal agricultural use determined on 10/1/1986; regulations are currently being written.
EDB	Not applicable	Exempt from the PCPA process because use was cancelled in 1984.
atrazine	Non-point (agricultural)	Legal agricultural use determined on 7/3/1986; regulations have been proposed.
aldicarb	Non-point (agricultural)	Use suspended in Del Norte County; finds in Humboldt are under PCPA investigation.
bromacil	Non-point (agricultural)	Legal agricultural use determined on 9/2/86; regulations are currently being written.

Table 2. (continued)

Detected Pesticide	Source(s)	Status in the PCPA Responce Process
xylene	Probable point (under investigation by the RWQCB)	Removed from the PCPA process because it resulted from a probable point source.
1,3-D	Possible point	Removed from the PCPA process as its presence not due to legal agricultural use.
alachlor	Point (faulty well)	Removed from the PCPA process as was the result of a point source contamination.
chlorothalonil	Point (faulty well)	See alachlor.
diazinon	Unknown (referred to RWQCB)	Removed from the PCPA process because its presence not due to legal agricultural use.
endrin	Not applicable	Removed from the PCPA process as there are no agricultural uses registered.
paradichlorobenzene	Not applicable	See endrin.
tetrachloroethylene	Not applicable	See endrin.

Table 3. A list of the 82 pesticides or related chemicals, sampled by various agencies, comparing the number of counties with confirmed postive sample results (regardless of contamination source), with the total number of counties sampled. These results (reported 9/86 through 8/87) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

PESTICIDE	NUMBER OF COUNTIES WITH POSITIVE RESULTS	TOTAL NUMBER OF COUNTIES
1,2-D	7	7
1,3-D	1	3
2,4,5-T	0	1
2,4-D	0	6
BHC (all isomers)	0	1
D-D mix	0	2
DBCP	7	8
DDD	0	1
DDE	0	1
DDT	0	1
DEF	0	1
EDB	2	2
PCP	0	1
alachlor	1	3
aldicarb	2	2
aldrin	0	1
ametryn	0	1

Table 3. (continued)

PESTICIDE	NUMBER OF COUNTIES WITH POSITIVE RESULTS	TOTAL NUMBER OF COUNTIES
atraton	0	1
atrazine	4	5
bromacil	1	1
carbaryl	0	1
carbofuran	0	1
carbophenothion	0	1
chlordane	0	1
chloroallyl alcohol (cis/trans)	0	1
chlorothalonil	1	1
chlorpropham	0	1
chlorpyrifos	0	1
cyanazine	0	1
cyprazine	0	1
diazinon	1	2
dieldrin	0	1
dimethoate	0	1
dinoseb	0	1

Table 3. (continued)

PESTICIDE	NUMBER OF COUNTIES WITH POSITIVE RESULTS	TOTAL NUMBER OF COUNTIES
dioxathion	0	1
disulfoton	0	1
diuron	1	2
endosulfan	0	1
endosulfan sulfate	0	1
endrin	1	6
endrin aldehyde	0	1
ethion	0	1
fenac	0	1
fenamiphos	0	1
fluometuron	0	1
glyphosate	0	1
heptachlor	0	1
heptachlor epoxide	0	1
lindane (gamma-BHC)	0	6
linuron	0	1
malathion	0	1

Table 3. (continued)

PESTICIDE	NUMBER OF COUNTIES WITH POSITIVE RESULTS	TOTAL NUMBER OF COUNTIES
methiocarb	0	1
methomyl	0	1
methoxychlor	0	6
methyl bromide	0	1
methyl parathion	0	1
metolachlor	0	1
mevinphos	0	1
monuron	0	1
neburon	0	1
oxamyl	0	1
paradichlorobenzene	1	1
parathion	0	1
phorate	0	1
phosmet	0	1
phosmet-OA	0	1
prometon	0	2
prometryn	0	1

Table 3. (continued)

PESTICIDE	NUMBER OF COUNTIES WITH POSITIVE RESULTS	TOTAL NUMBER OF COUNTIES
propazine	0	1
propham	0	1
propoxur	0	1
screen (carbamate)	0	1
screen (chlorinated hydrocarbon)	0	2
screen (organophosphate)	0	2
silvex	0	6
simazine	2	3
simetryn	0	1
tetrachloroethylene	1	1
tetrachlorophenol	0	1
toxaphene	0	6
trifluralin	0	1
xylene	2	2

Table 4. A list of the 82 pesticides or related chemicals, sampled for by various agencies, showing the number of wells sampled and the number of samples taken for each pesticide or related chemical, grouped in to positive, negative and total categories. These results (reported 9/86 through 8/87 by various agencies) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,2-D	18	45	10	18	28	63
1,3-D	1	6	10	21	11	27
2,4,5-T	0	0	4	5	4	5
2,4-D	0	0	16	21	16	21
BHC (all isomers)	0	0	4	6	4	6
D-D mix	0	0	14	15	14	15
DBCP	138	815	166	602	304	1417
DDD	0	0	4	6	4	6
DDE	0	0	4	6	4	6
DDT	0	0	4	6	4	6
DEF	0	0	4	5	4	5

Table 4. (continued)

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
EDB	11	44	191	674	202	718
PCP	0	0	4	5	4	5
alachlor	1	2	45	117	46	119
aldicarb	7	24	14	31	21	55
aldrin	0	0	4	6	4	6
ametryn	0	0	15	16	15	16
atraton	0	0	15	16	15	16
atrazine	9	19	151	268	160	287
bromacil	2	4	106	144	108	148
carbaryl	0	0	4	5	4	5
carbofuran	0	0	4	5	4	5
carbophenothion	0	0	19	21	19	21
chlordane	0	0	4	6	4	6
chloroallyl alcohol (cis/trans)	0	0	4	8	4	8
chlorothalonil	1	2	1	2	2	4

Table 4. (continued)

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
chlorpropham	0	0	4	5	4	5
chlorpyrifos	0	0	4	5	4	5
cyanazine	0	0	19	21	19	21
cyprazine	0	0	15	16	15	16
diazinon	1	6	27	61	28	67
dieldrin	0	0	4	5	4	5
dimethoate	0	0	4	5	4	5
dinoseb	0	0	4	5	4	5
dioxathion	0	0	4	5	4	5
disulfoton	0	0	4	5	4	5
diuron	13	29	88	113	101	142
endosulfan	0	0	4	6	4	6
endosulfan sulfate	0	0	4	6	4	6
endrin	1	2	15	20	16	22
endrin aldehyde	0	0	4	6	4	6

Table 4. (continued)

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
ethion	0	0	19	21	19	21
fenac	0	0	4	5	4	5
fenamiphos	0	0	2	2	2	2
fluometuron	0	0	4	5	4	5
glyphosate	0	0	2	2	2	2
heptachlor	0	0	4	6	4	6
heptachlor epoxide	0	0	4	6	4	6
lindane (gamma-BHC)	0	0	16	22	16	22
linuron	0	0	4	5	4	5
malathion	0	0	19	21	19	21
methiocarb	0	0	4	5	4	5
methomyl	0	0	4	5	4	5
methoxychlor	0	0	16	22	16	22
methyl bromide	0	0	12	13	12	13
methyl parathion	0	0	19	21	19	21

Table 4. (continued)

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
metolachlor	0	0	30	102	30	102
mevinphos	0	0	4	5	4	5
monuron	0	0	4	5	4	5
neburon	0	0	4	5	4	5
oxamyl	0	0	4	5	4	5
paradichlorobenzene	1	2	0	0	1	2
parathion	0	0	19	21	19	21
phorate	0	0	4	5	4	5
phosmet	0	0	2	8	2	8
phosmet-OA	0	0	2	8	2	8
prometon	0	0	132	186	132	186
prometryn	0	0	19	21	19	21
propazine	0	0	19	21	19	21
propham	0	0	4	5	4	5
propoxur	0	0	4	5	4	5

Table 4. (continued)

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
screen (carbamate)	0	0	10	10	10	10
screen (chlorinated hydrocarbon)	0	0	12	13	12	13
screen (organophosphate)	0	0	12	12	12	12
silvex	0	0	16	21	16	21
simazine	20	47	87	109	107	156
simetryn	0	0	15	16	15	16
tetrachloroethylene	1	3	17	21	18	24
tetrachlorophenol	0	0	4	5	4	5
toxaphene	0	0	16	22	16	22
trifluralin	0	0	15	16	15	16
xylene	2	5	6	11	8	16
TOTAL SAMPLE RESULTS		1055		3138		4193

counties from a total of 28 wells. Eight of the 82 pesticides (10%) were sampled in six or more counties; 61 pesticides (74%) were sampled in one county each. Most of the pesticides (90%) in the 1987 update to the data base were sampled in 30 or fewer wells and within that group 61% were sampled in 10 or fewer wells. Only nine percent of all of these pesticides were sampled in 100 or more wells. This variation in sampling distribution and the different extent of sampling conducted for pesticides prohibits us from presenting a complete picture of the impact of agricultural use of pesticides on California's ground water quality.

Detections

Sixteen (20%) of the 82 active ingredients and related chemicals included in the 1987 update to the data base were detected in well water, while 66 (80%) were not detected. Of these 16 positive pesticides, eight have been determined to be present as a result of agricultural use (DBCP, simazine, 1,2-D, diuron, EDB, atrazine, aldicarb and bromacil). All eight compounds are soil-applied pesticides. The remaining eight are considered to be the likely result of point source contamination (xylene, 1,3-D, alachlor, chlorothalonil, diazinon, endrin, paradichlorobenzene and tetrachloroethylene).

Pesticide residues were detected in a total of 1,055 well water samples from 190 wells. DBCP alone accounts for 73% or 138 of all positive wells (wells with two or more positive samples per chemical), and 77%, or 815 of all positive samples. The next most frequently detected pesticides were simazine, 1,2-D, diuron, EDB, atrazine and aldicarb which accounted for 11, 10, 7, 6, 5 and 4% of all positive wells, respectively. The remaining eight detected pesticides each accounted for 1% of all positive wells. Figure 1 shows the statewide distribution of the most frequently detected pesticides.

Table 5 displays the most frequently detected pesticides and the pesticides most frequently sampled for, showing that those pesticides most frequently detected are not always among those pesticides most often looked for. DBCP and simazine are exceptions, in that DBCP residues were detected in 45% of all wells sampled for DBCP and simazine residues were detected in 19% of all wells sampled for simazine.

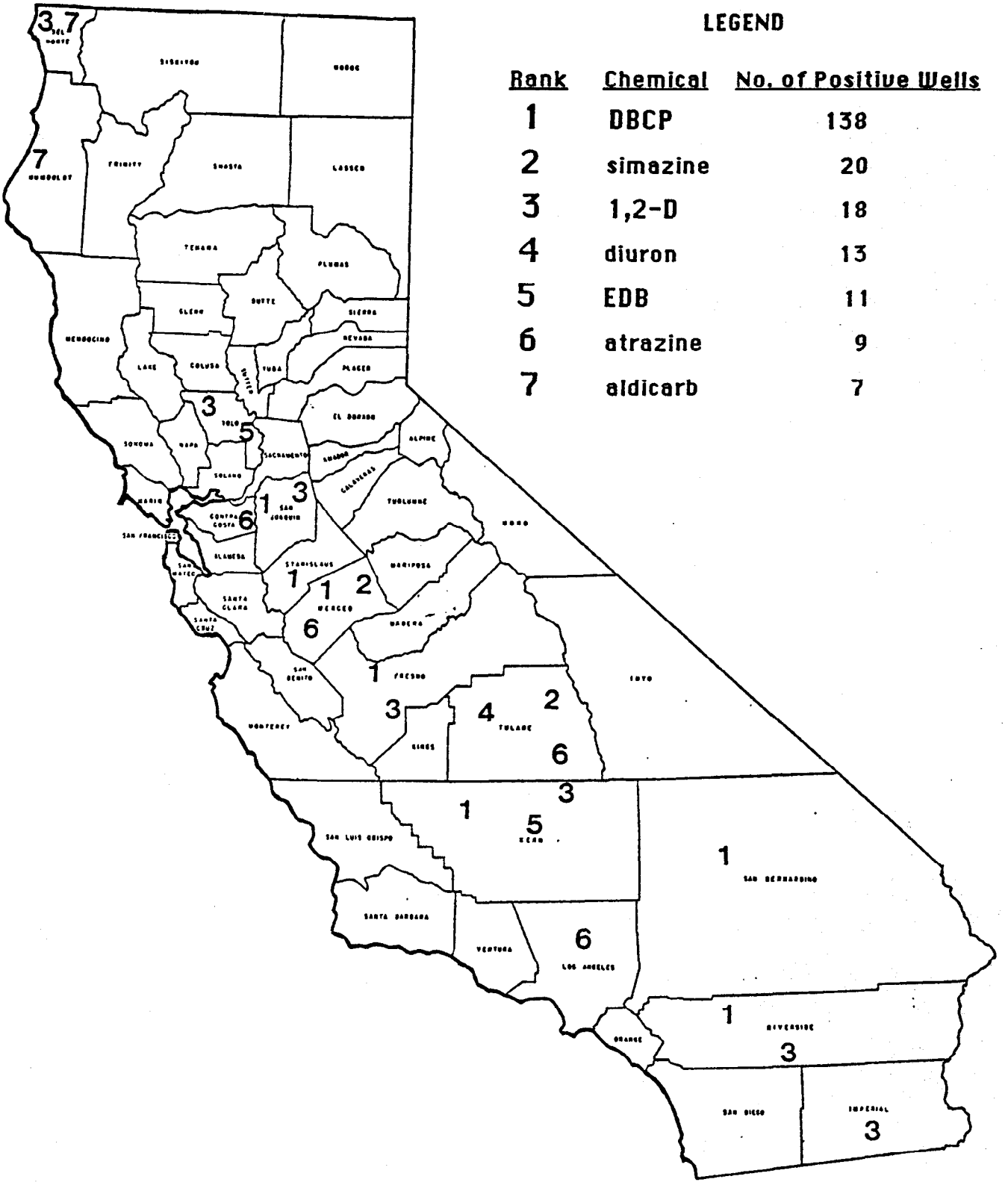

Figure 1. Distribution of the most frequently detected pesticides in well water in California counties. These results (reported 9/86 through 8/87 by various agencies) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

Table 5. (A) Most frequently detected compounds (found in $\geq$ 5 wells) out of 16 detected, and (B) most frequently sampled compounds (sampled in $\geq$ 100 wells) out of 82 compounds which were sampled for by various agencies. These results (reported 9/86 through 8/87) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

A. PESTICIDE	NUMBER OF WELLS WITH RESIDUES
DBCP	138
simazine	20
1,2-D	18
diuron	13
EDB	11
atrazine	9
aldicarb	7

B. PESTICIDE	TOTAL NUMBER OF WELLS SAMPLED REGARDLESS OF RESULTS
DBCP	304
EDB	202
atrazine	160
prometon	132
bromacil	108
simazine	107
diuron	101

RESULTS BY COUNTY:

Total Number of Samples

Results for 530 wells sampled for pesticides in 19 counties are included in the 1987 update to the data base. Table 6 presents the results for sampling in those counties showing the number of positive, negative and total samples taken and wells sampled. Kern County had the largest number of wells sampled as well as the largest number of samples taken (1,956 samples from 216 wells) amongst all 19 counties. Most of these samples were taken by Kern County in a study conducted from 1979 to 1986. Sampling in Kern County accounted for 41% of all wells sampled and 47% of all samples taken for pesticides. Tulare and Fresno Counties followed Kern in having the largest number of samples taken (776 and 696, respectively), but samples taken in Fresno County were collected from only 38 wells whereas samples taken in Tulare County were collected from 113 wells. More wells were sampled in Merced County than in Fresno County (52 wells compared with 38 wells), but approximately one half as many samples were taken. Sampling in these four counties (Kern, Tulare, Fresno and Merced) accounted for 91% of all samples taken in 79% of all wells sampled in the 1987 update to the data base. It must be remembered, however, that because different crops are grown in different counties, the kinds, and amounts of pesticides used will be different from one county to another. Therefore, it is not surprising that the chemicals sampled and the frequency of any one chemical being detected varied from county to county.

The number of pesticides sampled and the number of samples taken also varied between counties because sampling programs differed in design and area encompassed. Wells in Fresno County were sampled for the largest number of pesticides (68 of the 82 total), while all other 18 counties were each sampled for fewer than 10 pesticides (Table 7). A tabular summary of pesticides sampled in each county appears in Appendix E.

Detections

Pesticide residues were found in 14 of the 19 counties (74%) where wells were sampled (Table 7). Kern County had the highest number of wells with

Table 6. A list of the counties in which sampling was conducted comparing the number of wells and the number of samples reported by various agencies, grouped into positive, negative and total categories. These results (reported 9/86 through 8/87) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

COUNTY	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
Contra Costa	2	4	0	0	2	4
Del Norte	7	33	5	39	12	72
Fresno	18	42	20	654	38	696
Humboldt	4	12	7	23	11	35
Imperial	1	2	1	6	2	8
Kern	58	688	158	1268	216	1956
Los Angeles	2	4	0	0	2	4
Marin	0	0	5	36	5	36
Mendocino	0	0	4	42	4	42
Merced	15	34	37	343	52	377
Riverside	7	25	3	16	10	41
San Bernardino	5	15	4	11	9	26

Table 6. (continued)

COUNTY	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
San Diego	0	0	2	2	2	2
San Joaquin	16	32	1	1	17	33
Stanislaus	30	60	0	0	30	60
Sutter	0	0	1	4	1	4
Trinity	0	0	1	6	1	6
Tulare	22	89	91	687	113	776
Yolo	3	15	0	0	3	15
TOTAL	190	1055	340	3138	530	4193

Table 7. Summary by county showing the number of pesticides detected in well water and the total number of pesticides sampled for by various agencies. These results (reported 9/86 through 8/87) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

COUNTY	NUMBER OF DETECTED PESTICIDES	TOTAL PESTICIDES SAMPLED
Contra Costa	2	2
Del Norte	2	4
Fresno	5	68
Humboldt	2	4
Imperial	1	7
Kern	3	9
Los Angeles	1	1
Marin	0	6
Mendocino	0	6
Merced	4	6
Riverside	3	4
San Bernardino	1	1
San Diego	0	1
San Joaquin	2	2
Stanislaus	1	1
Sutter	0	4
Trinity	0	6
Tulare	4	8
Yolo	4	4

pesticide residues (58), followed by Stanislaus and Tulare Counties (30 and 22, respectively). Eight of the 14 counties (57%) had fewer than ten wells containing pesticide residues.

In Fresno County, five pesticides were detected after sampling was conducted for 68 pesticides. In all the other 13 counties where pesticides were detected, sampling was conducted for fewer than ten pesticides per county. A maximum of four pesticides were detected in any one county.

Table 8 is a checklist of all detected pesticides in the 1987 update to the data base and the counties in which they were found. Figure 2 is a detailed map of California indicating the townships within each county where at least one pesticide was detected in well water.

Table 8. Summary by county and pesticide of the number of wells with detectable pesticide residues. These results (reported 9/86 through 8/87 by various agencies) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

COUNTY	1,2-D	1,3-D	DBCP	EDB	alachlor	aldicarb	atrazine	bromacil	chlorothalonil	diazinon	diuron	endrin	paradichlorobenzene	simazine	tetrachloroethylene	xylene
Contra Costa							1						1			
Del Norte	7					4										
Fresno	1		16									1			1	1
Humboldt						3			1							
Imperial	1															
Kern	6		54	8												
Los Angeles							2									
Merced			12				1			1				1		
Riverside	1	1	6													
San Bernardino			5													
San Joaquin	1		15													
Stanislaus			30													
Tulare							5	2			13			19		
Yolo	1			3	1											1
TOTALS	18	1	138	11	1	7	9	2	1	1	13	1	1	20	1	2

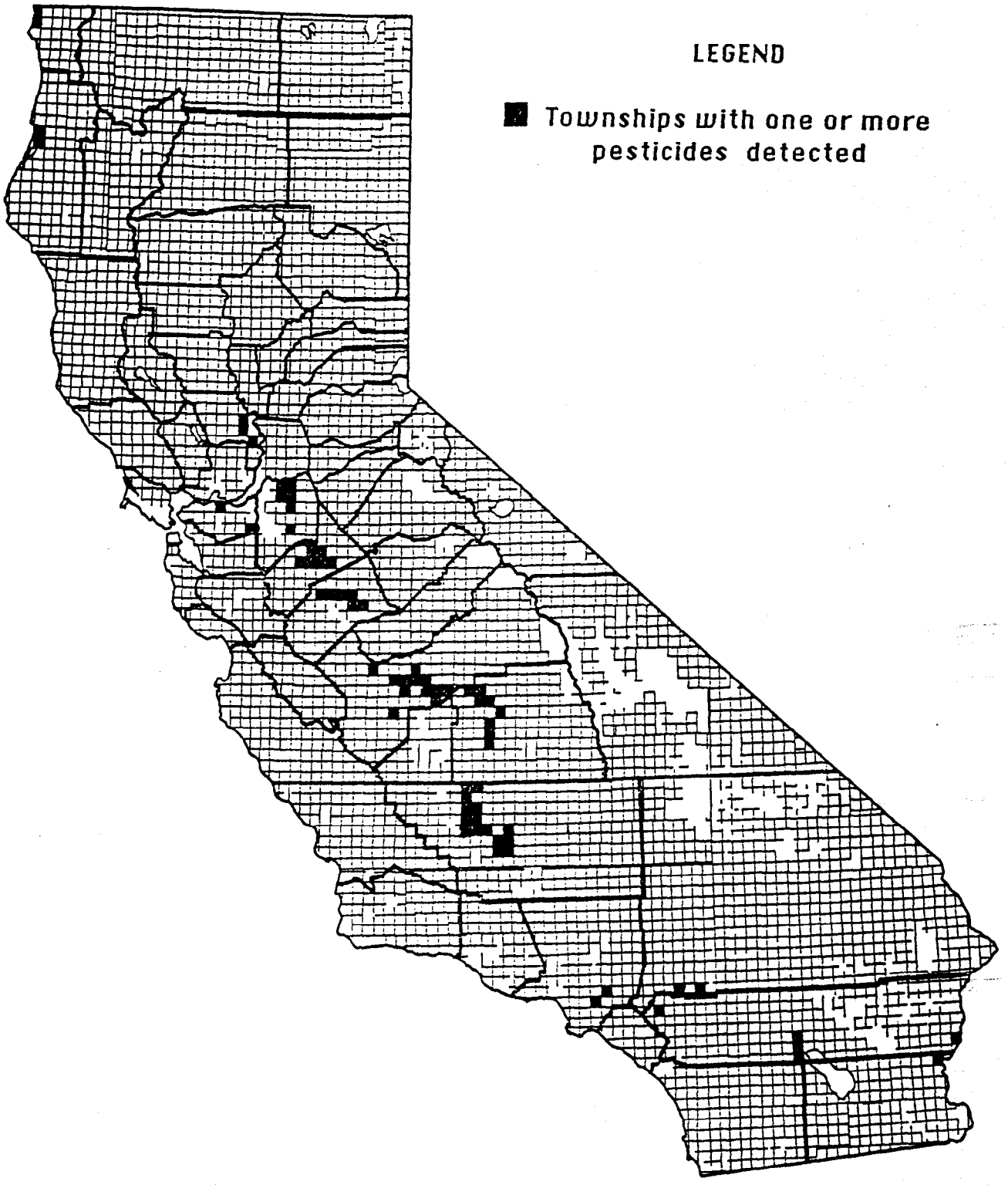

Figure 2. California townships with one or more pesticides detected in well water. These results (reported 9/86 through 8/87 by various agencies) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

STATUS OF DETECTED PESTICIDES:

The following section describes the status of each detected pesticide in the 1987 update to the data base:

(1) DBCP:

Although the nematicide DBCP was officially suspended from use in 1979, DBCP residues are still being detected in wells. The detection of DBCP was confirmed in 138 wells located in seven counties, out of 304 wells sampled in eight counties. (See Appendix E for positive well distribution, by county). The concentrations ranged from 0.001 to 23.0 ppb; the CDHS action level for DBCP is 1.0 ppb. Agricultural applications are considered to be the source of the DBCP residues found in well water because DBCP was typically applied to crops by adding it directly into irrigation water. The CDHS is conducting ongoing monitoring for DBCP in some wells and, in cooperation with the California Department of Water Resources (DWR), is providing funds for mitigation actions. Also, the CDHS is in the process of proposing a drinking water standard for DBCP that would require ongoing sampling of all community (large and small) water systems (D. Spath, personal communication). DBCP has not been entered into the PCPA pesticide detection response process (for an explanation of this process, see Monk, et al., 1987) because its use has already been suspended.

(2) simazine:

The detection of simazine was confirmed in 20 wells in two counties, out of 107 wells sampled in three counties. Concentrations ranged from 0.03 to 3.40 ppb; 41 of the 47 detected samples were below 1.00 ppb. The CDHS action level for simazine is 150 ppb. One of the twenty wells was a small system well sampled in the CDHS AB 1803 survey in Merced County. The other 19 wells were sampled in a CDFA study in Tulare County (Troiano and Segawa, 1987). Eighteen of the wells were domestic wells; one well's use was unknown. The agricultural uses of simazine as a selective herbicide to control weeds in orchards, alfalfa fields, and on rights-of-way were determined to be the most probable sources for the Tulare County finds. The detection of simazine was determined to be due to legal agricultural

use in the Director's "Legal Agricultural Use Determination" of August 4, 1986. Regulations for the modified use of simazine are now being written.

(3) 1,2-D:

The detection of 1,2-D was confirmed in 18 out of 28 wells sampled in seven counties. Seven of the positive wells were sampled in Del Norte County as part of an ongoing monitoring study by the North Coast RWQCB; all of the wells were used for drinking water. The source of this 1,2-D is considered to be from the historical agricultural use of 1,2-D in nematicides which are no longer allowed to be registered. Six of the positive wells were sampled in Kern County during the CDHS AB 1803 sampling survey (small systems phase); the sources are unknown. One well with detectable levels in Fresno County was sampled by the SWRCB in 1985. Samples from this well also tested positive for endrin, DBCP, and some industrial chemicals. The four other wells positive for 1,2-D were sampled in Imperial, Riverside, San Joaquin and Yolo Counties during the CDHS AB 1803 survey; sources are unknown. Concentrations found ranged from 0.5 ppb in Kern County, to 56 ppb in Yolo County, although 67% of all positive samples had concentrations below the CDHS action level of 10.0 ppb. The Central Valley RWQCB is investigating the Yolo County well.

1,2-D was formerly present in formulations at 31.2% and less than 7% by weight of active ingredients in the soil-applied products DD Mix, and Telone II, respectively. Since the discovery of its carcinogenicity, and since it has been found in ground water, its presence in agricultural products is now restricted to amounts of less than 0.5% by weight of active ingredients. Production of the product DD Mix was stopped in 1984; its use is no longer registered in California. 1, 2-D is now present only as a contaminant in seven products, at levels ranging from 0.15 to 0.5 % by weight of the 1,2-D, 1,3-D and related C-3 compounds portion of these products. Dow Chemical includes the impurity of 1,2-D in its product, Telone II, (composed of 94-96% 1,3-D as the active ingredient) with the list of inert compounds.

1,2-D has not been entered into the PCPA pesticide detection response process, because it is now only present in formulated products in low enough

percentages to technically classify it as a formulation contaminant, and not an active ingredient.

(4) **diuron:**

The detection of diuron was confirmed in 13 wells in Tulare County, out of 101 wells sampled in Tulare and Fresno Counties, in a CDFA sampling study (Troiano and Segawa, 1987). Concentrations ranged from 0.05 to 1.7 ppb; an action level for diuron has not yet been established by the CDHS. Eleven of the wells were used as sources of drinking water, one was an irrigation well, and one well's use was unknown. Diuron is an herbicide that is used to control weeds in many crops and in non-crop areas. Its agricultural use in citrus orchards, alfalfa fields, and rights of way has been determined to be the most probable source of well contamination in Tulare County. The detection of diuron was determined to be the result of legal agricultural use in the Director's "Legal Agricultural Use Determination" of October 1, 1986. Regulations for the modified use of diuron are now being written.

(5) **EDB:**

Although the U.S. Environmental Protection Agency (EPA) suspended all ethylene dibromide (EDB) registrations for U.S. uses in September, 1984, EDB is still being detected in wells. The detection of EDB was confirmed in 11 out of 202 wells sampled in Kern and Yolo Counties. Concentrations ranged from 0.04 to 2.1 ppb; the action level for EDB recommended by the CDHS is the limit of quantification (0.02 ppb). Eight of the positive wells were in Kern County, sampled during a Kern County study and during the CDHS AB 1803 sampling survey; the sources are unknown. EDB was also detected in three small systems wells in Yolo County during the CDHS AB 1803 sampling. Two of these wells also contained other compounds and are now being monitored by the Central Valley RWQCB. EDB was formerly used agriculturally as a soil fumigant (insecticide, nematicide).

EDB has not been entered into the PCPA pesticide detection response process, because its registration has been cancelled.

(6) **atrazine:**

The detection of low levels of atrazine has been confirmed in nine wells in four counties, out of 160 wells sampled in five counties. Concentrations ranged from 0.01 to 8.5 ppb - values below the 15 ppb action level established by the CDHS. Atrazine was found in one well in Contra Costa County, one well in Merced County and two in Los Angeles County in the CDHS AB 1803 sampling. The sources of the atrazine contamination of these small system wells are unknown. Atrazine was detected in five domestic wells in Tulare County during a CDFA sampling study (Troiano and Segawa, 1987). The use of atrazine to kill roadside weeds has been suggested as the probable agricultural non-point source for the Tulare County findings. Atrazine was entered into the PCPA pesticide detection response process at the time of the Director's "Legal Agricultural Use Determination" for this active ingredient on July 3, 1986. The Director has proposed regulations banning agricultural uses of atrazine in areas where it has been found in wells due to legal agricultural use, except in Los Angeles County, where all uses (except home use) would be banned in such areas.

(7) **aldicarb:**

The detection of aldicarb has been confirmed in four wells (three domestic, and one both domestic and irrigation) in Del Norte County, and in three domestic wells in Humboldt County, out of 21 wells sampled in these two counties. Only one of the seven wells had residues above the CDHS action level of 10 ppb; five of the other wells had concentrations less than or equal to 5.1 ppb. The contamination of the Del Norte County wells has been determined to be the result of the historical agricultural use of aldicarb in lily bulb fields in that county. For several years the North Coast RWQCB has been monitoring wells in Del Norte County for the presence of aldicarb because of its propensity for leaching in areas where the soil and climatic conditions are like those found in that county. Aldicarb use was suspended in Del Norte County in 1985. In Humboldt County, the Agricultural Commissioner no longer issues permits for its use in the areas surrounding the wells with detectable levels of aldicarb. The CDFA is currently investigating the finds in Humboldt County.

(8) **bromacil**:

The detection of bromacil has been confirmed two wells (one domestic, one irrigation) in Tulare County, out of 108 wells sampled during a CDFA monitoring study in that county (Troiano and Segawa, 1987). Tulare County was the only county where bromacil was sampled. The concentrations in four samples taken from the two wells ranged from 0.1 to 6.2 ppb; an action level for this compound has not yet been established. The most probable source of the bromacil has been determined to be from the agricultural use of this herbicide to control weeds in crops. Bromacil was entered into the PCPA pesticide detection response process at the time of the Director's "Legal Agricultural Use Determination" on September 2, 1986. Regulations for the modified use of bromacil are now being written.

(9) **xylene**:

The detection of xylene has been confirmed in one well in Fresno County and one well in Yolo County out of a total of eight wells sampled in these two counties. Levels found ranged from 4.1 to 6.3 ppb; the CDHS action level for xylene is 620 ppb. The source of the xylene in Fresno County is under investigation by the RWQCB. The well was originally sampled because of the potential for contamination from old gasoline tanks used to supply school buses, often found at or near rural schools. Follow up sampling is currently being done by the Central Valley RWQCB. However, the well is no longer used and the school is now connected to an adjacent water system. The Yolo County well with xylene residues is located at a farm site that is also being investigated as a probable point source by the Central Valley RWQCB. Thus, these detections of xylene have been removed from the PCPA pesticide detection response process.

(10) **1,3-D**:

The detection of 1,3-D has been confirmed in one well in Riverside County out of a total of 11 wells sampled in three counties. Concentrations ranged from 6.2 to 31.0 ppb; the CDHS has not yet established an action level for 1,3-D. The one positive well was sampled as part of the CDHS AB 1803

sampling; presence of 1,3-D was confirmed by a private laboratory. However, because it was determined that this residue did not result from leaching due to legal agricultural use, 1,3-D was removed from the PCPA detection response process.

(11) **alachlor:**

The detection of alachlor has been confirmed in one small system well in Yolo County, out of 46 wells sampled in three counties. This well also contained detectable levels of EDB. Alachlor was detected at 0.9 and 1.10 ppb; the action level recommended by the CDHS for this compound is the limit of quantification (0.2 ppb). The well was sampled as part of the CDHS AB 1803 sampling; the source of alachlor is thought to be a result of faulty well construction, i.e., a point source. This well has also been sampled for alachlor and other pesticides in previous years by the Yolo County Environmental Health Department. Filters have been placed on the well, and samples taken from the filtered water show no detectable levels of pesticide residues (J. Okusaka, personal communication). Alachlor is an herbicide used to control annual grasses and certain broadleaf weeds in soybeans, corn and peanuts. Alachlor was not entered into the PCPA detection response process, because its presence was determined to be the result of point source contamination.

(12) **chlorothalonil:**

The detection of chlorothalonil has been confirmed in an irrigation well in Humboldt County, out of two wells sampled in that county. The source of the chlorothalonil was from surface water run-off containing the compound entering the well directly through a visibly-cracked seal. The North Coast RWQCB has since had the well sealed, and is monitoring the well for signs of improvement in the water quality. Chlorothalonil has not been entered into the PCPA detection response process, because it was determined that faulty well construction (i.e., a point source) was the cause of contamination.

(13) **diazinon**:

The detection of diazinon has been confirmed in an irrigation well in Merced County, out of 28 wells sampled in two counties. Two laboratories confirmed the find at concentrations ranging from 0.1 ppb to 2.60 ppb, from a total of six samples. The CDHS recommended action level for this compound is 14 ppb. The well was sampled by the CDFA during a sampling study (report in progress). Diazinon is an insecticide used to control soil insects and other insects. Diazinon was removed from the PCPA detection response process because it was determined that this detection was not from leaching due to legal agricultural use.

(14) **endrin**:

The detection of endrin has been confirmed in one well in Fresno County, out of 16 wells sampled in six counties. The concentrations in the two samples were 0.12 and 0.21 ppb; the CDHS has not yet established an action level for endrin. This is the same well discussed in the section on 1,2-D that was sampled by the SWRCB. The well is located across the street from an EPA Superfund site, where high levels of endrin have been found in the soil but not in monitoring wells. Monitoring wells have been installed at the site, and near the well where the endrin was detected. Endrin was an insecticide used in small grains, cotton and non-agricultural areas. Endrin has not been entered into the PCPA pesticide detection response process because there are no currently active registered agricultural products that contain endrin.

(15) **paradichlorobenzene**:

The detection of paradichlorobenzene was confirmed in one well in Contra Costa County. Both samples contained 1.40 ppb of the compound; the CDHS recommended action level for this compound is the limit of quantification (0.5 ppb); taste and odor threshold is 0.3 ppb. The well was sampled as part of the CDHS AB 1803 sampling. Paradichlorobenzene is the active ingredient in moth balls and home use animal repellants; there are no actively registered agricultural use products. Therefore,

paradichlorobenzene was removed from the PCPA pesticide detection response process.

(16) **tetrachloroethylene:**

The detection of tetrachloroethylene has been confirmed in one domestic well, out of 18 wells sampled in Fresno County. Concentrations ranged from 0.6 ppb to 1.0 ppb; the CDHS action level is 4.00 ppb. This well was located near the well discussed in the sections on 1,2-D and endrin. Tetrachloroethylene was formerly used in mixtures with grain protectants and fumigants for stored grain; this use is no longer approved. There are no actively registered agricultural use products containing this compound. Therefore, tetrachloroethylene was removed from the PCPA pesticide detection response process.

RESULTS FOR SINGLE SAMPLE DETECTIONS:

1987 Data

Data received for inclusion in the 1987 data base were not always the result of recent monitoring activity. Consequently, information validating single sample detections (SSDs) of pesticides in well water (e.g., results from second samples or alternate analytical methods used in confirmation) were not always available. These samples may represent valid detections of pesticide residues but cannot be presented with the same confidence as detections with subsequent independent samples validating the presence of a pesticide. Therefore, these single sample detections are included in this separate portion of the Results section. In the following paragraphs comparisons made with results "previously presented" or "previously detected" refer to comparisons with positive data which were presented in the earlier portion of this Results section (see Tables 3,4,and 8 and Appendix E).

By Pesticide Active Ingredient

A total of 107 SSDs were included in the 1987 data base (Table 9). These results represent sampling conducted for ten pesticides (DBCP, EDB, alachlor, aldicarb, atrazine, bromacil, dieldrin, diuron, propham and simazine) in a total of 81 wells. All ten pesticides were included in Tables 3 and 4. Therefore, these pesticides were either detected in other monitoring studies where their presence was verified by additional samples, or they were sampled in a monitoring study where all other results were negative. The pesticides dieldrin and propham were not previously reported as detected (see Tables 3 and 4). Each of these two pesticides was found in only one positive sample in a single well.

By County

Single sample detections (SSDs) occurred in six counties: Fresno, Humboldt, Kern, Merced, San Bernardino and Tulare (Table 10). Most of the wells with SSDs (88%) occurred in Kern and Tulare Counties (31 and 40 wells,

Table 9. Number of wells sampled and number of samples taken for pesticides with single sample detections. These results (reported 9/86 through 8/87 by various agencies) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

PESTICIDES WITH SINGLE SAMPLE DETECTIONS	NO. OF WELLS SAMPLED	NO. OF SAMPLES TAKEN
DBCP	28	28
EDB	8	8
alachlor	1	1
aldicarb	1	1
atrazine	9	9
bromacil	8	8
dieldrin	1	1
diuron	18	18
propham	1	1
simazine	32	32
TOTAL SAMPLE RESULTS	107	

Table 10. Number of wells sampled and number of samples taken for pesticides with single sample detections, grouped by county. These results (reported 9/86 through 8/87 by various agencies) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

COUNTY	SINGLE SAMPLE DETECTIONS OF PESTICIDES	NO. OF WELLS SAMPLED	NO. OF SAMPLES TAKEN
Fresno			
	atrazine	1	1
	dieldrin	1	1
	propham	1	1
	simazine	1	1
	TOTAL SAMPLE RESULTS		4
Humboldt			
	aldicarb	1	1
	TOTAL SAMPLE RESULTS		1
Kern			
	DBCP	25	25
	EDB	8	8
	TOTAL SAMPLE RESULTS		33

Table 10. (continued)

COUNTY	SINGLE SAMPLE DETECTIONS OF PESTICIDES	NO. OF WELLS SAMPLED	NO. OF SAMPLES TAKEN
Merced			
	alachlor	1	1
	atrazine	2	2
	TOTAL SAMPLE RESULTS		3
San Bernardino			
	DBCP	3	3
	TOTAL SAMPLE RESULTS		3
Tulare			
	atrazine	6	6
	bromacil	8	8
	diuron	18	18
	simazine	31	31
	TOTAL SAMPLE RESULTS		63

respectively); however, pesticides with SSDs for these counties (DBCP and EDB; atrazine, bromacil, diuron and simazine, respectively) were previously presented as detected pesticides in various counties (see Table 8). In Fresno County the four SSD pesticides (atrazine, dieldrin, propham and simazine) were not previously detected, nor was alachlor previously detected in Merced County (see Appendix E). The SSD pesticide aldicarb was previously presented as detected in Humboldt County (see Table 8).

INDUSTRIAL-RELATED, POINT SOURCE CONTAMINATION:

Four studies submitted this year were of known point source contamination sites. These sites were located at wood treatment plants or sawmills; three were in Mendocino County, one in Siskiyou County. All results were from ongoing sampling of monitoring wells at or near the sites, conducted or required by the RWQCB, Region 1. The contamination was a result of on-site spills of chemicals used industrially in treatment processes, and rain runoff from treated and stored wood. The compounds pentachlorophenol, tetrachlorophenol, arsenic and hexavalent chromium were detected in the monitoring wells. Domestic wells sampled in areas surrounding the sites showed no signs of contamination from these sources.

Each RWQCB is responsible for protecting the water quality of their region. This task includes investigating potential point source problems, and issuing mitigation orders when corrective actions by the dischargers are necessary. The SWRCB is notified of these problems by the RWQCBs.

D. DISCUSSION

DATA BASE DEVELOPMENT

The well inventory data base was originally developed by the Environmental Hazards Assessment Program as a necessary first step in the CDFA's Ground Water Protection Plan (a department-initiated, nonstatutory program). The purposes of the data base were to allow the CDFA to: (1) identify reliable information on the occurrence of nonpoint source contamination of ground water by the agricultural use of pesticides; and (2) computerize the data to facilitate subsequent graphical, numerical and spatial analyses. There is now a third purpose for the data base: to enable the CDFA to meet the requirement in the PCPA directing the CDFA to report annually to the Legislature, the CDHS and the SWRCB on the extent and results of well water sampling for pesticide residues in California.

CONTENTS OF THE 1987 DATA BASE

All results that met the criteria for inclusion in the data base as discussed in the Materials and Methods section were summarized for this report. However, the data were presented in two groups: (1) those initial positive samples that were "confirmed" with a second discrete positive sample from the same well (same chemical), and all negative results; and (2) initial positives that were not "confirmed" with a second, discrete, positive sample. The decision was made to distinguish these two groups in order to not only increase the integrity of the data presented, but also to establish consistency between those pesticide detections presented in this report, and regulations that will be established for implementing mitigation or preventative measures, as required by the PCPA.

This year's summary of the contents of the data base is an update, so only data submitted between September 1, 1986 and August 31, 1987 are discussed. The 1987 update to the 1986 data base contains well sampling results for 82 pesticide active ingredients and related chemicals sampled between 1979 and 1987. Of these 82 pesticides, 16 were detected in well water. Based on

information which was submitted in 1986-87, eight of these detected pesticides are considered to be from agricultural non-point sources which were verified by further investigation.

LIMITATIONS ON INTERPRETING THE DATA

The well inventory data base is a compilation of the results of many diverse studies and monitoring activities designed by federal, state and local agencies to investigate possible well water contamination from pesticides. There has never been one central agency guiding or coordinating the sampling or monitoring efforts of all agencies in an attempt to characterize the presence of agricultural chemicals in a representative number of wells in the state. As a result, there is a disparate amount of sampling data from the 58 California counties. Therefore, predictions and conclusions about any one pesticide's leachability are limited to only those areas where the pesticide has been sampled. To make speculations as to a chemical's potential behavior in areas where it has not been sampled would require other kinds of information not included in this data base.

Below are some specific examples of deficiencies and differences found between studies which preclude a complete, statewide description of the impact on California's ground water from the leaching of pesticides after their legal agricultural use:

1. Few of the studies were of an ongoing nature, and many of the data were from studies done in the late 1970's and early 1980's. Therefore, it is not known if wells that were once sampled and found to contain pesticides are still contaminated. This kind of information is necessary for drawing conclusions about the impact of the leaching of pesticides on the present state of ground water quality in California.

2. Information on the integrity of a well's construction is important when determining the source of contamination of that well, because pesticides in surface water run-off can enter a well directly through a cracked or non-existing sanitary seal, as well as from leaching. However, well construction information was rarely reported because most studies were designed to identify presence or absence of pesticides in wells and not to determine the source of pollution or the integrity of wells sampled.

Knowing this, one cannot automatically assume that a pesticide detected in a well is necessarily the result of the pesticide having leached through the soil to ground water.

3. Other well construction information, such as well depth or depth of perforations, is also considered when determining if the source of a pesticide detected in well water is from leaching. For example, after surface water is ruled out as a possible source of contamination (e.g., from surface run-off entering a well directly through a cracked or non-existent seal), the depth of the well, or perforation depths or both can sometimes explain the presence of a pesticide in well water. Shallow wells and wells with shallower perforation depths are more vulnerable to ground water contamination from pesticides. In contrast, deeper wells, and wells with deeper perforation depths that contain pesticide residues more likely indicate that contamination has occurred because of the leaching properties of the chemical. Unfortunately, well construction information is rarely reported in studies submitted to the CDFA, so that explanations as to how particular wells become contaminated with pesticides are not always possible.

4. A lack of positive results may not indicate lack of potential for leaching. Negative results could indicate that a chemical did not leach through the soil to ground water after use because of some physical factor in the soil-crop-pesticide system. Negative results could also be due to the fact that the chemical had never been used in the area surrounding the well.

5. Agencies that sample wells for pesticides have limited resources, and monitoring studies can be very expensive, considering personnel and travel time, equipment, and laboratory costs ($100 to $800/sample, depending upon the chemical). Consequently, only a percentage of potentially impacted wells in a designated study area, and only a limited number of pesticides are sampled. Therefore, not all pesticides that are used in any one county are sampled for in well water in that county, nor do all counties where a particular pesticide is used have wells sampled for that pesticide. As a result, the data base may not represent a statistically valid sample of the state's population of wells, nor the extent of use of any particular pesticide throughout the state. Therefore, interpretation of the

significance of results included in the data base must be limited to pesticide behavior in only those areas sampled. Most well sampling has been conducted in densely populated areas, as opposed to rural areas (areas usually closer to pesticide use). Because not all areas in the state where pesticides are used have been equally sampled (i.e., same number of pesticides or wells), or have had well water samples analyzed for the same pesticides, it is inappropriate to draw quick conclusions about some areas of the state being more sensitive to leaching than others based solely on results included in the well inventory.

6. This data base does not contain the kinds of information necessary to determine the exact conditions and mechanisms which cause the contamination of ground water. Many factors that must be considered, such as pesticide use patterns and cultural practices, vary from one geographically-distinct area to another, and within local areas depending on individual growers' practices. Therefore, the detection of a particular pesticide in any two wells may be the result of entirely different sets of conditions and mechanisms. In other words, the explanation for one well being contaminated with a particular pesticide may not be the same for another contaminated well, whether located in the next field or in another county. Therefore, the results recorded in the data base must be examined individually for explanations, and not grouped together; general conclusions cannot be drawn as to a single pesticide's mobility in soil in all areas of the state.

Despite these limitations, the information on pesticide residues contained in the well inventory can be used in all of the following applications:

1) modeling
2) displaying the geographic distribution of well sampling
3) displaying the known geographic distribution of pesticide contamination in wells among those wells sampled
4) identifying areas potentially sensitive to pesticide leaching
5) designing studies for future sampling.

E. FACTORS CONTRIBUTING TO PESTICIDE MOVEMENT TO GROUND WATER AS A RESULT OF AGRICULTURAL USE

BACKGROUND

Effective regulation of pesticide use to prevent contamination of California's ground water requires (a) an understanding of the processes by which contamination occurs, and (b) reliable methods for preventing or mitigating contamination.

Contamination and subsequent mitigation methods vary depending on the nature of the contamination source. Contamination can result from either point or non-point sources. Pollutants from point sources, such as storage or waste sites, are deposited and concentrated in small, well-defined areas. Residues eventually leach from the upper to lower soil layers, encounter ground water and then follow the movement of ground water from that location. The movement can be traced back to its source by locating a residue plume. Pollution from a non-point source cannot be traced to a single, definable location. Instead, the pollutants are dispersed over a large, poorly defined area, resulting from applications of agricultural chemicals to crops. In this case, location of a distinct residue plume is not possible and pollutant movement is very difficult to predict or trace back to its source.

Pesticide residues in ground water can result from industrial or agricultural activities. Pollution from the industrial sector is usually attributed to point sources such as leaks at manufacturing, storage or waste sites. Industrial point sources have been the subject of considerable scientific research, and state and federal agencies have developed techniques to identify contamination sites and to designate mitigation methods (California Department of Health Services, 1985; California Assembly Resources Subcommittee on Status and Trends, 1983). Because the land mass affected by point source contamination is usually small, clean-up can be

accomplished by removal and treatment of soil or by containment and treatment of the polluted ground water plume (Hunt, et al., 1985). In addition, future contamination may be prevented by proper design and placement of storage or waste sites.

Residues of pesticides registered for agricultural use can reach ground water from both point and non-point sources. Point sources include pesticide storage or disposal sites and applicator wash-off sites. Most of the pesticide residue detections in wells cited in the reports Water Quality and Pesticides: a California Risk Assessment Program (Cohen and Bowes, 1984) and The Leaching Fields (Price, et al., 1985) were associated with point sources.

Agricultural non-point source problems are more difficult to identify and mitigate because of the large land masses involved, the lower concentration of chemicals in the soil, and the lack of well-defined contamination plumes. Unlike research on point sources of contamination, research to understand the processes involved in leaching of agricultural pesticides is only in its initial phase. Eventually, information gained from this research will be used to develop new agricultural practices that minimize the possibility of ground water pollution.

The agricultural scientist is at a disadvantage in finding solutions to the problem of agricultural pesticide residues in ground water for a number of reasons:

1) Pesticides are intentionally and repeatedly applied to the soil to avert crop loss by pests. Point source problems may be mitigated by stopping exposure to the soil, but use of this option with non-point sources from agricultural applications would result in crop loss.

2) To date, agricultural research on application of pesticides has sought to find low but effective rates of application so that costs of production are kept low. Can these rates be lowered further and still provide cost-effective protection? More research is needed to examine this question, but where

rates are already at their lowest effective level, new pest control methods will have to be devised.

3) Procedures for mitigating contamination from point sources are not appropriate for agricultural non-point sources because of the large land masses involved. Removal of soil to appropriate waste sites is not a viable clean-up option. Relocation of farms, homesteads and communities established around crops that grow well in areas sensitive to leaching is out of the question.

For these reasons, research is needed on new effective pest control methods specifically designed to prevent future ground water contamination.

DISCUSSION

The PCPA requires CDFA to provide the legislature with a general discussion of the factors that contribute to the movement of pesticides to ground water. These factors include the amount of pesticide used, method of application, physical and chemical characteristics of pesticides, irrigation practices, and soil type.

Pesticide residues in soil may disappear from the initial site of deposition in four ways: (1) through microbial action, microbes detoxify or break down the pesticide to nontoxic compounds; (2) through chemical degradation processes, such as hydrolysis which produces breakdown products; (3) through volatilization, the chemical diffuses from the soil surface; or (4) through leaching, the pesticide is transported from the upper to lower layers of soil. A ground water problem arises when leaching occurs at a faster rate than other processes. Previously, researchers thought that under non-point source conditions, leaching occurred at such a low rate that pesticides would not move from the upper to the lower layers of soil. But detections

of pesticides in ground water since 1979 provided strong evidence for the importance of leaching in agricultural situations.

Since there are no known quick-fixes for residues in ground water due to agricultural non-point sources, the best available way to mitigate the problem lies in regulation of pesticides before or at their point of use. To reach sounder regulatory decisions, the CDFA's Environmental Hazards Assessment Program (EHAP) conducts studies to provide information on how pesticides move through the soil to ground water. Information required by the PCPA for each factor contributing to pesticide mobility in soil has been accumulated and reviewed with respect to the impact of that factor on non-point source pollution by ground water. A discussion of current findings on each of these factors follows.

USE AND METHOD OF APPLICATION

Known non-point source pesticide pollutants are almost exclusively active ingredients that are applied to the soil. Pesticides that are applied to foliage, such as protective foliar fungicides and many insecticides, may not be important leachers for two reasons: (1) exposure to sun enhances the rate of degradation; and (2) concentrations that eventually reach the soil are low enough to allow for rapid degradation before leaching. Thus, direct application or incorporation or both of a pesticide into soil is an important factor contributing to ground water contamination. Additionally, there are no known differences in the ability of different pesticide formulations, whether wettable powder, granular or emulsifiable concentrate, to move through soil. Therefore, only direct application to soil can be singled out as contributing significantly to a potential leaching problem.

IRRIGATION PRACTICES

There are no reported studies in which the movement of a pesticide through soil was compared among different methods of irrigation at the same site of application. Thus, a direct comparison of the influence of types of irrigation on leaching is not possible. There has been speculation that low

volume irrigation methods (drip and trickle) may reduce leaching (Holden, 1986). In low volume systems less land area is watered so that the total amount of applied water is decreased with respect to conventional border, furrow or sprinkler methods. However, water may be applied daily so that movement of pesticides in wetted areas may actually be increased.

The EHAP has completed the sampling phase of a summer 1987 study designed to determine the effects of different types of irrigation on pesticide movement. Chemical analyses are currently in progress. Once the data are complete, types and regimes of irrigation will be identified that tend to either contribute to or mitigate pesticide movement.

PHYSICAL AND CHEMICAL CHARACTERISTICS OF PESTICIDES

The physical and chemical characteristics of pesticides thought to be important in movement through soil are: soil adsorption (usually denoted by the coefficient of soil versus water partitioning, Kd or Koc), hydrolysis half-life due to microbial or chemical activity, vapor pressure, and water solubility. These factors are used in models of pesticide transport through soils (Rao, 1985). Cohen, et al. (1984) estimated values to act as indicators of leaching potential. Recently, the CDFA has undertaken a statistical approach to derive more defensible values for determining potential ground water pollutants in connection with Section 13144 of the PCPA. A description of these procedures and specific numerical values is available in a separate report (Wilkerson and Kim, 1986). At this time, the Department has established specific numerical values for soil adsorption coefficient, water solubility and hydrolysis half-life and these values will be placed into regulation. Eventually, all specific numerical values will be placed into regulation.

Very few field studies have been conducted to determine the validity of any of these physicochemical values regardless of the method by which they were derived. Recently, a study by EHAP provided some insight into the relative importance of these values (Welling, et al., 1986). Three citrus herbicides were compared with respect to their movement through soil to ground water in

a potentially vulnerable area of the San Joaquin Valley. The compounds were simazine (low water solubility, low soil adsorption and intermediate soil half-life), diuron (moderately low water solubility, high soil adsorption and moderately high soil half-life), and bromacil (high water solubility, low soil adsorption and long soil half-life). All three pesticides were found in well water samples. These results indicated that physical and chemical properties alone may not adequately differentiate among pesticides with respect to leachability in a vulnerable geologic area.

SOIL TYPE

The type of soil is a very important factor in determining leaching of pesticides. Numerous detections of nonpoint source contamination have occurred in the predominatly sandy soils of the San Joaquin Valley whereas ground water contamination in coastal valleys (excluding those in the North Coast) is virtually non-existent (Cardozo, et al., 1985). The EHAP has undertaken an investigation to provide a statistical rating of vulnerable areas based on surface soil nomenclature (Teso, unpublished). In that study, occurrence of DBCP residues in wells was correlated with the occurrence of soil family names using a multivariate statistical approach.

As indicated in last year's report, a study was conducted to test the correlation of predicted values of soil vulnerability with occurrence of pesticide residues in well water. All data have been collected and the analysis is in progess. One problem encountered was the absence of pesticide residues in the wells tested. However, nitrates were also measured in the water. The highest values of nitrates were measured in soils that were associated with high probability ratings for the presence of presticides. Although the data for nitrates appears encouraging, the inability to detect any pesticide residues will require further investigation.

RAINFALL

Climatic factors, such as precipitation, may override all of the previously mentioned factors in causing ground water contamination. An example of the influence of climate is the experience with residues of aldicarb in well water in Del Norte County (Lee, 1983). Because soils in that area are high in organic matter, they may be expected to retard pesticide movement. However, annual rainfall is over 100 inches and it occurs primarily in winter months. Aldicarb was applied in the fall to lily bulb fields to control nematode problems in the soil. The amount of rainfall was apparently sufficient to drive pesticide residues to the shallow ground water located at approximately ten feet in spite of the high soil organic matter.

An opposite result was oberved in a study recently completed by the EHAP (Troiano and Garretson, 1988.) The effect of winter rain on movement of pesticides was investigated in Fresno, in the central San Joaquin Valley. Because soils in that area are sandy, they might be expected to leach pesticides very readily. However, winter rainfall is usually much less than in the Northern Coastal areas. In the winter of 1985-86, a total of only 10 inches of rainfall was recorded over a 164 day period. An inorganic ion was added to the soil to trace the movement of water. Most of the tracer was measured to about the 5.5 feet depth in the soil with some detected down to 10 feet, the lowest depth sampled. In contrast, most of the pesticide, known to leach through soils, was recovered in the first 6-inches of soil with some residues detected down to only 6 feet. At this site there was some retardation in movement of the pesticide compared to water flow. In this situation, the amount of winter rainfall was insufficient to move pesticide residues to significant depths. Thus, climatic conditions, such as rainfall, must not be overlooked as an important factor in the leaching of pesticides through soils and they may be important considerations in timing applications of pesticides.

F. SUMMARY

The detection of 16 pesticides and related compounds in California's well waters has been reported to the CDFA between September 1, 1986 and August 31, 1987. The CDFA has determined that residues from a total of eight of these chemicals have originated from agricultural non-point sources: DBCP, 1,2-D, EDB, aldicarb, atrazine, bromacil, diuron, and simazine (Table 11). This number may increase as more sampling data are collected and as knowledge of how agricultural pesticides move through soil to ground water increases.

Regulation of pesticides to prevent residues from entering well water as a result of agricultural use is difficult because of insufficient scientific knowledge of how pesticides move to ground water. Factors that contribute to ground water contamination by pesticides used in agriculture include amounts used and method of application, irrigation practices, pesticide physical and chemical characteristics, soil type, and climate. The role these factors play in the contamination process is not fully understood. The CDFA environmental scientists are working to understand these factors and to promote research on developing environmentally safe and economically feasible alternative pest control practices.

Table 11. A list of the eight pesticides detected in well water determined to be present as a result of legal agricultural use. California finds and the CDFA's actions are summarized. These results (reported 9/86 through 8/87 by various agencies) are an update to the 1986 well inventory data base. [Note: data submitted from the California Department of Health Services' AB 1803 (small systems) sampling survey available for this report included only positive results.]

Active ingredient	First found in CA well water	CDFA's role in mitigating the problem *
Dibromochloropropane (DBCP)	1979, by Central Valley Water Quality enforcement activities against Occidental Chemical Company, Lathrop.	Use suspended in 1979 after male sterility was discovered in workers at Lathrop plant. DBCP detections in 138 wells in 7 counties included in this year's update to the well inventory data base.
Ethylene dibromide (EDB)	1982, by CDFA during EPA-funded study on pesticide residues in soil and ground water.	Uses cancelled by CDFA in 1983 in all counties where residues were found. Detections in 11 wells in 2 counties are included in this year's update to the well inventory data base.
1,2-dichloropropane (1,2-D)	1983, by the Department of Health Services in a study of impact of organic residues on drinking water quality in Kern County. Subsequently extensive residues were found by North Coast Regional Water Quality Control Board in Del Norte Co.	Use of D-D (35% 1,2-D) suspended in Del Norte County by the CDFA, D-D was withdrawn from market. Telone II (0.05% 1,2-D) remains on the market. Detections in 18 wells in 7 counties are included in this year's update to the well inventory data base.

Table 11. (continued)

Active Ingredient	First found in CA well water	CDFA's role in mitigating the problem*
Aldicarb	1983, by North Coast Regional Water Quality Control Board in an investigation of the impact of agriculture on water quality on the North Coast.	Use suspended by the CDFA in Del Norte County where residues were found. Conducted studies of aldicarb in Monterey and Kern County wells with SWRCB and CDHS in 1979 (no detections). Finds in 7 wells in Del Norte and Humboldt Cos. included in this year's update to the well inventory data base. The CDFA is investigating the finds in Humboldt Co.
Simazine	1982, by CDFA during an EPA-funded study on pesticide residues in soil and ground water.	Conducted study of simazine movement through soil in 1984. Found residues in ground water at low levels in Glenn and Tulare Cos. in 1986, determined to be present due to agricultural use. Briefed state and county health officials. Entered simazine into the PCPA detection review process August 4, 1986. Director issued a finding on August 21, 1987. Conducted study in Tulare Co. in 1987. Finds in 2 counties included in this year's report.
Atrazine	1985, by CDHS during sampling of large water systems pursuant to AB 1803.	Monitored, and found low level residues in ground water in Glenn Co. and later in Tulare Co., and determined they were present due to agricultural use. Briefed state and county officials. Entered atrazine into the PCPA detection review process July 3, 1986. Regulations have been proposed. Detections in 9 wells in 4 counties included in this year's update to the well inventory data base.

Table 11. (continued)

Active Ingredient	First found in CA well water	CDFA's role in mitigating the problem*
Diuron	1986, by CDFA, in Tulare Co.	Sampled further; found low level in wells and determined they were present due to agricultural use. Briefed state and local health officials. Entered diuron into PCPA detection review process October 1, 1986. Director issued a finding on October 5, 1987. Conducted well studies in Tulare and Fresno Cos. in 1987. Detections in 13 wells in 1 county are included in this year's report.
Bromacil	1986, by the CDFA, in Tulare Co.	Monitored and found in 2 wells in Tulare Co., and determined to be the result of legal agricultural use. Briefed state and county officials. Entered bromacil into PCPA detection review process September 2, 1986. Director issued a finding on September 4, 1987. Conducted study of wells in Tulare and Fresno Cos. in 1987. Detected in 2 wells in 1 county.

* Does not include residues arising from point sources such as manufacturing sites, or isolated incidents arising from faulty wells or other special cases.

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II.

ACTIONS TAKEN BY THE CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE TO PREVENT PESTICIDES FROM ENTERING GROUND WATER AS A RESULT OF AGRICULTURAL USE

II. ACTIONS TAKEN BY CDFA TO PREVENT PESTICIDES FROM ENTERING GROUND WATER AS A RESULT OF AGRICULTURAL USE

The CDFA has responsiblity for regulating the sales and use of pesticides in California. In regard to protecting ground water, this responsibility means (a) identifying which pesticide active ingredients, under what conditions, present a threat to ground water quality by moving through soil as a result of agricultural use; and (b) taking appropriate regulatory action to prevent or mitigate ground water contamination. The CDFA actions to prevent agricultural pesticides from entering ground water accordingly focus on these goals. The actions occur in three major areas: implementation of the Pesticide Contaminaton Prevention Act (PCPA), registration and evaluation of pesticides, and environmental monitoring activities, including development of the Ground Water Protection Plan. These activities are described below.

Pesticide Contamination Prevention Act (establishing Sections 13141-13152, Article 15, Chapter 2, Division 7 of the California Food and Agricultural Code):

In addition to compiling the statewide inventory of wells sampled for pesticides described in this report, the CDFA has taken the following major actions to implement the Act.

February, 1987	A draft implementation plan was produced to clarify the CDFA's strategy of action.
July, 1987	The Director's decision on atrazine to conclude the Pesticide Detection Response Process prohibited use of the chemical in special ground water protection areas called Pesticide Management Zones (PMZs). PMZs have been proposed as part of the CDFA's regulatory scheme for potential ground water contaminants.
August, 1987	The Director's decision on simazine to conclude the Pesticide Detection Response Process required the modification of the agricultural uses of that chemical by:

(1) adding simazine to both the Groundwater Protection List (GPL) and the restricted materials list;
(2) requiring a permit for use of simazine in any PMZ;
(3) establishing a Ground Water Protection Training Program for agricultural pest control advisers (PCA) which would include simazine use in its curriculum;
(4) requiring the written recommendation of a trained PCA for the agricultural use of simazine in a PMZ before a permit may be issued; and
(5) prohibiting the use of simazine in artificial recharge areas which have been identified by acceptable geographic coordinates resulting in the designation of a PMZ.

September, 1987	The Director's decision on bromacil to conclude the Pesticide Detection Response Process required the modification of the agricultural uses of that chemical as described above for simazine, except that non-crop agricultural uses are prohibited.
October, 1987	The Director's decision on diuron to conclude the Pesticide Detection Response Process required the modification of the agricultural uses of that chemical as described above for bromacil.
October, 1987	The subcommittee of the Pesticide Registration and Evaluation Committee held a public hearing to review information concerning the ground water contamination potential of prometon as part of the Pesticide Detection Response Process for that chemical which is scheduled for completion in early 1988.
October, 1987	A Pesticide Detection Response Process hearing notice for the review of fenamiphos was sent to registrants and interested parties scheduling the oral phase of the hearing for April, 1988.
December, 1987	A rulemaking package to implement specific sections of the Act and the Director's decision for atrazine was noticed for public comment.

December, 1987	The first annual report to the Legislature, the State Water Resources Control Board, and the Department of Health Services concerning data gaps and chemicals exceeding the specific numerical values was delivered.

PESTICIDE REGISTRATION AND EVALUATION

The CDFA professional staff consider several factors contributing to a pesticide's potential for contaminating ground water during the registration and evaluation process. Requests for registration of products containing new active ingredients must be accompanied by data on product chemistry, effects on wildlife and aquatic organisms, and environmental fate. The data submitted vary with the prospective uses of the product, and include melting point, boiling point, solubility, density, vapor pressure, pH, viscosity, octanol/water partition coefficient, soil adsorption and other physicochemical characteristics, hydrolysis, photodegradation, aerobic and anaerobic metabolic breakdown, leaching and adsorption, volatility, and field dissipation and accumulation studies. To evaluate a new product containing an already-registered active ingredient, the CDFA reviews data on file for that active ingredient.

Based on these data, the CDFA assesses whether use of the product poses a potential for adverse effects to public health or the environment. If, after evaluating the data, the CDFA finds that all required data have been submitted and no potential adverse effects have been identified, the pesticide is registered for use according to label instructions.

Certain pesticides are registered by the U.S. Environmental Protection Agency or by California as restricted materials if they have been shown to have a significant but mitigable adverse health or environmental effect. State and Federal restrictions may differ. Restrictions may be placed on

quantity sold, location or manner of application. Examples of restricted materials are carbofuran, methyl bromide, fenamiphos, aldicarb, and paraquat. All applications of restricted materials are carefully controlled and documented by the County Agricultural Commissioner, who is the primary enforcement officer at the local level for federal and state pesticide use laws. All uses of restricted chemicals must be reported to the CDFA.

In addition to registering pesticides, the CDFA conducts reviews of pesticides in use. A pesticide found to cause an unanticipated adverse health or environmental effect--such as ground water contamination--may be reevaluated and its registration cancelled, or its use restricted or suspended. Examples of reevaluated chemicals for which regulations have been adopted prohibiting registration in California are DDT, arsenicals, mercury and cadmium. Alachlor has been placed in formal reevaluation by the CDFA partly due to public health concerns regarding the possibility of residues occurring in California ground water.

ENVIRONMENTAL MONITORING ACTIVITIES

Since 1979, the CDFA has been working to gain a clearer understanding of the movement of pesticides through soil in order to prevent ground water contamination through effective regulation of pesticide sales and use. The CDFA's Environmental Hazards Assessment Program (EHAP), in the Environmental Monitoring and Pest Management Branch, is at the core of this effort. The EHAP conducts monitoring studies throughout the state to measure off-target movement of pesticides in soil and ground water, gathers environmental fate data on registered pesticides, and tests mathematical models predicting the behavior of pesticides in soils. Information gained from this work guides the CDFA in the regulatory decision-making process described above.

The CDFA's goal relative to ground water is to use all relevant information to develop an accurate assessment of the magnitude of the residue problem, establish a reliable monitoring program, and derive an effective regulatory framework to eliminate pesticide residues in ground water. Since we are not yet able to assess the seriousness of the problem, we are looking at all levels of residues in ground water as unacceptable.

The EHAP first began monitoring soils and ground water for pesticide residues in 1979 in response to the discovery of aldicarb and DBCP in ground water in several states. At that time, very little ground water sampling had been done, and most soil sampling did not test for pesticide residues at depths below 100 centimeters. A complete list of EHAP's published reports is available from the Environmental Monitoring and Pest Management Branch of the CDFA. A list of the EHAP's recently published reports and studies in progress which examine aspects of pesticide movement to ground water follow.

PUBLISHED REPORTS

1. Survey for Pesticide Residues in California Well Water: 1986 Well Inventory Data Base (December, 1986). This is the first annual report to the Legislature on the contents of the CDFA's well inventory data base, as required by the Pesticide Contamintion Prevention Act. This report describes all well sampling results from 1975 through August, 1986.

2. Survey for Triazine Herbicides in Well Water, Glenn County, 1986 (December, 1986). In early 1986, the Agricultural Commissioner of Glenn County reported the presence of atrazine in a sample of domestic well water. The CDFA staff sampled 137 wells in a 37 square mile area. Of the 137 wells, 34 contained atrazine. Simazine and prometon were also found in 17 and 10 wells, respectively. Possible sources of contamination included normal uses of the pesticide for agricultural crops, rights-of-way, and non-crop areas.

3. Survey for Herbicides in Well Water in Tulare County (January, 1987). The CDFA's EHAP conducted a well survey in Tulare County to determine the presence of the herbicides simazine, atrazine, prometon, bromacil and diuron in well water. Simazine was detected in 54 of 122 samples,

diuron in 36 of 122 samples, and atrazine as well as bromacil in 11 of 120 samples. Prometon was not detected.

4. Measurement of Possible Cross-Contamination of Soil Samples During Soil Coring with the Split-Barrel or Bucket Auger Methods (August, 1987). The extent of contamination that occurs during soil sampling was examined for the split-barrel hollow auger method used by the EHAP of the CDFA, and for a manual bucket auger method. Contamination was observed with both methods of sampling. Recommendations for recognizing and minimizing problems with contamination are provided.

5. Sampling for Residues of Fenamiphos, Fenamiphos Sulfoxide and Fenamiphos Sulfone in Well Water (December, 1987). A well sampling survey was conducted in areas where use of fenamiphos coincided with areas of previous contamination by other pesticides. Twenty-four wells were sampled in Fresno County, twelve wells were sampled in San Joaquin County and 5 wells were sampled in Kern County. No residues of fenamiphos or its sulfoxide and sulfone metabolites were detected in any of the samples.

6. Effects of Seasonal Winter Rainfall on Pesticide Leaching in Fresno County (January, 1988). Rainfall has been implicated in the movement of pesticides to ground water in the northern coastal county of Del Norte, California. However, the importance of rainfall in other agricultural areas is not known. Rainfall in the Central Valley, an area where pesticide residues have also been detected in ground water, occurs mainly during the winter months. Therefore, this study was conducted to identify the influence of winter rainfall on movement of two pesticides, simazine (a herbicide) and diazinon (an insecticide), in sandy soil located in Fresno County. This study indicated pesticide and soil properties that might influence pesticide movement in areas of low rainfall and sandy soils: (1) results with diazinon indicated that pesticides with short soil half-lives will be rapidly degraded if kept near the surface, and (2) results with simazine indicated that in areas of low rainfall the water solubility of a pesticide will determine potential for movement from the surface sites.

STUDIES IN PROGRESS

1. Monitoring the movement of nonfumigant nematicides through the soil profile after application through drip irrigation.

2. Monitoring the persistence and movement of fenamiphos in lily bulb field soils in Del Norte County.

3. Survey of molinate and thiobencarb concentrations in soil and ground water in rice growing areas.

4. Effects of seasonal winter rainfall on pesticide leaching in Riverside

County.

5. Effects of type and amount of irrigation on pesticide movement.

6. Contracted research to evaluate five models of pesticide leaching.

7. Contracted research to determine amount of recharge water from different applications of irrigation.

8. Movement through soil: comparison of alachlor, aldicarb, atrazine, carbofuran, diazinon, malathion, oxamyl, simazine.

9. Movement through soil and well sampling: comparison of coastal and inland aquifers.

10. Coastal subsoil characteristics.

11. Monitoring persistence and movement in soil of nematicides registered for use on flower bulbs.

12. Kd comparison.

13. Sampling for alachlor, metolachlor, atrazine and nitrate in well water in Merced County.

In addition to conducting these technical studies, the Environmental Monitoring Branch has developed a Ground Water Protection Plan, described below.

GROUND WATER PROTECTION PLAN

In 1984, the CDFA began developing a long range plan to selectively control the application of ground applied pesticides to reduce their potential for ground water contamination. This Ground Water Protection Plan will incorporate the results of laboratory studies, well sampling, soil coring and computer modeling studies to estimate the potential for a pesticide to reach ground water. Localized information on factors that influence movement of pesticides through soils to ground water will be collected,

standardized, and distributed to County Agricultural Commissioners, who may use this information at their discretion in making local regulatory decisions or conditioning the CDFA regulatory decisions at the local level.

As groundwork for the plan, three data sets have been established, each of which will be regularly updated:

1. A statewide inventory of wells sampled by public agencies for agricultural pesticide residues of pesticides since 1975 (now required in the Pesticide Contamination Prevention Act, and described in this report),

2. Areas where selected restricted pesticides applied primarily to the soil are applied each year, beginning in 1983, and

3. A pesticide chemistry and environmental fate data base which contains information on surface and ground water detections in the nation, water quality and physicochemical parameters for individual pesticides.

The CDFA is also beginning work on other data sets which will consist of factors influencing the movement of pesticides to ground water, such as depth to ground water, soil type, and geologic and climatic conditions (discussion on pages 51 through 57). Eventually all data will be classified geographically by section (one square mile).

Data classified by section will provide Agricultural Commissioners with a scale of analysis specific enough to make sound decisions regulating pesticide use spatially by section, township (36 square miles), or by combinations of sections.

III.

ACTIONS TAKEN BY THE STATE WATER RESOURCES CONTROL BOARD TO PREVENT PESTICIDES FROM ENTERING GROUND WATER

Introduction

In compliance with Section 13152(e)[4] of the Food and Agricultural Code, the State Water Resources Control Board provides to the State Legislature actions taken by the agency to prevent pesticides from migrating to the ground waters of the State.

State of California

Memorandum

To : Jack C. Parnell, Director
Department of Food and Agriculture
1220 N Street, Room A-149
Sacramento, CA 95814

Date : JAN 15 1988

From : W. Don Maughan, Chairman
STATE WATER RESOURCES CONTROL BOARD

Subject: AB 2021 (PESTICIDE CONTAMINATION PREVENTION ACT)

The Pesticide Contamination Prevention Act requires that actions by the State Water Resources Control Board to prevent economic poisons from migrating to the ground waters of the State be reported to the Legislature annually. The attached report is a summary of actions during the past year, and pursuant to Section 13152(e)[4] of the Act, this information is submitted for inclusion in the report to the Legislature.

If you have any questions on this issue, please call Dr. Syed Ali at 3-7609.

Attachment

cc: Regional Board Executive Officers

Regional Board Branch Offices
Fresno, Redding, and Victorville

Ron Oshima
Department of Food and Agriculture

Dale Claypoole, Chief
Program Control Unit

IV. Actions taken by the State Water Resources Control Board (State Board) and Regional Water Quality Control Boards (Regional Boards) to prevent pesticides from entering ground water.

A. STATE WATER RESOURCES CONTROL BOARD

The State Board regulates water quality and water allocation in California, and together with the nine Regional Boards (Figure 1), the State Board protects the beneficial uses of surface (inland and coastal) and ground waters.

1. Pesticide Registration and Evaluation

Staff evaluated the potential impact to California waters of 1,233 pesticide registrations (as part of the registration process of the Department of Food and Agriculture), reviewed three Environmental Impact Reports, and responded to four citizens' inquiries. Staff sampled seven wells for oxamyl residues in Monterey County in October 1986. Oxamyl was not found in the water samples at the method detection limit of 2 ug/1 (ppb). Staff also provided information and recommendations to the Regional Boards for the prevention of pesticide pollution of ground water for 24 chemicals:

Chlorothalonil
Nemacur
Oryzalin
Diuron
Velpar
Pyrethrins
Triphenyl methane
Endothall
Copper alkanolamine
1:1'-ethylene-2:2'-dipyridylium dibromide
N,N'-dimethylalkylamine of endothal
Glyphosate
Poly (oxythylene[dimethyliminio] ethlene-(dimethyl iminio) ethylene dichloride
Petroleum hydrocarbons
N-alkyl 1,3-propylene diamines (core exit)
Methomyl
Chromated copper arsenates
Creosote
Pentachlorophenol
Sodium tetrathiocarbonate
Chlorpyrifos
Sulfuryl fluoride
Captafol
Tetrahydrophthalimide

Figure 1

STATE WATER RESOURCES CONTROL BOARD
P. O. Box 100, Sacramento, CA 95801

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

NORTH COAST REGION (1)

1440 Guerneville Road
Santa Rosa, CA 95403
(707) 576-2220

SAN FRANCISCO BAY REGION (2)

1111 Jackson Street, Rm. 6040
Oakland, CA 94607
(415) 464-1255

CENTRAL COAST REGION (3)

1102-A Laurel Lane
San Luis Obispo, CA 93401
(805) 549-3147

LOS ANGELES REGION (4)

107 South Broadway, Rm. 4027
Los Angeles, CA 90012
(213) 620-4460

CENTRAL VALLEY REGION (5)

3443 Routier Road
Sacramento, CA 95827-3098
(916) 361-5600

Fresno Branch Office

3614 East Ashlan Ave.
Fresno, CA 93726
(209) 445-5116

Redding Branch Office

100 East Cypress Avenue
Redding, CA 96002
(916) 225-2045

LAHONTAN REGION (6)

2092 Lake Tahoe Boulevard
P. O. Box 9428
South Lake Tahoe, CA 95731
(916) 544-3481

Victorville Branch Office

15371 Bonanza Road
Victorville, CA 92392
(619) 241-6583

COLORADO RIVER BASIN REGION (7)

73-271 Highway 111, Ste. 21
Palm Desert, CA 92260
(619) 346-7491

SANTA ANA REGION (8)

6809 Indiana Avenue, Ste. 200
Riverside, CA 92506
(714) 782-4130

SAN DIEGO REGION (9)

9771 Clairemont Mesa Blvd. Ste. B
San Diego, CA 92124
(619) 265-5114

8-87

2. Pesticide Contamination Prevention Act (AB 2021)

Staff evaluated four pesticides (atrazine, simazine, bromacil, and diuron) found in ground water as a result of their agricultural use and jointly conducted public hearings for these pesticides with staff of the Department of Health Services, and the Department of Food and Agriculture. Staff submitted findings and recommendations to the Director of the Department of Food and Agriculture following the close of each hearing. A public hearing for a fifth pesticide (prometon) is currently underway.

3. Ground Water Protection Strategy

In 1984, the U. S. Environmental Protection Agency issued its ground water protection strategy and requested each state to establish a program to protect ground water. The State Board developed a comprehensive Ground Water Protection Strategy to safeguard California's ground waters.

Components of the strategy are an assessment of the State's current ground water quality protection programs, a reemphasis of the State's goals and policies to protect ground water quality, and a recommendation to adopt preventive rather than reactive approaches for protecting ground water.

4. Toxic Substances Monitoring

Since 1979, the State Board has collaborated with U. S. Geological Survey, and Department of Water Resources to monitor California's high priority ground water basins for water quality parameters, such as nutrients, dissolved solids, and selected toxic substances including six pesticides.

Monitoring of fish tissue has been underway since 1977 by the State Board with field and laboratory support from the Department of Fish and Game. Samples of fish are annually collected statewide and analyzed for 50 pesticides and other toxics.

5. Priority Chemicals

Tributyltin: Based on a State Board study of tributyltin, an antifouling pesticide used in marine paints, the State Board co-sponsored a coastal survey for tributyltin, requested the Department of Food and Agriculture to reevaluate its registration and recommended amendments to tributyltin legislation. In addition, staff developed water quality criteria for this compound in marine and fresh waters and has initiated a fresh water sampling project.

Phthalic Acid Esters: Staff reviewed the toxicity and environmental fate of the six phthalic acid esters listed as priority pollutants by the U. S. Environmental Protection Agency. Attention was directed to this group of compounds because several of the phthalates are suspected carcinogens and reproductive toxins. In addition, some phthalates occur as inert ingredients in pesticides. Staff sampled surface and ground water, sediment, and marine mussels, and drafted a report that included water quality criteria for fresh and marine waters.

Polynuclear Aromatic Hydrocarbons: In December 1986, the State Board received a final report from the Southern California Coastal Water Research Project completing a contract for analyses of polynuclear aromatic hydrocarbons in marine and river sediments. Twenty-four Southern California sites were sampled. Results indicate that concentrations of these hydrocarbons in sediment greater than 5 mg/kg (ppm) may cause adverse effects to bottom-dwelling organisms. Seven of the 24 sampling sites were found to contain these compounds in sediments at concentrations greater than 5 ppm. Potential sources include petroleum spills, combustion products, and by-products of pesticide inert ingredients.

Monocyclic Aromatic Hydrocarbons: These compounds, components of most petroleum products, are solvents in many pesticide formulations and are also used as carriers in applications. Staff sampled surface waters of the San Francisco Bay and Delta system for these compounds and evaluated their environmental fate and toxicity; these results are currently being analyzed. Additionally, staff developed preliminary water quality criteria.

6. Nonpoint Source Pollution

Staff inventoried pollution of surface waters by known and suspected nonpoint sources, including pesticides, to identify priority sites and to develop a plan for nonpoint source management.

7. Laboratory Certification

Laboratory certification (Water Code Section 13176) is being designed to ensure that the analysis of compounds including pesticides required by the Porter-Cologne Act be performed by competent, properly staffed and equipped laboratories. To that end, the State Board is developing regulations for laboratory certification and a fee structure to support this work. Minimum standards for all phases of the certification process are being developed in cooperation with the California Department of Health Services.

8. Assembly Bill 1803 Follow-Up

Assembly Bill 1803 directed the California Department of Health Services to sample for organic chemicals in public drinking water systems. Four pesticides (DBCP, atrazine, simazine, and 1,2-D) have been detected. The purpose of the State Board AB 1803 Follow-Up Program is to identify the dischargers responsible for the well pollution.

9. Special Studies

Chlorinated Dioxins: Staff investigated the presence of chlorinated dibenzodioxins and dibenzofurans at sites that have used the pesticide pentachlorophenol as a wood preservative. A draft report discusses methods to evaluate the toxicity of mixtures of these compounds and suggests an approach for setting cleanup levels. The hazard evaluation procedure developed in this study could also be applied in other situations where such contamination has occurred.

Urban Lakes Toxics Survey: Staff coordinated a survey in Orange County of toxic pollutants in nine small urban lakes with the Departments of Water Resources and Fish and Game, and the Orange County Environmental Management Agency. In addition to other toxics, 50 pesticides were included for analysis in this survey.

10. Scientific Advisory Panel

In early 1986, the State Board, in conjunction with the Departments of Water Resources and Health Services, established the Scientific Advisory Panel on Ground Water Recharge. The panel was established to define the health significance of using reclaimed water for ground water recharge to augment domestic water supply, to evaluate the benefits and risks associated with such recharge, and to provide background information needed for the establishment of statewide criteria for ground water recharge with reclaimed water. The panel recently completed its report on Ground Water Recharge with Reclaimed Water.

B. REGIONAL WATER QUALITY CONTROL BOARDS

The nine Regional Boards protect California's ground and surface waters from discharges of pollutants, including pesticides (Porter-Cologne Act of 1969, Federal Water Pollution Control Acts of 1972 and 1977). These Acts enable the Regional Boards to regulate discharges through:

1. Adoption of water quality objectives in basin plans to protect specified beneficial uses of water in each of California's 15 watershed basins.

2. Submission of monitoring data by dischargers with Waste Discharge Requirements and National Pollutant Discharge Elimination System Permits.

3. Enforcement of cleanup actions through issuance of compliance schedules, Cease and Desist or Cleanup and Abatement Orders, or administrative civil liabilities.

4. Requirement for technical reports from state or local agencies and dischargers for AB 1803 follow-up investigations.

Information on mitigation of pesticide pollution during the past year is listed in Tables 1 through 7. Some of the actions were initiated in prior years and are ongoing. Regions 6 and 7 encountered no pesticide pollution during the past year. However, Region 6 staff surveyed all agricultural commissioners in their region for the occurrence of pesticide pollution.

Table 1. Actions taken on pesticide pollution in the North Coast Region (Region 1).

County	Site	Pesticide	Mitigation
Mendocino	Coast Wood Preserving	Chromium	Cease and Desist Order, Attorney General referral, court injunction, Cleanup and Abatement Order to determine extent of pollution and ensure appropriate cleanup.
	Louisiana-Pacific, Potter Valley	Pentachlorophenol	Cleanup and Abatement Order issued to investigate pollution and develop cleanup plans.
	Louisiana-Pacific, Fort Bragg	Pentachlorophenol	Cleanup and Abatement Order issued to investigate pollution and develop cleanup plans.
Siskiyou	Pine Mountain	Pentachlorophenol	Staff enforcement to determine extent of pollution and develop appropriate cleanup plans.
	High Ridge	Pentachlorophenol	Staff enforcement to determine extent of pollution and develop appropriate cleanup plans.
	SWF-Happy Camp	Pentachlorophenol	Staff enforcement to determine extent of pollution and develop appropriate cleanup plans.
Trinity	Sierra-Pacific Ind., Hayfork	Pentachlorophenol	Staff enforcement to determine extent of pollution and develop appropriate cleanup plans.
Humboldt	Eel River Sawmills A	Pentachlorophenol	Staff investigation to verify results.
Del Norte	Smith River Plains	Aldicarb 1,2-D	Staff monitoring wells under planning project to prevent additional pollution.

Table 2. Actions taken on pesticide pollution in the San Francisco Bay Region (Region 2).

County	Site	Pesticide	Mitigation
Contra Costa	Levin Metals, Richmond	DDT DDD	Cleanup and Abatement Order issued. Department of Health Services enforcement under State Superfund pending.
	Chevron Chemicals, Richmond	Difolatan Orthene Chlordane Lindane Aldrin DDT/DDD Dieldrin	Toxic Pits Cleanup Act exemption requirement submitted. RCRA (Resources Conservation and Recovery Act) ground water assessment ongoing.
	FMC Corp., Richmond	DDT/DDE Dieldrin Tedion	Remedial Action Plan submitted in Spring 1986. Investigation ongoing.
	Dow Chemicals, Pittsburg	Vikane Dowcil 75 Dowcil 100	Hydrologic Assessment Report submitted for Toxic Pits Control Act exemption. RCRA ground water assessment ongoing. Submitted Correction Action Program Proposal.
Alameda	FMC Corp., Newark	EDB DCA	Waste Discharge Requirement No. 85-113. Remedial Action Plan implemented.
	Peerless Electric Company, Berkeley	Pentachlorophenol	Investigations of upgradient source and downgradient migration ongoing.

Table 3. Actions taken on pesticide pollution in the Central Coast Region (Region 3).

County	Site	Pesticide	Mitigation
Santa Cruz	Western Farm Service: Green Gro, Watsonville	DDT DDD DDE Toxaphene Endosulfan I Endosulfan II Endosulfan Sulfate	Cleanup and Abatement Order issued in January 1985. Currently regulated with Waste Discharge Requirement Order No. 85-47. Site continues to monitor Endosulfan and PCB at detection level in late 1986.
Monterey	Puregro, Salinas	DDT	Cleanup and Abatement Order No. 86-323 issued. Site undergoing closure.

Table 4. Actions taken on pesticide pollution in the Los Angeles Region (Region 4).

County	Site	Pesticide	Mitigation
Los Angeles	So. Cal. Water Co.-- S. Arcadia Well--015/11W-09Q045	Atrazine	Potential discharger requested to conduct soil sampling.
	Los Angeles County wells	Atrazine Simazine Methylene chloride Ethylene thiourea DBCP	AB 1803 sampling detected these pesticides in 72 wells.

Table 5. Actions taken on pesticide pollution in the Central Valley Region. (Region 5).

County	Site	Pesticide	Mitigation
Fresno	Thompson Hayward Agriculture and Nutrition Co.	α-BHC β-BHC ν-BHC Dieldrin DBCP Diphenamid Heptachlor Heptachlor epoxide	Cleanup and Abatement Order issued. Site on State Superfund
	FMC Corp.	Aldrin Dieldrin DDT DDD DDE Heptachlor Lindane Toxaphene Ethyl parathion Malathion Ethion Thiodan Dimethoate Furadan DNOC DNBP	Site on State Superfund. Contamination Assessment Proposal requested.
	Agro-West, Inc.	BHC Dicofol Endosulfan Dacthal 2,4-D Diuron Methomyl Neburon Propham	Site on State Superfund. Hydrogeologic Assessment Report requested pursuant to the Toxic Pits Cleanup Act.
	Britz, Inc., Five Points	Toxaphene	Site on State Superfund. Contamination Assessment and Closure Plans requested.
	Chevron Chemical Company	Unspecified	Assessment began June 1984.
	Fresno County Wells	DBCP	DBCP detected in 99 wells (AB 1803 sampling)

Table 5 (Continued). Actions taken on pesticide pollution in the Central Valley Region (Region 5).

County	Site	Pesticide	Mitigation
Fresno (contd.)	Central Valley Aviation	Unspecified	Assessment began April 1985.
	Wilbur-Ellis	Unspecified	Assessment began June 1981.
	Union Carbide Test Plot	Aldicarb	Additional contamination assessment work requested.
Kern	Brown and Bryant, Inc., Arvin	1,2-D 1,3-D DBCP EDB Dinoseb	Site on State Superfund. Contamination Assessment Report requested.
	Puregro Co., Bakersfield	DBCP	Site on State Superfund. Contamination Assess- and Closure Plans for drywell requested.
	Guimarra Vineyard	DBCP	Contamination Assessment and Pond Closure Plan requested (J. R. Simplot-Edison).
	WASCO Airport	Aldrin Lindane Endrin Chlordane Methoxychlor DDT DDD DDE Thimet Malathion Methyl parathion Paraoxon Di-syston Omite Paraquat	Site on State Superfund. Cleanup and Abatement Order issued.

Table 5 (Continued). Actions taken on pesticide pollution in the Central Valley Region (Region 5).

County	Site	Pesticide	Mitigation
Madera	Western Farm Service, Inc.	Dinoseb	Hydrogeological Assessment Report requested for conformance with Toxic Pits Cleanup Act.
Tulare	Mefford Field, City of Tulare	p,p'-DDT p,p'-DDE 2,4,5-TP Dicamba DNBP Diuron	Contamination Assessment and Mitigation Reports requested.
	Tulare Airport	Unspecified	Assessment began January 1985.
	SCE poleyard, Visalia	Unspecified	Assessment began September 1972.
Merced	City of Turlock Airport	Dieldrin Propham Neburon	Contamination Assessment and Pond Closure Plans requested.
	Merced County wells	DBCP	AB 1803 sampling detected DBCP in ten wells.
San Joaquin	Occidental Chemicals, Lathrop	2,4-D 2,4,5-T DEF Toxaphene Lindane EDB DBCP Dieldrin Delnav Dimethoate Disulfoton Sevin Heptachlor DDT DDE DDD Aldrin Methyl parathion Ethyl parathion	Site remediation occurring pursuant to Stipulation and Judgement Approving Settlement (1981).
	Defense Depot, Tracy	Unspecified	Assessment began January 1982.

Table 5 (Continued). Actions taken on pesticide pollution in the Central Valley Region (Region 5).

County	Site	Pesticide	Mitigation
San Joaquin (contd.)	San Joaquin County Wells	DBCP	Assessment began February 1987. AB 1803 sampling detected DBCP in 15 wells.
	Sharpe Army Depot, Stockton	Unspecified	Assessment began 1982.
	Trinkle and Boys Flying Service	Unspecified	Assessment ongoing. Cease and Desist Order in preparation.
Stanislaus	Chemurgic, Fresno	Aldrin α -BHC β -BHC δ -BHC ν -BHC o,p'DDD p,p'DDD p,p'DDE p,p'DDT Endosulfan I Endosulfan II Endosulfan sulfate Endrin Heptachlor Heptachlor epoxide	Contamination Assessment Report requested. Cleanup and Abatement Order issued 11/26/86.
	Geer Road Landfill	Unspecified	Assessment began March 1985.
	Modesto City Wells	DBCP	AB 1803 sampling detected DBCP in ten wells. State Superfund study.
	Stanislaus County wells	DBCP	Assessment began February 1987. AB 1803 sampling detected DBCP in 40 wells.
	Union Carbide Test Plots	Aldicarb	Additional contamination assessment work requested.
Sacramento	Sacramento Army Depot	Diazinon Dursban Lindane	Assessment Report requested. Federal Superfund work in progress.

Table 5 (Continued). Actions taken on pesticide pollution in the Central Valley Region (Region 5).

County	Site	Pesticide	Mitigation
Sutter	Bowles Flying Service	Unspecified	Assessment ongoing. Toxic Pits Cleanup Act Cease and Desist Order in preparation.
Yolo	Frontier Fertilizer Co., Davis	EDB	Cleanup and Abatement Order issued. DHS State Superfund initiated.
Modoc	I'SOT, Inc. Canby	Pentachlorophenol	Cleanup and Abatement Order issued to investigate extent of contamination and develop cleanup plans.
Siskiyou	Roseburg Forest Products, Mt. Shasta	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.
Shasta	Calaran Lumber Co., Redding	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.
	Fibreboard Corp., Burney Operations	Pentachlorophenol	Staff enforcement to verify cleanup and removal of system and contaminated soil.
	Roseburg Forest Products, Anderson	Pentachlorophenol	System removed; no contamination remaining.
	Roseburg Forest Products, Paul Bunyan Facility	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.
	Sierra Pacific Industries, Central Valley	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.

Table 5 (Continued). Actions taken on pesticide pollution in the Central Valley Region (Region 5).

County	Site	Pesticide	Mitigation
	Sierra Pacific Industries, Old Champion Facility	Pentachlorophenol	Staff enforcement to verify cleanup and removal of system and contaminated soil.
Tehama	Crane Mills, Paskenta	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.
	Louisiana-Pacific, Red Bluff Operations	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.
	Wauleco, Inc., Corning	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.
Plumas	Siskiyou-Plumas Lumber Company, Quincy Operations	Pentachlorophenol	Staff enforcement to determine extent of contamination and develop appropriate action.

Table 6. Actions taken on pesticide pollution in the Santa Ana Region (Region 8).

County	Site	Pesticide	Mitigation
Orange	Great Western Savings, Irvine	1,2-D EDB	NPDES Permit issued November 1986. Ground water cleanup continuing.
	City of Orange (Well 1)	Simazine Atrazine	Investigation needed to confirm if solely non-point source.
Riverside	Arlington Basin	DBCP	Funding has been confirmed under the SWRCB Agricultural Drainage Loan Program, subject to acceptable interest rate for ground water cleanup by local agency.
	Lake Hemet MWD (Well A)	DBCP	Investigation needed to confirm if solely non-point source.
	Sunnymead MWC (Well 03)	DBCP	Investigation needed to confirm if solely non-point source.
	Corona (Well 8)	Simazine	Investigation needed to confirm if solely non-point source.
	Home Garden CWD (Wells 2 & 3)	DBCP Simazine	Investigation needed to confirm if solely non-point source.
	Victoria Farm MWC (Well 01)	DBCP	Investigation needed to confirm if solely non-point source.
	Riverside, City of (7 Wells)	DBCP	Investigation needed to confirm if solely non-point source.
	Riverside, City of (Russell B Well)	Simazine	Investigation needed to confirm if solely non-point source.
	Loma Linda Univ. (Arlington)	DBCP	Investigation needed to confirm if solely non-point source.

Table 6 (Continued). Actions taken on pesticide pollution in the Santa Ana Region (Region 8).

County	Site	Pesticide	Mitigation
Riverside	Riverside Co. Hall of Records	DBCP	Investigation needed to confirm if solely nonpoint source.
San Bernardino	Bunker Hill II Basin: Crafton/ Redlands Area (26 wells)	DBCP	Regional Board heads Technical Advisory Committee of local agency study to explore specific mitigation alternatives (TCE & DBCP). City of Redlands submitted application under Agricultural Drainage Loan Program for DBCP treatment. Investigation continuing to confirm if solely nonpoint source.
	So. San Brdo., Co. Wtr. Dept. (3 wells)	DBCP	Investigation needed to confirm if solely nonpoint source.
	Loma Linda, City of (5 wells)	DBCP	Investigation needed to confirm if solely nonpoint source.
	Cucamonga CWD (4 Wells)	DBCP	Investigation needed to confirm if solely nonpoint source.
	Monte Vista Water Dist. (Wells 01 & 9)	DBCP	Investigation needed to confirm if solely nonpoint source.
	Upland, City of (5 wells)	DBCP	Investigation needed to confirm if solely nonpoint source.

Table 7. Actions taken on pesticide pollution in the San Diego Region (Region 9).

County	Site	Pesticide	Mitigation
San Diego	Truly Nolen Exterminators	Chlordane Lindane Aldrin Dieldrin	Site is subject to the Toxic Pits Cleanup Act of 1984. Hydrogeologic Assessment Report being prepared.
San Diego	City of Oceanside (Well #12)	1,2-D	Investigation indicates potential agricultural use. Referred to Department of Food and Agriculture.

APPENDICES

APPENDIX A

FORMAT OF DATA ENTRY SHEETS

Format of Data Entry Sheets:

Each chemical analysis for a pesticide residue in a well water sample constitutes one record in the data base. Each record contains 132 columns of data. The following is an explanation of the format:

a. County code (Columns 1-2): This is a minimum reporting requirement. The 2-digit state code for counties is used, so as to coincide with the CDFA Pesticide Use Report format.

b. State well number (township/range/section/tract/sequence number) (Columns 3-13): This is a minimum reporting requirement. This is the U.S. Geological Survey's Public Lands Survey Coordinate System (Davis and Foote, 1966) used by the DWR to numerically identify individual wells. Township lines (T) are oriented from north to south and are 6 miles long. Range lines (R) are oriented east to west and are 6 miles wide. A 6 X 6 mile township is divided into 36, 1 mile by 1 mile sections (S), numbered consecutively from 1 to 36. Each section is again divided into 16 individual 40 acre tracts (Tr) that are identified by letters (A through P). In some cases, wells in a tract are further identified with a sequential number in the order of identification by the DWR. Most large water system wells have this sequence number, while most private wells do not.

   Many sampled wells had their T/R/S location indicated on data sheets or in a final report. The state well numbers for large system wells were found by cross-referencing the names of the well and water district to the well number in the CDHS station location file. This file is stored on the State Water Quality Information System (SWQIS) data base, which files large system wells by district, county, station name, well name and/or number.

   Tract letter and numbers for all wells were included when available. Private wells lacking T/R/S location were omitted from the main file because it was not possible to accurately locate them. In the future, wells should be identified by the complete, DWR-assigned state well number, as this number is now a minimum requirement for all submitted data.

c. Base line and meridian (Column 15): This is a minimum reporting requirement, and is included in the state well number. These lines divide the state into three areas: Humboldt, Mount Diablo and San Bernardino, forming the basic structure for the Township/Range/Section numbering system.

d. Columns 16, 17, 70 and 112 = blank spaces.

e. Study number (Columns 18-19): Numbers were assigned consecutively as studies were obtained.

f. Sampling agency code (Columns 20-23): Numbers were originally assigned consecutively to each contributing agency. The original codes were replaced with the DWR 4-digit code to increase compatibility of state data bases.

g. Date of sample (Columns 24-29): This is a minimum reporting requirement. In the original data base, only month and year of sample were recorded, and the sampling results from wells that were sampled more than once a month were averaged. Day, month and year of each sampling record is now included. The middle month of an indicated period is used when the date given is only a season, e.g., "all samples were taken in spring of 1982." However, the precise sampling date is recorded for most studies.

h. Chemical code (Columns 30-34): This is a minimum reporting requirement. Each chemical is assigned a 5-digit chemical code, corresponding to the chemical code used in the Pesticide Use Reporting System maintained by the Information Services Branch, CDFA. Breakdown products of pesticides are included, and are marked with an asterisk to distinguish them from the parent compound, e.g., 00262 = endrin, while *0262 = endrin aldehyde. This list will be updated as necessary.

i. Sample type (Column 35): This field was the "Value Code" column in the 1985 report, with an "A" for averaged values and an "O" for single observations. Data from the 1985 data base have retained the "A" and "O" codes, but new data are identified as individual samples, and assigned the appropriate code (see Appendix B: Explanation of Codes for sample type code definitions).

j. Chemical concentration (Columns 36-41): This is a minimum reporting requirement. Analytical results are recorded in parts pers billion (ppb), in scientific notation. Cols. 36-39 are the significant figures, col. 40 is the sign of the exponent (+ or -), and col. 41 is the exponent (power of 10). Trace amounts, non-detected, or less than the minimum detectable limit values are all recorded as non-detected (0.00+0).

k. Minimum detectable limit (MDL) (Columns 42-47): This is a minimum reporting requirement. The MDL for the chemical assay is recorded in ppb, in the same format as chemical concentration. The MDL for a given compound will vary by laboratory, date, or year, reflecting differences in analytical techniques. However, MDL values are not always reported by laboratories, especially when the results are positive.

l. Analyzing laboratory (Columns 48-51): This is a minimum reporting requirement. Data submitted from samples taken after December 1,1986 must include this information.

m. Method of analysis (Column 52): Specification of analytical method is limited to : EPA-approved, In-house, or Pesticide Analytical Method (PAM) at this time. Very few records currently in the data base contain this information.

n. Date of analysis (Columns 53-58): Month/day/year. This is also a minimum reporting requirement. Most records currently in the data base do not have this information.

o. File code (Columns 59-62): Internal file designation.

p. Summary year (Columns 63-64): This indicates the year of the Well Inventory Summary Report in which each record appears. This will be used for extracting from the main file only that data to be included in yearly updates.

q. Well location information (Columns 65-114): These fields designate specific well locations so that each record is identified with the well from which it came. This information is for internal CDFA use only.

r. - w. Well-specific information (Columns 115-131): Water well driller's reports, or well logs, contain valuable well construction information such as completed well depth and perforation depths. However, well log information is available in only a few studies.

r. Well depth (in feet) (Columns 115-118): This is the completed well depth, as recorded on a well log.

s. Depth to top of perforation (in feet) (Columns 119-121): Taken from a well log.

t. Depth to bottom of perforation (in feet) (Columns 122-125): Taken from a well log; often corresponds to depth of completed well.

u. Water depth (Columns 126-129): The value originally recorded in this field was "depth to standing water after well development," as recorded in the well log. This depth now corresponds to depth of standing water at time of sampling.

v. Log year (Columns 130-131): Year the well was drilled; information obtained from well log, raw data, or verbally from a well owner.

w. Well code (Col. 132): This is a minimum reporting requirement. This code indicates well use, e.g., private domestic or irrigation well, or both.

STATE OF CALIFORNIA
DEPARTMENT OF FOOD
AND AGRICULTURE

WELL INVENTORY FORMAT

ENVIRON. MONITOR. & PEST MGMT.
ENVIRON. HAZARDS ASSESSMENT
1220 N STREET, ROOM A-149
SACRAMENTO, CA 95814

line number		county	state well number: township	range	section	tract	sequence number	base meridian			study number	sampling agency	date of sample: month	day	year	chemical code	sample type	chemical concentration (ppb)	minimum detectible limit (ppb)	analyzing lab	meth of analysis	date of analysis: month	day	year	file code	summary year
1																										
2																										
3																										
4																										
5																										
6																										
7																										
8																										

	WELL LOCATION ADDRESS				WELL CONSTRUCTION INFORMATION						
line number	street number		RD DIR.	STREET NAME	road code	well depth	top perf.	bottom perf.	water depth	log year	well code
1											
2											
3											
4											
5											
6											
7											
8											

APPENDIX B

EXPLANATION OF CODES

I. County Code*

Code	County	Code	County	Code	County
01	Alameda	21*	Marin	41	San Mateo
02	Alpine	22	Mariposa	42	Santa Barbara
03	Amador	23*	Mendocino	43	Santa Clara
04	Butte	24*	Merced	44	Santa Cruz
05	Calaveras	25	Modoc	45	Shasta
06	Colusa	26	Mono	46	Sierra
07*	Contra Costa	27	Monterey	47	Siskiyou
08*	Del Norte	28	Napa	48	Solano
09	El Dorado	29	Nevada	49	Sonoma
10*	Fresno	30	Orange	50*	Stanislaus
11	Glenn	31	Placer	51*	Sutter
12*	Humboldt	32	Plumas	52	Tehama
13*	Imperial	33*	Riverside	53*	Trinity
14	Inyo	34	Sacramento	54*	Tulare
15*	Kern	35	San Benito	55	Tuolumne
16	Kings	36*	San Bernardino	56	Ventura
17	Lake	37*	San Diego	57*	Yolo
18	Lassen	38	San Francisco	58	Yuba
19*	Los Angeles	39*	San Joaquin		
20	Madera	40	San Luis Obispo		

* Counties included in the 1987 data base.

II. Base Meridian Code

H = Humboldt
M = Mt. Diablo
S = San Bernardino

III. Well Study Code

Code	Agency	Pesticide
01	CDHS	EDB
02	CDHS	1,2-D, EDB
03	CDHS	DBCP
04	CDHS	DBCP, EDB
05	CDHS	DBCP
06	CDFA	DBCP
07	CDFA	aldrin, chlordane, 1,3-D, DBCP, DDD, DDE, DDT, dicofol, EDB, endosulfan and endosulfan isomers, heptachlor, heptachlor epoxide, lindane, methoxychlor, pentachlorophenol, tedion
08	CDFA	atrazine
09	CDFA	DD mix, 1,3-D (Telone)
10	CDFA	cis/trans chloroallyl alcohol
11	CDFA	cis/trans chloroallyl alcohol, chlorinated hydrocarbons, 1,3-D, organophosphates
12	CDFA	carbofuran
13	CDFA	carbofuran, DBCP, EDB, simazine
14	CDFA	aldicarb
15	RWQCB	aldrin, BHC-isomers, chlordane, DDD, DDE, and DDT isomers, dieldrin, endosulfan, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, lindane, toxaphene
16	SWRCB	1,2-D, 1,3-D
17	FCHD	DBCP
18	FCHD	DBCP
19	CDHS, DWR	(STORET data); aldrin, chlordane, 2,4-D, DBCP, DDT, dieldrin, endrin, heptachlor, heptachlor epoxide, lindane, methoxychlor, silvex, toxaphene
20	SWRCB	EDB
21	RWQCB	aldicarb, 1,2-D
22	CDFA	1,2-D
23	DHS	Large systems well monitoring data (AB 1803)
25	CDFA	CH screen, dimethoate, glyphosate, malaoxon, malathion
28	DHS	DBCP
30	YCAD	(Yolo Co. Ag. Dept.); DD mix, EDB
31	DPW	(Davis Public Works); 2,4-D, endrin, lindane, methoxychlor, toxaphene, silvex
32	RWQCB	DBCP
33	SMEHD	(San Mateo Env. Health Dept.); aldicarb, aldrin, aminocarb, bendiocarb, a-BHC, b-BHC, d-BHC, bufencarb, carbamult, carbaryl, carbofenothion, carbofuran,
	DDE,	
		op-DDT, pp'-DDT, DEF, diazinon, dieldrin, dioxacarb, dioxathion, disulfoton, endrin, ethion, ethyl parathion, lindane, heptachlor, heptachlor epoxide,

		malathion, mesurol, methomyl, methoxychlor, methyl parathion, mirex, PCNB, perthane, phorate, propoxur, tetradifon, thiodan I & II, toxaphene
34	CDFA	alachlor, atrazine, CB, CH and OP screens, carbofuran, metolachlor, molinate, prometon, thiobencarb
35	CDFA	CH and OP screens, molinate, molinate sulfoxide
36	CDFA	alachlor, metolachlor
37	CDFA	chloroallyl alcohol, 1,3-D (Telone)
38	CDFA	bromacil, diuron, simazine
39	CDFA	CB, CH and OP screens, DBCP, disulfoton, EDB
40	CDFA	molinate, molinate sulfoxide, thiobencarb, thiobencarb sulfoxide
41	CDFA	DBCP
42	RWQCB	aldicarb, 1,2-D
43	CDFA	alachlor, amitraz, azinphos-methyl, CB, CH, OP and triazine (TZ) screens, DBCP, disulfoton, EDB, ethion, fenbutatin-oxide, fenvalerate, metolachlor, permethrin
44	CDFA	bromacil
45	CDFA	aldicarb, aldicarb sulfone, fenamiphos, fenamiphos sulfone and sulfoxide, nemacur, nemacur sulfone and sulfoxide
46	CDFA	azinphos-methyl, carbofenothion, carbofuran, CH and OP screens, dicofol, endosulfan, ethion, simazine, toxaphene
47	CDHS	alachlor, atrazine, 1,2-D, DBCP, DD mix, 1,4-dichlorobenzene, EDB, simazine, xylene
48	BLM	(US Bureau of Land Management); 2,4-D, endrin, lindane, methoxychlor, toxaphene, silvex
49[a]	RWQCB	atrazine, DDE, DDT, carbamate, thiocarbamate
50	CDFA	phosmet
52	CDFA	atrazine, bromacil, diuron, prometon, simazine
53	CDFA	DBCP, DD mix, 1,3-D (Telone)
54[a]	RWQCB	arsenic, bromide, 2,4-D, demeton, diazinon, disulfoton, endrin, ethion, ethyl parathion, malathion, methoxychlor, methyl parathion, phosalone, toxaphene, silvex, and 14 other chemicals
55	USGS	alachlor, ametryn, atratone, atrazine, cyanazine, cyprazine, diazinon, ethion, malathion, methyl parathion, parathion, prometon, prometryn, propazine, simazine and 5 other chemicals
56	CDFA	alachlor, atrazine, diazinon, metolachlor, nitrates
57	CDFA	1,3-D
58	MCDH	(Marin Co. Dept. of Health); 2,4-D, endrin, lindane, methoxychlor, toxaphene, silvex
59[a]	SCEHD	(Sacramento Co. Env. Health Dept.); 2,4-D, endrin, lindane, methoxychlor, toxaphene, silvex
60[a]	RWQCB	bentazon, carbofuran, methidathion, molinate, trifluralin
61	CDFA	diazinon
62	SWRCB	atrazine, chlordane, cyanazine, 2,4-D, dinoseb, fenac, oxamyl, PCP, prometon, prometryn, propazine, silvex, 2,4,5-T, tetrachlorophenol, toxaphene, and 40 other chemicals
63	RWQCB	glyphosate

64[b]	RWQCB	hexavalant chromium, PCP, tetrachlorophenol
65[b]	RWQCB	acenaphthene, arsenic acid, copper, napathalene, pentachlorophenol, tetrachlorophenol
66[b]	RWQCB	pentachlorophenol, tetrachlorophenol
67[a]	RWQCB	nemacur
68[b]	CH2M HILL	carbon tetrachloride, chloroform, 1,2-dichloropropane, trans-1,3 dichloropropene, cis-1,3-dichloropropene, methylene chloride, 1,1,2 trichloroethane
70	USF	(Mendocino National Forest); 2,4-D, endrin, lindane, toxaphene, methoxychlor, silvex
72	KCEH	(Kern Co. Env. Health); DBCP, EDB
73[a]	DWR	aldicarb, benomyl, carbaryl, carbofuran, CIPC, DBCP, diuron, EDB, eptam, IPC, methomyl, oxamyl
74	RWQCB	aldicarb, nemacur, nitrate
75[a]	CDFA	chlorpyrifos, trifluralin

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a= Data from these studies will be included in the 1988 data base.

b= Data from point source, industrial related sampling; records are stored in a separate data base.

IV. Sampling Agency Code

Code	Agency Name
3346	Anatec Lab (Davis Public Works study)
5060	CDHS (Sanitary Engineering Branch)
5050	DWR
4323	CDFA, Environmental Hazards Assessment Program
4323	CDFA, Worker Health and Safety Program
5112	Fresno County Health Department)
5119	Kern County (Environmental Health Department)
7736	Marin County Health Department
2894	RWQCB, Region 1 (North Coast)
5084	RWQCB, Region 4 (Los Angeles)
5088	RWQCB, Region 8 (Santa Ana)
1896	San Mateo County (Environmental Health Department)
1401	San Diego County (Agriculture Department)
6244	Sutter County (Agriculture Department)
5056	SWRCB
8904	US Bureau of Land Management
5005	US Forest Service
5000	USGS (US Geological Survey)
5104	Yolo County (Agriculture Department)

V. Chemical Codes

Code	Common Name
00506	1,2-D
00573	1,3-D
00639	2,4,5-T
00636	2,4-D
*0786	4-CLOC
90359	BHC (all isomers)
00185	D-D mix
00183	DBCP
00179	DCPA
00184	DDD
02092	DDE
00186	DDT
00187	DDVP
00190	DEF
00233	DMTT
00533	DNOC
00271	EDB
00263	EPN
00264	EPTC
00788	MCPA (no salt)
00786	MCPA, dimethylamine salt
00641	MCPB,sodium salt
00034	MSMA
00464	PCNB
00465	PCP
00549	Starlicide(R)
00542	TCA
00577	TEPP
01685	acephate
02218	acifluorfen
00003	acrolein
00678	alachlor
00575	aldicarb
*0575	aldicarb sulfone
00009	aldrin
00484	aluminum phosphide
00018	ametryn
****1	aminocarb
02016	amitraz
00020	amitrole
****2	atraton
00045	atrazine
00050	avitrol
****3	azinophos-ethyl
00314	azinophos-methyl
01924	bendiocarb
00053	benefin
01552	benomyl
00070	bensulide
01944	bentazon
01953	bifenox
00079	borax

Code	Common Name
00083	bromacil
00091	bufencarb
00565	butylate
00104	captan
00105	carbaryl
02176	carbendazim
00106	carbofuran
00108	carbon disulfide
00110	carbophenothion
01755	carboxin
02184	chloramben (NH4 salt)
00130	chlordane
00347	chlordecone
00300	chlordimeform
*0573	chloroallyl alcohol (cis/trans)
00132	chlorobenzilate
00135	chloroneb
00136	chloropicrin
00137	chloropropylate
00677	chlorothalonil
00576	chloroxuron
00141	chlorpropham
00253	chlorpyrifos
02143	chlorsulfuron
00171	creosote
01640	cyanazine
00516	cycloate
01701	cyprazine
00180	dalapon
00566	demeton
00048	diallate
00198	diazinon
00200	dicamba
00112	dichlobenil
00614	dichlofenthion
00346	dicofol
00072	dicrotophos
00210	dieldrin
01995	diethatyl ethyl
01930	difenzoquat methyl sulfate
00216	dimethoate
00238	dinoseb
****8	dioxacarb
00192	dioxathion
00226	diphenamid
00229	diquat dibromide
00230	disulfoton
00231	diuron
00245	dodine
00259	endosulfan
*0259	endosulfan sulfate
00260	endothall
00262	endrin
*0262	endrin aldehyde

Code	Common Name
02166	ethalfluralin
00268	ethion
01900	ethofumesate
00404	ethoprop
00008	ethyl alcohol
00472	ethylan
----1	ethylene thiourea
00285	fenac
01857	fenamiphos
*1857	fenamiphos sulfone
$1857	fenamiphos sulfoxide
01876	fenbutatin-oxide
00181	fensulfothion
01963	fenvalerate
01848	fluchloralin
00166	fluometuron
00295	formaldehyde
01855	glyphosate
00317	heptachlor
*0317	heptachlor epoxide
00321	hexachlorobenzene
01871	hexazinone
02194	isofenphos
01681	isopropalin
00359	lindane (gamma-BHC)
00361	linuron
*0367	malaoxon
00367	malathion
00368	maleic hydrazide
00369	maneb
00372	mercuric chloride
00293	merphos
00616	metam-sodium
01697	methamidophos
01689	methidathion
00375	methiocarb
00383	methomyl
00384	methoxychlor
00385	methyl bromide
00394	methyl parathion
00388	methylene chloride
01996	metolachlor
01692	metribuzin
00480	mevinphos
00402	mirex
00449	molinate
*0449	molinate sulfoxide
00052	monocrotophos
00408	monuron
00418	naled
01728	napropamide
00437	naptalam
00424	neburon
00490	nitralin
00592	nitrofen

Code	Common Name
02019	norflurazon
00578	orthodichlorobenzene
01868	oryzalin
00452	ovex
02017	oxadiazon
01910	oxamyl
00382	oxydemeton-methyl
01973	oxyfluorfen
00455	paradichlorobenzene
00458	paraquat
01601	paraquat dichloride
00459	parathion
00590	pebulate
01929	pendimethalin
02008	permethrin (cis and trans)
00478	phorate
00479	phosalone
00335	phosmet
*0335	phosmet-OA
00482	phosphamidon
00593	picloram
01897	profluralin
****9	promecarb
00499	prometon
00502	prometryn
00511	propachlor
00445	propargite
00504	propazine
00339	propham
00062	propoxur
00694	propyzamide
00509	pyrazon
00510	pyrethrins
02119	resmethrin
00517	ronnel
***CB	screen (carbamate)
***CH	screen (chlorinated hydrocarbon)
***OP	screen (organophosphate)
***TZ	screen (triazine)
****4	secbumeton
00603	siduron
00530	silvex
00531	simazine
****5	simetryn
00536	sodium chlorate
00688	sodium cyanide
00633	sodium fluoroacetate
00554	strychnine
02149	sulfometuron methyl
01810	tebuthiuron
00532	terbacil
****6	terbuthylazine
01691	terbutryn
00580	terrazole
01174	tetrachloroethylene

Code	Common Name
00777	tetrachlorophenol
00305	tetrachlorvinphos
00581	tetradifon
00586	thanite
01933	thiobencarb
*1933	thiobencarb sulfoxide
01684	thiophanate
00594	toxaphene
02133	triadimefon
00049	triallate
****7	trichloronate
00088	trichlorophon
00597	trifluralin
01987	vernolate
00622	xylene
00627	zineb
00629	ziram

VI. Sample Type Code

The following codes are used to identify additional information that is available for results of chemical analyses CDFA has received. Definitions of terms used, i.e., initial detection, split and replicate sample, are included.

Definitions:

Initial detection sample:
For a single study and one particular well, the initial detection sample for a chemical will be the positive sample with the earliest sampling date and/or time. Splits and replicates are coded in relation to the initial detection sample.

Split sample:
A single sample which is divided into subsamples. In reference to a single chemical, one of the subsample results may be coded as an initial detection sample. The other subsample results would then be coded as splits of the initial detection sample. If all of the subsample results are negative, the results would be coded as "S", for split samples.

Replicate sample:
A discrete sample taken from the same well as the initial detection sample. In reference to a single chemical, discrete samples taken during a single study will be recorded as replicates of the initial detection sample. If a replicate of the initial detection sample is split, then the results for the splits are still recorded as replicates of the initial detection sample. Information indicating that the replicates were also split samples is not recorded in the data base.

Codes:

(I) INITIAL DETECTION SAMPLE, NOT CONFIRMED
- -only one positive analysis
- -method and laboratory may or may not be known
- -no further sampling

(B) INITIAL DETECTION SAMPLE, w/FURTHER QUALITATIVE OR QUANTITATIVE ANALYSES HAVING ALL NEGATIVE RESULTS
- -initial detection with negative subsequent analyses
- -subsequent analyses are assigned the appropriate sample type codes "D" through "L" or "-"

(Q) INITIAL DETECTION SAMPLE, w/ FURTHER ANALYSES
- -initial detection with at least one positive subsequent analysis
- -no qualitative analyses
- -subsequent analyses are assigned the appropriate sample type codes "D" through "L" or "-"

(C) INITIAL DETECTION SAMPLE, CONFIRMED BY DATA SOURCE AGENCY
- -pertains to data from agencies other than CDFA
- -method of analysis and laboratory are unknown
- -a single value with no subsequent sampling
- -data confirmed by written or verbal statement from data source agency

(M) INITIAL DETECTION SAMPLE, QUALITATIVELY CONFIRMED
-initial detection sample is confirmed only qualitatively (eg. by using mass spectrophotometer)
-no further quantitative analyses

(P) INITIAL DETECTION, w/FURTHER QUANTITATIVE AND QUALITATIVE ANALYSES
-indicates that beyond the quantitative values recorded for the initial and subsequent analyses, some qualitative analyses were also performed
-qualitative analyses can be either for the initial or for the subsequent analyses
-at least one positive subsequent analysis
-subsequent analyses are coded with the appropriate sample type codes "D" through "L" or "-"

(D) SPLIT SAMPLE, METHOD- Different, LAB- Same
-a split sample analyzed with a different analytical method(s) but by the same laboratory as the initial detection sample

(E) SPLIT SAMPLE, METHOD- Same, LAB- Different
-a split sample analyzed with the same analytical method(s) but by a different laboratory than the initial detection sample

(F) SPLIT SAMPLE, METHOD- Different, LAB- Different
-a split sample analyzed with a different analytical method(s) and by a different laboratory than the initial detection sample

(G) SPLIT SAMPLE, METHOD- Same, LAB- Same
-a split sample analyzed with the same analytical method(s) and by the same laboratory as the initial detection sample

(H) REPLICATE SAMPLE, METHOD- Different, LAB- Same
-a replicate sample analyzed with a different analytical method(s) but by the same laboratory as the initial detection sample

(J) REPLICATE SAMPLE, METHOD- Different, LAB- Different
-a replicate sample analyzed with a different analytical method(s) and by a different laboratory as the initial detection sample

(K) REPLICATE SAMPLE, METHOD- Same, LAB- Different
-a replicate sample analyzed with the same analytical method(s) but by a different laboratory as the initial detection sample.

(L) REPLICATE SAMPLE, METHOD- SAME, LAB-SAME
-a replicate sample analyzed with the same analytical method(s) but by a different laboratory as the initial detection sample

(A) AVERAGED RESULT
-averaged lab results from two or more samples
-as of 1986, code no longer used

(N) SINGLE, NON-DETECTED
-negative lab result from a single sample
-as of 7-27-87, code no longer used

(O) SINGLE RESULT
-a positive or a negative value for a single observation
-as of 1986, code no longer used

(R) ROUTINE, ONGOING
-analyses from wells which are sampled on a regular, periodic basis
-these samples must have an initial sample to correspond to

(S) SPLIT SAMPLE
-no initial detection sample
-all split samples are negative

(-) NOT SPECIFIED
-used when laboratory or analytical methods are unknown for analyses subsequent to initial detection sample
-used when all discrete samples are negative

VII. Analyzing Laboratory Code

Code	Laboratory Name
1833	Aerojet-General Corportation, Solid Propulsion Lab
9600	Agricultural Primary Pollutants Lab
5191	Agricultural Technical Services Company
2378	Analytical Technologies, Inc. Lab
3346	Anatec, Inc., Lab
5991	Anlab- Dewante and Stowell Lab
2371	Appl, Inc., Lab
4792	Associated Lab
5806	B C Lab
4790	Babcock and Sons Lab
9534	Brelje and Race Lab
5819	Brown and Caldwell (Emeryville) Lab
2134	Brown and Caldwell (Pasadena) Lab
5811	California-American Water Company, Monterey Lab (CT & TEL)
9527	California Analytical Lab
5073	Cal. Dept. Fish and Game- Nimbus Lab
4323	Cal. Dept. Food and Agriculture Lab
5060	Cal. Dept. Health Services- Berkeley Lab
5091	Cal. Dept. Health Services- So. Cal. Lab
5146	California Water Labs
5701	California Water Service Company Lab
2217	Chevron Chemical Lab- Richmond
9485	CH2M Hill Lab
9217	City of Loma Linda
1200	City of Los Angeles, Dept. of Water and Power Lab
9054	City of Sacramento, American River Water Treatment Plant Lab
9490	City of Santee WWTP Lab
6291	EAL Corporation Lab
9480	Empire Medical Lab
7184	Environmental Monitoring and Services, Inc., Lab
9484	Environmental Quality Analysis, San Francisco Lab
3373	Environmental Research Group, Inc., Lab
5138	Fireman's Fund Insurance Companies, Environmental Lab
9470	Food Machinery Corporation, Envi Engr, Santa Clara Lab
5112	Fresno County Health Department Lab
5867	Fruit Growers Lab
4704	It Corporation, Lab
2993	McKesson Environmental Service Lab

Code	Laboratory Name
9590	Montgomery, James M., Consulting Engineers Lab
9551	Morse Lab
7445	Multi-Tech, Inc., Lab
2461	North Coast County Water District Lab
3334	North Coast, LTD, Lab
5497	Quality Assurance Lab of San Diego Lab
4072	Radian Lab Corporation
5201	Rockwell International Corporation, Newbury Park, Lab
3761	San Bernardino Clinical Lab
7998	Scientific Environmental Lab
5113	Sequoia Analytical Lab
4775	Shell Chemical- Martinez Lab
9465	Shell Chemical- Pittsburg Lab
9517	Shell Chemical- Salida Lab
9515	Shell Oil Company, Salida Lab
5879	Sierra Foothill Lab
6213	Stauffer Chemical Corporation, Martinez Lab
8046	Stauffer Chemical Corporation, Richmond Lab
9598	Stauffer Chemical Corporation, South Gate Lab
5809	Stoner Lab
6257	Suburban Water System Lab
3759	Thorpe Lab
9469	Truesdail Lab
5802	Twining, Fresno Lab
9250	Union Carbide Corporation Lab
5801	US Agricultural Consultants Lab
7227	US Department of Air Force, Brooks Base, Texas Lab

VIII. Method of Analysis Code

E = EPA approved Method
I = In-house
P = P.A.M. (Pesticide Analytical Method)
O = Other

IX. Road Code

AV = Avenue
BL = Boulevard
CR = Circle
CT = Court
DR = Drive
HY = Highway
LN = Lane
PL = Place
RD = Road
RT = Route
ST = Street
WY = Way

X. Well (Type) Code

USGS Code	CDFA Code	
	B =	Both I and D
	C =	Community well
	D =	Domestic (private) well (residences)
	I =	Irrigation (agricultural) well
	L =	Large Water System well (more than 200 service connections)
	N =	Non-community well (schools, hospitals, restaurants, filling stations, parks, campgrounds - see Title 22 for more detailed definitions)
	S =	State Small Water System well (less than 200 service connections)
	T =	Test, monitoring, or observation well
	U =	Unknown type of well
	X =	Irrigation and industrial well
	Y =	Industrial well
(D)	W =	Dewatering well (see USGS definition below)
(C)	( )=	Commercial well (we will include this category in whichever CDFA category it bests fits, for example, industrial or non-community, depending on the described use of the well; see USGS definition below).)
(S)	R =	Stock (see USGS definition below)
(U)	A =	Unused well (see USGS definition below)

(D) Dewatering means the water is pumped for dewatering a construction or mining site, or to lower the water table for agricultural purposes. In this respect, it differs from a drainage well that is used to drain surface water underground. If the main purpose for which the water is withdrawn is to provide drainage, dewatering should be indicated even though the water may be discharged into an irrigation ditch and subsequently used to irrigate land.

(C) Commercial use refers to use by a business establishment that does not fabricate or produce a product. Filling stations and motels are examples of commercial establishments. If some product is manufactured, assembled, remodeled, or otherwise fabricated, use of water for that plant should be considered industrial, even though the water is not used directly in the product or in the manufacturing of the product.

(S) Stock supply refers to the watering of livestock.

(U) Unused means water is not being removed from the site for one of the purposes described above. A test hole*, oil or gas well, recharge, drainage, observation*, or waste-disposal well will be in this category. * = this type of well will be given the CDFA code of "T"; the others will get a CDFA code of "A".

APPENDIX E

RESULTS BY COUNTY

AND

BY PESTICIDE ACTIVE INGREDIENT

COUNTY: CONTRA COSTA

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
atrazine	1	2	0	0	1	2
paradichlorobenzene	1	2	0	0	1	2
TOTAL SAMPLE RESULTS		4		0		4

COUNTY: DEL NORTE

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,2-D	7	19	5	9	12	28
aldicarb	4	14	8	14	12	28
phosmet	0	0	2	8	2	8
phosmet-OA	0	0	2	8	2	8
TOTAL SAMPLE RESULTS		33		39		72

COUNTY: FRESNO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,2-D	1	3	5	9	6	12
1,3-D	0	0	6	12	6	12
2,4,5-T	0	0	4	5	4	5
2,4-D	0	0	4	5	4	5
BHC (all isomers)	0	0	4	6	4	6
D-D mix	0	0	12	13	12	13
DBCP	16	32	1	1	17	33
DDD	0	0	4	6	4	6
DDE	0	0	4	6	4	6
DDT	0	0	4	6	4	6
DEF	0	0	4	5	4	5
PCP	0	0	4	5	4	5

COUNTY: FRESNO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
alachlor	0	0	15	16	15	16
aldrin	0	0	4	6	4	6
ametryn	0	0	15	16	15	16
atraton	0	0	15	16	15	16
atrazine	0	0	18	20	18	20
carbaryl	0	0	4	5	4	5
carbofuran	0	0	4	5	4	5
carbophenothion	0	0	19	21	19	21
chlordane	0	0	4	6	4	6
chlorpropham	0	0	4	5	4	5
chlorpyrifos	0	0	4	5	4	5
cyanazine	0	0	19	21	19	21

COUNTY: FRESNO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
cyprazine	0	0	15	16	15	16
diazinon	0	0	19	21	19	21
dieldrin	0	0	4	5	4	5
dimethoate	0	0	4	5	4	5
dinoseb	0	0	4	5	4	5
dioxathion	0	0	4	5	4	5
disulfoton	0	0	4	5	4	5
diuron	0	0	4	5	4	5
endosulfan	0	0	4	6	4	6
endosulfan sulfate	0	0	4	6	4	6
endrin	1	2	3	4	4	6
endrin aldehyde	0	0	4	6	4	6

COUNTY: FRESNO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
ethion	0	0	19	21	19	21
fenac	0	0	4	5	4	5
fluometuron	0	0	4	5	4	5
heptachlor	0	0	4	6	4	6
heptachlor epoxide	0	0	4	6	4	6
lindane (gamma-BHC)	0	0	4	6	4	6
linuron	0	0	4	5	4	5
malathion	0	0	19	21	19	21
methiocarb	0	0	4	5	4	5
methomyl	0	0	4	5	4	5
methoxychlor	0	0	4	6	4	6
methyl bromide	0	0	12	13	12	13

COUNTY: FRESNO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
methyl parathion	0	0	19	21	19	21
mevinphos	0	0	4	5	4	5
monuron	0	0	4	5	4	5
neburon	0	0	4	5	4	5
oxamyl	0	0	4	5	4	5
parathion	0	0	19	21	19	21
phorate	0	0	4	5	4	5
prometon	0	0	19	21	19	21
prometryn	0	0	19	21	19	21
propazine	0	0	19	21	19	21
propham	0	0	4	5	4	5
propoxur	0	0	4	5	4	5

COUNTY: FRESNO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
silvex	0	0	4	5	4	5
simazine	0	0	18	20	18	20
simetryn	0	0	15	16	15	16
tetrachloroethylene	1	3	17	21	18	24
tetrachlorophenol	0	0	4	5	4	5
toxaphene	0	0	4	6	4	6
trifluralin	0	0	15	16	15	16
xylene	1	2	6	11	7	13
TOTAL SAMPLE RESULTS		42		654		696

COUNTY: HUMBOLDT

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
aldicarb	3	10	6	17	9	27
chlorothalonil	1	2	1	2	2	4
fenamiphos	0	0	2	2	2	2
glyphosate	0	0	2	2	2	2
TOTAL SAMPLE RESULTS		12		23		35

COUNTY: IMPERIAL

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,2-D	1	2	0	0	1	2
2,4-D	0	0	1	1	1	1
endrin	0	0	1	1	1	1
lindane (gamma-BHC)	0	0	1	1	1	1
methoxychlor	0	0	1	1	1	1
silvex	0	0	1	1	1	1
toxaphene	0	0	1	1	1	1
TOTAL SAMPLE RESULTS		2		6		8

COUNTY: KERN

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,2-D	6	12	0	0	6	12
2,4-D	0	0	1	1	1	1
DBCP	54	638	159	588	213	1226
EDB	8	38	191	674	199	712
endrin	0	0	1	1	1	1
lindane (gamma-BHC)	0	0	1	1	1	1
methoxychlor	0	0	1	1	1	1
silvex	0	0	1	1	1	1
toxaphene	0	0	1	1	1	1
TOTAL SAMPLE RESULTS		688		1268		1956

COUNTY: LOS ANGELES

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
atrazine	2	4	0	0	2	4
TOTAL SAMPLE RESULTS		4		0		4

COUNTY: MARIN

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
2,4-D	0	0	5	6	5	6
endrin	0	0	5	6	5	6
lindane (gamma-BHC)	0	0	5	6	5	6
methoxychlor	0	0	5	6	5	6
silvex	0	0	5	6	5	6
toxaphene	0	0	5	6	5	6
TOTAL SAMPLE RESULTS		0		36		36

COUNTY: MENDOCINO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
2,4-D	0	0	4	7	4	7
endrin	0	0	4	7	4	7
lindane (gamma-BHC)	0	0	4	7	4	7
methoxychlor	0	0	4	7	4	7
silvex	0	0	4	7	4	7
toxaphene	0	0	4	7	4	7
TOTAL SAMPLE RESULTS		0		42		42

COUNTY: MERCED

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
DBCP	12	24	0	0	12	24
alachlor	0	0	30	101	30	101
atrazine	1	2	31	100	32	102
diazinon	1	6	8	40	9	46
metolachlor	0	0	30	102	30	102
simazine	1	2	0	0	1	2
TOTAL SAMPLE RESULTS		34		343		377

COUNTY: RIVERSIDE

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,2-D	1	3	0	0	1	3
1,3-D	1	6	3	8	4	14
DBCP	6	16	0	0	6	16
chloroallyl alcohol (cis/trans)	0	0	4	8	4	8
TOTAL SAMPLE RESULTS		25		16		41

COUNTY: SAN BERNARDINO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
DBCP	5	15	4	11	9	26
TOTAL SAMPLE RESULTS		15		11		26

COUNTY: SAN DIEGO

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
D-D mix	0	0	2	2	2	2
TOTAL SAMPLE RESULTS		0		2		2

COUNTY: SAN JOAQUIN

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,2-D	1	2	0	0	1	2
DBCP	15	30	1	1	16	31
TOTAL SAMPLE RESULTS		32		1		33

COUNTY: STANISLAUS

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
DBCP	30	60	0	0	30	60
TOTAL SAMPLE RESULTS		60		0		60

COUNTY: SUTTER

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
1,3-D	0	0	1	1	1	1
DBCP	0	0	1	1	1	1
screen (chlorinated hydrocarbon)	0	0	1	1	1	1
screen (organophosphate)	0	0	1	1	1	1
TOTAL SAMPLE RESULTS		0		4		4

COUNTY: TRINITY

PESTICIDE	POSITIVE		NEGATIVE		TOTAL	
	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES	NO. OF WELLS	NO. OF SAMPLES
2,4-D	0	0	1	1	1	1
endrin	0	0	1	1	1	1
lindane (gamma-BHC)	0	0	1	1	1	1
methoxychlor	0	0	1	1	1	1
silvex	0	0	1	1	1	1
toxaphene	0	0	1	1	1	1
TOTAL SAMPLE RESULTS		0		6		6