Maine Board of Pesticides Control

2005
PESTICIDES
AND
GROUND WATER MONITORING
PROGRAM

Heather Jackson
Maine Board of Pesticides Control
28 State House Station
Augusta, Maine 04333-0028
(207) 287-2731
heather.p.jackson@maine.gov

March 2006

TABLE OF CONTENTS

1. SUMMARY

The results of Maine's statewide pesticides and ground water monitoring program indicate that pesticide contamination of drinking water in private wells sometimes occurs at levels below established health advisory levels in areas near active pesticide use sites. The frequency of positive detections is low.

This monitoring program is repeated every five to seven years by the Maine Board of Pesticides Control (BPC) during the winter when the ground water table is lowest. The first monitoring survey was conducted in 1994 and the percentage of private drinking water wells with detections of a pesticide was 24% (31 of 129). The percentage of positive detections in the second survey, conducted in 1999, dropped to 9% (17 of 194). In addition, samples collected in 1999 from wells located adjacent to cornfields contained no detectable levels of pesticides, as compared to 14% in 1994, and there were fewer samples from wells located adjacent to potato and blueberry fields with detectable levels of pesticides. The number of different pesticides detected also decreased from ten in 1994 to four in 1999.

In 2005, 11% of the sampled wells were found to have low levels of a pesticide or pesticides (14 of 127) or 10% of the samples (14 of 137), since some wells were sampled twice if two different crops were near. Eight different pesticides were detected. As with the 1994 and 1999 surveys, hexazinone continues to be the most commonly found pesticide active ingredient (AI) in sampled drinking water wells.

2. STUDY OBJECTIVE

The objective of these studies is to assess the occurrence of pesticides in private drinking water wells located within ¼ mile down gradient of an active agricultural pesticide use site. Section VII, Ground Water Monitoring, of the January 1998 State of Maine Generic State Management Plan for Pesticides and Ground Water requires that statewide ground water monitoring be conducted every five to seven years to assess ground water quality trends. The 2005 Pesticides and Ground Water Monitoring Program was conducted in accordance with that plan.

3. STUDY DESIGN

3.1 Selection of Pesticides, Crops, and Crop Locations

The following data sources were used to determine what pesticide active ingredients and the associated crops would be targeted for 2005 sampling and the number of samples to collect near each commodity.

- 2003 Pesticide Dealer Reports – provided estimates of pounds of pesticide active ingredients (AIs) sold in Maine for agriculture;
- USDA-NRCS National Water and Climate Center's Windows Pesticide Screening Tool (WIN-PST), formerly called The National Pesticides/Soils Database and User Support System for Risk Assessment of Ground and Surface Water Contamination

(NPURG) – provided leachability ratings of active ingredients as "high", "intermediate", "low" or "very low"; and

- University of Maine Cooperative Extension Crop Specialists – provided expertise in determining what products and what relative amounts are used on particular crops.

Evaluation of the data gathered from the above sources resulted in the following sample allocations among pesticide use sites:

Use Site	Approx. Pounds of Leachable AIs sold in 2003[1]	Percent of Total AI	# of Samples (guide)	# of Samples Actual[2]
Potatoes	119,524	53.70%	78.4	67
Corn (forage and sweet)	49,611	22.30%	32.6	34
Blueberries	20,738	9.30%	13.6	11
Small Grains	25,691	11.50%	16.8	17
Orchard	845	0.38%	0.55	3
Christmas Trees	2,197	0.99%	1.45	2
Strawberries	3,877	1.74%	2.5	3
	Total: 222,483		**146[3]**	**137**

[1] Only "high" and "intermediate" leachers were tallied in this table. Some AIs were also included as part of this study if they had a "low" leachability rating coupled with high quantity sales.

[2] For quality assurance reasons, more than one sample was collected each from the christmas tree and orchard categories.

[3] Total number of samples collected was determined through the use of statistical analysis. The formula used is included in the Appendix as Figure 1.

Individual USGS 7.5-minute topographical maps containing known pesticide use sites previously identified by each of the five BPC field inspectors were randomly selected as areas for sampling. Each topographical map was numbered and entered into a database with the corresponding use site(s) associated with that map. A random number generator was then used to select map numbers containing the individual use sites. For example, the maps that had small grains grown within their boundaries were pooled together, then 17 of those map numbers were randomly chosen, with duplicates allowed.

If more than one field of the target crop existed on the randomly chosen topographical map, a numbered 10x10 grid was placed over the map and a random number list generated for each map directed the sampler to subsections of the map to further randomize the process. If there were no candidate use sites within the subsection, another subsection corresponding to the next number on the random list was searched for a candidate site. If there was more than one candidate use site within the subsection, the sampler assigned a number to each site and selected the sample site using a secondary random number table. A flow chart and accompanying standard operating procedure (SOP) for selecting a sample site are included in the Appendix as Figure 2. Figure 3 in the Appendix shows the sample distribution throughout the state.

3.2 Well Selection, Criteria, and Sampling

3.2.1 Random Selection of Wells

If more than one well was available for sampling, that met the criteria below, the wells were numbered and a random number table was used to select the well. This process prevented the sampler from introducing bias such as choosing the well closest to the field or farthest from the field. In many cases use of the random number table at this point was not necessary as it was difficult to find people home during the day to allow for sampling and that was a limiting factor.

3.2.2 Well Criteria

Once a specific sampling location was selected, the property was assessed to determine if the drinking water supply for that site met the following criteria:

- Private Residence (not a school, hospital, etc.) with people currently living there;
- Within ¼ mile of the target crop site (which must have had the target crop grown on it within the last year);
- Downgradient of or at equal elevation with the crop site;
- No filters or water treatment systems; and
- No water bodies (streams, ponds, rivers, etc.) between the crop site and the residence.

3.2.3 Sampling Methodology

Samples were collected from domestic water supplies (private residences) during the months of January, February and March. Residents were questioned as to any filtration systems on their water system, such as carbon (charcoal) filters, water softeners, reverse-osmosis filters, etc. If there were no filters, samples were collected from any cold-water tap. The cold water was allowed to run for 5 – 10 minutes to ensure that the water was collected from the well and not the pressure tank. If there were filters on the system, the sample was collected from a tap before the filter, such as from an outside tap.

Samples were collected in one-liter amber glass bottles, certified as pre-cleaned for collection of pesticide samples, with Teflon-lined caps. New latex gloves were donned at each sample site and worn during the collection process. Samples were kept under BPC custody in iced coolers or in a refrigerator until delivery to the analytical laboratory. Chain of Custody forms were filled out prior to leaving the sample site. Figure 4 in the Appendix is an example of the form used and shows the data collected at the time of sampling. The standard operating procedure (SOP) used to collect the sample and complete the Chain of Custody is also included as part of Figure 5.

3.3 Analytical Methodology

The University of Maine Food Chemical Safety Laboratory (UMFCSL) analyzed most of the samples collected during this study. The State's Health and Environmental Testing Laboratory (HETL) and APT Laboratory in Pennsylvania were also used. Samples were analyzed for the active ingredients that tend to be used on the crop located within ¼ mile of the sample collection site. The following table provides pertinent information relative to sample analysis.

Crop	Analyte	Leachablity[1]	Method[2]	MDL (ppb)[3]	Trade Name
Potatoes	Chlorothalonil	Low	SPE/GCMS	0.1	Bravo
	Endosulfan	Low	SPE/GCMS	0.1	Thiodan
	Ethoprop	High	SPE/GCMS	0.1	Mocap
	Metalaxyl	High	SPE/HPLC	1.0	Ridomil
	Metribuzin	High	SPE/GCMS	0.05	Sencor, Lexone
	Linuron	Intermediate	SPE/HPLC/PDA	2.0	Lorox
Forage/ Sweet Corn	Acetochlor	Intermediate	SPE/GCMS	0.05	Harness, Surpass
	Alachlor	Intermediate	SPE/GCMS	0.05	Lasso
	Atrazine	High	SPE/GCMS	0.05	AAtrex
	Chlorpyrifos	Low	SPE/GCMS	0.05	Lorsban
	Simazine	High	SPE/GCMS	0.1	Princep
	Dicamba	High	515.2/552	0.5	Banvel
	Methomyl	High	SPE/HPLC-PDA	2.0	Lannate
	Metolachlor	High	SPE/GCMS	0.05	Dual
	Atrazine metabolites	High	SPE/GCMS	2.0	metabolites
	2,4-D	Intermediate	515.2/552	3.0	
	Bentazon	High	515.3	5.0	Basagran
	Pendimethalin	Low	SPE/GCMS	2.0	Prowl
Blueberries	Chlorothalonil	Low	SPE/GCMS	0.1	Bravo
	Hexazinone	High	SPE/GCMS	0.1	Velpar, Pronone
	Hexazinone Metabolite B	N/A	SPE/GCMS	0.2	metabolite
	Fenbuconazole	Low	SPE/GCMS	0.1	Indar
	Phosmet	Low	SPE/GCMS	0.1	Imidan
	Propiconazole	Intermediate	SPE/GCMS	0.1	Orbit
	Captan	Low	SPE/GCMS	0.1	Captan
	Diuron	Intermediate	SPE/HPLC/PDA	1.0	Karmex
	Terbacil	High	SPE/GCMS	0.1	Sinbar
Small Grains	MCPA	High	LLE/GCMS	0.2	Rhomene
	Dicamba	High	LLE/GCMS	2.0	
	2,4-D	Intermediate	LLE/GCMS	0.2	
	Mecoprop	High	LLE/GCMS	0.2	
Orchard	2,4-D	Intermediate	LLE/GCMS	0.2	
	Captan	Low	SPE/GCMS	0.1	Captan
	Phosmet	Low	SPE/GCMS	0.1	Imidan
	Simazine	High	SPE/GCMS	0.1	Princep
Christmas Trees	Diazinon	Low	SPE/GCMS	0.05	Diazinon
	Metolachlor	High	SPE/GCMS	0.1	
	Simazine	High	SPE/GCMS	0.1	Princep
Strawberries	Terbacil	High	SPE/GCMS	0.1	Sinbar
	Dacthal	High	515.2	0.1	Dacthal
	Captan	Low	SPE/GCMS	0.1	Captan
	Napropamide	Intermediate	SPE/GCMS	0.1	Devrinol

[1] Leachability based on rating by WIN-PST.
[2] SPE/GCMS = solid phase extraction/gas chromatography with mass spec
SPE/HPLC/PDA = SPE/high performance liquid chromatography with photodiode array detector
LLE/GCMS = Liquid/Liquid extraction (with methylene chloride)/ GCMS
[3] ppb = parts per billion = (ug/L)

3.4 Quality Assurance/Quality Control

Field blanks, split samples, and duplicate samples were analyzed as part of this study for quality control purposes. Sample collectors prepared sample blanks (for a total of six blanks) using distilled water. Six duplicates were collected and three corn samples were split between HETL and UMFCSL. The samples were handled and labeled as if they were private well samples. All quality control samples were mixed in randomly with the private well samples to ensure that the laboratory did not treat QC samples differently. QA/QC results were all acceptable.

In addition to BPC QA/QC, all three laboratories maintain their own quality assurance/quality control (QA/QC) plans.

4. RESULTS

4.1 General

Of the 137 samples collected from 127 private drinking water wells (some wells were sampled for both small grain pesticides and potato pesticides counting as two samples from one well), 13 samples had detectable levels of one pesticide and one sample had a detectable level of two pesticides. At least one pesticide was detected in 14 of 127 wells. **Of all of the wells, 11% had positive detections, and 10% of the samples had positive detections (14 of 137).** There were no detections above any published EPA maximum contaminate levels (MCL), EPA health advisory levels (HAL), or Maine's maximum exposure guidelines (MEG).

There are basically two types of health based acceptable levels for pesticides in drinking water; these are the standards (EPA's MCLs) and the guidelines (EPA's HALs and Maine's MEGs). MEGs are set by the Environmental Toxicology program in the Maine Centers for Disease Control (MeCDC). MCLs are enforceable for public water systems, as defined by the Safe Drinking Water Act, and in setting them, the best available technology to achieve the level has to be considered. The MCLs and the guidelines (HALs and MEGs) are all used for guidance in private well situations.

The following table breaks down positive detections by use group:

Commodity Group	Number of samples collected	Samples with Positive Detections	
		Number	Percent
Potatoes	67	2	3.0%
Corn	34	4	11.8%
Blueberries	11	6	54.5%
Small Grains	17	1	5.9%
Orchards	3	0	0.0%
Christmas Trees	2	0	0.0%
Strawberries	3	1	33.3%
Totals:	**137**	**14**	**10.2%**

A total of eight different pesticide active ingredients were detected. The following table details results by active ingredient:

Use Site	Pesticides Analyzed	Trade Name	Range of Sample Concentrations (ppb)
Potatoes	Chlorothalonil	Bravo	**0.25 (1 sample)**
	Endosulfan	Thiodan	All ND (Non-Detect)
	Ethoprop	Mocap	All ND
	Metalaxyl	Ridomil	**1.61 (1 sample)**
	Metribuzin	Sencor, Lexone	All ND
	Linuron	Lorox	All ND
Corn (forage and sweet)	Acetochlor	Harness, Surpass	**0.10 – 0.12 (2 samples)**
	Alachlor	Lasso	All ND
	Atrazine	AAtrex	**0.24 – 0.42 (2 samples)**
	Bentazon	Basagran	All ND
	Chlorpyrifos	Lorsban	All ND
	Simazine	Princep	All ND
	Dicamba	Banvel	All ND
	Methomyl	Lannate	All ND
	Metolachlor	Dual	**0.07 (1 sample)**
	Atrazine metabolites		All ND
	2,4-D	Weedar64(and others)	All ND
	Pendimethalin	Prowl	All ND
Blueberries	Chlorothalonil	Bravo	All ND
	Hexazinone	Velpar, Pronone	**0.13 – 3.52 (6 samples)**
	Hexazinone Metabolite B	metabolite	**0.94 (1 sample)**

	Fenbuconazole	Indar	All ND
	Phosmet	Imidan	All ND
	Propiconazole	Orbit	All ND
	Captan	Captan	All ND
	Diuron	Karmex	All ND
	Terbacil	Sinbar	All ND
Small Grains	MCPA	Rhomene	All ND
	Dicamba		All ND
	2,4-D	Weedar64(and others)	**0.41 (1 sample)**
	Mecoprop		All ND
Orchard	2,4-D		All ND
	Captan	Captan	All ND
	Phosmet	Imidan	All ND
	Simazine	Princep	All ND
Christmas Trees	Diazinon	Diazinon	All ND
	Metolachlor		All ND
	Simazine	Princep	All ND
Strawberries	Terbacil	Sinbar	All ND
	Dacthal	Dacthal	**3.56 (1 sample)**
	Captan	Captan	All ND
	Napropamide	Devrinol	All ND

4.2 Results by Active Ingredient

4.2.1 Chlorothalonil

All 67 samples from wells near potato fields were analyzed for chlorothalonil, and one sample showed a detectable level (0.25 ppb). EPA's health advisory level (HAL) for chlorothalonil in drinking water is 150 ppb. The two year old, 200 feet deep, drilled well was located approximately 200 feet downgradient of the closest field. In accordance with the recommended response outlined in Section VIII - Response Framework of the BPC's Generic State Management Plan for Pesticides and Ground Water, BPC spoke with the farmer and reviewed his use and application practices. Chlorothalonil was used during the summer of 2005 after our sample was taken, but had not been used for at least seven years previous to our sample collection, and there are no other farmers nearby. This positive detection may have been a lab error.

4.2.2 Metalaxyl

Because metalaxyl analysis requires the laboratory to use a different method from the one for most of the rest of the potato pesticide active ingredients, and therefore charge more money, only five samples were analyzed. One sample from a dug well approximately 140 feet from a potato field contained 1.61 ppb metalaxyl. The depth of the well is unknown. Since the level detected in this survey was less than Maine's MEG of 420 ppb, and since metalaxyl is seldom used on potatoes due to resistance, a determination was made that no further investigation was necessary.

4.2.3 Acetochlor

All 34 samples from wells near corn fields were analyzed for acetochlor. Two of the samples were found to have positive detections of 0.10 ppb and 0.12 ppb. The MEG for acetochlor in drinking water is 20 ppb. One of the samples was collected from a 55 year old drilled well of unknown depth, approximately 500 feet from the corn field. The farmer has not had a spill, and only used Harness once, following the label. The land has recently been sold for development. The other sample was collected in a different town from a 13 year old, 90 feet deep drilled well. This well was approximately 900 feet from the corn field. It was difficult to track down the various farmers in the area, but it appears that it has been at least a number of years since this product may have been used. One of the farmers is now an organic grower, and another is moving toward selling off land for development.

The manufacturer, Monsanto, paid for these two wells to be resampled the following winter. Their results were non detect.

4.2.4 Atrazine

All 34 samples from wells near corn fields were also analyzed for atrazine. Atrazine was found in two wells at 0.24 ppb and 0.42 ppb. The maximum contaminant level (MCL) is 3 ppb. The first well is a 214 feet deep, 52 year old, drilled well. Metolachlor was also found in this sample (see below). The farmer for this field said he did have a spill of herbicide in the late 70's or early 80's that he thinks was atrazine. Atrazine has been detected at this site in the past. He has used a product called Bicep that contains both atrazine and metolachlor in recent years and that might have been applied heavily at the edges of the field as the sprayer was turning around. The spray was stopped during turnarounds but the boom emptied possibly causing more chemical release than normal in those areas. Roundup, which is not considered to be a leacher, is now being used on this field instead of atrazine and metolachlor. The second well with 0.42 ppb atrazine is located in a different town and is a 20 years old, drilled well approximately 150 feet deep, and approximately 300 feet from the corn field. The farmer has decided that corn will no longer be grown in this location in the future.

4.2.5 Metolachlor

Metolachlor was also assayed in all 34 samples taken near corn and it was found in one well at 0.07 ppb. EPA's HAL is 100 ppb. This was the same well where atrazine was found (see first well in the atrazine section above).

4.2.6 Hexazinone

Hexazinone has been detected in Maine's ground water for over 20 years. The fact that it was detected in 54.5% of the samples collected for blueberry pesticide analysis was not unexpected. The levels detected were well below the EPA HAL of 400 ppb, and further investigation, related to this study, was not warranted. Refer to other BPC reports on hexazinone for more information.

4.2.7 2,4-D

2,4-D was looked for in all 17 samples collected near small grains. It was detected once at 0.41 ppb. EPA's MCL is 70 ppb. The well is approximately 100 feet downgradient from the field. Other information about the well is unknown. It was discovered that the farmer has not used pesticides in recent years, and the homeowner was questioned about using a pesticide on their lawn or garden.

4.2.8 Dacthal

Samples for Dacthal analysis had to be sent to APT Laboratories in Pennsylvania. Due to the extra cost, only two samples were analyzed and one had a positive detection of 3.56 ppb. The analytical method looked for the sum of parent Dacthal plus metabolites. It is likely that the 3.56 ppb is mostly metabolites that pose little hazard in drinking water at that level. The farmer said Dacthal was used near the tested well in 2004. He said there was no spill. It is assumed that this product was used normally as it is frequently found in ground water in Rhode Island after normal use there.

4.3 Site Factors and Frequency of Detections

Information about well depth and distance to active pesticide use site was collected during this assessment. The following tables summarize that information. Numbers listed in non-bold font indicate all sites sampled. Numbers listed in bold parentheses indicate the number of sites with detectable levels of at least one pesticide active ingredient.

Use Site	**Well Depth (feet)**					
	< 100	100- 199	200 – 299	300 – 399	> 400	Unknown
Potatoes	15	16	5 **(1)**	3	--	28 **(1)**
Sweet/Forage Corn	10 **(1)**	8 **(1)**	4 **(1)**	1	--	11 **(1)**
Blueberries	4 **(2)**	2 **(1)**	1	--	--	4 **(3)**
Small Grains	4	5	--	--	--	8 **(1)**
Orchard	--	1	--	--	--	2
Christmas Trees	2	--	--	--	--	--
Strawberries	--	2 **(1)**	--	--	--	1

Use Site	**Well Construction**				
	Drilled	Dug	Driven Point	Spring	Unknown
Potatoes	57 **(1)**	5 **(1)**	1	2	2
Sweet/Forage Corn	23 **(4)**	3	--	3	5
Blueberries	11 **(6)**	--	--	--	--
Small Grains	13	--	--	--	4 **(1)**
Orchard	3	--	--	--	--
Christmas Trees	2	--	--	--	--
Strawberries	3 **(1)**	--	--	--	--

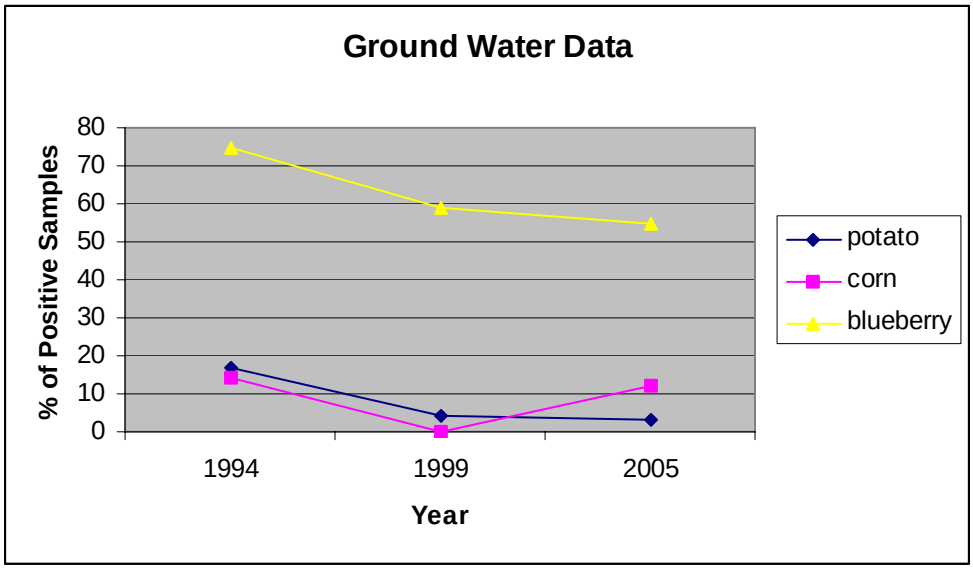
Use Site	Distance from Active Use Site (feet)			
	< 100	100 – 499	500 – 999	1000 – 1500
Potatoes	14	40 **(2)**	8	5
Sweet/Forage Corn	2 **(1)**	16 **(1)**	12 **(2)**	4
Blueberries	3 **(1)**	5 **(4)**	1	2 **(1)**
Small Grains	6	9 **(1)**	--	2
Orchard	1	1	--	1
Christmas Trees	1	1	--	--
Strawberries	1	1 **(1)**	1	--

4.4 Comparison of 1994, 1999 and 2005 Data

The following tables and graph compare the results of the initial ground water study conducted in 1994 to the one in 1999 and this assessment:

Commodity Group	Number of samples collected			Number of Samples with Positive Detections			Percent of Samples with Positive Detections		
	1994	**1999**	**2005**	**1994**	**1999**	**2005**	**1994**	**1999**	**2005**
Potatoes	47	102	67	8	4	2	17%	4%	3%
Corn	49	51	34	7	0	4	14%	0%	12%
Blueberries	20	22	11	15	13	6	75%	59%	55%
Small Grains	3	9	17	0	0	1	0%	0%	6%
Orchards	1	5	3	1	0	0	100%	0%	0%
Christmas Trees	5	4	2	0	0	0	0%	0%	0%
Strawberries	0	3	3	--	0	1	--	0%	33%
Rights-of-Way	3	0	0	0	--	--	0%	--	--
Market Garden	1	0	0	0	--	--	0%	--	--
Totals:	**129**	**197**	**137**	**31**	**17**	**14**	**24%**	**9%**	**10%**

No detections were above HAL/MEG/MCL for any of the three years except for diazinon found near an orchard in 1994. Diazinon was not used on the orchard but was applied by the well owner around the well to control ants.


Ground Water Data
% of Positive Samples
80
70
60
50
40
30
20
10
0
1994
1999
2005
Year
potato
corn
blueberry

Use Site	Pesticide AIs Analyzed	Range of Sample Concentrations (ppb)		
		2005	**1999**	**1994**
Potatoes	Atrazine	*--(not sampled)*	--	**0.13**
	Chlorothalonil	**0.25**	All ND	--
	Disulfoton	--	All ND	--
	Endosulfan	All ND	**0.13**	All ND
	EPTC	--	All ND	--
	Ethoprop	All ND	All ND	**0.08**
	Imidacloprid	--	All ND	--
	Linuron	All ND	--	--
	Maleic Hydrazide	--	All ND	--
	Metalaxyl	**1.61**	All ND	**0.63 – 6.51 (6 samples)**
	Metribuzin	All ND	**0.10 - 0.60 (4 samples)**	All ND
	Propamocarb	--	All ND	--
Corn	2,4-D	All ND	--	--
	Acetochlor	**0.10 – 0.12 (2 samples)**	All ND	--
	Alachlor	All ND	All ND	**1.70**
	Atrazine	**0.24 – 0.42 (2 samples**	All ND	**0.10 – 1.90 (6 samples)**
	Bentazon	All ND	All ND	--
	Chlorpyrifos	All ND	All ND	--
	Cyanazine	--	All ND	--
	Dicamba	All ND	All ND	--
	Dinoseb	--	*No use on Corn*	**3.50 (point source)**
	Methomyl	All ND	All ND	--
	Metolachlor	**0.07**	All ND	**0.30 – 10.20 (2 samples)**
	Pendamethalin	All ND	All ND	--
	Simazine	All ND	--	--
Blueberries	Azinphos-Methyl	--	All ND	--
	Chlorothalonil	All ND	--	--
	Fenbuconazole	All ND	--	--
	Total Hexazinone	**0.13 – 4.46 (6 samples)**	**0.22 - 1.97 (13 samples)**	**0.09 – 5.97 (15 samples)**
	Phosmet	All ND	All ND	--
	Propiconizole	All ND	**0.18**	*Not used in 1994*
	Captan	All ND	--	--
	Diuron	All ND	--	--
	Terbacil	All ND	All ND	--
Small Grains	**2,4-D**	**0.41**	--	--
	Dicamba	All ND	--	--
	MCPA	All ND	All ND	--
	Mecoprop	All ND	--	--

Orchard	2,4-D	All ND	--	--
	Captan	All ND	--	--
	Diazinon	--	*Not an orchard pesticide*	**7.35 (point source)**
	Fenarimol	--	All ND	--
	Oxamyl	--	All ND	--
	Phosmet	All ND	--	--
	Simazine	All ND	All ND	--
Christmas Trees	Diazinon	All ND	All ND	--
	Metolachlor	All ND	--	--
	Simazine	All ND	All ND	--
Strawberries	Captan	All ND	--	--
	Carbofuran	--	All ND	--
	Dacthal	**3.56**	--	--
	Metalaxyl	--	All ND	--
	Napropamide	All ND	All ND	--
	Terbacil	All ND	--	--

5 CONCLUSIONS

The percentage of samples collected from private drinking water wells with detectable levels of pesticide active ingredients decreased from 24% in 1994 to 9% in 1999. In 2005 10% of the samples collected contained one or more pesticides. The number of different pesticides detected decreased from ten in 1994 to four in 1999, but increased in 2005 to eight pesticides. Slight changes in the laboratory method detection limits over the years influence these numbers, as does varying weather patterns. Hexazinone continues to be the most commonly found active ingredient in Maine drinking water wells.

Overall, the results of this survey show that pesticides continue to be detected in drinking water wells located within ¼ mile of active pesticide use sites. However, the frequency of detections in Maine appears lower than the national average, and positive detections have been below any MCLs, HALs, and MEGs. Developing and using agricultural best management practices will hopefully continue to keep the frequency and levels of detections low.

APPENDIX

Figure 1. Statistical Formula for Sample Size

DETERMINATION OF SAMPLE SIZE

In determining the number of groundwater sample units needed for this monitoring program, the following formula^1 was used:

$$n = \frac{P(1-P)}{\frac{A^2}{Z^2} + \frac{P(1-P)}{N}}$$

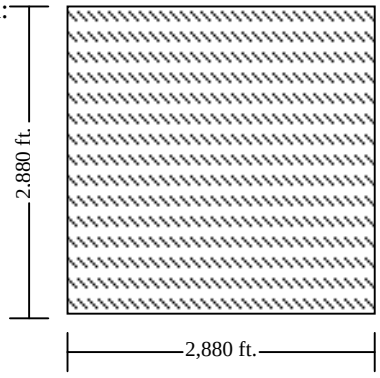
Where:

- n = sample size required
- N = size of the population samples are being taken from (i.e., the total number of wells)
- P = estimated percentage of the population possessing the attribute of interest (i.e., percentage of population with detectable levels of pesticides)
- A = Accuracy desired, expressed as a decimal (i.e., ..0.01, 0.03, 0.05, etc.)
- Z = number of standard deviation units corresponding to the desired confidence interval (see table below)

Z values:

Confidence Interval (CI)	**Z**
99%	2.5758
95%	1.9600
90%	1.6449
85%	1.4395
80%	1.2816

According to University of Maine Cooperative Extension crop specialists there are about 2,271 farms growing the crops focused on for this survey in Maine. According to the 2003 NASS, the average size of each farm is 190 acres, which, if the farm were square, would make a 2,880 ft x 2,880 ft farm:



1 *Air University Sampling and Surveying Handbook,* April 1996 Internet edition, www.au.af.mil/au/hq/selc/smpIntro.htm, downloaded 12/4/98

We then make an assumption that wells on only one side of the farm would be downgradient (one side would be upgradient, and two sides would be at the same elevation). Allowing for four properties along that downgradient side, that would make:

4 “high risk” properties per farm * 2271 farms of interest in Maine = 9,084 “high risk” properties in Maine.

The 1994 Pesticides in Ground Water study determined that 24% of “high risk” wells had detectable levels of pesticides, and the 1999 found 9%. The average of 24% and 9% is 16.5%.

We have decided that our accuracy desired will be ±5%, and our confidence level will be 90%. By plugging in our knowns into our sample size equation, we get:

N = 9,084
P = 0.165
A = 0.05
Z = 90% = 1.6449

So:

n = 145.79 samples

Figure 2. A flow chart and accompanying standard operating procedure (SOP) for selecting a sample site

SOP for Ground Water Sampling Site Selection
Related to Maine's "Generic State Management Plan for Pesticides and Ground Water"

Prepared by: Julie Chizmas

Revised by: _____ Date: _____
Heather Jackson

Reviewed by: _____ Date:_____
Henry Jennings

Approved by: _____ Date:_____
Robert Batteese

STATE OF MAINE
BOARD OF PESTICIDES CONTROL

SOP for Ground Water Sampling Site Selection
Related to Maine's "Generic State Management Plan for Pesticides and Ground Water"

1. Select a Quad/Crop combination from the Sampling Quads list that was prepared in Augusta.

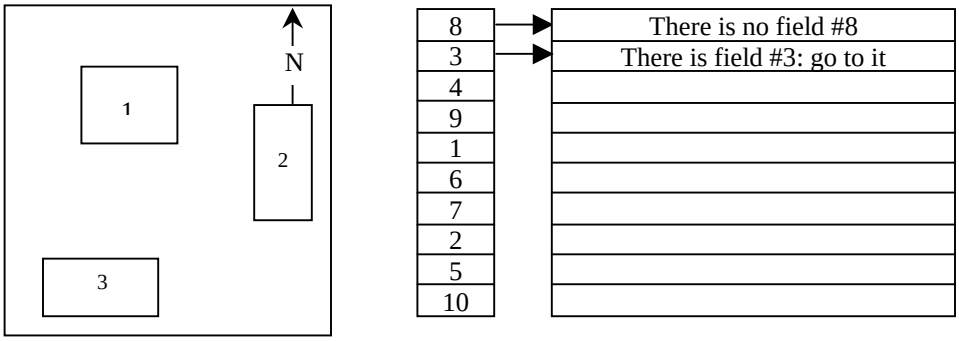
2. Place mylar overlay over quad.

3. Select a new Primary Random Number list (the one with 100 numbers on it).

4. Starting with the first random number (top left hand corner), check the corresponding cell on the quad to see if the crop is potentially present with residences close by.

5. Keep working through the random numbers from top to bottom until you identify a good target cell. At this point you'll need to drive to the target location.

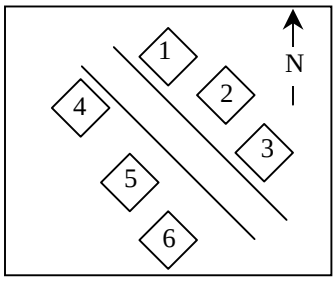
6. If, once you get to the target location, you find that there is more than one field with your target crop in that cell, number the potential fields from north to south and/or east to west. Then go to your secondary random number list and go through the numbers in one column until you select a field:



7. Once at the target location, look for properties meeting the following criteria:

A. Private Residence (not a school, hospital, etc.) with people currently living there;
B. Within ¼ mile of the target crop site (which must have had the target crop grown on it within the last year);
C. Down gradient or level with the crop site; and
D. No water bodies (streams, ponds, rivers, etc.) between the crop site and the residence.

8. If more than one well meets the ¼ mi. criteria, number the potential houses from north to south and/or east to west (depending on road direction). Then go to your secondary random number list and go through the numbers in one column until you select a sample site:



5	No one's home
9	There is no #9
2	They are home: sample site
8	
10	
4	
6	
3	
7	
1	

NOTE: If you used the secondary random number list to choose a field, then use the next column of numbers to choose a sample site; do not use the same list as you used for field selection.

9. If none of the qualified wells work out for sampling, and there was more than one field with the crop of interest in the cell, then go to the next field on the list you used to randomly determine the first field picked and start over with Step 7 to find a qualifying sample site:

8	There is no field #8
3	NO QUALIFYING SAMPLE SITES
4	There is no field #4
9	There is no field #9
1	There is field #1: go to it
6	
7	
2	
5	
10	

10. If none of the qualified wells work out for sampling, and there was only one field with the crop of interest in that cell, then go back to Step 5 to find another promising target cell.

11. After you have collected the sample from the site, CROSS OUT THE PRIMARY RANDOM NUMBER LIST YOU USED TO FIND THE CELL ON THE QUAD. Do not re-use those lists for locating other samples. If you have to collect more than one sample from one quad, you must use a different primary random number list.

Figure 3. Sample Distribution throughout Maine

County	Number of Samples Collected
Androscoggin	6
Aroostook	69
Cumberland	1
Franklin	1
Hancock	0
Kennebec	8
Knox	2
Lincoln	4
Oxford	7
Penobscot	7
Piscataquis	13
Sagadahoc	1
Somerset	3
Waldo	3
Washington	6
York	6

Figure 4. Sample Data Collection Sheet

Well ID: _____
USGS Map #: _____
Grid #: _____

2005 WATER SAMPLE INFORMATION SHEET

Maine Board of Pesticides Control
28 State House Station
Augusta, Maine 04333-0028
(207) 287-2731

SECTION 1: CROP

- ☐ Potatoes
- ☐ Small Grains
- ☐ Forage Corn
- ☐ Orchard
- ☐ Sweet Corn
- ☐ Christmas Trees
- ☐ Blueberries
- ☐ Strawberries

SECTION 2: ANALYSIS

Check more than one box if applicable

- ☐ Group 1
- ☐ Group 2
- ☐ Group 6
- ☐ Group 8
- ☐ Group 9
- ☐ Group 11
- ☐ HETL

SECTION 3: WELL IDENTIFICATION

Name: _____

Address: _____

_____, ME _____

Phone: _____

Directions to the Residence: _____

Well Location: _____

SECTION 4: WELL USE AND CONSTRUCTION INFORMATION

Well Use: ☐ Private ☐ Other _____ Approximate Age of Well: _____ yrs.

Well Construction: ☐ Dug ☐ Drilled ☐ Spring ☐ Driven ☐ Other _____ ☐ **Unknown**

Well Depth at Completion: *exactly* _____ ft. ☐ **Unknown** Depth of Casing: *exactly* _____ ft. ☐ **Unknown**

Is the Well Screened? ☐ No ☐ Yes -- Screened Intervals: Top: ____ ft. Bottom: ____ ft. ☐ **Unknown**
Top: ____ ft. Bottom: ____ ft.

SECTION 5: SAMPLE INFORMATION

SAMPLE ID: _____ Sample Date: _____ Sample Time: _____ AM PM

SECTION 6: WELL LOCATION

Latitude: N ___ ___ ° ___ ___ . ___ ___ ___ '

Longitude: W ___ ___ ___ ° ___ ___ . ___ ___ ___ '

**Altitude will be determined at BPC office using info above and topographic map*

Time: ___ ___ : ___ ___ : ___ ___ AM PM

EPE: _____ ft.

Distance from well to crop: _____ ft. Elevation of well with respect to crop: ☐ Downgradient ☐ Equal Elevation

SECTION 7: COMMENTS

SECTION 8: SAMPLE AUTHORIZATION

The undersigned hereby voluntarily consents to the collection of well water samples from the property described in the above Sections for the purpose of gathering information in connection with the statutory responsibilities of the Maine Board of Pesticides Control.

Well Owner/User: _____ Title: _____

Sampled By: _____ Date: _____

Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Date/Time:	Received by:	Date/Time:

White Copy = BPC Office Yellow Copy = Laboratory Pink copy = Well Owner/User or Agent

Figure 5. Ground Water Sampling Standard Operating Procedure (SOP)

1. A site location and a site ID (or well ID) are chosen at the Augusta office after the appropriate planning procedures have been followed (see Experimental Design section in "Quality Assurance Project Plan for Maine Board of Pesticides Control Water Quality Program and Related Laboratory Work"). Samples are to be collected from private domestic water supplies that are within ¼ mile down gradient from, or of equal elevation with, a pesticide use site.
2. Residents must be questioned as to any filtration systems on their water system, such as carbon (charcoal) filters, water softeners, reverse-osmosis filters, etc. If there are no filters, then samples may be collected from any cold-water tap (please remove the aerator, if possible). Cold water must be run for 5 – 10 minutes to ensure that a sample from the well is obtained as opposed to one that's been sitting in the pressure tank. If there are filters on the system, the sample must be collected from a tap before the filter (an outside tap is usually a safe choice); the water should still be run for 5 – 10 minutes prior to collection.
3. Samples are to be collected in 1-Liter amber glass bottles with teflon-lined caps, certified as precleaned for the collection of pesticide samples. Latex or nitrile gloves must be worn when collecting the sample; a fresh pair of gloves is needed at each site. For the best adhesion, labels should be placed on the bottles prior to filling the bottle with water. Fill sample bottles completely. Bottles must be labeled with sample ID, date of collection, sample collector initials, analysis to be performed, and sample location (town). Caps must be also labeled with the sample ID. Keep in mind that the "Site ID" or "Well ID" will be determined later.
4. Samples are placed in a cooler with ice packs or in a refrigerator to ensure that samples are kept in the dark and as close to 4°C as possible.
5. Make sure site information is recorded and signed by the property resident before leaving the site. Site information of interest, also available on a form, includes the following:

Well ID - This is a unique, 8-digit number assigned by the BPC Augusta office for each site that is sampled. Please do not write anything on the Well ID line.

USGS Map #: Please write the number of the 7.5-minute topographic map in which the site is located. The number of each topographic map you are given will be on the back of the map.

Grid Number: The number on the mylar overlay in which the site is located (for stratified random sampling projects).

SECTION 1 and 2: CROP/ANALYSIS

Crop/Analysis: Please check which crop is near the well. If there is more than one commodity within ¼ mile of the well, please list only the primary one, and list others in SECTION 7: COMMENTS. If there is a special pesticide use on a nearby commodity, please make a note of it in the COMMENTS section.

SECTION 3: WELL IDENTIFICATION

Name and Mailing Address: This is for the name and mailing address of the person to whom the analytical results are to be sent (usually the homeowner or renter). If, in the case of a rental situation, the results are to be sent to the landlord/owner, put the landlord/owner's name and mailing address here. Please note in SECTION 7: COMMENTS if the results are being sent to someone other than the well user.

Directions to the residence: Please write the route or road on which the site is located and the municipality in which the site is located, if different from that indicated in the mailing address. Use SECTION 7: COMMENTS if additional space is required.

Well Location: Please write the general location of the well, like in the basement, behind the house, etc.

SECTION 4: WELL USE AND CONSTRUCTION INFORMATION

Well Use: Please check the applicable box. All the wells tested in this survey should be private (used only by the homeowners/renters). If the well is not public, please check "Other", and write what it is used for.

Approximate Age of Well: Please give the age of the well, in years.

Well Construction: Check the applicable box or fill in "Other". If the well user doesn't know, check "Unknown".

Well Depth at Completion: Enter the exact depth in feet of the well only if the exact depth is known; estimates are not allowed. If unknown, please check the "Unknown" box.

Depth of Casing: Enter the exact depth in feet of the casing only if the exact depth is known; estimates are not allowed. If unknown, check the "Unknown" box.

Is the Well Screened? A screened well is one with openings or perforations in the casing at specified depths so that ground water is only drawn only from that depth. Most drinking water wells in Maine are **not** screened. Wells that may be screened are driven point wells through sand and gravel aquifers and drilled wells that are drilled only into the overburden and not to the bedrock. If the well is screened, please try to find out the screening intervals.

SECTION 5: SAMPLE INFORMATION

SAMPLE ID: This is the standard, 11-digit, alphanumeric code used by the inspection staff during sampling events: YYMMDDabcXX.

Sample Date: The date the sample was collected.

Sample Time: The time the sample was collected. If military time is not used, please circle AM or PM.

SECTION 6: WELL LOCATION

Latitude: Write the GPS reading, as it reads on the display.

Longitude: Write the GPS reading, as it reads on the display.

Time: The time displayed on the GPS unit when the latitude and longitude were marked.

EPE: The Estimated Position Error, as it reads on the GPS display.

Note: Due to past issues with the GPS altitude readings, the well altitude will be determined at the BPC office using topographical maps and the given latitude and longitude.

Distance from Well to Crop: Write the estimated distance (in feet) from the crop listed in Section 1 to the well.

Elevation of Well with Respect to the Crop: Please check whether the well is down gradient from the commodity, or at the same elevation as the commodity.

SECTION 7: COMMENTS

In addition to using this space as previously indicated, please record any additional observations or comments, such as the phone number to the residence sampled.

SECTION 8: SAMPLE AUTHORIZATION

Please have the well owner/user read the authorization statement and sign were indicated. A title is not needed unless the person who is signing is an employee or agent, such as a babysitter or farm hand. The sampler should also sign were indicated and date the document.

CHAIN-OF-CUSTODY

Please use the shaded area at the bottom of the Water Sample Information Sheet to track the transfer and receipt of samples.

WATER SAMPLE INFORMATION SHEET DISTRIBUTION

White Copy	=	BPC Office
Yellow Copy	=	Laboratory
Pink Copy	=	Well owner/user or agent

---

6. Deliver samples to the University of Maine at Orono Food Chemical Safety Laboratory (or other lab) as soon as possible and no later than three days after collection. Samples can be delivered to the Food Chemical Safety Laboratory on Monday, Tuesday, Wednesday, and Thursday. If a Friday delivery is required, deliver no later than noon. Do not deliver samples on Saturday or Sunday. Other laboratories may have different schedules.