

**PESTICIDE RESIDUES IN THE EAST CHEHALIS
SURFICIAL AQUIFER**

PESTICIDES IN GROUND WATER - REPORT NO. 5

Water Body No. WA-23-1100GW
94-26

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By
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Finally, David Nash of the Washington State Department of Health reviewed all results for health implications and wrote letters to well owners explaining these implications.

ABSTRACT

Eleven wells near Chehalis, Washington, were sampled in March 1993 for 123 pesticides and nitrate+nitrite as nitrogen. Field measurements of water temperature, pH, and specific conductance were also made. Four pesticides were detected in the initial samples; **atrazine, simazine, diuron, and dichlobenil**. One or more of these chemicals were detected in three wells, however concentrations were below health related levels set by the EPA.

Atrazine, simazine, and diuron were detected in verification samples collected on August 23, 1993, from the three wells. Dichlobenil was not detected although dichlorobenzamide, a suspected breakdown product of dichlobenil, was detected. One well had a nitrate+nitrite as nitrogen concentration greater than the 10 mg/L standard for public drinking water supplies.

INTRODUCTION

In March, 1993, 11 wells were sampled near Chehalis, Washington, for agricultural pesticides and nitrate + nitrite as nitrogen(N). All the wells were located in the East Chehalis Surficial Aquifer which underlies the Chehalis River valley upstream of the town of Grand Mound (Figure 1).

Crops grown in the Chehalis Valley include peas, sweet corn, silage corn, wheat, oats, strawberries, and hay. Dairies are also common, as are beef cattle, horses, and sheep. Although farming is still the major activity, urban and suburban development for the fast growing Chehalis-Centralia area is expanding in some parts of the valley.

Background

Agricultural chemicals, specifically pesticides, are used throughout Washington. Although pesticides are used extensively on farm lands, they are also applied in the urban and forest environment. Population growth and increasing urbanization are placing increasing demands on the ground water resource. At the same time, the effect of pesticide use on the State's ground water quality is largely unknown.

In 1987, the Washington State Legislature asked the Department of Ecology to investigate whether pesticides were contaminating ground water. The resultant project became known as the Washington State Agricultural Chemicals Pilot Study.

Erickson and Norton (1990) investigated ground water at three sites and published the initial results in 1990. Sites were:

1. near Lynden in Whatcom County,
2. near Sunnyside in Yakima County, and
3. near Pasco in Franklin County.

Additional sites have been sampled since this initial work. A portion of the East Naches Aquifer near Glead was sampled in 1990 (Erickson, 1992), a portion of the Quincy Surficial Aquifer was sampled in 1991 (Larson and Erickson, 1993), and portions of the Ahtanum and Moxee Surficial Aquifers were sampled in 1992 (Larson, 1993). Each study involved a different crop type, climatic condition, or aquifer.

PURPOSE

Sampling of the East Chehalis Aquifer extends the statewide monitoring of pesticides. It provides data on the concentrations of pesticides in ground water in an aquifer where agriculture is interspersed with residential development. The East Chehalis aquifer is a major source of inflow to the Chehalis River (Erickson, 1993) and is susceptible to contamination due to a relatively high water table.

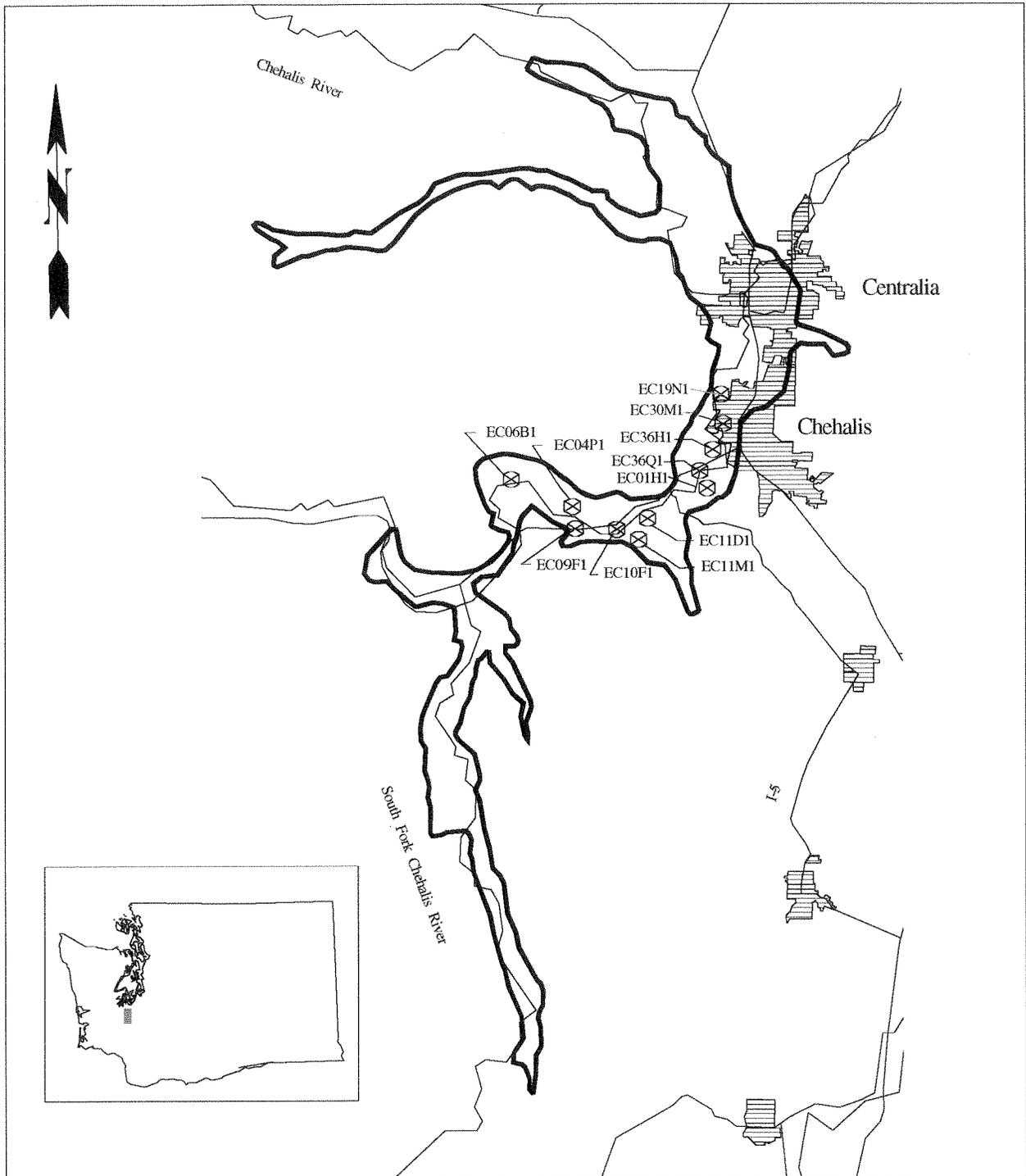


Figure 1. Location of sample wells within the East Chehalis Aquifer.

EAST CHEHALIS AQUIFER

The East Chehalis Aquifer is a 52 square mile aquifer located in the stream valley of the upper Chehalis River. It extends upstream from the mouth of Scatter Creek, underlying lower portions of both the mainstem and the South Fork. The East Chehalis Aquifer is arbitrarily separated from the West Chehalis Aquifer in the vicinity of Grand Mound. The West Chehalis Aquifer underlies the stream valley of the lower Chehalis River from Grand Mound to the river's mouth at Grays Harbor.

Hydrogeology

Erickson (1993) described the hydraulic characteristics of the aquifer within the study area. South of Centralia, the aquifer consists mostly of alluvial deposits of interlayered gravel, sand, silt, and clay. The gravel and sand layers are highly productive for ground water withdrawals, and most wells are completed in this zone. Near Centralia and northward, the aquifer consists mostly of sandy gravel outwash deposits. In general, the aquifer thickens from upstream to downstream, ranging from four to ten feet thick west of Adna up to 90 feet thick near Fords Prairie. Regionally, the Chehalis River serves as a ground water "sink" with water from the surficial aquifer flowing toward and into the river. Erickson (1993) estimated that mean ground water inflow to the Chehalis River from this aquifer ranges from 0.5 to 4.5 cubic feet per second per mile of river. Inflows were lowest in the upstream areas near Adna and highest in the downstream areas near Centralia. The higher inflows were due to higher hydraulic conductivities and increased aquifer thickness.

The water table is generally within 5 to 25 feet of the land surface, shallow near the river, and deeper on the flood plains along the valley's edge. The water table elevation is controlled by the level of the Chehalis River, precipitation, and irrigation.

Soils

Major soils are silt loams to silty clay loams formed in mixed alluvium on flood plains (SCS, 1987). They are very deep, poorly to well-drained, with moderate permeability on level to nearly level slopes. Moisture holding capacity is high, and soils at lower elevations have a high water table. Runoff is slow and the soils are subject to occasional brief flooding in winter and early spring. Typical soil series include the Chehalis silt loam and Reed silty clay loam. These soils are suitable for a wide variety of crops which include peas, sweet corn, corn for silage, wheat, oats, alfalfa, and strawberries. The Salkum silty clay loam, a very deep, well drained soil, is found on the higher terraces and glaciated hillsides. It is formed in highly weathered ancient glacial drift deposits. Annual precipitation ranges from 40 to 70 inches.

METHODS

To select appropriate wells for sampling, I searched the well log files located at Ecology's Southwest Region Office. I selected well logs based on a shallow depth, a high water table, and a representative location within the aquifer. In addition, I selected several wells used by Erickson (1993) in his study of the East Chehalis Aquifer. Once an adequate number of well logs were selected, I visited each well. Additional wells were located during the field survey.

Final well selection was controlled by:

1. source of the water--East Chehalis Aquifer,
2. location of the well with respect to aquifer boundaries and wells already selected,
3. availability of a well log,
4. ease of collecting a representative water sample, and
5. the owner's permission to sample.

Wells

I selected 11 wells for sampling the East Chehalis Aquifer; nine domestic and two irrigation. Wells were located near the Chehalis River to intercept ground water as it discharged to the river. The location of the wells with respect to aquifer boundaries is shown in Figure 1.

With one exception, wells ranged from 30 to 70 feet deep and averaged 52 feet. Well EC36Q1 was 200 feet deep and was sampled because it was the only known well in the vicinity. Water from this well is probably not representative of the East Chehalis Aquifer, and may originate from a deeper aquifer. The depth to ground water was measured in four wells and ranged from 4 to 13 feet. The type of well, surface elevation, total depth, and depth to water for the individual wells are presented in Appendix A.

Sampling

Initial sampling occurred in March 1993. Wells with detected pesticides were resampled in August 1993. Sampling was not timed to coincide with any specific agricultural activity, but rather was intended to detect pesticides that were persistent in ground water.

Sampling Procedures

I purged all wells before sampling until the temperature, pH, and specific conductance had stabilized and at least three casing volumes of water had been removed. I used an Orion meter for pH and temperature measurement, and a YSI meter for specific conductance. The pH meter was calibrated with pH 4.0 and 7.0 buffer at the start of each day and checked periodically during sampling. I purged and sampled the wells from existing faucets located

as close to the well as possible. If a faucet was available on the well head, it was used. However, most samples were collected after water had passed through the pressure tank plumbing.

Analytes Tested

Ground water was analyzed for 121 pesticides and pesticide breakdown products and for nitrate+nitrite as nitrogen. Most of the pesticides were derived from the Environmental Protection Agency's (EPA) list of leachable pesticides which have properties conducive to migration through soil to ground water (Cohen, 1985). Target pesticides, test methods, and quantitation limits are presented in Appendix B.

With the exception of carbamates, samples were analyzed by the Ecology/EPA Manchester Laboratory. Carbamates were analyzed by Water, Food and Research Laboratory in Tigard, Oregon, a contract lab.

Quality Assurance

The quality of the results is good. The qualitative and quantitative accuracy, validity, and usefulness of data from Water, Food and Research Laboratory were independently reviewed by Stuart Magoon of the Ecology/EPA Manchester Laboratory. A description of the quality assurance review and its results for samples analyzed by the Manchester Lab and the contract lab are included as Appendix C.

RESULTS

In the initial sampling, one or more pesticides were detected in three of the 11 study wells. The pesticides detected were **atrazine**, **simazine**, **diuron**, and **dichlobenil**. The concentrations of detected pesticides are presented in Table 1, including both the results of the initial and the verification sampling.

Table 1. Concentrations of pesticides detected ($\mu\text{g/L}$).				
Site ID	Atrazine	Simazine	Diuron	Dichlobenil
EC06B1	0.42 / 0.12			
EC09F1				0.009 J / U
EC10F1	0.05 J / 0.044J	0.05 J / 0.028J	0.12 / 0.15 NJ	
/ = initial value followed by verification value J = Positively identified, but the value is an estimate. NJ = Evidence the analyte is present; the associated numerical result is an estimate. U = The analyte was not detected.				

All four compounds are herbicides used to control weeds such as crabgrass, foxtail, horsetail, and chickweed. Atrazine is a selective triazine herbicide used before or just after the crop emerges; simazine is also a selective triazine herbicide applied before the crop emerges; dichlobenil is another pre-emergence herbicide; and diuron is used both pre- and post-emergence.

Atrazine

Atrazine was initially detected in two wells, EC06B1 and EC10F1. Atrazine was positively identified in both samples, but concentrations were low enough in EC10F1 that only an estimate of the concentration was possible.

Atrazine was also detected in the two verification samples. Again, concentrations were low and only an estimated concentration was reported for EC10F1.

Simazine

Simazine was positively identified in well EC10F1 in both the initial and verification samples. Both concentrations were below the quantification limit and could only be estimated.

Diuron

Diuron was detected in well EC10F1 in the initial sample but was not positively identified in the verification sample. The gas chromatographic breakdown product of the nitrogen containing compound diuron was detected. Since the presence of diuron had been confirmed in the initial sample, HPLC confirmation was not performed and the concentration is reported as an estimate.

Dichlobenil

For the initial sample, dichlobenil was positively identified in well EC09F1 at a concentration below the quantification limit and is reported as an estimate. However, dichlobenil was not detected in the verification sample from this well. The non-target compound dichlorobenamide was detected, however, and the laboratory reported this compound as a probable breakdown or derivative product of dichlobenil.

Nitrate + Nitrite as Nitrogen

Nitrate + nitrite as nitrogen (N) was detected in 3 of the 11 wells sampled (Table 2). Concentrations ranged from <0.01 to 14.5 mg/L. The concentration of nitrate + nitrite as N in well EC06B1 (14.5 mg/L initial and 15.2 mg/L verification) exceeded the 10.0 mg/L drinking water standard for nitrate as N. Atrazine was also detected in this well. Pesticides (diuron or dichlobenil) were detected in the other two wells in which nitrate was detected.

The remaining eight wells had nitrate+nitrite as N concentrations less than the 0.01 mg/L detection limit.

Health Concerns

To reduce the risk of health effects, the Environmental Protection Agency (EPA) has set the maximum contaminant level (MCL) for atrazine in drinking water at 3.0 µg/L and the MCL for simazine at 4.0 µg/L. Detected atrazine concentrations were eight times lower than the MCL and simazine detections were 50 times lower than the MCL. EPA has set a Lifetime Health Advisory level for diuron in drinking water at 10 µg/L. Diuron was detected at less than two percent of this value. EPA has not set a Lifetime Health Advisory level or MCL for dichlobenil in drinking water.

The standard for public drinking-water systems for nitrate as N is 10.0 mg/L. This concentration was exceeded in one well. However, eight of the 11 wells had a nitrate + nitrite as N concentration less than 0.01 mg/L.

Field Measurements

The water temperature, pH, and specific conductance of study wells are shown in Table 3. The average temperature of the ground water was 11.3°C. The average pH was 7.1 and the average specific conductance was 368 µmhos/cm. Well EC36Q1 had a specific conductance of 1,000 µmhos/cm, exceeding the 700 µmhos/cm secondary drinking water standard. This well, at 200 feet in depth, was the deepest well in the study. The water sampled is probably not comparable to that of the remaining wells.

Table 2. Nitrate - nitrite as nitrogen (mg/L).	
Site ID	Value
EC01H1	< 0.01
EC04P1	< 0.01
EC06B1	14.5 / 15.2*
EC09F1	1.66
EC10F1	0.53
EC11D1	< 0.01
EC11M1	< 0.01
EC19N1	< 0.01
EC30M1	< 0.01
EC36H1	< 0.01
EC36Q1	< 0.01
* Initial and verification samples.	

Table 3. Temperature (°C), pH (standard units), and specific conductance (μmhos/cm) of ground water samples.			
Site ID	Temp.	pH	Cond.
EC01H1	11.0	7.65	NA
EC04P1	10.8	7.53	380
EC06B1	11.9	6.44	240
EC09F1	11.2	6.49	195
EC10F1	11.1	6.71	210
EC11D1	11.6	7.33	235
EC11M1	11.5	7.34	230
EC19N1	11.0	7.15	680
EC30M1	11.3	6.74	245
EC36H1	10.5	6.86	270
EC36Q1	12.1	8.18	1000
NA = Not analyzed			

CONCLUSIONS

1. Four pesticides were detected in ground water from the East Chehalis Surficial Aquifer: **atrazine, simazine, diuron and dichlobenil**. The presence of atrazine, simazine, and diuron were confirmed by the verification sampling. Dichlobenil was not detected in the verification sample, but the breakdown product, dichlorobenzamide, was found.
2. None of these pesticides were detected above concentrations established by the EPA for health protection.
3. No impairment of water use due to pesticides was found.
4. One sample had a nitrate + nitrite as N concentration exceeding the 10.0 mg/L drinking water standard, and another had a specific conductance that exceeded the 700 μmhos/cm secondary drinking water standard.

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APPENDICES

Appendix A. East Chehalis Surficial Aquifer study wells.

Site ID	Water Use	Ground Elevation (ft.)	Well Depth (ft.)	Depth to Water (ft.)
EC01H1	Domestic	180	60	*
EC04P1	Domestic	200	65	4
EC06B1	Domestic	205	U	*
EC09F1	Irrigation	198	70	9
EC10F1	Domestic	185	37	*
EC11D1	Domestic	180	30	*
EC11M1	Domestic	170	49	9
EC19N1	Domestic	162	50	*
EC30M1	Irrigation	170	39	13
EC36H1	Domestic	138	64	*
EC36Q1	Domestic	180	200	*

* = Not measured
U = Unknown

Appendix B. Target analytes for the East Chehalis Aquifer pesticide study.

Pesticide	Method	Quantification Limit ($\mu\text{g/L}$)
1,2-Dibromo-3-Chloropropane (DBCP)	EPA 504	0.02
1,2-Dibromoethane (EDB)	EPA 504	0.02
1,2-Dichloropropane	EPA 846	1.0
2,4,5-T	EPA 615	0.01
2,4,5-TB	EPA 615	0.01
2,4,5-TP (Silvex)	EPA 615	0.01
2,4-D	EPA 615	0.03
2,4-DB	EPA 615	0.06
3,5-Dichlorobenzoic Acid	EPA 615	0.03
4-Nitrophenol	EPA 615	0.07
5-Hydroxydicamba	EPA 615	0.02
Abate (Temephos)	EPA 1618	0.75
Acifluorfen (Blazer)	EPA 615	0.03
Alachlor	EPA 1618-N	0.20
Aldicarb	EPA 531.1	1.0
Aldicarb Sulfone	EPA 531.1	1.0
Aldicarb Sulfoxide	EPA 531.1	2.0
Ametryn	EPA 1618-N	0.08
Atraton	EPA 1618-N	0.25
Atrazine	EPA 1618-N	0.08
Azinphos (Guthion)	EPA 1618	0.15
Baygon (Propoxur)	EPA 531.1	1.0
Benefin	EPA 1618-N	0.13
Bentazon	EPA 615	0.11
Bolstar (Sulprofos)	EPA 1618	0.06
Bromacil	EPA 1618-N	0.50
Bromoxynil	EPA 615	0.01
Butachlor	EPA 1618-N	0.29
Butifos (DEF)	EPA 1618	0.12
Butylate	EPA 1618-N	0.13
Carbaryl	EPA 531.1	2.0
Carbofuran	EPA 531.1	2.0
Carbophenothion	EPA 1618	0.08
Carboxin	EPA 1618-N	0.92
Chloramben	EPA 615	0.02
Chlorothalonil (Daconil)	EPA 1618-N	0.20
Chlorpropham	EPA 1618-N	0.42
Chlorpyrifos	EPA 1618	0.06
Cis-1,3-Dichloropropene	EPA 846	1.0
Coumaphos	EPA 1618	0.10
Cyanazine	NPS 4	0.10

Appendix B. Continued.

Pesticide	Method	Quantification Limit ($\mu\text{g/L}$)
Cycloate	EPA 1618-N	0.13
Dacthal (DCPA)	EPA 615	0.01
Dalapon (DPA)	EPA 615	0.05
Demeton-O	EPA 1618	0.05
Demeton-S	EPA 1618	0.06
Diazinon	EPA 1618	0.07
Dicamba	EPA 615	0.01
Dichlobenil	EPA 1618-N	0.10
Dichlorprop	EPA 615	0.03
Dichlorvos (DDVP)	EPA 1618	0.07
Diethyl Fumarate	EPA 1618	0.25
Dimethoate	EPA 1618	0.07
Dinoseb	EPA 615	-.02
Dioxathion	EPA 1618	0.14
Diphenamid	EPA 1618-N	0.25
Disulfoton (Di-Syston)	EPA 1618	0.05
Diuron	NPS 4	0.10
EPN	EPA 1618	0.08
Eptam	EPA 1618-N	0.13
Ethalfuralin (Sonalan)	EPA 1618-N	0.13
Ethion	EPA 1618	0.06
Ethoprop	EPA 1618	0.07
Ethyl Azinphos (Ethyl Guthion)	EPA 1618	0.13
Fenamiphos	EPA 1618	0.12
Fenarimol	EPA 1618-N	0.25
Fenitrothion	EPA 1618	0.06
Fensulfothion	EPA 1618	0.08
Fenthion	EPA 1618	0.06
Fluridone	EPA 1618-N	0.67
Fonofos	EPA 1618	0.05
Hexazinone	EPA 1618-N	0.13
Imidan	EPA 1618	0.09
Ioxynil	EPA 615	0.01
MCPA	EPA 615	1.7
MCPP	EPA 615	1.7
MGK264	EPA 1618-N	0.59
Malathion	EPA 1618	0.07
Merphos (1 & 2)	EPA 1618	0.13
Methiocarb	EPA 531.1	3.0
Methomyl	EPA 531.1	1.0
Methyl Chlorpyrifos	EPA 1618	0.06

Appendix B. Continued.

Pesticide	Method	Quantification Limit ($\mu\text{g/L}$)
Methyl Paraoxon	EPA 1618	0.15
Methyl Parathion	EPA 1618	0.06
Metolachlor	EPA 1618-N	0.25
Metribuzin	EPA 1618-N	0.08
Mevinphos	EPA 1618	0.08
Molinate	EPA 1618-N	0.22
Monocrotophos	EPA 1618	0.58
Napropamide	EPA 1618-N	0.25
Norflurazon	EPA 1618-N	0.13
Oxamyl (Vydate)	EPA 531.1	2.0
Oxyfluorfen	EPA 1618-N	0.22
Parathion	EPA 1618	0.07
Pebulate	EPA 1618-N	0.20
Pendimethalin	EPA 1618-N	0.13
Pentachlorophenol	EPA 615	0.004
Phorate	EPA 1618	0.06
Phosphamidan	EPA 1618	0.20
Picloram	EPA 615	0.02
Prometon (Pramitol 5p)	EPA 1618-N	0.08
Prometryn	EPA 1618-N	0.08
Pronamide (Kerb)	EPA 1618-N	0.25
Propachlor (Ramrod)	EPA 1618-N	0.17
Propazine	EPA 1618-N	0.08
Propetamphos	EPA 1618	0.17
Ronnel	EPA 1618	0.06
Simazine	EPA 1618-N	0.08
Sulfotepp	EPA 1618	0.05
Tebuthiuron	EPA 1618-N	0.08
Terbacil	EPA 1618-N	0.42
Terbutryn (Igran)	EPA 1618-N	0.08
Tetrachlorvinphos (Gardona)	EPA 1618	0.17
Tetraethyl Pyrophosphate	EPA 1618	0.06
Trans-1,3-Dichloropropene	EPA 846	1.0
Treflan (Trifluralin)	EPA 1618-N	0.13
Triadimefon	EPA 1618-N	0.22
Triallate	EPA 1618-N	0.22
Vernolate	EPA 1618-N	0.13
Xylene	EPA 846	1.0

Appendix C. Quality Assurance Review

Analyses were conducted by the Ecology/EPA Manchester Laboratory. The qualitative and quantitative accuracy, validity, and usefulness of data were reviewed by Stuart Magoon of Manchester Laboratory. Laboratory quality control (QC) followed standard Manchester guidelines and included laboratory blanks, surrogate spikes, and pesticide matrix spikes. The relative percent difference (RPD) was used to estimate analytical precision. The RPD is the ratio of the difference and the mean of duplicate (or replicate) samples expressed as a percentage.

In addition to laboratory QC samples, a single duplicate sample was collected for field quality assurance (QA). A duplicate sample consisted of an identical sample submitted to the laboratory with different sample identification.

No pesticides or nitrate-nitrite-N were detected in the transport blank. However, because of the preponderance of below quantitation limit results, duplicate and replicate samples were not useful in determining precision of the analyses, except for nitrate-nitrite as N.

In general, the quality of the results are good. Specific comments on each laboratory method follow:

Chlorinated herbicides by EPA Method 8150: All sample extraction and analysis holding times were met. No target compounds were detected in the laboratory blanks. Surrogate spike recoveries for 2,4,6-tribromophenol ranged from 14% to 65% except for EC10F1 which had 2% recovery. No recovery limits have been established for this method. Results for EC10F1 had the "J" data qualifier added to the results because of the 2% surrogate spike recovery. Matrix spike recoveries ranged from 11% to 50%. The lowest recoveries were for Dinoseb at 11% and 17%. The relative percent differences (RPD) ranged from 25% to 43%. No matrix spike recovery limits or RPD have been established for this method.

Volatile organics by EPA SW 846 Method 8260: All samples were analyzed within the recommended 14 day holding time. No pesticides were detected in the laboratory blanks, although low levels of the common laboratory solvents acetone and methylene chloride were found. Surrogate recoveries for p-Bromofluorobenzene; 1,2-dichloroethane-d4; 1,2-dichlorobenzene-d4; D8-toluene; and Fluorobenzene were within acceptable limits, ranging from 90% to 124%. Matrix spikes were within acceptable limits for both percent recovery and RPD. Percent recovery for pesticides ranged from 89% to 108%.

Ethylene dibromide (EDB) and dibromochloropropane (DBCP) by EPA Method 504: All samples were extracted and analyzed within the recommended holding times. No target compounds were detected in the laboratory blanks. Surrogate recoveries for methylated dalapon ranged from 93% to 120%. No recovery limits have been established for this method. No matrix spikes were analyzed with these samples.

Nitrogen containing pesticides by EPA Method 1618: All samples were extracted within seven days and extracts were analyzed within the recommended holding time. No target analytes were detected in laboratory blanks. Dimethylnitrobenzene was used as the surrogate compound, no specific nitrogen containing pesticide surrogates were available for this analysis. Surrogate recoveries ranged from 50% to 69%. No surrogate recovery limits have been established for this method. Matrix spike recoveries for the eight nitrogen containing compounds spiked, ranged from 68% to 103%, except for hexazinone, and the RPD from 0% to 20%. No recommended recovery limits or RPD have been established for this method. Hexazinone recoveries (19% and 20%) were significantly lower than the other nitrogen pesticides. However, no hexazinone was detected in any sample.

Atrazine was also analyzed in one follow-up sample, and simazine and diuron in two samples. These samples were completed within the recommended seven day holding time. Analytes were not detected in laboratory blanks. Surrogate recovery for dimethylnitrobenzene ranged from 91% to 104%. No dimethylnitrobenzene recovery limits have been set for this method. No matrix spikes were analyzed with these samples.

Urea pesticides by modified EPA 1618 Method: All samples were extracted within seven days and extracts were analyzed within the recommended holding time. No target analytes were detected in laboratory blanks. Surrogate recoveries for dimethylnitrobenzene ranged from 50% to 69%. No surrogate recovery limits have been established for this method. Both the target compounds, diuron and cyanazine, were used in the matrix spikes. The spike recoveries were 79% and 80% with an RPD of 1.3% for diuron, and 55% to 57% with a 3.6% RPD for cyanazine. No recommended recovery limits or RPD have been established for this method.

Diuron was also analyzed in one followup sample. The gas chromatographic breakdown product of the nitrogen containing target compound diuron was detected in the sample. However, since the presence of diuron was previously confirmed in the initial sample, HPLC confirmation was not performed and subsequent qualification deemed presumptive.

Organo-phosphorous pesticides by EPA 1618 Method: All samples were extracted within seven days and extracts were analyzed within the recommended holding time. No target analytes were detected in the laboratory blanks. Surrogate recovery for triphenyl phosphate (TPP) ranged from 73% to 104%. No recommended recovery limits have been established for this method. Matrix spike recoveries for nine organo-phosphorous pesticide compounds spiked, ranged from 99% to 113% and the RPD ranged from 0% to 4.5%. No recommended recovery limits or RPD have been established for this method.

Carbamates by EPA Method 531.1: All samples were analyzed within the known stability period of 28 days from collection. Method blanks, as per method 531.1, were not performed, however, since no target analytes were detected in any of the samples, the samples themselves have served the purpose of a method blank. Surrogate recovery for BDMC ranged from 83% to 117% and matrix spike recovery ranged from 55% to 125%. There are no quality control limits established for recovery or precision for this method.

Pyrethrin pesticides by modified EPA 1618 Method: All samples were extracted within seven days and analyzed within the recommended holding time. No target analytes were detected in the laboratory blanks. No specific surrogates were available for this method. Matrix spike recoveries for the pyrethrin, fenvalerate (2 isomer) ranged from 89% to 93% and the RPD was 4.4%. No recommended recovery limits or RPD have been established for this method.

Nitrate-nitrite as nitrogen by EPA Method 353.2: All samples were analyzed within recognized holding times. No laboratory blank or field duplicate were analyzed.