SETTING REVISED SPECIFIC NUMERICAL VALUES
OCTOBER, 1989

October, 1989

Environmental Hazards Assessment Program

STATE OF CALIFORNIA
Department of Food and Agriculture
Division of Pest Management, Environmental Protection and Worker Safety
Environmental Monitoring and Pest Management Branch
1220 N Street, Sacramento, California 95814

EH 89-13

SETTING REVISED SPECIFIC NUMERICAL VALUES

OCTOBER, 1989

Pursuant to the

Pesticide Contamination Prevention Act

By

Bruce Johnson

ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

TABLE OF CONTENTS

	Page
Table of Contents	i
List of Tables	ii
Introduction	1
Methods	1
Results	5
Conclusion	7
References	12
Appendices	

LIST OF TABLES

		Page
Table 1.	List of contaminants.....	2
Table 2.	List of non-contaminants.....	3
Table 3.	Statistics for log10 transformed characteristics of contaminant and non-contaminant pesticides.....	6
Table 4.	90th percentile calculations based on log10 transformed contaminant data.....	8
Table 5.	Classification of contaminant compounds based on specific numeric values.....	9
Table 6.	Classification of non-contaminant compounds based on specific numeric values.....	10
Table 7.	Classification errors using 90th percentile statistics..	11

SETTING REVISED SPECIFIC NUMERICAL VALUES

INTRODUCTION

The Pesticide Contamination Prevention Act requires the Department of Food and Agriculture to set certain numeric threshold values for chemical properties of pesticides. Compounds which exceed these values may be placed on a Ground Water Protection List (Wilkerson and Kim, 1986). The current report details derivation for 1989 of specific numerical values utilizing the 90th percentile of distributions of chemical properties.

METHODS

The methodology in 1989 was similar to that in 1988 (Johnson, 1988). For the 1989 report, more ground water studies and more physicochemical parameter studies were available for use. In this report, the term contaminant refers to a compound which has demonstrated a propensity to leach into ground water as a result of normal agricultural use. The detection studies used were reviewed for consistency and accuracy and are listed in Appendix A. Based on these ground water studies, two lists of compounds were created. One list contained compounds which had been detected in ground water to a significant degree (contaminants), and the other list contained compounds which have not been detected to a significant degree in ground water (non-contaminants) as a result of agricultural non-point source contamination. The definition of 'significant degree' and the criteria used to judge the validity of a reported ground water find are discussed in Appendix B. Based on the review of detection studies and newly received studies since 1988, a few compounds were reclassified (see Tables 1 and 2). In addition, estimates were obtained for some properties for some compounds for which there were no data in 1988.

Table 1. List of contaminants. Units are Koc = cm^3/gm, hydrolysis and aerobic metabolism = days (half life), water solubility = ppm. Data has been rounded to 2 significant figures. No data is indicated by -1.

Pesticide	Koc	Hydrolysis Half-Life	Aerobic Metabolism Half-Life	Water Solubility
Alachlor	150	720	18	200
Aldicarb	79	670	14	6000
Atrazine	180	160	190	33
Bromacil	60	110	300	820
Carbofuran	48	60	23	320
Chloramben	280	370	-1	700
Chlorothalonil (a)	2500	49	35	0.6
Chlorthal dimethyl	4000	36	24	3
Cyanazine	180	260	15	170
2,4-D (a)	53	4	8	230
DBCP	80	7100	180	1000
Dicamba	1.5	30	61	6100
Dieldrin	7100	1500	1000	0.12
Dinoseb	110	30	-1	75
Diuron	460	110	-1	42
EDB	44	7100 (b)	44	3400
Fonofos (a)	5100	110	120	16
Metolachlor	190	210	-1	530
Metribuzin	150	130	110	1100
Oxamyl	6	6	180	280000
Picloram	26	650	350	430
Prometon	79	1100	280	720
Propachlor	340	-1	-1	700
Propylene dichloride	49	-1	-1	2700
Simazine	220	110	110	4.9

(a) Compounds on non-contaminant list in 1988.
(b) Winsorized original value of 100,000,000 (see text).

Table 2. List of non-contaminants. Units are Koc = cm^3/gm, hydrolysis and aerobic metabolism = days (half life), water solubility = ppm. Data has been rounded to 2 significant figures. No data is indicated by -1.

Pesticide	Koc	Hydrolysis Half-Life	Aerobic Metabolism Half-Life	Water Solubility
Aldrin	14000	-1	120	0.027
Ametryne	380	28	37	190
Carbaryl	360	5.2	8	110
Chlordane	33600	110	54	1.9
Chlorpyrifos (a)	17000	73	88	0.71
DDD	46000	-1	-1	-1
DDT	160000	-1	3800	0.003
Diazinon	1200	20	17	61
Dimethoate	17	62	2	25000
Disulfoton	940	320	2	14
1,3-D	150	7	13	1000
Endosulfan	2000	14	32	0.33
Ethroprop	180	-1	25	770
Fenamiphos	280	300	22	560
Heptachlor	16000	180	2000	0.06
Lindane	2500	310	790	10
Linuron	670	55	78	75
Malathion	1000	48	1	140
Methiocarb	490	24	-1	27
Methyl bromide	390	-1	35	9200
Naled (a)	167	0.68	3	2000
Pendimethalin	16000	60	1300	0.28
Phorate	2400	3.1	3	18
Prometryn (a)	680	75	150	48
Silvex (a)	-1	-1	16	160
Toxaphene	-1	110	-1	1.9
Trifluralin	9900	110	180	1.8

(a) Compound on contaminant list in 1988.

Four characteristics were determined for each compound: soil adsorption (Koc), hydrolysis half life, soil aerobic metabolism (SAM) half life, and solubility. Estimates of these properties were based on reviewed studies from the open literature and CDFA approved studies which fulfilled the data-call-in requirements of the Pesticide Contamination Prevention Act. More detailed information about the data values can be found in Johnson (1988, Appendix II).

Comparison of the distributions for these characteristics to expected normal distributions indicated that these physicochemical properties were extremely non-normally distributed. A log10 transformation was used to normalize the distributions. All statistical calculations were performed on log10 transformed data. The standard t-test, not assuming equal variances, was used to determine mean separation of contaminants versus non-contaminants for each chemical characteristic. The percentile calculations were based on the mean, standard deviation and appropriate t-value using 1 less than the number of observations for degrees of freedom. For Koc, the 90th percentile was the point below which 90% of the contaminant population fell. For hydrolysis and water solubility, the 90th percentile was the point above which 90% of the contaminant population fell. Aerobic metabolism lacked discriminatory power since the two means were not significantly different. Therefore its importance in the discrimination procedure was reduced by choosing the point above which only 10% of the combined contaminant and non-contaminant populations fell. For all parameters, estimates were then back-transformed to obtain final values.

One hydrolysis observation was 'winsorized' (Snedecor and Cochran, 1967) because of its extreme value. Hydrolysis half life studies typically last less than 365 days. Therefore the estimated half life for EDB of 100,000,000

was regarded as uncertain and reduced to the next highest value which was 7100 days for DBCP.

The language of the law provides for the following logic in testing each compound:

Classify as a potential contaminant if:
(A or B) and (C or D) are true,
where
A = 'Koc less than V1'
B = 'water solubility greater than V2'
C = 'hydrolysis half life greater than V3'
D = 'SAM half life greater than V4'
and V1, V2, V3, V4 are specific numerical values.

After determining the specific numeric values, this test was applied to the contaminant and non-contaminant compounds to determine an error rate for the classification procedure.

RESULTS

Contaminants and non-contaminants and their estimated Koc, hydrolysis, soil aerobic metabolism and water solubility properties are listed in Table 1 and Table 2, respectively. The statistics for the two groups are summarized in Table 3. Variances were not significantly different. However, testing power probably was reduced by moderately low sample sizes. Therefore non-equal variance t-tests were used to determine significance of mean separation. Means were significantly different between contaminants and non-contaminants except for soil aerobic metabolism.

Table 3. Statistics for log10 transformed characteristics of contaminant and non-contaminant pesticides.

		Contaminants	Non-contaminants	P-values (a)
Koc				
	Mean	2.17	3.23	.001
	SD	0.84	0.95	.247
	N	25	25	
Hydro.				
	Mean	2.24	1.61	.009
	SD	0.83	0.70	.518
	N	23	21	
SAM				
	Mean	1.87	1.60	.251
	SD	0.58	0.97	.088
	N	19	24	
Solub.				
	Mean	2.34	1.29	.019
	SD	1.37	1.71	.189
	N	25	26	

(a) P-value for mean separation based on t test, not assuming equal variances. Separation for standard deviations (SD) based on Levene's test for equal variances. Values of p less than .05 are considered significant.

The 90th percentile calculations are shown in Table 4. The back-transformed 90th percentiles are Koc 1900 cm^3/gm, hydrolysis 14 days, soil aerobic metabolism 610 days and water solubility 3 parts per million (ppm).

The classification of contaminants and non-contaminants, using the logic detailed in the Methods Section in combination with the derived 90th percentiles, is shown in Tables 5 and 6, respectively. The errors associated with this technique are shown in Table 7. Three compounds contained insufficient information to classify. Of the remaining 49, 30.6% were misclassified. Most of the errors resulted from misclassification of non-contaminants. This error rate was an improvement over 1988, where the misclassification rate was 35.4% (Johnson, 1988).

CONCLUSION

A list of 26 contaminant and 26 non-contaminant pesticides were analyzed to determine specific numeric values. Significant mean separation of log10 transformed values occurred for Koc, water solubility and hydrolysis, but not for aerobic metabolism. Based on the log10 transformed means, 90th percentiles were computed. Back-transformed 90th percentiles were Koc 1900 cm^3/gm, hydrolysis 14 days, soil aerobic metabolism 610 days and solubility 3 ppm. The compounds were classified as potential contaminants if (Koc < 1900 or water solubility > 3.0) and (hydrolysis half life > 14 or soil aerobic metabolism half life > 610). This procedure resulted in a 30.6% misclassification rate, which compared favorably to the 35.4% error rate in 1988.

Table 4. 90th percentile calculations based on log10 transformed contaminant data. The formula is 90th percentile = mean + (SD)(T), where + was used for Koc and SAM and - for hydrolysis and solubility, SD is standard deviation, and T is the appropriate T value (value where 90% of the distribution is lower for Koc and SAM and higher for hydrolysis and solubility with N-1 degrees of freedom).

	Mean of log10 values	SD	N	T	Log10 90th percentile	Back-transform
Koc	2.17	0.84	25	1.32	3.28	1900 cm^3/gm
Hydro.	2.24	0.83	23	1.32	1.14	14 days
SAM	1.72(a)	0.82(a)	43	1.30	2.79	610 days
Solub.	2.34	1.37	25	1.32	0.53	3 ppm

Note: Back-transformed values may not agree exactly with computations using values in this table due to greater precision in original calculations and round-off differences. Back-transformed values were rounded off to nearest integer or 2 significant places.

(a) Based on pooled contaminant and non-contaminant data since no significant differences were detected between the 2 group means.

Table 5. Classification of contaminant compounds based on specific numerical values. See Table 1 for further notes.

Pesticide	Koc	Hydrolysis Half-Life	Aerobic Metabolism	Water Solubility	Class
Alachlor	150*	720*	18	200*	C
Aldicarb	79*	670*	14	6000*	C
Atrazine	180*	160*	190	33*	C
Bromacil	60*	110*	300	820*	C
Carbofuran	48*	60*	23	320*	C
Chloramben	280*	370*	-1	700*	C
Chlorothalonil	2500	49*	35	0.6	N
Chlorthal dimethyl	4000	36*	24	3	N
Cyanazine	180*	260*	15	170*	C
2,4-D	53*	4	8	230*	N
DBCP	80*	7100*	180	1000*	C
Dicamba	1.5*	30*	61	6100*	C
Dieldrin	7100	1500*	1000*	0.12	N
Dinoseb	110*	30*	-1	75*	C
Diuron	460*	110*	-1	42*	C
EDB	44*	7100*	44	3400*	C
Fonofos	5100	110*	120	16*	C
Metolachlor	190*	210*	-1	530*	C
Metribuzin	150*	130*	110	1100*	C
Oxamyl	6*	6	180	280000*	N
Picloram	26*	650*	350	430*	C
Prometon	79*	1100*	280	720*	C
Propachlor	340	-1	-1	700	I
Propylene dichloride	49	-1	-1	2700	I
Simazine	220*	110*	110	4.9*	C

* Indicates value which exceeds specific numeric value.
C Indicates classified as contaminant.
N Indicates classified as non-contaminant.
I Indicates insufficient information to classify.

Table 6. Classification of non-contaminant compounds based on specific numerical values. See Table 2 for further notes.

Pesticide	Koc	Hydrolysis Half-Life	Aerobic Metabolism	Water Solubility	Class
Aldrin	14000	-1	120	0.027	N
Ametryne	380*	28*	37	190*	C
Carbaryl	360*	5.2	8	110*	N
Chlordane	33600	110*	54	1.9	N
Chlorpyrifos	17000	73*	88	0.71	N
DDD	46000	-1	-1	-1	I
DDT	160000	-1	3800*	0.003	N
Diazinon	1200*	20*	17	61*	C
Dimethoate	17*	62*	2	25000*	C
Disulfoton	940*	320*	2	14*	C
1,3-D	150*	7	13	1000*	N
Endosulfan	2000	14	32	0.33	N
Ethoprop	180*	-1	25	770*	N
Fenamiphos	280*	300*	22	560*	C
Heptachlor	16000	180*	2000*	0.06	N
Lindane	2500	310*	790*	10*	C
Linuron	670*	55*	78	75*	C
Malathion	1000*	48*	1	140*	C
Methiocarb	490*	24*	-1	27*	C
Methyl bromide	390*	-1	35	9200*	N
Naled	167*	0.68	3	2000*	N
Pendimethalin	16000	60*	1300*	0.28	N
Phorate	2400	3.1	3	18*	N
Prometryn	680*	75*	150	48*	C
Silvex	-1	-1	16	160*	N
Toxaphene	-1	110*	-1	1.9	N
Trifluralin	9900	110*	180	1.8	N

* Indicates value which exceeds specific numeric value.
C Indicates classified as contaminant.
N Indicates classified as non-contaminant.
I Indicates insufficient information to classify.

Table 7. Classification errors using 90th percentile statistics.

Number of Compounds

		Classified as non-contam	Classified as contam	
Actual Class	non-contam	16	10	26
	contam	5	18	23
Total				49
Number misclassified				15

Fraction of Compounds

		Classified as non-contam	Classified as contam	
Actual Class	non-contam	.327	.204	.531
	Contam	.102	.367	.469
Total				1.000
Fraction misclassified				.306

REFERENCES

Johnson, Bruce. 1988. Setting revised specific numerical values November 1988. Environmental Hazards Assessment Program. Department of Food and Agriculture, State of California. Sacramento, CA.

Snedecor G.W., W.G. Cochran. 1967. Statistical methods. Iowa State University Press, Ames, Iowa.

Wilkerson, M. R. and K. D. Kim. 1986. The pesticide contamination prevention act: Setting specific numerical values. Environmental Hazards Assessment Program. California Department of Food and Agriculture.

A P P E N D I X A

DETECTION HISTORY DATA BASE REFERENCES
June, 1989

G0001
5335
Peoples, S.A., Maddy, K.T., Cusick, W., Jackson, T., Cooper, C., and Fredrickson, A.S.
"A Study of Samples of Well Water Collected From Selected Areas in California to Determine the Presence of DBCP and Certain Other Pesticide Residues". Bull Environm. Contam. Toxicol. 24:611-618,1980. (These results are also in reference G0025).

G0002
5336
Bushway R.J., Litten W., Porter K., and Wertam J.
"A Survey of Azinphos Methyl and Azinphos Methyl Oxon in Water and Blueberry Samples from Hancock and Washington Counties of Maine". Bull. Environm. Contam. Toxicol. 28:341-347,1982.

G0003
5337
Maddy K.T., Fong H.R., Lowe J.A., Conrad D.W., and Fredrickson A.S.
"A Study of Well Water in Selected California Communities for Residues of 1,3-Dichloropropene, Chloroallyl Alcohol and 49 Organophosphate or Chlorinated Hydrocarbon Pesticides". Bull. Environ. Contam. Toxicol. 29:354-359,1982.

G0004
5338
Marti L.R., Kanel J., and Dougherty R.C.
"Screening for Organic Contamination of Groundwater: Ethylene Dibromide in Georgia Irrigation Wells". Environ. Sci. Technol. 18:973-974,1984.

G0005
5339
Page G.W.
"Comparison of Groundwater and Surface Water for Patterns and Levels of Contamination by Toxic Substances". Environ. Sci Technol 15(12):1975-1981.

G0007
5341
Harkin J.M., Jones F.A., Fathulla R., Dzantor E.K., O'Neill E.J., Kroll D.G., and Chesters G.
Pesticides in Groundwater Beneath the Central Sand Plain of Wisconsin.

0009
5343
Kelley R. and Wnuk M.
Little Sioux River Synthetic Organic Compound Municipal Well Sampling Survey. Iowa Department of Water, Air and Waste Management. March 1986. (NOTE: Pesticide use for positive and negative confirmed: R. Kelly 8/25/86. Reported terbufos positive may be dyfonate- suspect analytical method. Pesticide use based on extensive survey).

G0010
5344
Cohen S.Z., Eiden C., and Lorber M.N.
"Monitoring Ground Water for Pesticides in the USA"-preprint. EPA Office of Pesticide Programs, 1985. (These results are included in reference G0025).

G0011 5345 Troiano J.J. and Segawa R.T. Survey For Herbicides in Well Water in Tulare County. California Department of Food and Agriculture. January 1987.

G0012 5346 Exner M.E. and Spalding R.F. "Groundwater Contamination and Well Construction in Southeast Nebraska". Ground Water 23(1):26-34,1985.

G0013 5484 Spalding R.F., Junk G.A., and Richard J.J. "Pesticides in Ground Water Beneath Irrigated Farmland in Nebraska, August 1978". Pesticides Monitoring Journal 14(2):70-73,1980.

G0014 5347 Frank R., Sirons G.J., and Ripley B.D. "Herbicide Contamination and Decontamination of Well Waters in Ontario, Canada 1969-78". Pesticides Monitoring Journal 13(3):120-127,1979.

G0015 5348 La Fleur, K.S. "Movement of Carbaryl Through Congaree Soil Into Ground Water". J Environ. Qual. 5(1):91-92,1976.

G0016 5349 Brodie J.E., Hicks W.S., Richards G.N., and Thomas F.G. "Residues Related to Agricultural Chemicals in the Groundwaters of the Burdekin River Delta, North Queensland". Env. Pollution (series B) 8:187-215,1984.

G0017 5350 Zaki M.H., Moran D., and Harris D. "Pesticides in Groundwater: The Aldicarb Story in Sulfolk County, NY". Am J. of Public Health 72(12):1391-1395,1982.

G0018 5351 Wehtje G., Leavitt J.R.C., Spalding R.F., MielkeL.N., and Schepers J.S. "Atrazine Contamination of Groundwater in the Platte Valley of Nebraska from Non-point Sources". The Science of the Total Environment 21:47-51,1981.

G0019 5352 Katz B.G. and Mallard G.E. "Chemical and Microbiological Monitoring of a Sole-source Aquifer Intended for Artificial Recharge, Nassau County, New York".

G0020 5353 Segawa R.T., Maykoski R., and Sava R.J. Survey for Triazine Herbicides in Well Water, Glenn County, 1986. California Department of Food and Agriculture. December 1986.

G0021 5354 "1985 Summary Report: Interagency Pesticide Monitoring Program". Massachusetts Interagency Pesticide Task Force. March 1986.

G0022 5355 Results and Implications of the Investigation of Ethylene Dibromide in Ground Water in Western Washington. Washington State Department of Social and Health Services; Water Supply and Waste Section. February 1985.

G0023 5356 Tucker Ph.D, and Robert K. Groundwater Quality in New Jersey: An Investigation of Toxic Contaminants. Office of Cancer and Toxic Substance Research. March 1981.

G0025 5358 Brown M., Cardozo C., Nicosia S., Troiano J., and Alias S. Sampling For Pesticide Residues in California Well Water: 1986 Well Inventory Data Base; December 1,1986. California Department of Food and Agriculture. 1986.

G0026 5359 Bruck G.R. Pesticide and Nitrate Contamination of Ground Water Near Ontario, Oregon. US EPA. November 1986.

G0027 5360 Klaseus T. Minnesota Pesticide Monitoring Surveys- interim report. Minnesota Department of Health, and Minnesota Department of Agriculture. October 16, 1986.

G0028 Dr. Wayne Iwaoka- Department of Agriculture in Hawaii 5361"Well Sampling Data by Hawaii Sugar Planters Association". January 30, 1986. (from Nancy Andrews EPA-San Francisco).

G0029 5362 Memorandum from: Catherine Cardozo, CDFA to Ron Oshima. CDFA. Subject: Cis-1,3-Dichloropropene Find in One Well in Riverside County. February 27, 1987.

G0030 555639 Greenberg M., Anderson R., Keene J., Kennedy A., Page G.W., and Schowgurow S. "Empirical Test of the Association Between Gross Contamination of Wells With Toxic Substances and Surrounding Land Use." Environ. Sci. Technol. 16(1):14-19,1982.

G0031 5363 Pesticides and Groundwater: Surveys of Selected Minnesota Wells. Minnesota Department of Health, and Minnesota Department of Agriculture. February 1988.

G0032 5364 Memorandum from: Charles G. Rock, Ciba-Geigy. Corporation, to Masuo Robinson, CDFA. Subject: Report of Results of Surface-Water Monitoring. November 3, 1987.

G0033 5365 Memorandum from: Charles G. Rock, Ciba-Geigy. Corporation, to Masuo Robinson, CDFA. Subject: Report of Surface Water- Monitoring Metolachlor. October 28, 1987.

G0034 Progress Report 7 of the Interagency Delta Health 5366 Aspects Monitoring Program. State of California Department of Water Resources. October 1987.

G0035 Memorandum: Charles G. Rock, Ciba-Geigy Corporation, 5367 to Masuo Robinson, CDFA. Subject: Report of Findings: Simazine and Metolachlor in Ground and Surface Waters- Study Report. November 23, 1987.

G0036 5368 Ames, M., Cardozo, C., Nicosia, S., Troiano, J., Monk, S. Ali, S., and Brown, S. Sampling for Pesticide Residues in California Well Water: 1987 Update Well Inventory Data Base. California Department of Food and Agriculture. December 1, 1987.

G0037 5369 Memorandum from: Charles G. Rock, Ciba-Geigy. Corporation, to Masuo Robinson, CDFA. Subject: Report of Findings of Atrazine and Metolachlor in Arkansas and Hawaii. January 25, 1988.

G0038 5370 Krill, R.M., and Sonzogni, W.C. "Chemical Monitoring of Wisconsin's Groundwater". Journal of American Water Works Association 78(9): 70-75, 1986.

G0039 5371 Memorandum from Charles G. Rock, Ciba-Geigy. Corporation, to Masuo Robinson, CDFA. Subject: Notice of Groundwater Finds. October 15, 1987.

G0040 5495 Memorandum from: Donald B. Carlson, PhD, FMC, to Frank L. Davido, Office of Pesticide Programs. Subject: Carbofuran Groundwater Detection Incident.

G0041 5496 McConnell J.B. Movement and Fate of Ethylene Dibromide (EDB) in Ground Water in Seminole County, Georgia. U.S. Geological Survey. Water Resources Investigation Report 87-4030. 1987.

G0042
5497 Chen H. and Druliner A.D.
Nonpoint-source Agricultural Chemicals in Ground Water in Nebraska--Preliminary Results for Six Areas of the High Plains Aquifer. U.S. Geological Survey. Water Resources Investigation Report 86-4338. 1987.

WHS01
5372 Summary of Reports From Physicians of Illnesses That Were Possibly Related To Pesticide Exposure During The Period January 1 - December 31, 1985 in California. California Department of Food and Agriculture. February 18, 1986.

G0043 Cardozo C., M. Pepple, J. Troiano, D. Weaver, and B. Fabre.
Sampling For Pesticide Residues In California Well Water 1988 Update Well Inventory Data Base; December 1, 1988. California Department of Food and Agriculture. 1988.

G0044 Wehtje, G.R., R.F. Spalding, O.L. Burnside, S.R. Lowry, and J.R.C. Leavitt.
"Biological Signifiance And Fate of Atrazine Under Aquifer Conditions." Weed Science. Vol. 31(5): 610-618, September, 1983.

G0045
SC2705 Junk, G.A., R.F. Spalding, and J.J. Richard.
"Areal, Vertical And Temporal Differences In Ground Water Chemistry: II. Organic Constituents." Journal of Environmental Quality. Vol. 9(3): 479-483, 1980.

G0046 Pionke, H.B., D.E. Glotfelty, A.D. Lucas, and J.B. Urban.
"Pesticide Contamination of Groundwaters in the Mahantango Creek Watershed." Journal of Environ. Quality. Vol. 17(1): 76-84, 1988.

G0047 Lym, R.G., and C.G. Messersmith.
"Survey for Picloram in North Dakota Groundwater." Weed Technology. Vol. 2(2): April, 1988.

G0048 Sandhu, Shingara S., W.J. Warren, and Peter Nelson.
"Pesticidal Residue in Rural Potable Water." Journal of American Water Works Association. Vol. ( ): 41-45, January, 1978.

G0049 Isensee, A.R., C.S. Helling, T.J. Gish, P.C. Kearney, C.B. Coffman, and W. Zhuang.
"Groundwater Residues of Atrazine, Alachlor, and Cyanazine Under No-Tillage Practices." Chemosphere. Vol. 17(1): 165-174, 1988.

G0050 Albanis, T.A., P.J. Pomonis, and A.T. Sdoukos. "Movement of Methyl Parathion, Lindane and Atrazine Through Lysimeters in Field Conditions." Toxicological and Environmental Chemistry. Vol. 17: A 35-45, 1988. **[SOIL COLUMN DATA]**

G0051 Oki, D.S. and T.W. Giambelluca. "DBCP, EDB, and TCP Contamination of Ground Water in Hawaii." Groundwater. Vol. 25(6): 693-702, 1987.

G0052 Hallberg, G.R., Dr. "The Impacts of Agricultural Chemicals on Ground Water Quality." GeoJournal. Vol. 15(3): 283-295, 1987. **[REVIEWS OTHER STUDIES/DATA -NOTHING NEW TO ENTER]**

G0053 Libra, R.D., G.R. Hallberg, B.E. Hoyer, and L.G. Johnson. "Agricultural Impacts on Ground Water Quality: The Big Spring Basin Study, Iowa." From: Proceedings of the Agricultural Impacts on Ground Water -A Conference-; August 11-13, 1986, Omaha, Nebraska. (NWWA sponsored)

G0054 Alchari, R.G., S.S. Sandhu, and W.J. Warren. "Chlorinated Hydrocarbon Residues in Ground Water." Bull. Environ. Contam. and Toxicol. Vol. 13(1): 94-96, 1975.

G0055 Frink, C.R. and L. Hankin. "Pesticides in Ground Water in Connecticut." The Connecticut Agric. Exper. Station and The Dept. of Envir. Protection Bulletin 839. pp. 3-10, October, 1986.

G0056 Eiden, C. (U.S. EPA) Letter to Hershel Baugher, July 25, 1986. Well sampling results from joint EPA/USGS shallow oberservation well survey in Dos Palos area; July 1985.

G0057 Cohen, S.Z., S.M. Creeger, R.F. Carsel, and C.G. Enfield. "Potential for Pesticide Contamination of Ground Water Resulting From Agricultural Uses." Office of Pesticide Programs, EPA. (In Press), February, 1984; (to be published in the American Chemical Society Symposium Series 'Treatment and Disposal of Pesticide Wastes'). **[data in G0057 also found in G0010].**

G0058 Texas Dept. of Agriculture. "Investigation of Arsenic Contamination of Ground Water Occurring Near Knott, Texas." 1988.

G0059 Memorandum from: Jerry Harrison,Ciba-Geigy Corporation, to Masuo Robinson, CDFA. Subject: Report of findings of Metolachlor and Atrazine in Ground Water. January 17, 1989.

G0060 Robbins, Vic.
Kansas Water Quality; 1986-1987: 305(b) Report. Kansas Dept. of Health and Environment, Bureau of Water Protection; Topeka, Kansas. April 1988.

G0061 Droste, Edward X.
"Groundwater Contamination From the Agricultural Use of Ethylene Dibromide (EDB) in Simsbury, Connecticut." From: Proceedings of The Fourth Annual Eastern Regional Ground Water Conference; July 14-16, 1987, Burlington, Vermont.

G0062 Kelley, R., G.R. Hallberg, L.G. Johnson, R.D. Libra, C.A. Thompson, R.C. Splinter, and M.G. DeTroy.
"Pesticides in Ground Water in Iowa." From: Proceedings of The Impacts on Ground Water -A Conference-; July 11-13, 1986, Omaha, Nebraska. (NWWA sponsored)

G0063 DeTroy, Mark G.
"Areal and Vertical Distribution of Nitrate And Herbicide in The Iowa River Alluvial Aquifer, Iowa County, Iowa" From: Proceedings of The Agricultural Impacts on Groundwater -A Conference-; August 11-13, 1986, Omaha Nebraska.

G0064 Steichen, James, James Koelliker, Doris Grosh, Alan Heiman, Robert Yearout, and Victor Robbins.
"Contamination of Farmstead Wells by Pesticides, Volatile Organics, and Inorganic Chemicals in Kansas." Ground Water Monitoring Review. Vol. 8(3):153-160. Summer 1988.

G0065 Letter From: Rhone-Poulenc to Gary Sprock; Subject: Aldicarb find in well monitoring of eleven states. Nov.17, 1987.

G0066 Study of Pesticide Contamination in Connecticut's Ground Water -Interim Report. Connecticut Department of Environmental Protection Agency. February 1988.

G0067 Hallberg, G.R., R.D. Libra, E.A. Bettis III, and B.E. Moyer. Hydrogeologic And Water Quality Investigations in The Big Spring Basin, Clayton County, Iowa, 1983 Water - Year. Iowa Geological Survey, Open File 84-4. 1984.

G0068 Kelley, Richard D. Synthetic Organic Compound Sampling Survey of Public Water Supplies. Iowa Department of Water, Air, And Waste Management. April 1985.

G0069 Kolliker, J.K., J.M. Stieche, and D. Grosh. Identification of Factors Affecting Farmstead Well Water Quality in Kansas. Kansas Water Resources Research Institute, Report No. G1226-02. March 1987.

G0070 Results of Maryland Groundwater Herbicide Survey. State of Maryland Office of Environmental Programs Department of Health and Hygiene. Fall 1983.

G0071 Neil, C.D., J.S. Williams, and T.K. Weddle. Second Annual Report -Pesticides in Ground Water Study. Maine Geological Survey Department of Conservation. 1987.

G0072 Rettig, B. and C. Jacobs. 1985 Domestic Well Water Sampling in Central Nebraska: Laboratory Findings And Their Implications. Nebraska Department of Health. 1987.

G0073 Barton, C., E.F. Vowinkel, and J. Hawyn. Preliminary Assessment of Water Quality And Its Relation to Hydrogeology And Land Use: Potomac-Raritan-Magothy Aquifer System, New Jersey. U.S. Geological Survey Water-Resources Investigations, Report 87-4023. 1987

G0074 Loria, R., R.E. Eplee, J.H. Baier, T.M. Martin, and D.D. Moyer. "Efficacy of Sweep-Shank Fumigation With 1,3-Dichloropropene Against Pratylenchus penetrans And Subsequent Groundwater Contamination." Plant Disease. Vol. 70(1):42-45, January 1986.

G0075 Postle, Jeffrey K.
Groundwater Monitoring Project For Pesticides. A Progress Report Submitted by Department of Agriculture, Trade, and Consumer Protection to the Department of Natural Resources. October 2, 1987.

G0076 Mississippi Pesticide Hazard Assessment Project. Annual Progress Report No. 15. Mississippi State University, Mississippi State Chemical Laboratory. May 1984.

G0077 Grade A Dairy Farm Well Water Quality Survey. Wisconsin Department of Agriculture, Trade and Consumer Protection, and Wisconsin Agricultural Statistics Service. April 1989.

G0078 Status Report -Pesticide Sampling Programs 1980-1987. Suffolk County Department of Health Services; Bureau of Drinking Water. May 1988.

G0079 Letter From: Therese Murtagh to Bruce Johnson. A Subject: Confirmation letters on pesticide findings in EPA references. April 10, 1989.

A P P E N D I X B

CRITERIA FOR INCLUSION OF COMPOUND AS 'CONTAMINANT'

To classify a compound as a contaminant for the purposes of determining the specific numerical values, ground water studies are required which document the presence of the compound in ground water due to legal agricultural use. The ideal study would include the following attributes: good chemical analytical quality control such as spike recoveries conducted near the proposed lower limit of detection and field blanks; adequate confirmation of all positive detections; low temperature storage and clean handling of samples; sufficient description of wells to discern if the casing were cracked; sufficient site descriptions to determine if point sources such as leaky pesticide containers in mixer/loader operations, or direct entry mechanisms like dry wells may have caused the positive detection; surveys to insure that the detected compound was in normal agricultural use; and verification chemical sampling that may include reanalysis of the same positive sample and/or analysis of a second replicate sample obtained from the same location.

In practice, few studies fulfill all of these requirements. Studies vary in how much sampling and surveying was conducted, and in how much of what was conducted is reported. Several studies reviewed present detailed questionnaires, but fail to present the data from the questionnaires. Alternatively, in many instances the survey data is summarized so that it is not possible to link the actual well in which a pesticide was found to the particular site description for the well. Consequently, judgments are required in order to classify a compound as a contaminant. For the purposes of eventual statistical analysis, these judgments should be made independently

of whatever knowledge may exist about the physicochemical characteristics of a compound. Otherwise the analysis becomes biased.

As a practical matter, the general conduct of the studies is evaluated. The sampling and laboratory methods are evaluated for analytical quality and the reviewer looks for hints or direct statements as to possible point source contamination. Recognizing the uncertainty and possible inability to determine the source of contamination, three out-of-state studies with positive ground water detections are required for a compound to be considered a contaminant. This will constitute evidence that a compound has leached into ground water to a significant degree. Studies are not used which fail to report on methods, are poorly written, or present reasons for doubting the validity of the methods. Alternatively, compounds detected in California, which have been found in ground water may be considered contaminants if samples are confirmed and subsequent investigation indicates that the compound reached ground water through leaching and not from a point source or other extenuating condition. Also, a compound may be classified as a contaminant if it is shown to leach by column studies or soil coring studies, even though ground water sampling may not be involved.

When metabolites are found, they must be reported as metabolites, not as the parent compound because the SNV process depends on the characteristics of the actual compounds which leached or did not leach. Unfortunately, in some cases, there is no information available on adsorption, hydrolysis, etc. for metabolites.