

MAINE STATE LEGISLATURE

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the Geological Survey

DEPARTMENT OF CONSERVATION

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Contents: 21 page report

Report to the 112th Maine State Legislature
Energy and Natural Resources Committee
by

The Maine Geological Survey
Department of Conservation
in cooperation with
Department of Agriculture, Food and Rural Resources
Department of Human Services
Department of Environmental Protection
Department of Transportation
State Planning Office
U.S. Geological Survey, Water Resources Division

Compiled by
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Maine Geological Survey
Department of Conservation
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Introduction

The Ground Water Policy Review Committee of the Land and Water Resources Council recommended to Governor Brennan in December, 1984, that a state-wide screen of the impact of agricultural practices on ground-water quality be conducted. Governor Brennan and the Legislature accepted the recommendation and directed the Maine Geological Survey, Department of Conservation, to coordinate an inter-agency, three year screening study, with annual progress reports to the Legislature's Energy and Natural Resources Committee.

The study was authorized to determine whether the detection of Temik (aldicarb) and elevated nitrates in ground water in some agricultural areas of Maine were symptoms of a larger problem. The recent findings of soil fumigants and other pesticides in ground water in the Connecticut Valley and other agricultural areas of Southern New England lent added urgency to this study.

An ad-hoc Pesticides in Ground Water Group was assembled to plan and conduct the study. Participants in the group included representatives of the Maine Geological Survey, Department of Conservation; Bureau of Agriculture and Rural Resources and Pesticides Control Board, Department of Agriculture, Food and Rural Resources; Water and Oil and Hazardous Materials Bureaus, Department of Environmental Protection; Environmental Health Unit, Health Engineering, and Public Health Laboratory, Department of Human Services; Location and Environment, Department of Transportation; Natural Resources Division, State Planning Office; and the U.S. Geological Survey, Water Resources Division.

With such a broad range of expertise and interest within the group, it was determined that we should focus our knowledge in a pesticide ranking matrix to determine which pesticides were most likely to be found in ground water.

In order to develop a list of pesticides which might be found in ground water, we collected information on the quantity sold, the types of crops and application methods, and the persistence and leachability for each commonly used pesticide. Each of these factors was given a numerical rating, ranging from 1 to 10, and the pesticides were ranked based on the average of the three ratings.

A discussion of the factors and the ranking procedure is presented in the attached "Pesticides Selection (matrix) Project" report. The ranking depended on available data from other state and national studies, as well as Pesticide Control Board records.

Of the 44 pesticides ranked, 25 can be analyzed by the State's Public Health Lab using available methods (Table 1). A list of these pesticides and their detection limits is attached. Work is underway to develop and verify methods for the other pesticides in the top 20, including breakdown products of maneb and mancozeb (dithiocarbamates).

The priority list of pesticides was subdivided based on application to various crop types. A suite of pesticide tests were developed for potatoes, corn, market gardens, blueberries, and orchards. Copies of the laboratory request sheets are attached.

Site Selection

The next step in planning the study was to determine sampling locations. Based on research in other states, we determined that the most geologically sensitive areas should be sampled in order to assess the worst case possibilities. Areas judged geologically sensitive have thin or sandy soils, shallow water table and high aquifer potential. If pesticides were not found in the most likely areas, then it is probable that other, less sensitive areas would also be pesticide-free.

Sampling locations were selected to provide areal coverage of the State's agricultural areas, and to represent the different crop types. Whenever possible, monitoring wells installed by the U.S. Geological Survey, Maine Geological Survey, and Department of Environmental Protection cooperative Aquifer Mapping Project were used, as well as wells from the USGS-MGS Saco River Valley study. These carefully constructed wells can be used to extract shallow ground water from sand and gravel aquifers. They are often located in agricultural areas. Their use minimized drilling expense, variability in well construction, and logistical problems.

In areas where monitoring wells were not available, household wells belonging to cooperating farmers and agricultural area residents were sampled. Private wells were used mostly in Aroostook County and orchard sampling. A total of 46 wells were sampled, 14 of them twice, for a grand total of 60 samples.

Sampling and Analysis

Ten blueberry, 24 potato, 4 forage crop, 17 sweet corn/market gardens, and 5 orchard samples were analyzed for pesticides. The potato samples were obtained both from ground water beneath sandy soils in glacial valleys and from ground water beneath till-derived soils in northern Maine. A number of the samples were difficult to classify as the wells were located between potato and market crop fields. In these cases, the sample was analyzed for both sets of pesticides.

Samples from monitoring wells were collected using a gas bladder portable pump or a submersible pump. At least 3 well volumes were pumped prior to sampling to ensure the water samples were representative of the geochemical environment. Specific conductance (a measure of total dissolved ion concentration) was measured during pumping and samples were taken after the conductance stabilized. Ground-water samples from monitoring wells were filtered through 0.45 micron filters in the field to remove sediments. Literature search, after the sampling, indicated that the filters and sampling equipment used may adsorb certain pesticides.

A laboratory test of selected pesticides indicated that pesticides related to guthion and aldicarb may have been sorbed onto sampling apparatus or filters. Further testing and sampling will be conducted over the next year to obtain better recovery of these compounds.

Samples from most private wells, since they are sediment-free, were not filtered. The tap was allowed to run until specific conductance of the water stabilized prior to sample collection.

All samples were chilled and delivered to the Public Health Laboratory within 72 hours of collection. The samples were then extracted and analyses were run on the extract.

Results

Results of the chemical analyses presented in table 3. Nitrate was the only substance found in concentrations exceeding health advisories or proposed recommended maximum concentration levels in drinking water (USEPA: 10 mg/L NO₃-N). Twelve wells exceeded this standard. Traces (see pesticides information sheet, table 1) of dinoseb were detected in the initial sampling of 5 wells (53005, 57601, 57605, 57501, and 57606) and metribuzin was detected in 3 wells (57604, 57605, 82203), all in potato growing areas. Wells (53005, 57601, 57605, 57501, and 57606) were re-sampled in September and did not show detectable amounts of either chemical. Thiodon was detected in one well (dt6) in a potato growing area. Atrazine was detected in July in one well (21620) near a corn field; alachlor was detected near another corn field (43105).

Copper was found in two orchard wells (8516 A and L). Because no other, related compounds (nitrate or other pesticides) were detected, and because acidic ground water in the area is known to leach copper from plumbing, the low concentrations detected are not believed to result from agricultural practices. Arsenic, at a concentration below drinking water standards, was found in another orchard well (853001).

Samples from 2 wells (852604 and 852606) in blueberry growing areas contained traces of hexazinone. With the exception of aldicarb, detection limits for all chemicals tested were more sensitive than available health standards. Unfortunately, many of these chemicals do not have standards or guidelines published or promulgated. Continued effort by USEPA is needed to develop standards for pesticides.

Summary

The first year of the study has yielded useful results despite technical difficulties in developing both sampling and analytical techniques. Preliminary indications are that pesticides are not detectable in most of the sensitive areas sampled. Pesticides were found most often in northern Maine, but even there, concentrations were low.

We plan to refine our sampling and analytical procedures for the next field season and, where possible, increase the number of wells sampled in sensitive areas. With this additional information, we should be able to make a more quantitative assessment of the presence of pesticides in ground water.

PESTICIDE SECTION
MAINE PUBLIC HEALTH LABORATORY

PESTICIDE INFO SHEET

<u>CHEMICALS</u>	<u>SYNONYMS</u>	<u>METHOD</u>	<u>PPB</u> <u>MLD</u> ¹
Alachlor		II	4.50
Aldicarb	Temik	Sp-2	50.00
Atrazine		II	2.5
Butylate	Sutan	II	2.30
Captan		II	1.25
Carbofuran	Furadan	II	15.00
Chlorothalonil	Bravo	II	1.25
2,4-D		Ia ²	1.25
2,4,5-T		Ia ²	1.25
2,4,5-TP	Silvex	Ia ²	.25
Diazinon		II	7.60
Dicamba	Banvel	Ib	1.25
Difolitan		II	1.25
DNBP	Premerge, Dinoseb	Ib	1.25
Dursban	Chlorpyrifos	II	1.25
Endosulfan	Thiodan	II	1.0
Endrin		II	.50
Eptam	EPTC	II	1.25
Guthion	Azinphos 'methyl	II	5.0
Imidan	Phosmet	II	12.5
Lindane		II	.50
Linuron	Lorox	II	12.0
Malathion		II	1.25
Methomyl	Lannate	Sp-3	64.0
Methoxychlor		II	1.50
Methyl Parathion		II	1.0
Metribuzin	Sencor	II	0.25
Monitor	Methamidophos	Sp-4	----
PCNB	Terraclor	II	1.5
Sevin	Carbaryl	II	50.0
Simazine		II	8.0
Triclopyr	Garlon	Ia*	.5
Trifluralin	Treflan	II	.60
Velpar	Hexazinone	Sp-1	62.0
Copper			20.0

¹MLD: "Minimum Level of Detection" of the analysis under our conditions for which statistically sound recovery data is available.

TRACE: The analysis detected the pesticide indicated but at a concentration below the stated MLD.

²Compounds detected in a "Ia" screen will also be detected in a "Ib" screen and should have similar detection limits. In general, a "Ib" screen is more effective.

SPECIAL NOTE: This information effective 11/14/85. It will be updated as Lab techniques and needs change.

Pesticides in Ground Water Study: 1985 Sampling Results-table 3

sample #	Crop type	Geologic Setting	depth to water, ft	Nitrate mg/l		Pesticides detected*	filtered
				summer	fall	summer fall	
dt6	potatoes	sand	15	17.2	15.2	thiodan	yes
dt8	"	and	13	2.56	--	none	yes
dt11	"	gravel	17	0	0.16	none	yes
dt10	and	"	18	7.17	6.82	none	yes
dt3	market	"	14	0.63	0.43	none	yes
dt1	garden	"	10	0	--	none	yes
dt12	"	"	16	1.33	--	none	yes
53003	potatoes	till		19.2	--	none	no
53005	"	"		9.5	--	dinoseb	no
57601	"	"		10.2	0	dinoseb	no
57602	"	"	20	5.85	5.17	none	no
57701	"	"		1.67	1.51	none	no
57604	"	"		22.2	11.28	metribuzin	no
57605	"	"		5.55	4.26	dinoseb and metribuzin	no
57501	"	"	15	4.63	6.8	dinoseb	no
57702	"	"		5.75	4.26	none	no
57606	"	"	12	4.61	4.6	dinoseb	no
57703	and peas	"		12.4	9.5	metribuzin	no
57603	processing	"		2.67	3.4	none	no
43103	corn	sand	7	1.82	--	alachlor	yes
dt5	and	and	14	3.47	--	none	yes
dt4	market	gravel	8	0	--	none	yes
dt2	garden	"	16	6.94	--	none	yes
dt7	"	"	15	7.68	--	none	yes
dt9	"	"	13	0	--	none	yes
43001	"	"	16	12.4	--	none	no
41801	"	"	14	16.2	--	none	no
21620	"	"	15	41.5	--	atrazine	no
53002	"	till		24.8	--	none	no

*all at trace levels unless otherwise noted

Pesticides in Ground Water Study: 1985 Sampling Results-table 3,page2

sample #	Crop type	Geologic Setting	depth to water, ft	Nitrate mg/l		Pesticides detected*		filtered
				summer	fall	summer	fall	
8516A	orchard	till		0.64	--	copper .05 mg/l (from piping)		no
8516B		"		0.25	--	none		no
8516C		"		0.82	--	copper .07 mg/l (from piping)		no
851601		"	1	1.2	--	none		no
853001		"		0	--	arsenic .037 mg/l		no
852601	blueberry	sand	47	--	0		none	yes
852602		and	17	--	0		none	yes
852603		gravel	22	--	0		none	yes
852604		"	30	--	0		hexazinone	yes
852605		"	21	--	0		none	yes
852606		"	13	--	0.16		hexazinone	yes
852701		"	49	--	0		none	yes
852502		"	4	--	0		none	yes
854501		"	5	--	0		none	yes
852501		"	0	--	0		none	no

*all at trace levels unless otherwise noted

TO : PUBLIC HEALTH LABORATORY

ATT: PESTICIDE LAB

SAMPLE LOCATION CODE _____

CROP TYPE: ORCHARD

DATE OF SAMPLE COLLECTION _____ BY: _____

DATE RECEIVED IN LAB _____ BY: _____

DATE EXTRACTED _____ BY: _____

BLANK NO. _____

SAMPLE BOTTLE NO. _____

(II SCREEN with emphasis on captan, phosmet, guthion & simazine -
1 LITER BROWN AMBER BOTTLE

~~Dithiocarbamate test -
48 ML GLASS VOR BOTTLE~~

Nitrates -
250 ML WHITE PLASTIC BOTTLE

Copper & arsenic
250 ML WHITE PLASTIC BOTTLE

Please list specific pesticides that are KNOWN to be used at this location and indicate when they were last used.

SUGGESTED SAMPLING PERIOD: SAMPLE FIRST WEEK OCTOBER

II Screen with emphasis on Captan, Phosmet, Guthion & Simazine.....	\$125
Dithiocarbamate test for Maneb/Mancozeb.....	100
AA for arsenic & copper.....	12
Auto A for nitrates.....	6

TO : PUBLIC HEALTH LABORATORY

ATT: PESTICIDE LAB

SAMPLE LOCATION CODE _____

CROP TYPE: BLUEBERRY

DATE OF SAMPLE COLLECTION _____ BY: _____

DATE RECEIVED IN LAB _____ BY: _____

DATE EXTRACTED _____ BY: _____

BLANK NO. _____

SAMPLE BOTTLE NO. _____

(II SCREEN with emphasis on
guthion & Diazinon -
1 LITER BROWN AMBER BOTTLE

_____ Hexazinone -
1 LITER BROWN AMBER BOTTLE

_____ Arsenic -
250 ML WHITE PLASTIC BOTTLE

_____ Nitrate -
250 ML WHITE PLASTIC BOTTLE

Please list specific pesticides that are KNOWN to be used at this location and indicate when they were last used.

SUGGESTED SAMPLING PERIOD: LAST WEEK IN AUGUST - FIRST WEEK SEPT

II screen with emphasis on Guthion and Diazinon.....	\$125
Special Test for Hexazinone.....	50
AA for Arsenic.....	6
Auto A for Nitrates.....	6

TO: PUBLIC HEALTH LABORATORY

ATTENTION: PESTICIDE LAB

SAMPLE LOCATION CODE _____

CROP TYPE: POTATOES

DATE OF SAMPLE COLLECTION _____

BY: _____

DATE RECEIVED IN LAB _____

BY: _____

DATE EXTRACTED _____

BY: _____

BLANK NO. _____

LAB I.D. No.	SAMPLE BOTTLE NO.		RESULTS
_____	_____	EARLY SEASON II SCREEN with emphasis on Linuron, EPTC, and Metribuzin - Special Test for Temik - 1 LITER BROWN AMBER BOTTLE	_____
_____	_____	LATE SEASON II SCREEN with emphasis on Phosmet, Guthion, Endosulfan, Carbaryl and Chlorothalanil - Special test for Moxidip test - 1 LITER BROWN AMBER BOTTLE	_____
_____	_____	Special test for Dinoseb and Dalapon - 1 LITER BROWN AMBER BOTTLE	_____
_____	_____	Special test for Moxidip - 1 LITER BROWN AMBER BOTTLE	_____
_____	_____	Arsenic - 250 ML WHITE PLASTIC BOTTLE	_____
_____	_____	Nitrates - 260 ML WHITE PLASTIC BOTTLE	_____
_____	_____		_____
_____	_____		_____

Please list specific pesticides that are KNOWN to be used at this location and indicate when they were used.

SUGGEST SAMPLING PERIODS FOR POTATO CROPS:

First or Second week of July

II Screen with emphasis on Linuron, EPTC and Metribuzin.....	\$125.00
Special test for Temik.....	50.00
Special test for Dinoseb and Dalapon.....	125.00
AA for Arsenic.....	6.00
Auto A for Nitrates.....	6.00

First or Second in September

II Screen with emphasis on Phosmet, Guthion, Endosulfan, Carbaryl and Chlorothalanil.....	\$125.00
Special test for Dithiocarbamates.....	50.00
Special test for Moxidip.....	50.00
AA for Arsenic.....	6.00
Auto A for Nitrates.....	6.00

TO : PUBLIC HEALTH LABORATORY

ATT: PESTICIDE LAB

SAMPLE LOCATION CODE _____

CROP TYPE: MARKET GARDENS

DATE OF SAMPLE COLLECTION _____ BY: _____

DATE RECEIVED IN LAB _____ BY: _____

DATE EXTRACTED _____ BY: _____

BLANK NO. _____

SAMPLE BOTTLE NO. _____

(II SCREEN with emphasis on diazanon, malathion, trifuralin, & carbaryl
1 LITER BROWN AMBER BOTTLE

_____ Special test for Dinoseb & Dalapon
1 LITER BROWN AMBER BOTTLE

_____ Nitrates -
250 ML WHITE PLASTIC BOTTLE

Please list specific pesticides that are KNOWN to be used at this location and indicate when they were last used.

SUGGESTED SAMPLING PERIOD: 1st or 2nd WEEK SEPTEMBER

II SCREEN with emphasis on Diazinon, malathion, trifuralin, & carbaryl.....\$125
Special test for Dinoseb and Dalapon..... 125
Auto A for Nitrates..... 6

TO : PUBLIC HEALTH LABORATORY

ATT: PESTICIDE LAB

SAMPLE LOCATION CODE _____

CROP TYPE: FORAGE CROPS and/
or SWEET CORN

DATE OF SAMPLE COLLECTION _____ BY: _____

DATE RECEIVED IN LAB _____ BY: _____

DATE EXTRACTED _____ BY: _____

BLANK NO. _____

SAMPLE BOTTLE NO. _____

(II SCREEN with emphasis on
atrazine, simazine, butylate,
alachlor, cyanazine and
carbofuran
1 LITER BROWN AMBER BOTTLE

(II SCREEN with emphasis on
carbaryl (Sweet corn only)-
1 LITER BROWN AMBER BOTTLE

Special Test for Methomyl
(sweet corn only)
1 LITER BROWN AMBER BOTTLE

Nitrates - \$6
250 ML WHITE PLASTIC BOTTLE

Please list specific pesticides that are KNOWN to be used at this location and indicate when they were last used.

SUGGESTED SAMPLING PERIOD:

SAMPLE 1st OR 2nd WEEK IN JUNE
II Screen with emphasis on Atrazine, Butylate,
Alachlor, Simazine, Cyanazine & Carbofuran.....\$125
Auto A for nitrates..... 6

SAMPLE 1st OR 2nd WEEK IN SEPTEMBER - SWEET CORN ONLY
~~II Screen with emphasis on Carbaryl.....\$125~~
Special Test for methomyl..... 75
Auto A for nitrates..... 6

Appendix A

Pesticide Selection Project:
Pesticides in Ground-Water Group

Contributors:

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Craig Neil, DOC, Maine Geological Survey
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Compiled by:

Andrews L. Tolman, DOC, Maine Geological Survey

October 30, 1985

The ongoing Maine Pesticides Study was recommended by the Ground-Water Policy Review Committee. The recommendation was endorsed by Governor Brennan and funding for analytical costs of the study was provided by the Legislature. The study was planned and is being executed by an inter-agency Pesticides in Ground-water Group with representation from the Maine Department of Agriculture, Pesticides Control Board; Maine Department of Environmental Protection; the Department of Human Services, Drinking Water Program, State Public Health Lab; and the U.S. Geological Survey. The Maine Geological Survey was directed to coordinate the project.

The project is to be conducted over a three-year period, with 1985 as the first year. Because the recommendation was not accepted until the spring of 1985, a quick start was mandatory. The group resolved both to narrow the field of investigation and to utilize the work already done in other states (notably Wisconsin and California) as an aid to design the study.

All the scoring and ranking was performed based on data available from existing studies and records. The amount and reliability of data varied among both pesticides and categories. For example, the quantity sold is known much more accurately than the leachability of a particular pesticide. Similarly, one pesticide can be used as either a foliar spray or applied to the soil, with different ground-water contamination potentials.

In developing the rankings and selecting sampling locations, a conservative approach was adopted: the "worst case" for any given element was used in the ranking, and wells in the most geologically sensitive locations were selected for sampling. However, new data are being developed by EPA and pesticides manufacturers, particularly on leachability, which may make the rankings less reliable.

The quantity, application, and leachability scores were each developed separately and then combined to yield a total score. The development of each score will be explained separately. Quantity and application scores were developed primarily by Pesticides Control Board staff, and leachability scores primarily by the Drinking Water Program.

As the Pesticides Work Group began to function, it immediately became clear that there was a need, due to time and financial constraints, to focus our attention on those pesticides that were both commonly used in Maine and that posed the greatest threat of contamination to ground water. We therefore scored and ranked commonly used, registered pesticides on three attributes: quantity of pesticide sold, method of pesticide application, and the leachability of the pesticide in soils.

Upon completion, the matrix included 44 pesticides. All 44 are being analyzed for in the first round of samples, after which the matrix and analyzed list will be refined.

The quantity of pesticide sold was categorized on a scale of 1-10 as follows:

- | | | | |
|-----|---------------------------|------|----------------------------|
| 1 = | 0 - 5,000 lbs. sold | 6 = | 30,000 - 40,000 lbs. sold |
| 2 = | 5,000 - 10,000 lbs. sold | 7 = | 40,000 - 50,000 lbs. sold |
| 3 = | 10,000 - 15,000 lbs. sold | 8 = | 50,000 - 60,000 lbs. sold |
| 4 = | 15,000 - 20,000 lbs. sold | 9 = | 60,000 - 300,000 lbs. sold |
| 5 = | 20,000 - 30,000 lbs. sold | 10 = | > - 300,000 lbs. sold |

1984 Maine Agricultural Pesticide Sales

Generic Name of Pesticide	Lbs. of Active Ingredient Sold in 1984	Score	Principal Uses
maneb (F)	500,000+	10	Potatoes, apples, broccoli, vegetables, dried beans
mancozeb (F)	581,987	10	Potatoes, apples, broccoli, vegetables, dried beans
dinoseb (H, TK)	323,224	10	Potatoes, peas, dried beans, vegetables
chlorothalanil (F)	129,959	9	Potatoes, broccoli
disulfoton (SI)	58,576	8	Potatoes
phosmet (I)	57,910	8	Apples, potatoes, vegetables
atrazine (H)	54,974	8	Forage corn, sweet corn
methamidophos (I)	47,604	7	Potatoes
captan (F)	37,920	6	Apples, seed treat potatoes, vegetables strawberries, peas
hexazinone (H)	33,540	6	Blueberries
dalapon (H)	32,437	6	Potatoes
metribuzin (H)	24,980	5	Potatoes
linuron (H)	23,825	5	Potatoes
azinphos-methyl (I)	18,033	4	Blueberries, apples, potatoes
diquat (TK)	17,980	4	Topkill potatoes
metolachlor (H)	14,242	3	Forage corn, sweet corn
PCNB (STF)	13,059	3	Seed treat potatoes
aldicarb (SI)	12,906	3	Potatoes
E.P.T.C. (H)	12,847	3	Potatoes, dried beans, beans
carbaryl (I)	12,145	3	Vegetables, sweet corn, potatoes, apples
carbofuran (SI)	12,291	3	Forage corn, potatoes, vegetables
metalaxyl (F)	11,899	3	Potatoes
cyanazine (H)	10,634	3	Forage corn, sweet corn
butylate (H)	10,645	3	Forage corn, sweet corn
alachlor (H)	10,250	3	Forage corn, sweet corn
demeton (I)	9,838	2	Oats, potatoes, apples
glyphosate (H)	9,572	2	Apples, sweet corn, beans, vegetables
endosulfan (I-SI)	8,420	2	Potatoes, apples, vegetables
dodine (F)	7,341	2	Apples
thiabendazole (STF)	6,429	2	Potatoes-seed treatment
simazine (H)	5,985	2	Apples, forage corn, Christmas trees
dichlone (F)	4,855	1	Apples
napropamide (H)	4,734	1	Broccoli, strawberries, vegetables
copper sulfate (F)	4,729	1	Apples
trifluralin (H)	3,848	1	Peas, broccoli, dried beans, vegetables

cupric hydroxide (F)	3,455	1	Apples, dried beans
benomyl (F)	2,597	1	Blueberries, apples, dried beans, straw- berries
oxydemeton-methyl (I)	2,340	1	Potatoes, vegetables
diazinon (I)	2,205	1	Vegetables

KEY:

F = fungicide	SI = soil incorporated granular insecticide
H = herbicide	STF = seed treatment fungicide
I = insecticide	TK = topkill

It should be noted that the top six pesticides are all used on potatoes, and that only 14 of this list are not used on potatoes.

The application method and timing is an important variable in determining the likelihood of ground-water transport. Clearly, a foliar application during July, a normally dry season, has less chance of reaching ground water than a spring soil injection of the same material. Each material was ranked based on its dominant use. The highest score would be generated by a soil incorporated pesticide (4) applied in the spring, during recharge (3) at a rate of 8 or more pounds per acre (3) for a total of 10. The lowest rating would be achieved by a foliar application (1) during the summer (1) at a rate of less than 3 lbs/acre (1); for a score of 3. Table 2 shows the results of the application rating.

Table 2
PESTICIDE APPLICATION RATING

PESTICIDE	APPLICATION			SCORE
	METHOD	TIMING	DOSE	
dalapon	3	3	3	9
E.P.T.C.	4	3	2	9
disulfoton	4	3	1	8
carbofuran	4	3	1	8
cyanazine	3	3	2	8
butylate	3	3	2	8
alachlor	3	3	2	8
aldicarb	4	3	1	8
napropamide	4	3	1	8
trifluralin	4	3	1	8
PCNB	2	3	3	8
dinoseb	2	2.5	3	7.5
hexazinone	3	3	1	7
metribuzin	3	3	1	7
linuron	3	3	1	7
metolachlor	3	3	1	7
glyphosate	3	3	1	7
simazine	3	3	1	7
atrazine	3	3	1	7
captan	1	3	3	7
thiabendazole	2	3	1	6

manab or mancozeb	1	1	3	5
phosmet	1	1	3	5
copper sulfate	1	1	3	5
chlorothalanil	1	1	3	5
carbaryl	1	1	3	5
azinphos-methyl	1	1	2	4
diquat	1	2	1	4
methamidophos	1	1	2	4
endosulfan	1	1	2	4
dodine	1	1	2	4
dichlone	1	1	2	4
benomyl	1	1	2	4
metalaxyl	1	1	1	3
demeton	1	1	1	3
cupric hydroxide	1	1	1	3
oxydemeton	1	1	1	3
diazinon	1	1	1	3

RATING KEY

APPLICATION METHOD	TIMING	DOSE (in maximum number of lbs./ acre/year)
4 = Soil incorporated	3 = Spring	3 = 8 and above
3 = Applied to soil	2 = Fall	2 = 3 - 8
2 = Seed treatment	1 = Summer	1 = 0 - 3
1 = Foliar application		

The leachability score was subdivided into four parts. First, pragmatically, the pesticide was scored on whether it had been found in ground water. A pesticide found in ground water in Maine or on EPA's list of mobile pesticides received a 3.

Secondly, the pesticides were rated on laboratory water solubility on an exponential scale, with those soluble at greater than 300 ppm scored as 2. Thirdly, they were scored on their affinity for organic matter in soils, with a low affinity given 1 point. Finally, they were scored on their stability in the soil system. Sub-components of this score were soil degradation, hydrolysis and photo degradation, and laboratory and field half life. The maximum score was 4. Results of this ranking are shown on Table 4.

Table 4 .

CRITERIA FOR RATING LEACHABILITY

- (1) Found in ground Water MAX Score = 3
- 1 - Not found in groundwater, but has high leaching potential
 - 2 - Found in groundwater
 - 3 - On EPA known "leachers" list or has been found in ground water in Maine.
- (2) Solubility in water MAX Score = 2
- 0 - Less than 30 PPM
 - 1 - Greater than 30 PPM
 - 2 - Greater than 300 PPM
- (3) Affinity for organic matter MAX Score = 1
- Kd (Soil/water adsorption coefficient) is less than 5 and usually less than 1 or 2.
Koc (Kd divided by soil organic carbon content) is less than 300 - 500.
- (4) Stability of pesticides
- Soil degradation: MAX Score = 2
 - 1 - Soil half life is greater than 2 to 3 weeks but less than 6 months.
 - 2 - Soil half life is greater than 6 months.
 - Hydrolysis and photo degradation: MAX Score = 1

Hydrolysis half life is greater than 6 months or Photolysis half life is greater than 2 - 3 weeks.
 - Laboratory/field half life: MAX Score = 1

Greater than 2 - 3 weeks

LEACHABILITY RATING

Pesticide Name	found in groundwater	solubility in water	stability in soils	affinity for organic matter	Total
1. Aldicarb	3	2	4	1	10
2. Carbofuran	3	2	4	1	10
3. Atrazine	3	1	4	1	9
4. Metribuzin	2	2	4	1	9
5. Metholachlor	2	2	4	1	9
6. Dinoseb	3	1	3	1	8
7. Alachlor	3	1	3	1	8
8. Simazine	3	0	4	1	8
9. Azinophos-methyl	3	1	3	0	7
10. Thibendazole	1	2	4	0	7
11. Linuron	0	1	4	1	6
12. Paraquat	0	2	4	0	6
13. Hexazinone	0	2	2	1	5
14. Dalapon	0	2	2	1	5
15. Metalaxyl	0	2	2	1	5
16. Butylate	0	1	3	1	5
17. Glyphosate	0	2	3	0	5
18. Meneb	0	1	2	1	4
19. Mancozeb	0	1	2	1	4
20. E.P.T.C.	0	2	2	0	4
21. Carbaryl	0	1	2	1	4
22. Cyanazine	0	1	2	1	4
23. Endosulfan	2	1	2	0	4
24. Dodine	0	2	2	0	4
25. Pentachloro- nitrobenzene	-	-	-	-	4
26. Napropamide	-	-	-	-	4
27. Oxydemeton	-	-	-	-	4
28. Diazinon	-	-	-	-	4
29. Endothal	-	-	-	-	4
30. Malathion	-	-	-	-	4
31. Methamidophos	0	1	1	1	3
32. Permethrin	0	0	3	0	3
33. Chlorothalinil	0	0	2	0	2
34. Disulfoton	2	0	0	0	2
35. Diquat	0	2	0	0	2
36. Demeton	0	2	0	0	2
37. Dichlone	0	0	2	0	2
38. Triflualin	0	0	2	0	2
39. Methomyl	0	0	2	0	2
40. Benomyl	0	0	2	0	2
41. Phosmet	0	0	0	0	0
42. Captan	0	0	0	0	0

The scores were combined using a number of techniques in an attempt to develop a realistic ranking of likelihood for ground-water transport. The first attempt utilized a non-parametric, or ordinal, approach, which simply added ranks of pesticides, so that the lowest score was the most likely to be found in groundwater.. There were some objections that this did not fairly represent the range of variability in the data, so later approaches used the actual scores from each ranking.

The scores of each pesticide for the four parameters were then put into a master matrix (Table 5). Column 1 of Table 5 ranks the pesticides in decreasing score. Column 2 is the pesticide name. Column 3 is the quantity sold score. Column 4 is the pesticide application score. Column 5 is the leachability score. Column 6 is the unweighted score, which is the average of the values in columns 3, 4, and 5. Column 7 is the analyzability of each pesticide, based on Maine Public Health Laboratory capabilities.

A decision was made to screen primarily for the top 20 pesticides. Work is underway to develop analytical methods for those pesticides for which a method is not now available.

Pesticide in Ground Water Ranking Matrix

rank	Pesticide Name	quantity	how applied	leachable	score	testable
1	dinoseb	10	7.5	8	8.50	yes
2	atrazine	8	7	9	8.00	yes
3	carbofuran	3	8	10	7.00	yes
4	aldicarb	3	8	10	7.00	yes
5	metribuzin	5	7	9	7.00	yes
6	dalapon	6	9	5	6.67	yes
7	mancozeb	10	5	4	6.33	no
8	maneb	10	5	4	6.33	no
9	alachlor	3	8	8	6.33	yes
10	metolachlor	3	7	9	6.33	?
11	linuron	5	7	6	6.00	yes
12	disulfoton	8	8	2	6.00	no
13	hexazinone	6	7	5	6.00	yes
14	simazine	2	7	8	5.67	no
15	butylate	3	8	5	5.33	yes
16	E.P.T.C.	3	9	4	5.33	yes
17	chlorothalonil	9	5	2	5.33	yes
18	azinphos-methyl	4	4	7	5.00	yes
19	cyanazine	3	8	4	5.00	?
20	PCNB	3	8	4	5.00	yes
21	thiabendazole	2	6	7	5.00	yes
22	glyphosate	2	7	5	4.67	no
23	methamidophos	7	4	3	4.67	no
24	captan	6	7	0	4.33	yes
25	phosmet	8	5	0	4.33	yes
26	napropamide	1	8	4	4.33	no
27	carbaryl	3	4	4	3.67	yes
28	metalaxyl	3	3	5	3.67	?
29	trifluralin	1	8	2	3.67	yes
30	endosulfan	2	4	4	3.33	yes
31	dodine	2	4	4	3.33	no
32	diquat	4	4	2	3.33	no
33	diazanone	1	3	4	2.67	yes
34	oxydemeton	1	3	4	2.67	?
35	paraquat	1		6	2.33	no
36	benomyl	1	4	2	2.33	no
37	demeton	2	3	2	2.33	no
38	dichlone	1	4	2	2.33	no
39	copper sulfate	1	5		2.00	yes
40	endothal	1		4	1.67	no
41	malathion	1		4	1.67	yes
42	permethrin	1		3	1.33	no
43	cupric hydroxide	1	3		1.33	yes
44	methomyl	1		2	1.00	no