III. Appendices

E. Water Appendix

1. Comparisons of Estimated Regional OP Pesticide Distributions with Occurrences in Ambient Waters from the USGS NAWQA Program

OPP conducted refined surface water modeling to estimate potential OP cumulative exposure in drinking water. These estimates represent combined OP concentrations in untreated surface water sources of drinking water. As a part of its evaluation, OPP compared estimated OP concentrations in water to available surface water monitoring data. The most extensive source of monitoring data for multiple pesticides is the USGS NAWQA program. NAWQA included nine OP pesticides that are part of the OP cumulative risk assessment: azinphos-methyl, chlorpyrifos, diazinon, disulfoton, ethoprop, malathion, methyl parathion, phorate, and terbufos. Not every OP was included in each regional assessment, which represents a drinking water source that is potentially vulnerable to cumulative OP impacts. Only chlorpyrifos was included in each of the regional assessments. Similarly, only those OP pesticides used in the vicinity of monitoring stations have the potential to be found in each of the NAWQA study units.

While comparisons of the estimated concentrations with ambient water monitoring are valuable in evaluating and characterizing the OP cumulative drinking water exposure assessment, certain limitations need to be acknowledged:

- This is not a comparison of the same water bodies. The estimated cumulative OP concentrations used in the regional exposure assessments represent concentrations that would occur in a reservoir, and not in the streams and rivers represented by the NAWQA sampling.

- The sampling frequency of the NAWQA study (sample intervals of 1 to 2 weeks apart or less frequent) was not designed to capture peak concentrations, so it is unlikely that the monitoring data will include true peak concentrations. This may be particularly critical for pesticides such as phorate or terbufos, where the estimated pulse load of the parent is of a relatively short duration.

- The estimated concentration profile represents a wide distribution of weather patterns (19 to 35 years), while the NAWQA data reflect a smaller time window (generally up to 3 years). Thus, the estimated profile may better characterize the year-to-year fluctuations in weather patterns than is seen in the shorter time frame of the NAWQA study.

- Several regionally-significant OP pesticides were not included in the NAWQA study, so direct comparisons are not possible. Several significant transformation products, in particular the sulfone and sulfoxide products of disulfoton, phorate, and terbufos, were also not included in NAWQA.

- ❏ The NAWQA study did not focus on drinking water, and monitoring reflect a range of ambient waters. OPP tried to focus on those sampling sites that fed into drinking water sources or were reflective of drinking water sources in the region.

The significance of detections or non-detections in the monitoring data depends partially on the persistence and activity of the parent compound versus the metabolites. Given the frequency of sampling, NAWQA is more likely to detect a persistent OP pesticide than a nonpersistent one if they are indeed present in water. Relatively persistent and active OP compounds in the NAWQA tored in NAWQA include diazinon, chlorpyrifos, ethoprop, and azinphos methyl. Diazinon and chlorpyrifos, also with the most widespread use, were the most frequently detected compounds. Malathion is not considered to be persistent but was observed frequently. It is used as an adulticide and was detected most frequently in mixed and urban areas.

However, compounds such as phorate, terbufos, and disulfoton have generally non-persistent parent compounds, and rapidly form persistent and toxic sulfoxide and sulfone metabolites. The NAWQA data analyzed do not contain analyses for sulfoxide and sulfone metabolites, and there were generally few or no detections of the parent compounds. As illustrated in Region A, the likely short pulse of the parent phorate may be missed in bi-weekly sampling. It is possible that exposure to total toxic residues (parent + sulfoxide + sulfone) is likely underestimated. Similarly, a non-detection of a parent compound may not signify that toxic residues of a particular pesticide are not present in a sample. Consequently, exposure to total toxic residues is also likely to be underestimated.

This appendix is divided into seven sections – one for each of the regions in the OP cumulative risk assessment. Each of those regional sections are divided into two parts. The first part provides a comparison of the estimated concentration distributions for the OP pesticides included in the exposure assessment. The second part summarizes the USGS National Water Quality Assessment (NAWQA) program study units found in the regions.

a. Region A: Florida

The major contributor to the estimated OP cumulative exposure in this reagion was phorate use on sugarcane. Minor contributions came from phorate use on corn and ethoprop use on sugarcane. Table III.E.1-1 summarizes the estimated distribution profile for OP pesticide included in the exposure assessment. More detailed discussion and analysis of the OP load in drinking water sources can be found in section II.A.

Table III.E.1-1. Predicted percentile concentrations of individual OP pesticides and of the cumulative OP distribution in the Florida Region.

Chemical	Crop/Use	Concentration in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
Acephate	Peppers	7.7e-02	6.8e-03	8.5e-04	2.8e-04	8.7e-05	5.7e-05	4.3e-06
Chlorpyrifos	Corn, Citrus	2.0e-01	9.6e-02	4.9e-02	3.3e-02	2.1e-02	1.8e-02	9.1e-03
Diazinon	Lettuce, Tomato	2.9e-02	1.5e-02	9.1e-03	6.4e-03	4.0e-03	3.3e-03	1.1e-03
Ethoprop	Sugarcane	1.5e+00	5.1e-01	2.5e-01	1.7e-01	9.8e-02	8.0e-02	3.8e-02
Methamidophos	Peppers, Tomato	9.3e-03	1.7e-03	2.6e-04	8.4e-05	1.6e-05	9.9e-06	1.8e-07
Phorate(ttl)	Corn, Sugarcane	1.2e+01	7.2e-01	1.8e-02	1.1e-04	5.4e-09	8.5e-11	4.4e-12
OP Cumulative (in Methamiiophos Equivalents, ppb)		1.4e+01	9.0e-01	7.8e-02	3.6e-02	2.0e-02	1.7e-02	8.1e-03

i. Comparison of Monitoring Data versus Model Estimates

The South Florida (SOFL) NAWQA study unit includes the vulnerable drinking-watersheds of the Florida Region. The estimated concentrations of chlopryrifos were similar to the detections reported from agricultural sampling stations, with 80th percentile and greater estimated concentrations 5 to 8 times greater than similar percentiles of reported detections. Estimated 99th percentile concentrations for diazinon were similar to that measured in the SOFL unit. No comparisons could be made at lower percentiles, which extended beyond the frequencies of detection for these chemicals. While 90th and 95th percentile estimates for ethoprop were 20 to 30 times greater than similar percentiles from the SOFL unit, 99th and maximum estimates were closer (6 to 7 times greater). The study reported no detections of the parent phorate. While the estimated 99th percentile concentration of total phorate residues (including sulfone and sulfoxide) was more than two orders of magnitude greater than the limit of detection (LOD) for phorate, the LOD fell between the 90th and 95th percentile of the estimated distribution.

Figure III.E.1-1 compares the estimated percentile concentrations for ethoprop with the monitoring percentiles from the Hillsboro Canal at S-6 near Shawano. The estimated and observed levels of ethoprop in the Hillsboro Canal were similar with the exception of the maximum concentrations.

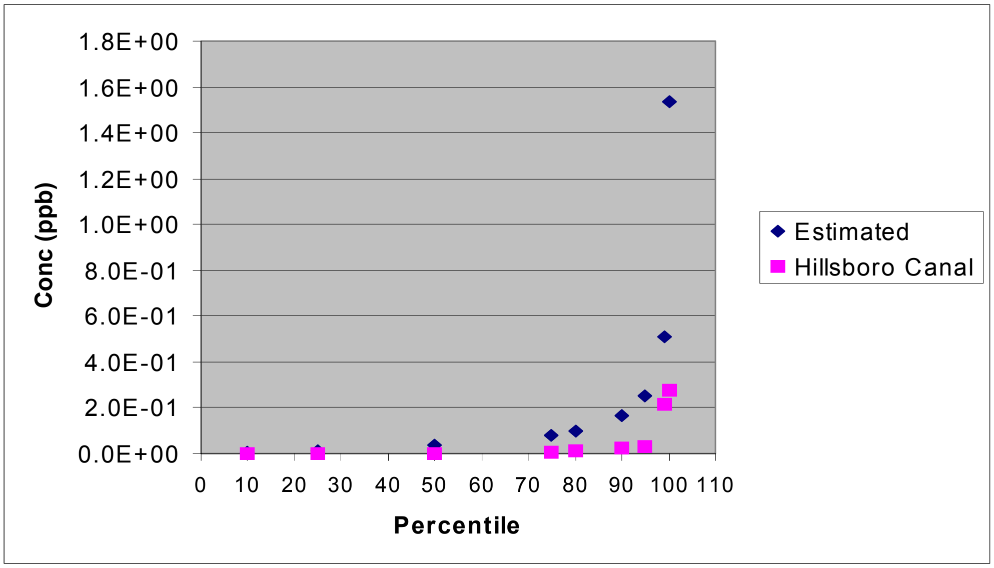

Figure III.E.1-1. Comparison of observed and estimated ethoprop concentrations in the Florida Region.

ii. Summary of NAWQA Monitoring Data in the Region

The **Southern Florida (SOFL) NAWQA** study unit includes the Biscayne aquifer, the Everglades, and portions of the Flatwoods and highly vulnerable Central Ridge regions of Florida. The Floridan, surficial and intermediate aquifers are also important sources of drinking water in this study unit. Ground water supplied 94% of water used in the study unit in 1990 (USGS Circular 1207).

Intensive surface water sampling in the SOFL study unit included canals draining mixed use (vegetables), citrus and sugar cane fields. Diazinon and chlorpyrifos were detected at low concentrations in the mixed use canal. Chlorpyrifos(max 0.023ug/l) and malathion (max 0.084 µg/l) were detected in 25% and 20% of samples from the citrus canal, with fewer detections of azinphos-methyl, methyl-parathion and ethoprop. Ethoprop was extensively (32%) detected in the sugarcane canal, with a maximum concentration of 0.279 µg/l. Chlorpyrifos, methyl parathion, diazinon and malathion were detected less frequently, and at lower concentrations. Sugarcane is the most important use for ethoprop. Although the sugarcane canal is not used for drinking water, this targeted monitoring indicates transport of ethoprop from the fields can be expected to occur.

The **Georgia-Florida Coastal Plain (GAFL) NAWQA** study unit extends from central Florida south of Tampa to just north of Atlanta, Georgia. The USGS reports that 80% of the population in this area derives its drinking water from ground water, and that 94% of that ground water is drawn from the Upper Floridan aquifer. About 25% of this region is devoted to agriculture, and more than half to forestry. Most of the Georgia portion of the study unit is located within the Coastal Inlands Farm resource Region.

Surface-water monitoring in the GAFL study unit were located in Georgia, outside of the Fruitful Rim, SE Farm resource Region. Sampling in Florida included intensive sampling from an urban stream in Tallahassee, and a number of fixed stream-sampling stations. Diazinon and chlorpyrifos were detected frequently (54% and 45%) in urban and mixed land-use samples. Malathion was detected in 35% of urban stream samples, but not in mixed land-use samples, with a maximum concentration of 0.2 µg/l. Ethoprop, phorate, azinphos-methyl and diazinon were detected in 3 or fewer agricultural samples each, at concentrations <0.1 µg/l.

Table III.E.1-2. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units Found in the Florida Region.

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
Concentation (ug/L)										
Southern Florida										
All Locations	Maximum	0.023	0.014	0.021	0.279	0.084	0.070	0.060	0.011	0.017
	99th	0.012	0.005	0.021	0.075	0.027	0.050	0.022	0.011	0.017
	95th	0.006	0.002	0.017	0.012	0.026	0.035	0.006	0.002	0.013
	90th	0.005	0.002	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.7%	2.0%	0.0%	10.0%	8.0%	1.6%	2.0%	0.0%	0.0%
Agricultural	Maximum	0.023	0.005	0.021	0.279	0.084	0.070	0.060	0.011	0.017
	99th	0.012	0.005	0.021	0.094	0.027	0.050	0.023	0.011	0.017
	95th	0.006	0.002	0.017	0.014	0.025	0.025	0.006	0.002	0.013
	90th	0.005	0.002	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.5%	0.0%	0.0%	9.0%	8.1%	1.4%	1.8%	0.0%	0.0%
Reference	Maximum	0.004	0.002	0.017	0.003	0.015	0.0421	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.003	0.0132	0.034702	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.006	0.00511	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	5.3%	5.3%	0.0%	0.0%	0.0%
Mixed	Maximum	0.005	0.014	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.005	0.014	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.005	0.013	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.004	0.013	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	9.1%	27.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Canal-C111 (Ag)	Maximum	0.023	0.005	0.021	0.005	0.084	0.070	0.040	0.011	0.017
	99th	0.014	0.005	0.021	0.005	0.073	0.053	0.026	0.011	0.017
	95th	0.008	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.006	0.002	0.017	0.003	0.026	0.029	0.006	0.002	0.013
	80th	0.005	0.002	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
Concentation (ug/L)										
	Frequency	25.6%	0.0%	0.0%	1.2%	19.8%	3.5%	2.3%	0.0%	0.0%
Hillsboro Canal (Ag)	Maximum	0.007	0.005	0.021	0.279	0.027	0.050	0.060	0.011	0.017
	99th	0.006	0.003	0.018	0.215	0.011	0.050	0.024	0.004	0.014
	95th	0.004	0.002	0.017	0.033	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.024	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.011	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.009	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	10.8%	1.4%	0.0%	32.4%	1.4%	0.0%	4.1%	0.0%	0.0%
US Sugar Outflow (Ag)	Maximum	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Florida Portion of GA-FL Coastal Plain										
All Locations	Maximum	0.028	0.276	0.060	0.073	0.204	0.054	0.035	0.031	0.013
	99th	0.024	0.244	0.019	0.012	0.086	0.051	0.035	0.016	0.013
	95th	0.016	0.101	0.017	0.005	0.020	0.001	0.006	0.002	0.013
	90th	0.011	0.084	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	80th	0.008	0.058	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	75th	0.006	0.051	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	45.1%	54.2%	0.0%	3.5%	18.8%	2.1%	0.0%	1.4%	0.0%
Urban/ Residential	Maximum	0.028	0.276	0.017	0.007	0.204	0.001	0.006	0.002	0.013
	99th	0.0265	0.27375	0.017	0.0055	0.117	0.001	0.006	0.002	0.013
	95th	0.01725	0.16325	0.017	0.003	0.0364	0.001	0.006	0.002	0.013
	90th	0.0155	0.1005	0.017	0.003	0.02	0.001	0.006	0.002	0.013
	80th	0.011	0.081	0.017	0.003	0.011	0.001	0.006	0.002	0.013
	75th	0.01	0.07275	0.017	0.003	0.009	0.001	0.006	0.002	0.013
	50th	0.004	0.0445	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	52.6%	92.1%	0.0%	2.6%	35.5%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.006	0.083	0.017	0.073	0.005	0.001	0.006	0.031	0.013
	99th	0.006	0.076	0.017	0.044	0.005	0.001	0.006	0.022	0.013
	95th	0.005	0.038	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.005	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	56.8%	15.9%	0.0%	6.8%	0.0%	0.0%	0.0%	4.5%	0.0%

b. Region B: Northwest

Ethoprop had the highest estimated concentrations in the region (Table III.E.1-3), while dimethoate, azinphos methyl, and chlorpyrifos also contributed to the estimated peak OP cumulative load. More detailed discussion and analysis of the OP load in drinking water sources can be found in section II.B.

Table III.E.1-3. Estimated percentile concentrations of individual OP pesticides and of the cumulative OP distribution in the Northwest Region.

Chemical	Crop/Use	Concentration in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
Acephate	Cauliflower, nursery, mint	5.0e-04	3.6e-04	1.9e-04	7.8e-05	9.8e-06	4.4e-06	1.7e-08
Azinphos Methyl	Apples, pears, cherries, blackberry	7.5e-03	2.2e-03	9.8e-04	6.7e-04	4.1e-04	3.6e-04	2.1e-04
Bensulide	Broccoli, cabbage, cucumbers	4.0e-02	3.2e-02	2.5e-02	2.2e-02	1.8e-02	1.7e-02	1.3e-02
Chlorpyrifos	Fruit/nut trees, cole crops, onions, corn, grass, trees, mint	6.0e-02	2.7e-02	1.6e-02	1.3e-02	9.8e-03	8.8e-03	5.1e-03
Diazinon	Fruit trees, legumes, cole crops, onions, nursery, hops, berries	1.4e-02	9.9e-03	7.0e-03	5.8e-03	4.3e-03	3.9e-03	2.4e-03
DDVP	Naled degradate	8.2e-05	2.8e-08	2.1e-12	4.9e-13	1.5e-13	9.6e-14	1.7e-14
Dimethoate	Fruit trees, legumes, cole crops, Christmas trees	2.8e-02	2.5e-03	6.8e-04	3.2e-04	1.2e-04	5.8e-05	6.5e-06
Disulfoton	Broccoli	1.1e-04	8.2e-05	6.1e-05	5.2e-05	4.1e-05	3.6e-05	2.2e-05
Ethoprop	Beans, snap	7.2e-01	6.6e-01	5.1e-01	4.1e-01	2.8e-01	2.5e-01	1.6e-01
Malathion	Apples, cherries, squash, onions, berries	1.5e-02	2.7e-03	9.2e-04	2.6e-04	3.2e-05	8.1e-06	4.5e-11
Methamidophos	Acephate degradate	7.3e-05	1.5e-06	6.4e-09	1.3e-10	2.0e-12	7.1e-13	8.1e-15
Methidathion	Pears	1.3e-04	5.5e-05	2.8e-05	1.6e-05	5.7e-06	3.5e-06	3.0e-07
Methyl Parathion	Onions	1.9e-04	5.0e-05	1.9e-05	1.2e-05	5.1e-06	3.5e-06	5.4e-07
Naled	Cole crops	1.4e-04	3.5e-06	2.6e-10	1.3e-12	7.2e-13	6.0e-13	3.0e-13
ODM	Cabbage, Christmas Trees	7.0e-04	1.4e-04	5.2e-05	3.1e-05	1.6e-05	1.3e-05	3.2e-06
Phosmet	Fruit trees	1.7e-03	1.1e-04	1.6e-06	1.8e-08	1.9e-11	2.2e-12	3.7e-13
OP Cumulative Concentration in Methamidophos Equivalents, ppb		1.4e-01	1.2e-01	9.2e-02	7.5e-02	5.1e-02	4.6e-02	3.0e-02

i. Comparison of Monitoring Data versus Model Estimates

Six OP pesticide parent compounds included in this assessment were tracked in the NAWQA study for the Willamette Valley. The upper percentile estimated concentrations for four individual OP pesticides were less than the maximum detections reported in the NAWQA monitoring for the Willamette Valley. Estimated azinphos methyl concentrations were two three orders of magnitude lower than reported detections at all percentiles. Estimated malathion concentrations were also one to two orders of magnitude lower than reported detections at all percentiles. Estimated diazinon concentrations were an order of magnitude lower than reported detections at the 95th and greater percentiles. Estimated concentrations for chlorpyrifos were similar to reported detections at all percentiles. The highest monitoring detect of ethoprop is three times the estimated maximum peak. Neither disulfoton nor methyl parathion were detected in the Willamette Valley study. The entire estimated distributions for disulfoton and methyl parathion were below the limits of detection.

All of the maximum monitoring detects occurred in Zollner Creek. This stream has a watershed with 99% agricultural use. A comparison of distributions showed that estimated OP concentrations at percentiles of 80th or greater were generally lower (up to 2-3 orders of magnitude) than reported monitoring distributions in Zollner Creek. At lower percentiles, the concentration profiles were similar.

When the estimated concentrations are compared with the NAWQA monitoring for rest of the agricultural watersheds (with particular focus on Pudding River) in the Willamette Valley, the estimated concentrations were similar to the monitoring concentrations, except for azinphos methyl and diazinon, which were still an order of magnitude lower than maximum monitoring detections.

Zollner Creek and the Pudding River had all but two detections in the agricultural sites. For chlorpyrifos (Figure III.E.1-2), the estimated and observed concentrations were consistent except that the observed concentrations in Zollner Creek were higher at the highest percentiles. For ethoprop (Figure III.E.1-3), the estimated concentrations were slightly higher than the observed concentrations except for the highest percentiles, at which the observed concentrations were higher than the estimated. For azinphos methyl and diazinon (Figures III.E.1-4 and -5), the estimated concentrations were consistent with those observed in the Pudding River, but were consistently lower than the Zollner creek concentrations.

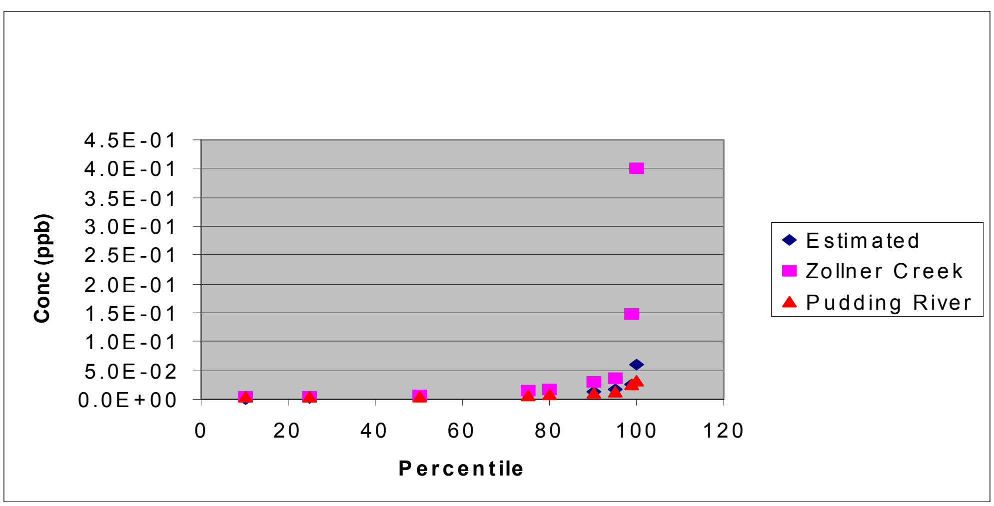

Figure III.E.1-2. Comparison of observed and estimated chlorpyrifos concentrations in the Northwest Region.

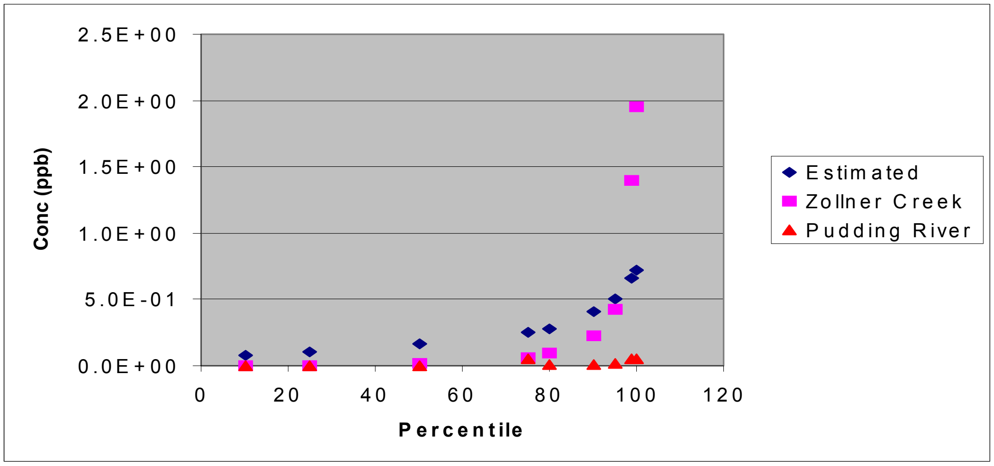

Figure III.E.1-3. Comparison of observed and estimated ethoprop concentrations in the Northwest Region.

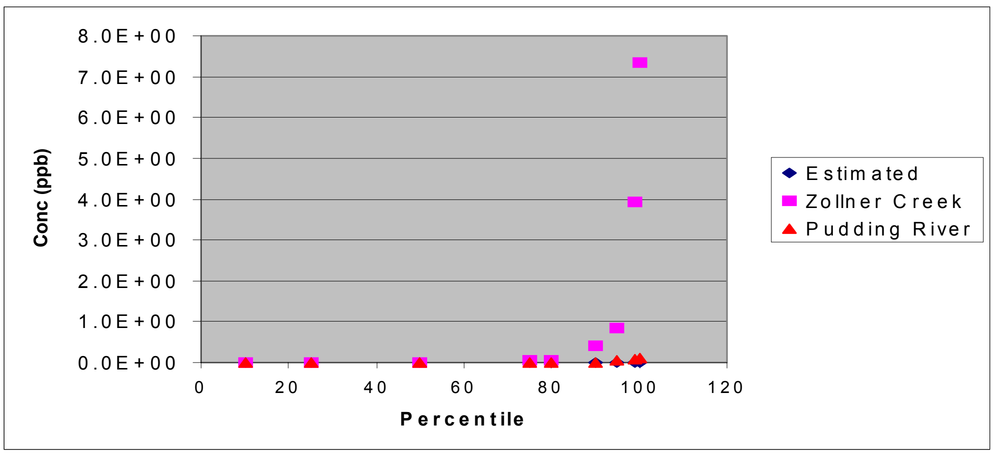

Figure III.E.1-4. Comparison of observed and estimated azinphos methyl concentrations in the Northwest Region.

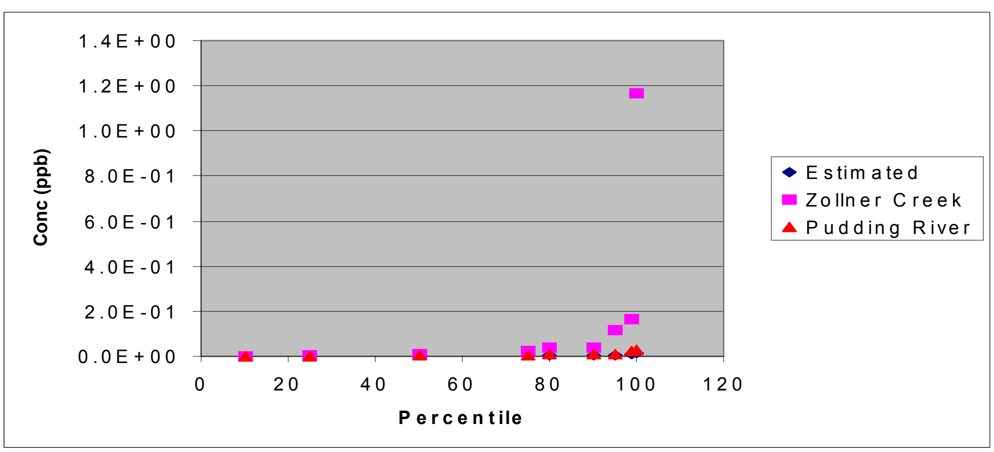

Figure III.E.1-5. Comparison of observed and estimated diazinon concentrations in the Northwest Region.

ii. Summary of NAWQA Monitoring Data in the Region

The great majority of the surface water in the Northwest Region drains to the Columbia River. The Columbia is a highly managed water body, and constitutes an important source of electricity and irrigation water.

The **Willamette Basin (WILL) NAWQA** study unit is located in western Oregon. This is the high-use, high vulnerability region selected to represent the Fruitful Rim, NW through PRZM-EXAMS simulation modeling. Twenty-two percent of land in this basin is devoted to agriculture, and another 70% to forestry. The cities of Portland, Salem and Eugene are located within this study unit. In 1990, 70% of Oregon's population lived in the Willamette Basin (USGS Circular 1161).

Surface water is the predominant source of drinking water in the area. The city of Portland derives its water from the pristine Bull Run Watershed, and is not even required to filter its water. However, water resources in the agricultural Willamette Valley are vulnerable to contamination from agricultural chemicals. Data from the WILL include some of the highest OP concentrations in the NAWQA program.

Four intensive stream-sampling sites were sampled monthly in urban and agricultural areas. Another 44 stream stations throughout the study unit were sampled once each in 1993 and 1994. Azinphos methyl, ethoprop, diazinon, malathion and chlorpyrifos were the active OPs detected in surface water of the WILL.

The highest OP concentrations in this study unit were detected in Zollner Creek, which drains a basin 99% devoted to agriculture. Forty-three pesticides in all were detected at this sampling station. Azinphos methyl was detected in 32% of samples at this site, with a maximum concentration of **7.35 ug/l.** Ethoprop was detected in 75% of Zollner Creek samples, with a maximum detection of 1.95 ug/l. Diazinon and chlorpyrifos were detected in 72% and 65% of samples, with maximum detections of 1.28 and 0.40 ug/l, respectively. The highest concentration of malathion detected in the WILL, 0.24 ug/l, was also detected in Zollner Creek.

Zollner Creek is not a direct source of drinking water. However, it illustrates the possibility of high acute concentrations and OP co-occurrence possible if sampling is undertaken near use sites. Twenty-six of the samples taken from the Zollner Creek had detections of 4 OPs, and five samples had 5 OPs detected together. The NAWQA program does not include monitoring targeted to drinking water intakes downstream from heavy OP use areas. Zollner Creek data indicates that if such a scenario exists, exposure to multiple OPs may be possible.

Ground-water studies in the WILL were designed to assess the quality of vulnerable resources. Seventy shallow domestic wells in alluvial aquifers were sampled once each, as were 53 monitoring wells in the alluvial aquifer located in irrigated and non-irrigated farmland regions. Ten further urban wells were installed near Portland, and sampled once each. Terbufos was the only OP detected, once at <0.01 ug/l.

The **Central Columbia Plateau (CCPT) NAWQA** study unit is located almost completely in the arid region of eastern Washington, spilling over into western Idaho. It is an area with extensive dryland agriculture, with irrigation from the Columbia Basin Irrigation Project in the west, and intermittent areas of ground-water irrigation. Much of the area has few, if any, natural perennial streams. The area is much less prone to surface runoff than the Willamette Valley, which was the region for surface-water modeling scenarios for the cumulative assessment.

Eighty-four percent of drinking-water supply in this region comes from ground water. However, irrigation has changed the local hydrology over the last 50 years. In the western portion of the study unit (Quincy-Pasco subunit), water from the Columbia Basin Irrigation Project has caused a rise in the water table of 50 to 500 feet. Discharge to surface-water bodies is such that NAWQA recommends sampling of irrigation wasteways as a way to monitor trends in atrazine and nitrate concentrations in this region's ground water. Ground-water withdrawals in the North-Central subunit, by contrast, has caused up to a 150-foot decline in the water table in some places.

Ground-water studies included monitoring of ground water near irrigated row crops, orchards, and dryland grains. All three studies included both domestic wells and monitoring wells near fields (generally within 100 feet for row crops and orchards, and edge-of-field for grains). Azinphos-methyl, chlorpyrifos and methyl parathion were all detected in ground water in the CCPT. Azinphos methyl was detected four times (1%) in the orchard study, with a maximum concentration of about 0.2 ug/l. Methyl parathion was detected twice in the same study (max 0.07 ug/l), but orchard uses of methyl parathion are being phased out (Roberts and Jones, 1996).

In addition to fixed sites throughout the study unit, the CCPT included four intensive sites sampling areas of potato, potato and corn, orchard,and wheat culture. **This targeted sampling resulted in greater than average agricultural detection of OPs in surface water**. Every OP included as an analyte was detected in at least one surface-water sample. For instance, azinphos methyl was detected in 16.4% of agricultural samples, with a maximum concentration of 0.5 ug/l. Ethoprop was detected in 9.2% of agricultural samples, with a maximum concentration of 0.22 ug/l. Chlorpyrifos was detected in 27% of agricultural samples, with a maximum concentration of 0.12 ug/l. Diazinon, malathion, methyl parathion, phorate and terbufos were all detected in 6% of samples or fewer, with maximum concentrations of <0.1 ug/l.

Every OP was also detected in stream samples described as "mixed use." While the frequency of detection overall was less than in agricultural streams, the maximum concentrations were higher. For instance, the maximum concentration of disulfoton in these streams was **3.8 ug/l.** The rest of the OPs were detected at < 1.0 ug/l, but mostly with maximum concentrations of above 0.1 ug/l.

Therefore, higher frequencies and concentrations of OPs were found by targeted monitoring in this semi-arid area, just as they were at the Zollner Creek in the Willamette Valley.

Only 6% of land in the **Puget Sound Basin (PUGT) NAWQA** study unit is dedicated to agriculture. Drinking water in this region is drawn about equally from surface-water and ground-water sources.

No OPs were detected in three ground-water monitoring programs sampling from the Fraser aquifer in the "Puget Lowlands." The Fraser is a shallow, unconfined, glacial aquifer which underlies the main agricultural region in the study unit. Surface-water studies in the PUGT included 4 intensive study sites (2 agricultural, 1 urban, 1 mixed-use) that were sampled weekly to monthly for a year (two for urban samples). In addition, 13 urban and residential sites were sampled 2 to 4 times each in response to detections of diazinon and other urban-use chemicals.

Diazinon was detected in 47% of agricultural surface-water samples , with a maximum concentration of 0.113 ug/l. Diazinon was detected in 84% of urban stream samples. Chlorpyrifos was only detected in urban or mixed-use samples. The only other OPs detected were malathion (1 of 20 detections from agricultural use, maximum concentration 0.087 ug/l) and ethoprop (3 detections, maximum 0.019 ug/l).

Table III.E.1-4. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Northwest Region

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Willamette River Basin										
All Locations	Maximum	0.401	1.280	0.021	1.950	0.237	7.350	0.006	0.011	0.017
	99th	0.060	0.192	0.021	0.558	0.029	0.914	0.006	0.011	0.017
	95th	0.023	0.061	0.021	0.099	0.027	0.081	0.006	0.011	0.017
	90th	0.014	0.029	0.017	0.033	0.020	0.050	0.006	0.002	0.013
	80th	0.008	0.013	0.017	0.009	0.005	0.001	0.006	0.002	0.013
	75th	0.006	0.009	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	39.3%	49.9%	0.0%	28.7%	4.5%	9.7%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.401	1.280	0.021	1.950	0.237	7.350	0.006	0.011	0.017

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	99th	0.099	0.722	0.021	1.011	0.075	2.289	0.006	0.011	0.017
	95th	0.032	0.136	0.021	0.269	0.027	0.555	0.006	0.011	0.017
	90th	0.018	0.045	0.017	0.115	0.020	0.173	0.006	0.002	0.013
	80th	0.011	0.017	0.017	0.046	0.005	0.040	0.006	0.002	0.013
	75th	0.010	0.013	0.017	0.031	0.005	0.023	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	Frequency	48.0%	59.2%	0.0%	52.3%	6.6%	20.9%	0.0%	0.0%	0.0%
Ag: Zollner Creek only	Maximum	0.401	1.280	0.021	1.950	0.237	7.350	0.006	0.011	0.017
	99th	0.147	1.167	0.021	1.402	0.136	3.927	0.006	0.011	0.017
	95th	0.036	0.165	0.021	0.421	0.027	0.854	0.006	0.011	0.017
	90th	0.029	0.119	0.021	0.227	0.027	0.415	0.006	0.011	0.017
	80th	0.017	0.037	0.017	0.099	0.010	0.050	0.006	0.002	0.013
	75th	0.014	0.025	0.017	0.063	0.005	0.050	0.006	0.002	0.013
	50th	0.006	0.010	0.017	0.018	0.005	0.001	0.006	0.002	0.013
	Frequency	64.8%	71.6%	0.0%	75.0%	6.8%	32.2%	0.0%	0.0%	0.0%
Ag Besides Zollner Creek	Maximum	0.032	0.170	0.017	0.054	0.013	0.099	0.006	0.002	0.013
	99th	0.023	0.082	0.017	0.043	0.012	0.077	0.006	0.002	0.013
	95th	0.011	0.010	0.017	0.013	0.007	0.001	0.006	0.002	0.013
	90th	0.009	0.009	0.017	0.006	0.005	0.001	0.006	0.002	0.013
	80th	0.005	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.0%	42.2%	0.0%	20.6%	6.3%	4.9%	0.0%	0.0%	0.0%
Forest/ Reference	Maximum	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	99th	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	95th	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.046	0.112	0.021	0.009	0.052	0.171	0.006	0.011	0.017
	99th	0.046	0.105	0.021	0.009	0.042	0.126	0.006	0.011	0.017
	95th	0.040	0.067	0.021	0.007	0.027	0.050	0.006	0.011	0.017
	90th	0.029	0.057	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.020	0.033	0.017	0.005	0.019	0.001	0.006	0.002	0.013
	75th	0.016	0.031	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	50th	0.006	0.023	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	60.0%	97.5%	0.0%	13.2%	10.0%	2.6%	0.0%	0.0%	0.0%
Mixed	Maximum	0.014	0.031	0.021	0.029	0.027	0.050	0.006	0.011	0.017
	99th	0.013	0.023	0.021	0.024	0.027	0.050	0.006	0.011	0.017
	95th	0.007	0.009	0.021	0.013	0.027	0.050	0.006	0.011	0.017
	90th	0.006	0.006	0.017	0.005	0.005	0.001	0.006	0.002	0.013
	80th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	38.3%	43.5%	0.0%	14.8%	2.6%	0.9%	0.0%	0.0%	0.0%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Upper Snake River										
All locations	Maximum	0.190	0.095	0.017	0.004	0.020	0.031	0.006	0.012	0.013
	99th	0.011	0.009	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	3.0%	3.4%	0.0%	1.3%	0.4%	0.9%	0.0%	0.4%	0.0%
Agricultural	Maximum	0.190	0.095	0.017	0.003	0.020	0.031	0.006	0.012	0.013
	99th	0.072	0.041	0.017	0.003	0.005	0.003	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	4.2%	4.2%	0.0%	0.0%	0.6%	1.2%	0.0%	0.6%	0.0%
Forest/ Reference	Maximum	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.004	0.002	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.002	0.017	0.004	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	1.6%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%
Central Columbia Plateau										
All locations	Maximum	0.120	0.270	3.810	0.220	0.130	0.500	0.300	0.062	0.096
	99th	0.088	0.059	0.024	0.059	0.027	0.128	0.091	0.011	0.017
	95th	0.022	0.010	0.017	0.005	0.012	0.055	0.006	0.002	0.013
	90th	0.009	0.005	0.017	0.004	0.005	0.040	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.010	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	18.9%	7.7%	2.1%	8.3%	3.5%	9.9%	1.3%	0.5%	0.5%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethopro p	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Agricultural	Maximum	0.120	0.100	0.035	0.220	0.093	0.500	0.094	0.045	0.087
	99th	0.116	0.052	0.022	0.107	0.027	0.134	0.007	0.011	0.017
	95th	0.057	0.005	0.017	0.005	0.011	0.072	0.006	0.002	0.013
	90th	0.016	0.002	0.017	0.004	0.005	0.050	0.006	0.002	0.013
	80th	0.006	0.002	0.017	0.003	0.005	0.013	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	26.7%	6.2%	3.1%	9.2%	5.6%	16.4%	2.1%	0.5%	0.5%
Mixed	Maximum	0.108	0.116	3.810	0.115	0.130	0.257	0.300	0.062	0.096
	99th	0.043	0.051	0.029	0.033	0.027	0.078	0.158	0.012	0.017
	95th	0.010	0.010	0.021	0.005	0.023	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.017	0.005	0.005	0.030	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	11.4%	11.4%	1.1%	7.4%	1.1%	2.8%	0.6%	0.6%	0.6%
Puget Sound Basin										
All locations	Maximum	0.075	0.501	0.021	0.019	0.087	0.050	0.006	0.011	0.017
	99th	0.029	0.411	0.021	0.006	0.073	0.050	0.006	0.011	0.017
	95th	0.005	0.155	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.107	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.004	0.050	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.031	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	2.4%	50.7%	0.0%	1.4%	9.4%	0.0%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.004	0.113	0.017	0.013	0.025	0.001	0.006	0.002	0.013
	99th	0.004	0.102	0.017	0.011	0.020	0.001	0.006	0.002	0.013
	95th	0.004	0.066	0.017	0.004	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.053	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	47.1%	0.0%	5.9%	2.9%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.075	0.501	0.021	0.005	0.087	0.050	0.006	0.011	0.017
	99th	0.033	0.486	0.021	0.005	0.078	0.050	0.006	0.011	0.017
	95th	0.015	0.285	0.018	0.003	0.038	0.001	0.006	0.002	0.013
	90th	0.006	0.171	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.004	0.108	0.017	0.003	0.013	0.001	0.006	0.002	0.013
	75th	0.004	0.093	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.031	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	5.3%	84.2%	0.0%	0.0%	17.9%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.005	0.083	0.021	0.019	0.027	0.050	0.006	0.011	0.017
	99th	0.005	0.060	0.021	0.008	0.027	0.050	0.006	0.011	0.017

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	95th	0.005	0.011	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.004	0.007	0.018	0.005	0.009	0.011	0.006	0.004	0.014
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	15.2%	0.0%	1.3%	2.5%	0.0%	0.0%	0.0%	0.0%

c. Region C: Arid/Semiarid West

Estimated concentrations for individual OP pesticides in the region were in the sub-part per billion range (Table III.E.1-5). Several OPs – chlorpyrifos, diazinon, disulfoton, methidathion, and phorate– had estimated maximum concentrations of 0.1 to 0.3 ppb. At the 99th percentile level, only diazinon had an estimated concentration greater than 0.1 ppb. More detailed discussion and analysis of the OP load in drinking water sources can be found in section II.C.

Table III.E.1-5. Estimated percentile concentrations of individual OP pesticides and of the cumulative OP distribution in the Arid/Semiarid West Region.

Chemical	Crop/Use	Concentration in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
Acephate	Legume vegetables, tomato	1.6e-02	1.3e-02	8.5e-03	5.0e-03	3.7e-04	1.0e-04	3.7e-06
Azinphos Methyl	Apples, pears; nuts (almonds, walnuts)	3.8e-02	5.7e-03	2.5e-03	1.8e-03	1.3e-03	1.1e-03	4.7e-04
Chlorpyrifos	Nuts; fruit trees; alfalfa; sugarbeets; corn; grapes; tomato; asparagus	1.3e-01	5.4e-02	3.7e-02	3.0e-02	2.3e-02	2.0e-02	1.2e-02
Diazinon	nuts; fruit trees; grapes; brassicas; tomato; melons	2.3e-01	1.4e-01	8.1e-02	5.6e-02	3.2e-02	2.5e-02	9.9e-03
DDVP	Naled degradate	1.3e-03	1.9e-04	9.4e-06	6.3e-07	2.6e-09	1.4e-10	8.2e-13
Dimethoate	Fruit trees; alfalfa; corn; grapes; legumes; tomatoes; brassicas; melons	8.4e-02	2.2e-02	1.6e-02	1.3e-02	8.0e-03	5.4e-03	1.4e-03
Disulfoton	Asparagus	1.2e-01	4.9e-02	3.7e-02	3.3e-02	2.8e-02	2.6e-02	1.7e-02
Malathion	Alfalfa; corn; grapes, legumes; tomatoes; asparagus	8.3e-03	1.9e-03	1.2e-03	7.9e-04	3.0e-04	1.2e-04	2.8e-08
Methamidophos	Acephate degradate; tomato; sugarbeet; legume; brassicas	1.3e-02	3.0e-03	1.6e-03	9.6e-04	3.6e-04	2.3e-04	4.6e-06
Methyl Parathion	Alfalfa	5.3e-03	2.6e-03	1.4e-03	8.6e-04	1.4e-04	4.7e-05	4.3e-08
Methidathion	Nut trees; fruit trees	1.5e-01	6.5e-02	3.5e-02	2.0e-02	8.4e-03	5.8e-03	7.6e-04
Naled	Nut trees; fruit trees; sugarbeets; grapes; legumes	4.4e-03	9.0e-04	5.3e-05	1.0e-05	2.3e-07	1.2e-08	2.1e-12
ODM	Sugarbeet; brassicas; melons	3.8e-03	2.2e-03	1.1e-03	6.7e-04	3.9e-04	3.2e-04	1.4e-04
Phorate	Sugarbeet, corn	2.6e-01	1.0e-02	5.1e-04	4.2e-05	3.5e-07	3.2e-08	3.5e-12
Phosmet	nut trees; fruit trees; alfalfa	3.2e-02	3.0e-03	6.1e-04	6.3e-05	1.4e-06	2.3e-07	1.2e-11
OP cumulative concentration in methamidophos equivalents		7.6e-01	2.2e-01	1.6e-01	1.4e-01	1.2e-01	1.1e-01	7.6e-02

i. Comparison of Monitoring Data versus Model Estimates

In comparison to NAWQA monitoring from agricultural sites in the San Joaquin-Tulare Basin, estimated concentrations for individual OP pesticides tended to be similar to or less than reported detections in the NAWQA study unit. Reported detections of azinphos methyl,malathion, and methyl parathion were an order of magnitude greater than the estimated concentrations for the 75th to 90th percentiles and greater. The 99th percentile of monitoring detections for diazinon was an order of magnitude greater than estimated concentrations. Estimated chlorpyrifos distributions through the median and diazinon distributions below the 99th percentile were similar to the distributions of monitoring concentrations in the agricultural streams. Neither phorate nor disulfoton were detected in the NAWQA study. Approximately 99 percent of the estimated concentrations for phorate fell below the USGS analytical limit of detection (LOD). The estimated maximum concentration for disulfoton was 7 times greater than the LOD; 99[th] and 95[th] percentile estimates were roughly 2 times greater than the LOD.

Numerous co-occurrences of chlorpyrifos and diazinon were observed in many of the agricultural sites. For chlorpyrifos (Figure III.E.1-6) and diazinon (Figure III.E.1-7) concentrations in a representative water body such as Orestimba Creek, the estimated concentrations were consistent with the lower percentiles of monitoring data in Orestimba creek, but were lower at the highest percentiles.

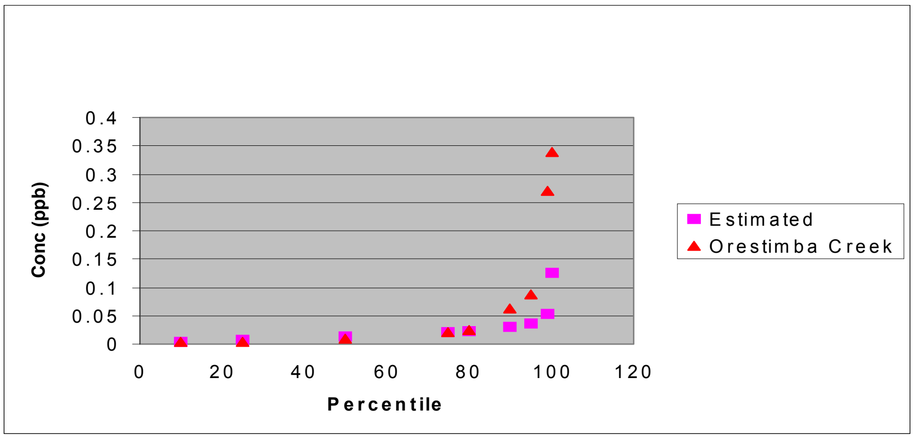

Figure III.E.1-6. Comparison of observed and estimated chlorpyrifos concentrations in the Arid/Semiarid West Region.

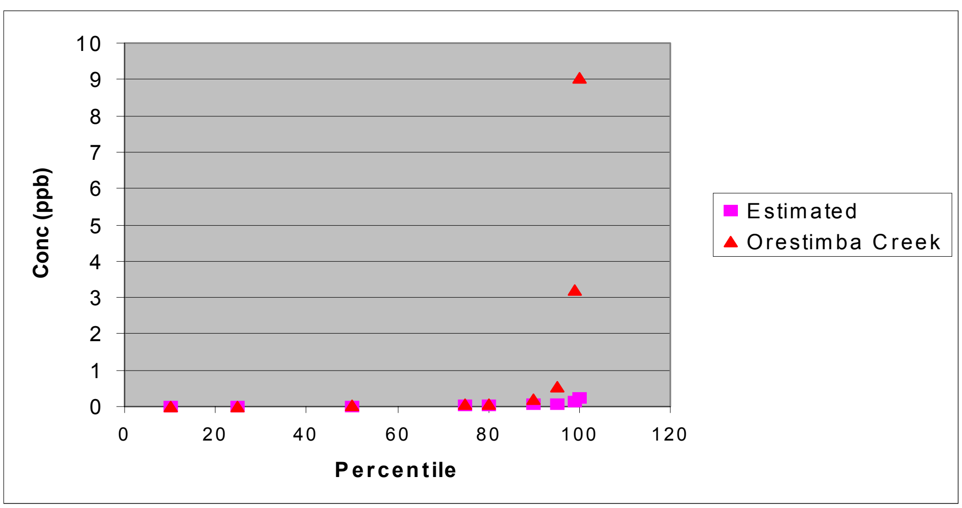

Figure III.E.1-7. Comparison of observed and estimated diazinon concentrations in the Arid/Semiarid West Region.

ii. Summary of NAWQA Monitoring Data in the Region

The **Sacramento River Basin (SACR) NAWQA** study site includes the Sacramento Valley in the West region. The Sacramento River is the largest river in the State of California, and is a highly managed water body which meets the needs of the more than one million people in the Sacramento area. The USGS indicates that while the concentrations of OP insecticides in agricultural and urban streams in this region "sometimes exceed amounts that are toxic to zooplankton in laboratory tests, the toxicity is greatly reduced or eliminated when concentrations of these pesticides are diluted by the Sacramento River" (USGS Water Resources Circular 1215).

Surface-water monitoring included 3 intensive sampling sites, including the Colusa Basin Drain, which in the late 1980s had elevated concentrations of methyl parathion and malathion detected. Since that time, a program to reduce spray drift and increase paddy-water holding time has reduced detected concentrations dramatically. A description of this program is included in the State Monitoring Appendix. An urban intensive study site was also sampled.

In the SACR study, chlorpyrifos, diazinon, malathion and azinphos-methyl were detected in surface water. Diazinon was detected in 71% of agricultural samples, and 35% of mixed land-use samples, with a maximum concentration of slightly over 0.1 ug/l. Chlorpyrifos was detected in 29% of agiricultural samples, and a single mixed land-use sample, with a maximum concentration detected of about 0.05 ug/l. Malathion was detected in 53% of urban samples and 33% of agricultural samples, with a maximum detection of nearly 1 ug/l.

The **San Joaquin-Tulare Basins (SANJ) NAWQA** study site includes the southern Central Valley of California. Surface water accounts for more overall water use than ground water, but ground water is the predominant source of drinking water in this region (USGS Water Resources Circular 1159). Irrigation accounts for the greatest amount of water use, and is also the greatest source of aquifer recharge, which can lead to contamination of ground water with agricultural chemicals.

Ground-water monitoring in the SANJ included single samples from 30 domestic wells around the eastern portion of the valley. Monitoring also included in single samples from 20 domestic wells and 10 monitoring wells each in almond, vineyard and row crop land-use ground-water studies. More than 50% of the monitoring wells in each of these studies was within a quarter-mile of cropped fields. Chlorpyrifos, malathion and diazinon were detected in one, two and three ground water samples, respectively. One detection of malathion at 0.1 ug/l was the highest OP concentration detected in ground water.

The SANJ report specifically mentions that "high concentrations of organophosphate insecticides, resulting from application to some orchards during the winter, are of particular concern" (USGS Water Resources Circular 1159). Surface-water monitoring included biweekly to monthly sampling at intensive agricultural, rangeland and urban sites in 1993. Another 23 sites were sampled once at low flow in urban and agricultural areas.

Diazinon was detected in 71% of samples taken, with a maximum concentration of 3.8 ug/l. Chlorpyrifos was detected in 52 % of samples, with a maximum concentration of about 0.5 ug/l. Azinphos methyl was also extensively (12%) detected, with a maximum concentration of about 1.0 ug/l. Malathion was detected in 8% of samples, with a maximum concentration between 0.5 and 1.0 ug/l. Ethoprop, disulfoton, methyl parathion and terbufos were detected in fewer than 1% of samples analyzed.

The maximum concentrations of chlorpyrifos were detected in samples taken around the winter application season.

The USGS San Joaquin River Basin study included a study designed to determine sampling frequency needed to characterize the occurrence and distribution of pesticides in surface water in a semiarid agricultural region such as the SJRB. Results indicated that sampling three times per week is more likely to detect higher concentrations than once per week as indicated by the larger variance about the median for the more frequent sampling. Sampling once per week is sufficient if only the median concentration is important.

The **Central Arizona Basins (CAZB) NAWQA** study unit is located in southern and central Arizona. The dominant source of drinking water in central Arizona are deep basin aquifers, some of which may have been recharged thousands of years ago. At the very least, 55% of wells tested in the Central Arizona Basins NAWQA study area (CAZB) were recharged before 1953 (USGS Water Resources Circular 1213).

Alluvial deposits in the vicinity of major streams in Arizona range in thickness up to about 300 feet, and where locally saturated serve as aquifers. Chlorpyrifos was detected in a single sample from a shallow monitoring well in the CAZB study unit, but no OP was detected in samples from wells installed in the deeper aquifers. Although a single sampling of a well network is not definitive in determining the likelihood of pesticide contamination, the depth of the aquifers, combined with the very low rainfall for the region, result in very slow recharge rates which may delay contamination by OP residues for a long time.

Surface-water monitoring in this region included two intensive sampling sites from agricultural streams, and three other fixed sites which were sampled quarterly. Diazinon was detected in 97% of samples, and chlorpyrifos in 94%, all below 0.5 ug/l. malathion was detected in 26% of samples at similar concentrations. Disulfoton was detected once at nearly 1 ug/l. Azinphos methyl, methyl parathion and phorate are also reported to have been detected in surface water.

However, while these mixed agricultural/urban streams may be effected ecologically by this contamination, they are not used as drinking water sources. The two streams (Buckeye Canal and Hassayampa River) are typical of most in the region, in that flow is maintained through addition of treated wastewater effluent and irrigation return water.

Table III.E.1-6. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Arid/Semiarid West Region

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
San Joaquin-Tulare Basins										
All Locations	Maximum	0.340	9.050	0.060	0.029	0.390	1.000	0.090	<0.06	0.100
	99th	0.182	1.148	<0.021	0.011	0.068	0.210	0.021	<0.018	0.018
	95th	0.053	0.340	<0.021	<0.005	0.027	0.056	<0.006	<0.011	<0.017
	90th	0.030	0.170	<0.021	<0.005	0.027	0.050	<0.006	<0.011	<0.017
	80th	0.015	0.080	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	75th	0.012	0.055	<0.017	<0.003	<0.015	<0.050	<0.006	<0.003	<0.013
	50th	0.005	0.016	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	61.3%	83.9%	0.1%	1.2%	13.8%	10.5%	0.3%	0.0%	0.3%
Agricultural	Maximum	0.340	9.050	<0.050	0.029	0.390	1.000	0.090	<0.06	0.100
	99th	0.258	2.180	<0.021	0.018	0.126	0.276	0.056	<0.047	0.020
	95th	0.085	0.360	<0.021	<0.005	0.027	0.099	<0.006	<0.011	<0.017
	90th	0.042	0.160	<0.021	<0.005	0.027	0.060	<0.006	<0.011	<0.017
	80th	0.025	0.082	<0.017	<0.003	<0.009	0.050	<0.006	<0.003	<0.013
	75th	0.019	0.066	<0.017	<0.003	<0.005	0.045	<0.006	<0.002	<0.013
	50th	0.008	0.020	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	66.9%	85.3%	0.0%	2.9%	12.6%	24.6%	0.6%	0.0%	0.3%
Mixed	Maximum	0.260	2.900	<0.021	0.010	0.160	0.400	0.018	<0.06	0.024
	99th	0.069	0.764	<0.021	<0.005	0.037	0.059	<0.006	<0.011	<0.017
	95th	0.030	0.230	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	90th	0.017	0.150	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	80th	0.011	0.067	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	75th	0.009	0.047	<0.021	<0.005	<0.019	<0.050	<0.006	<0.011	<0.017
	50th	0.005	0.013	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.017
	Frequency	57.4%	82.9%	0.0%	0.3%	12.2%	3.2%	0.2%	0.0%	0.3%
Sacramento R. Basin										
All Locations	Maximum	0.045	1.380	<0.021	<0.005	0.634	0.500	<0.006	<0.011	<0.017
	99th	0.033	0.780	<0.021	<0.005	0.139	0.237	<0.006	<0.011	<0.017
	95th	0.019	0.425	<0.021	<0.005	0.054	<0.050	<0.006	<0.011	<0.017
	90th	0.015	0.296	<0.021	<0.005	0.028	<0.050	<0.006	<0.011	<0.017
	80th	0.007	0.177	<0.017	<0.003	0.027	<0.017	<0.006	<0.002	<0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
Concentation (ug/L)										
	75th	0.005	0.089	<0.017	<0.003	0.027	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.009	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	26.5%	67.7%	0.0%	0.0%	25.2%	1.3%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.016	0.106	<0.021	<0.005	0.054	<0.050	<0.006	<0.011	<0.017
	99th	0.016	0.103	<0.021	<0.005	0.053	<0.050	<0.006	<0.011	<0.017
	95th	0.016	0.082	<0.021	<0.005	0.036	<0.050	<0.006	<0.011	<0.017
	90th	0.014	0.063	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	80th	0.008	0.034	<0.017	<0.003	0.027	<0.001	<0.006	<0.002	<0.013
	75th	0.005	0.030	<0.017	<0.003	0.023	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.008	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	26.5%	76.5%	0.0%	0.0%	29.4%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.045	1.380	<0.021	<0.005	0.634	0.500	<0.006	<0.011	<0.017
	99th	0.041	1.186	<0.021	<0.005	0.458	0.464	<0.006	<0.011	<0.017
	95th	0.032	0.751	<0.021	<0.005	0.137	0.159	<0.006	<0.011	<0.017
	90th	0.026	0.563	<0.017	<0.003	0.083	<0.062	<0.006	<0.002	<0.013
	80th	0.020	0.434	<0.017	<0.003	0.055	<0.024	<0.006	<0.002	<0.013
	75th	0.017	0.410	<0.017	<0.003	0.048	<0.001	<0.006	<0.002	<0.013
	50th	0.009	0.275	<0.017	<0.003	0.015	<0.001	<0.006	<0.002	<0.013
	Frequency	78.4%	100.0%	0.0%	0.0%	56.8%	2.7%	0.0%	0.0%	0.0%
Mixed	Maximum	0.006	0.154	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	99th	0.005	0.071	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	95th	<0.005	0.049	<0.021	<0.005	0.027	<0.050	<0.006	<0.011	<0.017
	90th	<0.005	0.035	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	80th	<0.005	0.015	<0.019	<0.004	<0.024	<0.028	<0.006	<0.006	<0.015
	75th	<0.004	0.011	<0.017	<0.003	<0.01	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.003	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	3.6%	50.0%	0.0%	0.0%	9.5%	1.2%	0.0%	0.0%	0.0%
Central Arizona Basin										
All Locations	Maximum	0.154	0.207	0.826	<0.005	0.270	0.300	0.521	0.080	<0.017
	99th	0.152	0.132	0.775	<0.005	0.256	0.242	0.503	0.013	<0.017
	95th	0.067	0.111	0.021	<0.005	0.243	0.091	0.256	0.011	<0.017
	90th	0.047	0.102	<0.018	<0.003	0.118	0.050	0.036	<0.010	<0.013
	80th	0.029	0.082	<0.017	<0.003	0.027	0.006	<0.006	<0.002	<0.013
	75th	0.025	0.077	<0.017	<0.003	0.015	<0.001	<0.006	<0.002	<0.013
	50th	0.016	0.056	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	82.7%	82.7%	4.1%	0.0%	24.5%	1.0%	9.2%	5.1%	0.0%
Agricultural	Maximum	0.154	0.207	0.826	<0.003	0.270	0.300	0.521	0.080	<0.013
	99th	0.153	0.170	0.801	<0.003	0.263	0.204	0.512	0.047	<0.013
	95th	0.122	0.083	0.747	<0.003	0.252	<0.074	0.453	0.011	<0.013
	90th	0.067	0.079	<0.017	<0.003	0.160	<0.032	0.259	0.004	<0.013
	80th	0.047	0.070	<0.017	<0.003	0.017	<0.001	0.036	<0.002	<0.013
	75th	0.038	0.058	<0.017	<0.003	0.013	<0.001	<0.006	<0.002	<0.013
	50th	0.020	0.037	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
Concentation (ug/L)										
	Frequency	93.8%	89.6%	8.3%	0.0%	29.2%	2.1%	18.8%	10.4%	0.0%
Mixed	Maximum	0.043	0.123	<0.017	<0.003	0.243	<0.24	<0.006	<0.002	<0.013
	99th	0.039	0.119	<0.017	<0.003	0.213	<0.226	<0.006	<0.002	<0.013
	95th	0.032	0.112	<0.017	<0.003	0.131	<0.12	<0.006	<0.002	<0.013
	90th	0.029	0.110	<0.017	<0.003	0.119	<0.048	<0.006	<0.002	<0.013
	80th	0.025	0.103	<0.017	<0.003	0.018	<0.001	<0.006	<0.002	<0.013
	75th	0.024	0.100	<0.017	<0.003	0.006	<0.001	<0.006	<0.002	<0.013
	50th	0.017	0.074	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	94.6%	100.0%	0.0%	0.0%	27.0%	0.0%	0.0%	0.0%	0.0%

d. Region D: Northeast/ North Central

Terbufos, which accounted for three-fourths of total OP use in the assessment area, dominated the cumulative load for the region(Table III.E.1-7). More detailed discussion and analysis of the OP load in drinking water sources can be found in section II.D.

Table III.E.1-7. Predicted percentile concentrations of individual OP pesticides and of the cumulative OP distribution in the Northeast/North Central Region.

Chemical	Crop/Use	Concentrations in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
AzinphosMethyl	Potato	4.9e-02	2.2e-02	1.2e-02	7.2e-03	4.2e-03	3.1e-03	7.0e-04
Chlorpyrifos	Sugarbeet, Wheat	4.7e-02	2.6e-02	1.5e-02	1.1e-02	6.2e-03	4.7e-03	1.4e-03
Dimethoate	Potato	3.8e-02	7.4e-03	2.8e-03	1.1e-03	2.2e-04	1.2e-04	1.6e-05
Phorate	Sugar beet	5.6e-02	2.5e-03	7.9e-05	2.8e-06	2.9e-09	8.2e-11	3.8e-13
Terbufos	Sugar beet	1.9e+00	5.9e-01	1.9e-01	7.9e-02	2.0e-02	1.1e-02	1.7e-03
OP Cumulative Concentrations in Methamidophos equivalents		4.9e+00	1.5e+00	4.8e-01	2.0e-01	5.5e-02	3.0e-02	5.5e-03

i. Comparison of Monitoring Data versus Model Estimates

A comparison of estimated concentrations for individual OP pesticides with NAWQA monitoring indicates that the predicted maximum and 99th percentile concentrations of chlorpyrifos, azinphos methyl, and phorate were similar to monitoring detections in the Red River Basin. The highest reported detection for terbufos was equivalent to the estimated 90th percentile concentration. However, the model estimates include the more persistent and mobile sulfone and sulfoxide residues, while the monitoring only represents the parent concentrations.

In the 28 agricultural sampling sites, only the Snake River (combined locations), Turtle River, and the Tamarac River had any detections of OP's. Neither terbufos nor phorate were detected. However, it is important to note that parent terbufos and phorate rapidly form sulfoxide and sulfone metabolites, and the analytical method may be for parent only. Azinphos methyl, was the only OP detected from a site other than the Snake River and the Turtle River. Estimated and observed concentrations of cchlorpyrifos (Figure III.E.1-8) were consistent throughout all percentiles.

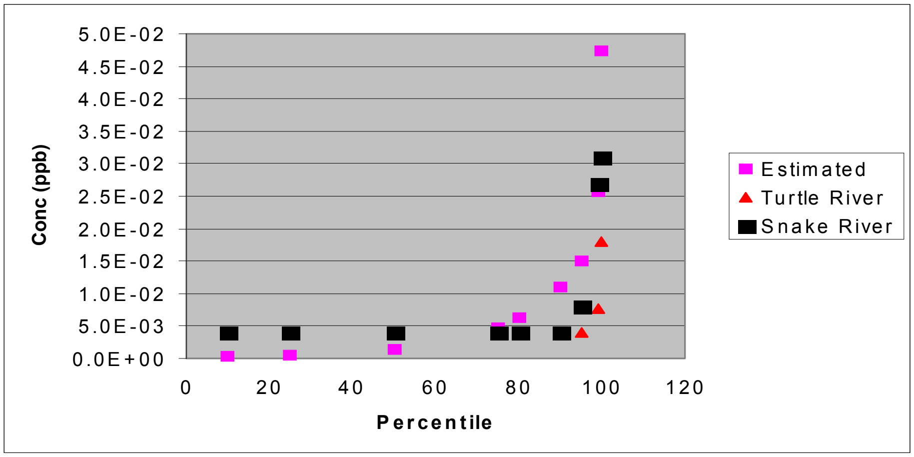

Figure III.E.1-8. Comparison of observed and estimated chlopryrifos concentrations in the Northeast/North Central Region.

In the preliminary assessment, the estimated peak and upper percentile concentrations of chlorpyrifos in the Heartland region (central Illinois) are roughly equivalent to the concentrations detected in the agricultural watersheds of the Lower Illinois River Basin (LIRB) while the maximum estimated concentration of total terbufos residues (parent plus toxic sulfoxide and sulfone transformation products) was an order of magnitude greater than the maximum detection reported for the parent terbufos (without the transformation products) in the LIRB. The maximum detection of terbufos in NAWQA fell between the 90^{th} and 95^{th} percentile of estimated concentrations to total terbufos residues. Between 80 and 90 percent of the estimated terbufos concentrations were below the analytical level of detection.

ii. Summary of NAWQA Monitoring Data in the Region

Stream-water sampling in the **Red River of the North Basin (REDN) NAWQA** study unit included a study of intensive agriculture areas, in which 5 stations were sampled at least monthly and during runoff events between 1993 and 1995. Chlorpyrifos is the OP most often detected in the REDN study unit. Chlorpyrifos was detected in 14 samples, but only five of these were samples from streams identified as "agricultural" (maximum concentration 0.031 ug/l). The nine other chlorpyrifos detections, and the three reported diazinon detections, were from "mixed land-use" (MLU) streams, and may not represent agricultural contamination. Malathion, disulfoton, ethoprop, methyl parathion, phorate, terbufos, and azinphos methyl were also detected in surface water samples.

Malathion is the only OP which was detected in ground water. This single detection was at a concentration below 0.01 ug/l. this sample was taken from the unconsolidated glacial aquifer. No pesticides of any kind (including herbicides) were detected in five samples from buried glacial aquifers or six samples from older bedrock aquifers (Cowdery, 1998).

Table III.E.1-8. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Northern Great Plains Portion of the Northeast/North Central Region.

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Red River Basin										
All Locations	Maximum	0.087	0.104	0.080	0.099	0.290	0.117	0.114	0.078	0.080
	99th	0.020	0.004	<0.017	0.004	0.020	<0.001	0.010	<0.002	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	4.5%	1.0%	0.3%	0.6%	3.5%	0.6%	1.0%	0.3%	0.3%
Agriculture	Maximum	0.031	<0.005	<0.020	0.004	0.290	0.01	<0.010	<0.020	<0.013
	99th	0.018	<0.002	<0.017	<0.004	0.016	<0.003	<0.006	<0.002	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	2.8%	0.0%	0.0%	0.6%	1.7%	0.6%	0.0%	0.0%	0.0%
Mixed	Maximum	0.087	0.104	0.080	0.0992	0.107	0.117	0.114	0.078	0.080
	99th	0.028	0.009	<0.017	<0.003	0.036	<0.001	0.068	<0.012	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	0.009	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	7.2%	2.4%	0.8%	0.8%	6.3%	0.8%	2.4%	0.8%	0.8%
Upper Mississippi River Basin										
All Locations	Maximum	0.060	0.190	<0.021	0.020	0.0543	0.0148	<0.006	<0.011	<0.017
	99th	0.007	0.102	<0.021	<0.005	0.042	<0.137	<0.006	<0.011	<0.017
	95th	<0.004	0.053	<0.017	<0.003	<0.015	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	0.022	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	0.007	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	1.7%	24.3%	0.0%	0.6%	3.2%	0.3%	0.0%	0.0%	0.0%
Agricultural	Maximum	<0.060	<0.005	<0.021	0.020	0.0061	<0.050	<0.006	<0.011	<0.017
	99th	<0.020	<0.005	<0.021	0.009	0.150	<0.050	<0.006	<0.011	<0.017
	95th	<0.004	<0.002	<0.017	<0.004	<0.027	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	0.0%	0.0%	0.0%	2.7%	1.4%	0.0%	0.0%	0.0%	0.0%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Urban	Maximum	0.064	0.300	<0.021	<0.005	0.078	0.039	<0.006	<0.011	0.033
	99th	0.040	0.232	<0.021	<0.005	0.027	0.039	<0.006	<0.011	0.018
	95th	0.021	0.113	<0.017	<0.003	0.020	<0.007	<0.006	<0.002	<0.013
	90th	0.015	0.060	<0.017	<0.003	0.010	<0.001	<0.006	<0.002	<0.013
	80th	0.008	0.028	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	0.005	0.020	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	32.6%	59.1%	0.0%	0.0%	11.4%	2.3%	0.0%	0.0%	0.8%
Mixed	Maximum	0.006	0.009	<0.021	<0.005	0.0051	0.400	<0.006	<0.011	<0.017
	99th	0.005	0.008	<0.021	<0.005	<0.027	0.200	<0.006	<0.011	<0.017
	95th	<0.004	0.006	<0.017	<0.003	<0.005	<0.040	<0.006	<0.002	<0.013
	90th	<0.004	0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	80th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	50th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	2.0%	13.2%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%

In the corn-soybean dominated **Lower Ilinois River Basin (LIRB)** unit, chlorpyrifos and diazinon were the OPs most often detected in surface water, with peak concentrations detected in July and August. Diazinon was detected in 30% of samples overall (75 detections), but in <5% of agricultural streams (8 detections), with a maximum agricultural concentration of 0.071 ug/l. By contrast, 29 of the 37 detections of chlorpyrifos were in agricultural streams (18% of samples from agricultural areas), with a maximum concentration of 0.30 ug/l. Malathion (four detections, maximum 0.027 ug/l), methyl parathion (1 detection, 0.211 ug/l), and terbufos (3 detections, max 0.03 ug/l) were also detected in surface water. All but one detection of malathion were in streams draining agricultural areas.

Only one detection of diazinon (,0.01 ug/l) was reported for all OPs in ground water. This detection occurred in one of 60 samples taken from domestic and public supply wells in “major aquifers” in the study unit. No OPs were detected in a land-use study in which “very shallow monitoring wells” were sampled in areas of corn and soybean production. The ground water that was sampled from the 57 wells was generally less than 10 years old.

The **White River Basin (WHIT)** study unit is located in central and southern Indiana. Agriculture accounts for 70% of land use in the study unit, with corn and soy as the predominant crops. As in the LIRB, atrazine and metolachlor were detected in all samples. Sampling took place between 1992 and 1996.

Diazinon, chlorpyrifos and malathion were the OPs most extensively detected in surface water. Diazinon was extensively (25%) detected in streams draining agricultural areas, with a maximum detection of 0.41 ug/l. When urban and mixed land-use samples are included, however, diazinon was detected at even greater frequency and concentration (54.4%, max 1.1 ug/l in 801 urban stream samples). The same was true for chlorpyrifos (agricultural max 0.12 ug/l) and malathion (overall max 0.67 ug/l), which were detected at half the frequency in surface water draining agricultural areas alone than in the whole data set.

Azinphos methyl (8 detections), methyl parathion, ethoprop, terbufos and disulfoton (1 detection) were the other active OPs detected in surface water, in descending order of frequency. Of these, only ethoprop had a detection above 0.1 ug/l (one sample at 0.14 ug/l). Terbufos, the OP with the highest RPF value, was detected at concentrations of 0.013 and 0.016 ug/l.

The **Eastern Iowa (EIWA)** study unit comprises most of eastern Iowa, and a very small portion of southern Minnesota. Agriculture accounts for 90% of land use in the study unit.

Chlorpyrifos (urban and agricultural) and malathion (1 urban well sample) were detected in shallow alluvial aquifer. They were not detected in the deeper carbonate aquifer. Chlorpyrifos was detected in 16 and 10 percent of shallow ground-water wells in agricultural and urban areas, respectively, much more than the 1 % national average.

Chlorpyrifos was detected in 7 percent of agricultural streams, and 6 percent of mixed land-use streams. Diazinon (2 samples, .005 and .006) and malathion (9 samples, max 0.078) were also detected in surface water. By contrast, herbicides atrazine and malathion were detected in every surface water sample collected.

Table III.E.1-9. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Heartland Portion of the Northeast/ North Cental Region.

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methy lparathion	phorate	terbufos
		Concentation (ug/L)								
Lower Illinois R. Basin										
All Locations	Maximum	0.300	0.071	0.021	0.005	0.027	0.500	0.211	0.011	0.030
	99th	0.263	0.038	0.021	0.005	0.027	0.087	0.006	0.011	0.017
	95th	0.083	0.029	0.017	0.003	0.006	0.024	0.006	0.002	0.013
	90th	0.040	0.021	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.007	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.010	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	15.5%	30.6%	0.0%	0.0%	1.6%	0.0%	0.4%	0.0%	1.2%
Agriculture	Maximum	0.300	0.017	0.021	0.005	0.027	0.5	0.211	0.011	0.030
	99th	0.300	0.011	0.018	0.004	0.015	0.050	0.006	0.005	0.018
	95th	0.117	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.050	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methy lparathion	phorate	terbufos
		Concentation (ug/L)								
	80th	0.010	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	18.0%	4.8%	0.0%	0.0%	1.8%	0.0%	0.6%	0.0%	1.8%
Mixed	Maximum	0.090	0.071	0.021	0.005	0.027	0.300	0.006	0.011	0.017
	99th	0.067	0.054	0.021	0.005	0.027	0.142	0.006	0.011	0.017
	95th	0.042	0.037	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.024	0.031	0.017	0.003	0.005	0.050	0.006	0.002	0.013
	80th	0.005	0.025	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.022	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.014	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	10.4%	83.8%	0.0%	0.0%	1.3%	0.0%	0.0%	0.0%	0.0%
Eastern Iowa										
All Locations	Maximum	0.400	0.057	0.021	0.004	0.078	0.800	0.006	0.011	0.017
	99th	0.070	0.007	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.010	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	5.3%	3.4%	0.0%	0.4%	1.1%	0.0%	0.0%	0.0%	0.0%
Agricultural	Maximum	0.400	0.006	0.021	0.005	0.078	0.1	0.006	0.011	0.017
	99th	0.039	0.005	0.021	0.005	0.027	0.054	0.006	0.011	0.017
	95th	0.009	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	6.4%	0.7%	0.0%	0.0%	1.4%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.400	0.057	0.021	0.005	0.027	0.800	0.006	0.011	0.017
	99th	0.122	0.011	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.013	0.005	0.017	0.003	0.005	0.006	0.006	0.002	0.013
	90th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	4.0%	6.4%	0.0%	0.8%	0.8%	0.0%	0.0%	0.0%	0.0%
White River Basin										
All Locations	Maximum	0.300	1.100	0.050	0.14	0.670	0.046	0.011	0.060	0.016
	99th	0.080	0.380	0.050	0.015	0.050	0.050	0.015	0.020	0.050
	95th	0.025	0.130	0.021	0.005	0.027	0.015	0.006	0.011	0.017
	90th	0.015	0.058	0.017	0.003	0.011	0.001	0.006	0.002	0.013
	80th	0.009	0.025	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.006	0.017	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	23.1%	54.4%	0.1%	1.2%	9.9%	1.0%	0.4%	0.0%	0.2%
Agricultural	Maximum	0.120	0.410	0.021	0.014	0.330	0.046	0.010	0.060	0.013
	99th	0.065	0.123	0.021	0.005	0.027	0.046	0.006	0.011	0.017
	95th	0.014	0.024	0.017	0.003	0.013	0.002	0.006	0.002	0.013
	90th	0.006	0.011	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methy lparathion	phorate	terbufos
		Concentation (ug/L)								
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	10.9%	24.0%	0.0%	0.3%	5.1%	1.6%	0.6%	0.0%	0.3%
Mixed	Maximum	0.180	0.180	0.050	0.015	0.033	0.007	0.011	0.060	0.016
	99th	0.128	0.066	0.050	0.015	0.027	0.050	0.015	0.020	0.050
	95th	0.045	0.034	0.050	0.005	0.015	0.015	0.006	0.020	0.050
	90th	0.018	0.023	0.021	0.005	0.005	0.010	0.006	0.011	0.017
	80th	0.010	0.014	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.007	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.4%	62.8%	0.3%	1.0%	2.9%	0.3%	0.3%	0.0%	0.3%
Urban	Maximum	0.300	1.100	0.021	0.140	0.670	0.011	0.006	0.060	0.017
	99th	0.088	0.600	0.021	0.019	0.405	0.011	0.006	0.060	0.017
	95th	0.026	0.358	0.017	0.005	0.046	0.016	0.006	0.011	0.013
	90th	0.020	0.240	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.014	0.136	0.017	0.003	0.014	0.001	0.006	0.002	0.013
	75th	0.012	0.100	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	50th	0.005	0.043	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	55.1%	93.8%	0.0%	3.4%	30.7%	1.1%	0.0%	0.0%	0.0%

The **Lake Erie-Lake Saint Clair Drainages (LERI) NAWQA** study unit assessed the water quality of streams draining to these lakes in parts of Michigan, Ohio, Indiana, New York and Pennsylvania. Although historic industrial pollution on the shores of the Great Lakes has led to the identification of the AOCs mentioned above, about 75% of the area included in this study unit is dedicated to agricultural use. Insecticides were included in weekly to monthly sampling at 4 sites from 1996 to 1998. The streams sampled drain watersheds with areas from 310 to 6330 square miles.

Chlorpyrifos and diazinon were extensively detected in agricultural, mixed land-use and urban stream samples. Both were more frequently detected in urban samples than agricultural samples (36% vs 13% for chlorpyrifos, 70% vs 23% for diazinon). The maximum agricultural stream concentration of chlorpyrifos was about 0.4 ug/l. The maximum agricultural stream concentration of diazinon was 0.1 ug/l. Malathion and methyl parathion are also listed as infrequent contaminants in this study.

Eighty percent of the population of the **Hudson River Basin (HDSN) NAWQA** study unit, which is located almost completely in New York, derives its drinking water from surface water supply. People drawing water from domestic wells do so mostly from unconsolidated surficial glacial and post-glacial aquifers. The region has more land devoted to forest than agriculture (62% versus 25%).

Surface-water monitoring for OPs in this study unit was limited to the 46 fixed sampling sites distributed through the basin. Diazinon was extensively detected (16%), with a maximum concentration of 0.697 ug/l. While the highest detection of diazinon was from an agricultural stream, fewer than 20% of the samples with detections of diazinon were from agricultural streams. Chlorprifos was detected in little more than 1% of agricultural streams, with a maximum detection of 0.024 ug/l. Malathion was detected in 6% of urban streams, with a maximum detection of 0.13 ug/l.

Diazinon and malathion were detected in ground water in this study unit. The monitoring program included single samples from shallow (<50 feet deep) monitoring wells (26 urban, 18 agricultural) in the unconsolidated glacial and post-glacial deposits, and domestic wells throughout the region ranging in depth from 7 to more than 100 feet deep. Diazinon was detected domestic and urban wells (2% of all wellls, max detection <0.1 ug/l). Malathion was detected in about 5% of domestic wells (1% overall, max concentration <0.05 ug/l).

The **Connecticut, Housatonic and Thames River Basins (CONN) NAWQA** study unit includes parts of Connecticut, Massachusetts, New Hampshire, New York and Vermont, and includes only 12 % agricultural land (most is forested and undeveloped). Surface water is the predominant drinking water supply, although 924 thusand of the 4.5 million people in the region had domestic wells in 1990 (USGS Circular 1155).

The fixed site surface water sampling program in this study included 12 sites around the basin sampled about 15 times per year. In addition, a single intensive urban stream site was sampled about 40 times per year in 1993 and 1994. Diazinon was frequently detected in surface water, including a 92% frequency in urban stream samples. Chlorpyrifos (max concentration <0.1 ug/l) and disulfoton (max concentration <0.01 ug/l) were detected in 1% and <1% of samples, respectively. Malathion, however, was detected in 4% of samples, with a maximum concentration of 7.5 ug/l. This detection did not occur in an agricultural stream.

Although other insecticides such as carbofuran and permethrin were detected in ground water, and although diazinon was detected extensively in surface water, no OPs were detected in ground water in this study unit. The monitoring network included 163 wells sampled once each, with 120 of these in surficial aquifers. An additional 14 wells were sampled for a flowpath.

The **New Jersey-Long Island Coastal Drainages (LINJ) NAWQA** study unit includes mixed-use and urban stream samples, and agricultural, mixed use and urban ground water samples. Only seven surface water samples were collected in a stream considered to drain solely agricultural land.

An nearly equivalent number of people in the LINJ study unit derive their drinking water from surface water as from surficial aquifers. The surficial aquifers in both the southern half of New Jersey and Long Island are coarse grained soils which are susceptible to pesticide contamination.

Chlorpyrifos and diazinon were detected extensively in urban and mixed use surface water samples. Urban uses of chlorpyrifos and diazinon are currently being phased out. Only three of the urban and mixed land-use surface-water sampling sites had more than 50% agricultural land use. It is not possible to distinguish chlorpyrifos and diazinon in these samples derived from agricultural or urban/suburban use. Neither chlorpyrifos nor diazinon were detected in ground water.

The population of the **Lower Susquehanna River Basin (LSUS) NAWQA** study unit, which is located in south-central Pennsylvania and northeasternmost Maryland, derives 75% of its public water supply from surface-water sources. Public supply in this region served 1.2 million people in 1992. Another 800,000 derived their drinking water from private domestic wells. The land use in the majority of this region is equally divided between agricultural and forested land (47% each- USGS Circular 1168).

The LSUS is a study unit with relatively high frequency of OPs in surface water. Many of these correspond with tree fruit uses simulated in PRZM-EXAMS modeling for this region. Azinphos-methyl, for instance, was detected in 9% of agricultural stream samples, with a maximum concentration of 0.4 ug/l. Chlorpyrifos was detected in about 18% of agricultural streams (maximum concentration 0.09 ug/l), and diazinon was detected in little over 5% in agricultural streams (maximum concentration 0.055 ug/l). Methyl parathion, which will no longer be used on tree fruits, was detected in 2 agricultural stream samples, with a maximum concentration of 0.063 ug/l.In the LSUS, 187 sites sampled were once, 3 sites sampled intensively from 1993 to 1995.

Other OPs not included in the simulation modeling for the Northern Crescent were detected in the LSUS study. Malathion was detected in 8% of urban samples, and 3% of agricultural samples, with a maximum concentration of 0.129 ug/l. Ethoprop was detected in 1.4% of samples 8 detections), with a maximum concentration of 0.052 ug/l.

Diazinon is the only OP detected in ground water. It was detected in 2 samples at concentrations <0.01 ug/l.

The **Western Lake Michigan Drainage (WMIC) NAWQA** study unit provides further data on OP contamination in the Great Lakes region, covering eastern Wisconsin and part of the Upper Peninsula of Michigan. Agriculture accounts for 37% of the land use in this region, while 50% is forested. Drinking water is predominantly derived from surface-water supplies in this area, mostly from Lakes Michigan and Winnebago.

Pesticides were included as analytes at three intensive stream sampling sites, and at 145 other sampling sites in agricultural, urban and mixed land-use areas. Diazinon was the OP most detected in this region (5%), with detections ranging to about 0.05 ug/l. Chlorpyrifos, phorate, malathion and methyl parathion were detected in no more than 3 samples each. The maximum detection among these was a phorate detection of about 0.1 ug/l.

The **Upper Mississippi River Basin NAWQA** study unit is located predominantly in Minnesota, with a small number of samples taken as well in Wisonsin and Iowa.

Although stream-water samples were collected from streams representing various land uses, urban streams accounted for nearly all of the OP detections in surface water in this study unit. Diazinon was detected in 9% of urban stream samples, and 48% of mixed land-use samples (maximum concentration 0.3 ug/l), but in none of the 50 agricultural stream samples collected. Similarly, chlorpyrifos was detected in 32% of urban streams, but not in any agricultural samples. Malathion was detected in 11% of urban samples (maximum concentration 0.08 ug/l), but only a single agricultural sample. Two detections of ethoprop (maximum concentration 0.02 ug/l) represent the only other OP detections in agricultural streams.

Diazinon was detected in four ground-water samples taken from wells in “major aquifers.” The maximum concentration detected was greater than 10 ug/l, which represented the highest concentration of diazinon in ground water detected in the NAWQA program.

Table III.E.1-11. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Northern Cresent Portion of the Northeast/ North Central Region.

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Lower Susquehanna River Basin										
All Locations	Maximum	0.090	0.060	0.034	0.052	0.129	0.409	0.063	0.016	0.030
	99th	0.030	0.025	0.034	0.017	0.025	0.117	0.012	0.004	0.026
	95th	0.011	0.011	0.017	0.006	0.010	0.018	0.006	0.002	0.013
	90th	0.008	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.0%	8.4%	0.0%	1.4%	3.5%	5.5%	0.8%	0.0%	0.2%
Agriculture	Maximum	0.090	0.055	0.034	0.039	0.025	0.409	0.063	0.004	0.026
	99th	0.032	0.015	0.034	0.028	0.017	0.127	0.012	0.004	0.026
	95th	0.011	0.004	0.017	0.006	0.009	0.073	0.006	0.002	0.013
	90th	0.008	0.002	0.017	0.003	0.005	0.002	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.6%	5.3%	0.0%	2.4%	3.3%	9.1%	0.8%	0.0%	0.0%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Urban	Maximum	0.047	0.060	0.034	0.052	0.129	0.044	0.041	0.016	0.026
	99th	0.024	0.034	0.033	0.016	0.04016	0.04214	0.040	0.004	0.025
	95th	0.014	0.021	0.017	0.003	0.013	0.001	0.006	0.002	0.013
	90th	0.010	0.013	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	16.5%	18.3%	0.0%	0.9%	8.3%	1.9%	1.8%	0.0%	0.0%
Mixed	Maximum	0.082	0.051	0.034	0.006	0.027	0.220	0.012	0.011	0.030
	99th	0.033	0.017	0.034	0.006	0.027	0.096	0.012	0.011	0.027
	95th	0.010	0.005	0.034	0.006	0.010	0.050	0.012	0.004	0.026
	90th	0.008	0.004	0.021	0.005	0.010	0.002	0.006	0.004	0.017
	80th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	8.1%	8.1%	0.0%	0.0%	0.0%	2.6%	0.0%	0.0%	1.2%
Long Island/ New Jersey										
All Locations	Maximum	0.064	0.300	0.021	0.005	0.078	0.039	0.006	0.011	0.033
	99th	0.038	0.211	0.021	0.005	0.027	0.039	0.006	0.011	0.017
	95th	0.019	0.089	0.017	0.004	0.025	0.027	0.006	0.002	0.017
	90th	0.010	0.048	0.017	0.003	0.006	0.001	0.006	0.002	0.013
	80th	0.005	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.015	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	24.6%	52.6%	0.0%	0.0%	7.6%	1.2%	0.0%	0.0%	0.4%
Agricultural	Maximum	0.030	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	99th	0.027	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	95th	0.014	0.006	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.005	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	38.5%	0.0%	0.0%	15.4%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.064	0.300	0.021	0.005	0.078	0.039	0.006	0.011	0.033
	99th	0.040	0.232	0.021	0.005	0.027	0.039	0.006	0.011	0.018
	95th	0.021	0.113	0.017	0.003	0.020	0.007	0.006	0.002	0.013
	90th	0.015	0.060	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	80th	0.008	0.028	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	32.6%	59.1%	0.0%	0.0%	11.4%	2.3%	0.0%	0.0%	0.8%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Mixed	Maximum	0.040	0.103	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.037	0.101	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.009	0.070	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.007	0.043	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.005	0.025	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	16.4%	60.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hudson River Basin										
All Locations	Maximum	0.060	0.697	0.021	0.005	0.130	0.05	0.006	0.011	0.017
	99th	0.017	0.130	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	95th	0.005	0.052	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.004	0.032	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.010	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	2.5%	28.2%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.0%
Agricultural Cropland	Maximum	0.024	0.697	0.021	0.005	0.027	0.05	0.006	0.011	0.017
	99th	0.013	0.054	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.004	0.021	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	1.3%	10.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban Residential	Maximum	0.060	0.550	0.021	0.005	0.13	0.05	0.006	0.011	0.017
	99th	0.016	0.237	0.021	0.005	0.0979	0.05	0.006	0.011	0.017
	95th	0.005	0.119	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.076	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.004	0.045	0.017	0.003	0.015	0.001	0.006	0.002	0.013
	75th	0.004	0.039	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.015	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	4.8%	60.6%	0.0%	0.0%	5.8%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum det	0.024	0.093	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.017	0.064	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.005	0.028	0.017	0.003	0.011	0.002	0.006	0.002	0.013
	90th	0.004	0.014	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	Frequency	2.9%	34.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Delmarva Peninsula (1999-2001)										
All Locations	Maximum det	0.014	0.005	0.021	0.005	0.034	0.05	0.006	0.011	0.017
	99th	0.009	0.005	0.021	0.005	0.029	0.05	0.006	0.011	0.017
	95th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	75th	0.005	0.004	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.1%	7.9%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%

e. Region E: Humid Southeast

Only acephate and terbufos (total residues) had estimated maximum concentrations greater than 1 ppb (Table III.E.1-12). Terbufos, acephate, phorate, and disulfoton contributed to the peak OP cumulative loads in water. More detailed discussion and analysis of the OP load in drinking water sources can be found in section II.E.

Table II.E.6. Predicted percentile concentrations of individual OP pesticides and of OP cumulative distribution, Southeast Region.

Chemical	Crop/Use	Concentration, ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
Acephate	Cotton, Peanut, Tobacco	1.7e+00	4.3e-02	3.1e-03	7.0e-04	2.1e-05	1.8e-06	1.7e-08
Chlorpyrifos	Corn, Peanut, Tobacco	2.6e-01	9.9e-02	5.6e-02	3.8e-02	2.2e-02	1.8e-02	5.8e-03
Dimethoate	Cotton	7.4e-02	1.2e-02	2.7e-03	1.0e-03	2.3e-04	7.7e-05	9.1e-07
Disulfoton (total residues)	Cotton	4.3e-02	2.8e-02	1.6e-02	1.2e-02	7.8e-03	6.5e-03	3.4e-03
Ethoprop	Tobacco	2.2e-01	1.4e-01	4.8e-02	2.9e-02	1.5e-02	1.2e-02	4.9e-03
Methamidophos	Acephate degradate	2.1e-01	5.2e-03	1.7e-04	9.8e-06	4.5e-08	1.4e-08	4.2e-10
Phorate (total residues)	Cotton, Peanut	6.6e-01	3.9e-02	1.7e-03	4.7e-05	2.1e-09	1.4e-11	1.0e-12
Terbufos (total residues)	Corn	1.5e+00	4.0e-01	1.1e-01	3.9e-02	6.5e-03	1.6e-03	1.2e-04
Tribufos	Cotton	2.4e-02	1.6e-02	1.1e-02	9.6e-03	7.8e-03	7.3e-03	5.4e-03
OP Cumulative Concentration in Methamidophos Equivalents		3.8e+00	1.1e+00	3.6e-01	1.6e-01	6.5e-02	4.9e-02	1.8e-02

i. Comparison of Monitoring Data versus Model Estimates

The **Albemarle-Pamlico Drainage Basin (ALBE) NAWQA** study unit, located primarily in the Piedmont and Coastal Plain physiographic provinces of southeastern Virginia and northeastern North Carolina, includes the area identified as a vulnerable watershed for the OP cumulative assessment. The NAWQA study included chlorpyrifos, disulfoton, ethoprop, phorate, and terbufos in its monitoring program.

Chlorpyrifos was detected in 14% of agricultural streams, at a maximum of 0.058 ug/l, roughly equivalent to the estimated 95th percentile concentration. The estimated concentrations and measured concentrations in the ALBE agricultural streams were within a factor of 10 of each other at the 90th and greater percentiles. Ethoprop was detected in 4% of all samples, with a maximum detection of 0.8 ug/l in an agricultural stream, greater than the estimated peak of 0.2 ug/l. Phorate was detected in little more than 1% of samples, with a maximum concentrations of about 0.03 ug/l, roughly equivalent to the 99th percentile estimated concentration. Terbufos was detected in a single mixed land-use sample at 0.01 ug/l, slightly less than the 90th percentile estimated concentration.

For chlopyrifos, both estimated and observed concentrations in Chicod Creek were consistent except for the 80th percentile and higher, at which the estimated values dramatically increased (Figure III.E.1-9). Ethoprop, another contributor chemical, was only detected once in Chicod Creek.

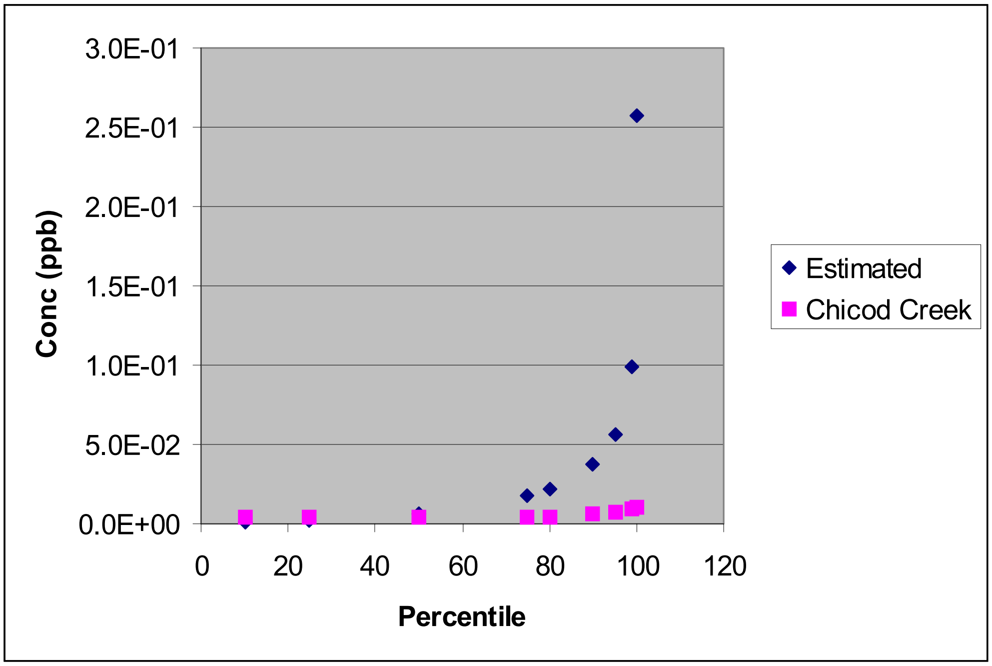

Figure III.E.1-9. Comparison of observed and estimated chlorpyrifos concentrations in the Humid Southeast Region.

ii. Summary of NAWQA Monitoring Data in the Region

The **Albemarle-Pamlico Drainage Basin (ALBE) NAWQA** study unit is located primarily in the Piedmont and Coastal Plain physiographic provinces of southeastern Virginia and northeastern North Carolina. Nearly equivalent portions of the population derived drinking water from surface water and ground water in 1990, with one-third of the population drawing water from domestic wells.

Shallow wells (< 50 feet) in unconsolidated surficial aquifers were sampled because they were most likely to be vulnerable to contamination. Several public supply wells were also included to see if pumping drew contamination from the surficial wells. Diazinon was detected in 7% of ground-water samples, and chlorpyrifos in a single ground-water sample. The USGS Circular 1157 indicates that both were detected in the agricultural (corn-soybean) land-use study, but does not indicate whether some of the diazinon detections occurred in the Virginia Beach urban land-use study. The maximum concentration of diazinon in ground water was about 0.1 ug/l. The single detection of chlorpyrifos was <0.01 ug/l.

Diazinon (9.5%) and chlorpyrifos (13.9%) were the OPs most frequently detected in agricultural streams, although both were more often detected in mixed land-use streams. Diazinon was detected at a maximum concentration of 0.11 ug/l in these streams, and chlorpyrifos at a maximum of 0.058 ug/l. Malathion was detected in 7.7% of all samples, with a maximum detection of 0.055 ug/l. Ethoprop was detected in 4.4% of all samples, with a maximum detection of 0.8 ug/l in an agricultural stream. Phorate and azinphos methyl were detected in little more than 1% of samples each, with maximum concentrations of about 0.03 ug/l. Terbufos was detected in a single mixed land-use sample at 0.01 ug/l. Surface water was collected at four intensive sampling sites, and 66 other stream sites sampled one to six times in the study.

The **Apalachicola-Chattahoochee-Flint River Basin (ACFB) NAWQA** study site extends from north of Atlanta along the Georgia-Alabama border through the Florida panhandle to the Gulf of Mexico. The northern portion of the study unit is in the Piedmont physiographic province, and the southern portion in the Coastal Plain. Ninety-three percent of the population in the Piedmont derived drinking water from surface water in 1990, while surface water and ground water served nearly equivalent populations in the Coastal Plain. Nearly half of the ground water in the basin was supplied by the vulnerable, karst limestone, Upper Floridan aquifer.

Pesticides were most frequently detected in the karst recharge areas of the Upper Floridan aquifer, but OPs were rarely detected. USGS Circular 1164 indicates that chlorpyrifos and terbufos were both detected once at about 0.01 µg/l, but the dataset available on the study unit world wide web page does not include these detections. Diazinon was detected twice in the urban land-use study. Malathion was detected once in the agricultural land-use study at a concentration of 0.011 µg/l.

Diazinon, chlorpyrifos and malathion were frequently detected in this study unit, but almost exclusively in urban or suburban stream samples. Malathion was detected in an urban stream with a maximum concentration of 0.14 µg/l. Ethoprop was detected twice in urban or suburban streams, and once in an agricultural stream (maximum concentration 0.021 µg/l). Azinphos-methyl, disulfoton and terbufos were detected once each in urban or suburban streams, at concentrations of 0.018 µg/l or less.

The **Potomac River Basin (POTO) NAWQA** study unit is comprised of parts of Virginia, West Virginia, Maryland, Pennsylvania and the District of Columbia. Surface water is the dominant source of drinking water in this basin, although nearly 800,000 people in the basin relied on domestic wells in 1990.

Surface-water sites included for intensive sites sampled 24 times a year for two years in agricultural and urban areas. Twenty-three tributaries with watersheds of greater than 100 square miles were sampled once each, and 25 to 39 tributaries with smaller basins were sampled once each for three years. Diazinon was the most detected OP, found in 24% of samples, with a maximum concentration of 1.4 ug/l.Chlorpyrifos was detected in 8% of samples, with a maximum concentration of 0.041 ug/l. Methyl parathion was detected in 2% of samples, but some portion of these detections might be due to since-cancelled orchard uses. Malathion, ethoprop and azinphos methyl were also detected in fewer than 5% of samples.

Ground-water was sampled one time from each of 48 wells in the Piedmont and physiographic province from the Washington DC metropolitan area through central Maryland. Another 54 agricultural and 3 forest region wells were sampled once each to the west in the Valley and Ridge physiographic region. Chlorpyrifos is described as an important agricultural chemical in the Potomac River Basin, with use on corn, alfalfa and apples. It was detected in two ground-water samples, with a maximum concentration of about 0.05 ug/l. Diazinon was detected in ground water three times, with a maximum concentration of about 0.01 ug/l, and malathion once at <0.005 ug/l. Neither is listed as a major agricultural chemical in the region.

The **Santee River Basin and Coastal Drainages (SANT) NAWQA** study unit includes much of South Carolina, and extends into southwestern North Carolina. Eighty-six percent of drinking water in this region is from rivers and reservoirs, although rural regions which are not on public supply rely on domestic wells. In the north of the study unit, the relatively undeveloped land in the Blue Ridge physiographic province has little affect on water quality. However, development is more extensive in the Piedmont, and the rivers which provide drinking water are well-regulated, as 85% of water use is for the production of energy. Toward the coast, slow-moving rivers in the Coastal Plain run through marshland and row-crop farmland.

Analysis for pesticides was included in intensive (3 sites) and fixed-site (13 sites) surface water studies over a range of land uses, and at 16 urban sampling sites. Chlorpyrifos, diazinon and malathion were the only OPs detected more than once. All three were detected in more than half of urban samples, but only chlorpyrifos (60%) was detected in more than 10 % of agricultural samples. Chlorpyrifos was detected at a maximum concentration of 0.03 µg/l in an agricultural stream, and malathion at 0.216 in an urban stream. Methyl parathion was detected once in an urban stream at 0.013 µg/l.

Diazinon was detected in a single agricultural well at around 0.005 µg/l, and in a well from the Sandhills aquifer at about 0.06 µg/l. Chlorpyrifos and diazinon were detected in 2 and 3 urban wells, respectively. No other OPs were detected in ground water.

Table III.E.1-13. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Southern Seaboard Portion of the Humid Southeast Region.

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Albemarle										
All Locations	Maximum	0.058	0.110	0.021	0.800	0.067	0.031	0.020	0.033	0.01
	99th	0.020	0.066	0.021	0.013	0.044	0.031	0.006	0.024	0.017
	95th	0.008	0.013	0.017	0.005	0.021	0.020	0.006	0.010	0.013
	90th	0.005	0.009	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	14.6%	28.1%	0.0%	4.4%	7.7%	1.1%	0.0%	1.4%	0.3%
Agriculture	Maximum	0.058	0.110	0.017	0.800	0.055	0.013	0.006	0.019	0.013
	99th	0.034	0.073	0.017	0.021	0.010	0.001	0.006	0.019	0.013
	95th	0.009	0.008	0.017	0.003	0.005	0.001	0.006	0.010	0.013
	90th	0.006	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	13.9%	9.5%	0.0%	5.0%	3.0%	1.0%	0.0%	2.0%	0.0%
Mixed	Maximum	0.030	0.110	0.021	0.014	0.067	0.031	0.020	0.033	0.01
	99th	0.012	0.044	0.021	0.010	0.046	0.031	0.006	0.011	0.017
	95th	0.007	0.018	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.012	0.017	0.005	0.023	0.024	0.006	0.002	0.013
	80th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	16.3%	54.2%	0.0%	3.9%	13.7%	1.3%	0.0%	0.7%	0.7%
Santee River										
All Locations	Maximum	0.095	0.323	0.021	0.005	0.216	0.039	0.013	0.011	0.017
	99th	0.062	0.116	0.021	0.005	0.097	0.039	0.006	0.011	0.017
	95th	0.022	0.031	0.021	0.005	0.029	0.050	0.006	0.011	0.017
	90th	0.014	0.020	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.007	0.008	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	75th	0.006	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	39.9%	24.3%	0.0%	0.0%	15.9%	0.0%	0.4%	0.0%	0.0%
Agriculture	Maximum	0.030	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	99th	0.027	0.008	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	95th	0.014	0.006	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.005	0.017	0.003	0.008	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	38.5%	0.0%	0.0%	15.4%	0.0%	0.0%	0.0%	0.0%
Forest	Maximum	0.007	0.015	0.017	0.003	0.018	0.001	0.006	0.002	0.013
	99th	0.006	0.010	0.017	0.003	0.01306	0.001	0.006	0.002	0.013
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	2.6%	2.6%	0.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.095	0.323	0.021	0.005	0.216	0.05	0.0125	0.011	0.017
	99th	0.084	0.298	0.021	0.005	0.18518	0.05	0.008	0.011	0.017
	95th	0.022	0.102	0.021	0.005	0.089	0.050	0.006	0.011	0.017
	90th	0.015	0.048	0.017	0.003	0.059	0.001	0.006	0.002	0.013
	80th	0.011	0.032	0.017	0.003	0.028	0.001	0.006	0.002	0.013
	75th	0.010	0.030	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	50th	0.005	0.018	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	Frequency	67.6%	80.9%	0.0%	0.0%	48.5%	0.0%	1.5%	0.0%	0.0%
Mixed	Maximum	0.006	0.015	0.021	0.005	0.0886	0.050	0.006	0.011	0.017
	99th	0.005	0.011	0.021	0.005	0.049	0.050	0.006	0.011	0.017
	95th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.004	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	1.5%	7.7%	0.0%	0.0%	6.2%	0.0%	0.0%	0.0%	0.0%
All Locations	Maximum	0.170	2.800	0.018	0.021	0.140	0.11	0.006	0.011	0.017
	99th	0.059	0.255	0.021	0.005	0.045	0.05	0.006	0.011	0.017
	95th	0.016	0.063	0.017	0.005	0.027	0.050	0.006	0.002	0.013
	90th	0.011	0.032	0.017	0.003	0.009	0.001	0.006	0.002	0.013
	80th	0.005	0.016	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.6%	46.5%	0.2%	0.5%	6.7%	0.2%	0.0%	0.0%	0.2%
Agricultural Cropland	Maximum	0.099	0.012	0.021	0.010	0.009	0.05	0.006	0.011	0.017
	99th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.6%	0.6%	0.0%	0.6%	1.3%	0.0%	0.0%	0.0%	0.0%
Urban Residential	Maximum	0.170	2.800	0.018	0.021	0.14	0.11	0.006	0.011	0.017
	99th	0.085	0.366	0.021	0.008	0.06669	0.05	0.006	0.011	0.017
	95th	0.040	0.124	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	90th	0.020	0.067	0.017	0.003	0.017	0.001	0.006	0.002	0.013
	80th	0.011	0.033	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.010	0.029	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.011	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	50.0%	81.9%	0.4%	0.9%	11.6%	0.4%	0.0%	0.0%	0.4%
Mixed	Maximum	0.018	0.103	0.021	0.005	0.044	0.300	0.006	0.011	0.017
	99th	0.014	0.063	0.021	0.005	0.035	0.070	0.006	0.011	0.017
	95th	0.010	0.029	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.008	0.019	0.017	0.003	0.016	0.001	0.006	0.002	0.013
	80th	0.005	0.013	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	21.8%	52.8%	0.0%	0.0%	6.3%	0.0%	0.0%	0.0%	0.0%
Georgia portion of GA-FL coastal Plain										
All Locations	Maximum	0.028	0.097	0.021	0.018	0.226	0.166	0.200	0.003	0.018
	99th	0.017	0.068	0.021	0.010	0.027	0.073	0.006	0.011	0.017
	95th	0.007	0.010	0.017	0.005	0.026	0.050	0.006	0.002	0.013
	90th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	8.9%	11.6%	0.3%	4.0%	5.2%	0.6%	0.0%	0.3%	0.3%
Agricultural	Maximum	0.021	0.025	0.021	0.018	0.025	0.166	0.200	0.003	0.018
	99th	0.014	0.007	0.021	0.009	0.025	0.079	0.006	0.011	0.017
	95th	0.006	0.002	0.017	0.005	0.007	0.001	0.006	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	6.7%	1.4%	0.5%	3.3%	2.9%	1.0%	0.0%	0.5%	0.5%
Mixed	Maximum	0.028	0.097	0.021	0.015	0.226	0.3	0.050	0.020	0.017
	99th	0.018	0.087	0.021	0.012	0.033	0.05	0.032	0.011	0.017
	95th	0.008	0.026	0.021	0.006	0.027	0.050	0.006	0.011	0.017

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	90th	0.006	0.011	0.017	0.005	0.017	0.001	0.006	0.002	0.013
	80th	0.004	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.006	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	13.5%	31.5%	0.0%	5.4%	9.9%	0.0%	0.0%	0.0%	0.0%

The **NAWQA Upper Tennessee River Basin (UTEN) study** unit includes Henderson County, North Carolina, the OP high-use area chosen for the Eastern Uplands surface-water modeling. The study area is located primarily in western North Carolina, eastern Tennessee, and southwest Virginia. Sampling in this study occurred between 1995 and 1999, and included nine of the OP insecticides that are part of the cumulative water assessment.

Surface-water monitoring was concentrated in the unregulated portions of the Tennessee River, which is extensively dammed for generation of hydroelectric power. Chlorpyrifos (10% of samples), diazinon (12%) and malathion are the only OPs detected in 428 samples taken biweekly between March and November, 1996. The maximum concentration of diazinon reported was 0.59 ug/l. The frequency of detection for diazinon was greater for sampling locations identified as “mixed land use” while the frequency of detection for chlorpyrifos was greater from “agricultural” sampling sites.

No OPs were detected in ground-water sampling for the Upper Tennessee River (UTEN) NAWQA study. Thirty monitoring wells were located next to tobacco fields, while 30 additional wells and 35 springs were randomly selected from around the Valley and Ridge portion of the study site. Each well or spring was sampled a single time. Domestic wells are the main source of drinking water for one-third of the popluation in the UTEN study region.

The **Kanawha-New River Basin (KANA)** NAWQA study site, located primarily in south-central West Virginia and southwest Virginia, represents a less agricultural region with less OP use. Chlorpyrifos, diazinon and malathion were detected in the KANA study. Diazinon and malathion were detected in surface water.

Chlorpyrifos was detected in one of 60 domestic or supply wells in the Kanawha-New River (KANA) NAWQA study at a concentration of 0.004 ppb. Thirty of the wells were located in the mountainous coal-mining Appalachian Plateau physiographic province in West Virginia. Chlorpyrifos was detected in a well in the relatively more agricultural Blue Ridge physiographic province, in the southern portion of the study unit. Domestic wells are reported to supply drinking water to thirty percent of the population in the KANA study unit.

The **Allegheny and Monongahela River Basins (ALMN)** study unit is located in northeastern West Virginia and western Pennsylvania. Agriculture accounts for only 30% of land use in the study unit, "commonly low-intensity pasture, dairy and hay." Diazinon and chlorpyrifos are the only active OPs detected in this monitoring program. Diazinon was detected at two of 18 agricultural stream samples, and in seven of 26 (31%) urban stream samples, with maximum concentrations of about 0.1 ug/l. Chlorpyrifos is also reported as having been detected in surface water. Surface water is the main source of drinking water in the Pittsburgh region.

Diazinon was also detected in ground water in six of 58 samples from major aquifers in the Allegheny-Monongahela River (ALMN) NAWQA study, with a maximum concentration of 0.007 ppb. Domestic wells are reported by the USGS as the major source of drinking water for people living in rural areas of the ALMN study unit.

Table III.E.1-14. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Eastern Uplands Portion of the Humid Southeast Region.

Land Use	Value	chlor-pyrifos	diazinon	disulfoton	ethoprop	mala-thion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentration, ug/L								
Upper Tennessee River Basin										
All Locations	Maximum	0.033	0.590 [1]	<0.021	0.018	0.046 [1]	0.0386	<0.006	<0.011	<0.017
	95th	0.005	0.005	<0.017	<0.003	<0.005	<0.050	<0.006	<0.002	<0.013
	90th	0.005	0.004	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	10.1%	12.1%	0.0%	0.4%	1.4%	0.2%	0.0%	0.0%	0.0%
Agriculture	Maximum	0.033	0.006	<0.021	<0.005	0.015	<0.11	<0.006	<0.011	<0.017
	95th	0.006	0.004	<0.017	<0.003	<0.008	<0.050	<0.006	<0.002	<0.013
	90th	0.005	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	13.2%	3.9%	0.0%	0.0%	2.0%	0.0%	0.0%	0.0%	0.0%
Forestry	Maximum	0.012	0.066	<0.021	0.018	0.015	0.0386	<0.006	0.011	0.017
	95th	0.005	0.008	<0.021	<0.005	<0.027	<0.050	<0.006	<0.011	<0.017
	90th	<0.005	0.005	<0.017	<0.003	<0.005	<0.005	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	5.0%	16.3%	0.0%	1.3%	1.3%	1.3%	0.0%	0.0%	0.0%
Mixed	Maximum	0.014	0.040	<0.021	0.015	0.0061	<0.700	<0.006	<0.011	<0.017
	95th	0.005	0.005	<0.017	<0.003	<0.005	<0.200	<0.006	<0.002	<0.013
	90th	<0.004	0.005	<0.017	<0.003	<0.005	<0.034	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	8.6%	14.8%	0.0%	0.5%	0.5%	0.0%	0.0%	0.0%	0.0%
(1) The maximum concentrations of diazinon and malathion occurred at a sample site located in a watershed influenced by mining. Sample sites representing watersheds with mining land uses were not broken out separately in this summary table.										
Kanawha-New River Basin										
All Locations	Maximum	0.004	0.004	<0.017	<0.003	0.005	<0.06	<0.006	<0.002	<0.013
	95th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013

Land Use	Value	chlor-pyrifos	diazinon	disulfoton	ethoprop	mala-thion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentration, ug/L								
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	4.4%	1.5%	0.0%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%
NOTE: Because of the low number of samples (68 samples were analyzed for OPs) and the low frequency of detects, monitoring data for this study unit were not broken down by land use within the watershed.										
Allegheny and Monongahela River Basin										
All Locations	Maximum	0.010	0.097	<0.017	<0.003	<0.020	0.033	<0.006	<0.002	<0.013
	95th	<0.004	0.027	<0.017	<0.003	<0.005	<0.010	<0.006	<0.002	<0.013
	90th	<0.004	0.013	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	0.003	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	7.4%	27.2%	0.0%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%
Agriculture	Maximum	0.010	0.094	<0.017	<0.003	<0.005	0.033	<0.006	<0.002	<0.013
	95th	0.009	0.016	<0.017	<0.003	<0.005	<0.220	<0.006	<0.002	<0.013
	90th	0.005	0.003	<0.017	<0.003	<0.005	<0.066	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	21.1%	10.5%	0.0%	0.0%	0.0%	5.3%	0.0%	0.0%	0.0%
Urban	Maximum	<0.004	0.097	<0.017	<0.003	<0.005	<0.8	<0.006	<0.002	<0.013
	95th	<0.004	0.051	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	90th	<0.004	0.027	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	0.013	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	6.5%	35.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	<0.004	0.010	<0.017	<0.003	<0.02	<0.010	<0.006	<0.002	<0.013
	95th	<0.004	0.006	<0.017	<0.003	<0.010	<0.006	<0.006	<0.002	<0.013
	90th	<0.004	0.005	<0.017	<0.003	<0.010	<0.001	<0.006	<0.002	<0.013
	75th	<0.004	<0.002	<0.017	<0.003	<0.005	<0.001	<0.006	<0.002	<0.013
	Frequency	0.0%	23.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

f. Region F: Lower Midwest

Estimated maximum concentrations of malathion and terbufos (parent plus sulfoxide/sulfone) were in the single parts per billion (Table III.E.1-15). More detailed discussion and analysis of the OP load in drinking water sources can be found in section II.F.

Table III.E.1-15. Predicted percentile concentrations of individual OP pesticides and of the cumulative OP distribution, Lower Midwest Region

Chemical	Crop/Use	Concentrations in ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
Acephate	Cotton	1.4e-01	1.2e-02	1.0e-03	1.9e-04	2.0e-06	1.0e-07	1.1e-09
Chlorpyrifos	Alfalfa,Corn, Cotton, Sorghum	1.3e-01	5.9e-02	2.9e-02	1.8e-02	1.8e-02	8.4e-03	3.5e-03
Dicrotophos	Cotton	3.9e-02	7.9e-03	2.4e-03	9.3e-04	9.3e-04	6.7e-05	2.6e-06
Dimethoate	Corn,Cotton, Wheat	6.5e-02	2.1e-02	7.0e-03	4.1e-03	4.1e-03	1.6e-03	3.3e-04
Malathion	Cotton	1.5e+00	8.2e-02	3.4e-02	1.5e-02	1.5e-02	1.8e-03	6.1e-06
Methamidophos	Acephate degradate	4.6e-02	8.5e-04	3.1e-05	1.1e-06	1.1e-06	3.1e-10	1.4e-11
MethylParathion	Alfalfa, Cotton	6.8e-02	1.5e-02	4.4e-03	2.4e-03	2.4e-03	5.3e-04	3.3e-05
Phorate	Cotton	4.2e-02	3.8e-03	1.2e-04	2.0e-06	2.0e-06	1.7e-11	2.0e-13
Phostebupirim	Corn	6.9e-02	3.2e-02	1.4e-02	8.9e-03	8.9e-03	3.7e-03	1.4e-03
Terbufos	Corn	1.4e+00	4.9e-01	1.7e-01	7.9e-02	7.9e-02	8.6e-03	4.4e-04
Tribufos	Cotton	6.1e-02	3.6e-02	2.3e-02	1.9e-02	1.9e-02	1.3e-02	9.4e-03
OP cumulative in methamidophos equivalents		3.7e+00	1.3e+00	4.8e-01	2.3e-01	5.7e-02	3.0e-02	4.6e-03

i. Comparison of Monitoring Data versus Model Estimates

A comparison of estimated concentrations for individual OP pesticides with NAWQA monitoring indicate that, except for terbufos, NAWQA sites in the Trinity River Basin had higher detections than were predicted for this regional assessment. For methyl parathion, the highest monitoring detect was an order of magnitude greater than the estimated maximum concentration. Although in-depth analysis of use has not been made, it is possible that the methyl parathion discrepancies may reflect differences resulting from uses that have been canceled and are not reflected in the modeling. For chlorpyrifos and malathion, the highest monitoring detections were twice as great as the highest estimated concentration. These differences are not great, and may reflect contributions from urban uses. The estimated concentrations for terbufos include parent terbufos plus the sulfoxide and sulfone transformation products while NAWQA only analyzed for the less persistent and less mobile parent.

Although diazinon has been frequently detected in the Trinity River Basin, particularly in urban streams, the latest NASS surveys indicate little or no agricultural uses of diazinon in the Central Hills area. Detections of diazinon in the Trinity River Basin may reflect residential uses which are being canceled or uses on other crops during the sampling period that are not reflected in current use surveys.

ii. Summary of NAWQA Monitoring Data in the Region

The **Trinity River Basin (TRIN)** study unit is the NAWQA monitoring program closest to the Central Hills of Texas, the high-use area the Agency chose for the PRZM EXAMS surface-water modeling scenario. More than 90% of water in this basin is supplied by surface water, mostly in reservoirs (USGS Circular 1171). Much of the agricultural land is used for grazing cattle.

Diazinon, chlorpyrifos and malathion were detected in 97%, 71% and 32% of urban samples, respectively.The maximum concentration of diazinon in urban samples was 2.3 µg/l. Diazinon was also detected frequently in agricultural samples (46%) and rangeland streams (38.5%), with a maximum detection of 0.16 ug/l. Azinphos-methyl, methyl parathion and disulfoton were detected in less than 3% of agricultural samples. Of these azinphos had the highest maximum concentration, 0.55 µg/l.

Ground-water sampling was done at outcrop areas of the four major aquifers in the study unit; confining units or minor aquifers are present at the surface (outcrop) over more than half of the area of the TRIN. Diazinon was detected in nearly half of the samples drawn from the 24 wells in the Trinity aquifer outcrop. However, half of the wells also had salinity higher than acceptable for potable water. The maximum concentration of diazinon in ground water was about 0.1 ug/l. It is not clear whether these detections were associated with urban or agricultural applications of diazinon.

The **South-Central Texas (SCTX) NAWQA** study unit includes the city of San Antonio. Ground water is the predominant source of drinking water in this area. The water is mostly derived from the Edwards Aquifer, which is one of the most productive in the world. The Edwards aquifer is recharged by surface water where precipitation and streams meet the fractured and faulted Edwards at its outcrop. This hydraulic connection makes stream and river-water quality important for the Edwards aquifer, which supplies about 70% of water withdrawn in the study unit. The Trinity aquifer is locally important in the Hill Country in the north of SCTX, but is generally less productive than the Edwards.

Ground-water monitoring included domestic wells in the area where surface-water and precipitation recharge the Edwards aquifer, public supply wells in the confined part of the Edwards aquifer, and domestic wells from the less permeable Trinity aquifer. Diazinon was the only OP detected, three times in shallow urban ground water, once in a major aquifer sample, each time <0.1 ug/l. No agricultural ground-water samples were collected.

Three surface-water sampling sites were located at urban and agricultural streams. These were sampled weekly to monthly from January, 1997 to March, 1998. Diazinon was detected in 38% of agricultural samples with a maximum concentration of 0.059 ug/l. Chlorpyrifos (max 0.008 ug/l) was detected in 21% of agricultural samples, and malathion in 9% of all samples (max 0.142 ug/l).

In the **Central Nebraska Basins (CNBR) NAWQA** study unit, ground water is the major source of drinking water. The major source of ground water, the Platte River alluvial aquifer, is hydraulically connected with the North Platte River, both through discharge to the river and increased recharge from the river due to pumping from the aquifer. Sampling included single samples from 11 shallow wells installed in this aquifer. No active OP was detected in ground-water in this limited study (fonofos was detected twice).

A second ground-water study included 61 wells installed in two clusters: one in a recharge area in a meadow near corn fields, and another in and north of a public-supply wellfield on Indian Island in the Platte River near Grand Island. The intention was to study land-use effects on shallow ground-water along the flow path. This study was useful in further showing that the alluvial aquifer shows increasing influence from the Platte River from upstream to downstream. While it did measure pesticide concentrations at a wellfield designed to be protected from agricultural ground-water contamination, it was not designed to evaluate acute exposure to pesticides. No OPs were detected in this study.

OPs were included at four fixed surface-water sampling sites on the Platte River and its tributaries. These were located in areas of heavy corn production. All were sampled monthly, but two of these also were sampled more intensively in the spring and summer of 1992 (including 12 weeks of alternate-day sampling). These two were located in the glaciated area in the eastern, downstream portion of the study unit.

Chlorpyrifos, diazinon and malathion were the most frequently detected OPs. Diazinon was detected mostly in urban or mix-use streams, while at least of the detections of the other two occurred in agricultural streams. Chlorpyrifos had the highest single concentration detected of the three in agricultural streams, at 0.13 µg/l. Methyl parathion, azinphos-methyl and terbufos were detected in less than 3% of samples. A detection of 0.27 µg/l terbufos was the highest concentration detected for any OP.

Table III.E.1-16. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Lower Midwest Region

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Trinity River Basin										

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
All Locations	Maximum	0.110	2.300	0.05	0.018	0.380	0.55	0.230	0.016	0.018
	99th	0.069	1.186	0.059	0.012	0.144	0.135	0.044	0.011	0.016
	95th	0.033	0.396	0.017	0.003	0.030	0.001	0.006	0.002	0.013
	90th	0.017	0.186	0.017	0.003	0.014	0.001	0.006	0.002	0.013
	80th	0.009	0.061	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.037	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	25.7%	61.3%	0.6%	0.0%	9.2%	1.6%	1.6%	0.0%	0.0%
Agriculture	Maximum	0.048	0.160	0.05	0.012	0.038	0.55	0.230	0.011	0.013
	99th	0.012	0.110	0.060	0.012	0.026	0.437	0.044	0.011	0.013
	95th	0.009	0.024	0.017	0.003	0.010	0.001	0.006	0.002	0.013
	90th	0.004	0.016	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.011	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.009	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	9.4%	46.2%	0.6%	0.0%	2.9%	1.8%	2.9%	0.0%	0.0%
Range	Maximum	0.004	0.037	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	99th	0.004	0.036	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	95th	0.004	0.032	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.004	0.024	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	38.5%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.110	2.300	0.021	0.018	0.38	0.14	0.051	0.016	0.018
	99th	0.089	2.040	0.018	0.017	0.237	0.114	0.050	0.016	0.017
	95th	0.068	1.175	0.017	0.003	0.140	0.053	0.006	0.002	0.013
	90th	0.050	0.665	0.017	0.003	0.068	0.001	0.006	0.002	0.013
	80th	0.032	0.420	0.017	0.003	0.029	0.001	0.006	0.002	0.013
	75th	0.027	0.375	0.017	0.003	0.022	0.001	0.006	0.002	0.013
	50th	0.011	0.140	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	71.2%	97.0%	0.0%	0.0%	31.8%	3.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.022	0.340	0.021	0.005	0.0339	0.050	0.006	0.011	0.017
	99th	0.020	0.271	0.020	0.004	0.031	0.037	0.006	0.009	0.016
	95th	0.014	0.075	0.017	0.003	0.022	0.001	0.006	0.002	0.013
	90th	0.010	0.072	0.017	0.003	0.009	0.001	0.006	0.002	0.013
	80th	0.005	0.053	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.048	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.030	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	22.2%	92.6%	0.0%	0.0%	11.1%	0.0%	0.0%	0.0%	0.0%
South-Central Texas										
All Locations	Maximum	0.105	0.527	0.0651	0.128	0.142	0.18	0.132	0.083	0.109
	99th	0.010	0.210	0.021	0.008	0.084	0.050	0.006	0.011	0.017
	95th	0.007	0.095	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.063	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	80th	0.004	0.029	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.020	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	19.2%	56.0%	0.5%	0.5%	9.3%	0.6%	0.5%	0.5%	1.1%

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Agriculture	Maximum	0.008	0.059	0.017	0.003	0.008	0.001	0.006	0.002	0.013
	99th	0.007	0.047	0.017	0.003	0.007	0.001	0.006	0.002	0.013
	95th	0.006	0.017	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	90th	0.005	0.007	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	20.6%	38.2%	0.0%	0.0%	8.8%	0.0%	0.0%	0.0%	2.9%
Range	Maximum	0.005	0.0031	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	99th	0.005	0.0031	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	95th	0.005	0.0031	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.005	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	80th	0.005	0.004	0.019	0.004	0.018	0.030	0.006	0.007	0.015
	75th	0.004	0.003	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Urban	Maximum	0.010	0.527	0.021	0.005	0.107	0.05	0.006	0.011	0.017
	99th	0.010	0.430	0.021	0.005	0.0925	0.05	0.006	0.011	0.017
	95th	0.009	0.176	0.021	0.005	0.029	0.050	0.006	0.011	0.017
	90th	0.006	0.138	0.017	0.003	0.027	0.001	0.006	0.002	0.013
	80th	0.005	0.072	0.017	0.003	0.011	0.001	0.006	0.002	0.013
	75th	0.005	0.069	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.012	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	29.4%	76.5%	0.0%	0.0%	19.6%	0.0%	0.0%	0.0%	0.0%
Mixed	Maximum	0.105	0.159	0.065	0.128	0.142	0.180	0.132	0.083	0.109
	99th	0.028	0.123	0.029	0.041	0.049	0.076	0.030	0.025	0.034
	95th	0.006	0.052	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.005	0.040	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.004	0.028	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.022	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.008	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	15.9%	59.8%	1.2%	1.2%	4.9%	1.2%	1.2%	1.2%	1.2%
Central Nebraska										
All Locations	Maximum	0.140	0.039	0.021	0.021	0.054	0.0078	0.061	0.019	0.270
	99th	0.109	0.023	0.021	0.005	0.027	0.050	0.025	0.011	0.020
	95th	0.035	0.012	0.021	0.005	0.027	0.050	0.006	0.011	0.017
	90th	0.018	0.006	0.017	0.003	0.007	0.001	0.006	0.002	0.013
	80th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.004	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	21.6%	23.2%	0.0%	0.0%	6.1%	0.6%	2.8%	0.0%	0.8%
Agriculture	Maximum	0.130	0.014	0.021	0.021	0.054	0.003	0.061	0.019	0.190
	99th	0.109	0.011	0.021	0.007	0.027	0.052	0.055	0.012	0.020
	95th	0.032	0.005	0.017	0.005	0.017	0.040	0.006	0.011	0.017
	90th	0.020	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.007	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.005	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
	Frequency	25.9%	8.6%	0.0%	0.0%	5.9%	0.5%	2.7%	0.0%	0.5%
Mixed	Maximum	0.140	0.0394	0.021	0.005	0.0444	0.050	0.028	0.011	0.270
	99th	0.109	0.025334	0.021	0.005	0.029	0.050	0.022	0.011	0.019
	95th	0.047	0.01454	0.017	0.003	0.020	0.001	0.006	0.010	0.013
	90th	0.016	0.009	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	80th	0.005	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.005	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	17.8%	39.9%	0.0%	0.0%	5.5%	0.0%	3.1%	0.0%	1.2%

g. Region G: Mid-South

Maximum estimated concentrations of acephate, dicrotophos, and terbufos were in the single parts per billion, while the maximum estimated concentration of malathion was greater than 10 ppb (Table III.E.1-17). More detailed discussion and analysis of the OP load in drinking water sources can be found in section II.G.

Table III.E.1-17. Predicted percentile concentrations of individual OP pesticides and of the cumulative OP distribution in the Midsouth Region.

Chemical	Crop/Use	Concentration, ug/L (ppb)						
		Max	99th	95th	90th	80th	75th	50th
Acephate	Cotton	4.6e+00	7.4e-01	1.1e-01	2.8e-02	1.6e-03	2.2e-04	3.9e-07
Chlorpyrifos	Corn	3.7e-02	1.6e-02	7.0e-03	3.9e-03	1.8e-03	1.3e-03	5.3e-04
Dicrotophos	Cotton	1.5e+00	6.3e-01	2.9e-01	1.4e-01	4.7e-02	2.7e-02	9.7e-04
Dimethoate	Corn, Cotton	2.1e-01	6.1e-02	1.3e-02	6.3e-03	1.3e-03	4.6e-04	1.0e-05
Disulfoton	Cotton	1.3e-02	1.1e-02	6.4e-03	4.9e-03	3.1e-03	2.7e-03	1.3e-03
Malathion	Cotton	1.4e+01	1.8e+00	4.2e-01	2.5e-01	8.5e-02	5.0e-02	1.5e-03
Methamidophos	Cotton	7.2e-01	8.1e-02	7.7e-03	1.0e-03	1.2e-05	6.8e-07	8.4e-09
Methyl Parathion	Cotton, Soybeans	1.5e-01	8.1e-02	4.4e-02	2.3e-02	1.0e-02	6.7e-03	1.7e-04
Phorate	Cotton	5.6e-01	8.7e-02	4.2e-03	1.1e-04	8.9e-08	1.5e-09	3.6e-15
Profenofos	Cotton	1.8e-01	2.7e-02	3.8e-03	9.7e-04	9.1e-05	3.0e-05	3.3e-07
Phostebupirim	Corn	3.6e-02	1.5e-02	7.3e-03	4.5e-03	2.5e-03	2.1e-03	9.5e-04
Terbufos	Corn	1.0e+00	3.5e-01	1.2e-01	6.8e-02	2.1e-02	1.2e-02	4.9e-04
Tribufos	Cotton	3.3e-01	2.2e-01	1.7e-01	1.2e-01	7.6e-02	6.6e-02	4.4e-02
OP Cumulative Concentration (in ppb methamidophos equivalents)		8.7e+00	4.3e+00	1.9e+00	1.0e+00	4.4e-01	3.1e-01	4.1e-02

i. Comparison of Monitoring Data versus Model Estimates

The maximum detect from the USGS NAWQA Mississippi Embayment study unit for chlorpyrifos was an order of magnitude greater than the maximum estimated concentration. The estimated maximum concentration is roughly equivalent to the 90th percentile concentration in the monitoring data. The maximum detect for methyl parathion in NAWQA was four times greater than the maximum estimated concentration. The estimated peak concentration falls somewhere between the 95th and 99th percentile of monitoring data. The maximum detect for disulfoton in NAWQA was an order of magnitude greater than the estimated maximum concentration, which was less than the analytical limit of detection (LOD) for disulfoton in the USGS study. On the other side, the maximum estimated concentration for malathion was an order of magnitude greater than the highest NAWQA detection, which fell between the 95th and 99th percentile in the estimated distribution.

While dicrotophos was not included in the NAWQA study, it was included in an earlier USGS study on cotton pesticides in the Mississippi Embayment (USGS Fact Sheet 022-98; Thurman et al, 1998. Available from the web site http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.022-98.html). Dicrotophos was detected in 35% of the samples (a comparison of the dicrotophos LOD of 0.016 ug/L to the estimated concentration distribution shows an equivalent percentage above the LOD). The maximum detection reported for dicrotophos corresponds to the estimated 90th to 95th percentiles.

The Bogue Phalia River near Leland, MS contained the most detections and co-occurrences. Malathion, methyl parathion, and chlopyrifos were all detected in the Bogue Phalia River, but chlorpyrifos was only detected twice. For malathion (Figure III.E.1-10), both estimated and observed concentrations were consistent except for the highest percentiles. For methyl parathion (Figure III.E.1-11), the observed concentrations were higher than estimated starting about the 80th percentile.

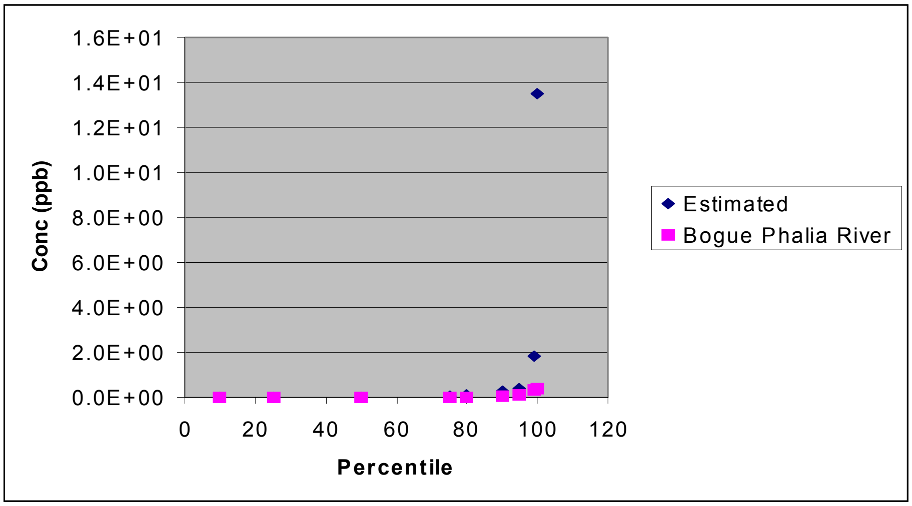

Figure III.E.1-10. Comparison of observed and estimated malathion concentrations in the Mid-South Region.

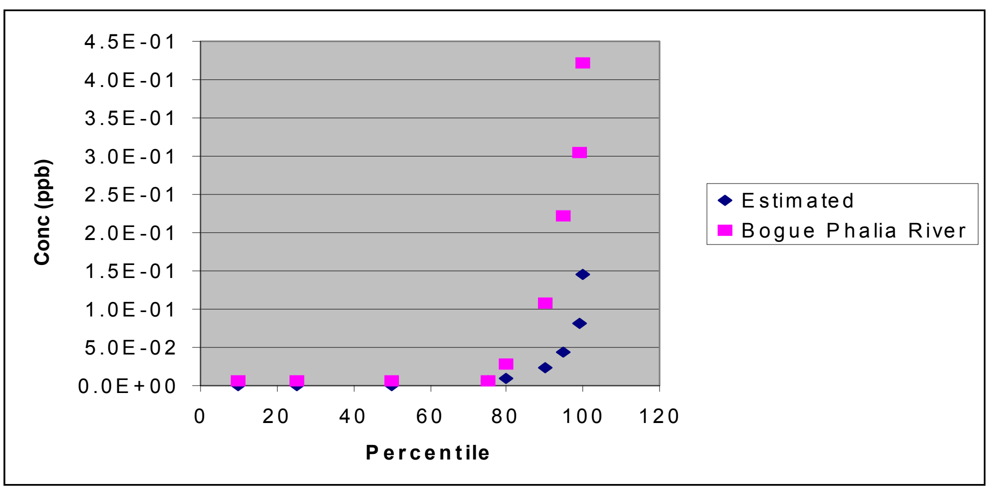

Figure III.E.1-11. Comparison of observed and estimated methyl parathion concentrations in the Mid-South Region.

ii. Summary of NAWQA Monitoring Data in the Region

The **Mississippi Embayment NAWQA** study unit extends from northeast Louisiana along the Mississippi River as it forms the borders of Mississippi, Arkansas, Tennessee and Missouri. The USGS description of the region states that 62% is used for agriculture, up to 90% in areas of intensive row-crop agriculture. About 94% of drinking water supplies in this study unit were derived from ground water in 1995 (USGS Circular 1208).

None of the nine active OPs included as analytes were detected in ground water studies in this study unit. Surface-water sampling resulted in the detection of multiple OPs. Sampling programs included three agricultural streams, one mixed use stream, and one urban stream sampled at least biweekly for two years. In addition, 38 sites from "streams that drained all major crop types grown in the Study Unit" were sampled once each (USGS Circular 1208).

Diazinon and chlorpyrifos were detected in 96% and 100% of urban stream samples, respectively. They were detected in 4% and 6% of agricultural stream samples. Malathion was detected in 56% of urban, 36% of mixed use, and 11% of agricultural samples, with a maximum concentration of 0.616 ug/l (agricultural).

Other OPs were detected in surface water as well. Methyl-parathion was detected in 10% of samples, with a maximum concentration of 0.422 ug/l. Azinphos-methyl was detected in 5 samples, with a maximum detected concentration of 1.0 ug/l. Disulfoton was detected in three samples, with a maximum detection of 0.213 ug/l. Phorate was detected once at 0.2, ethoprop once at 0.206 ug/l, and terbufos twice, with a maximum concentration of 0.173 ug/l.

The U.S. Geological Survey (USGS) Organic Geochemistry Research Group (OGRG) designed a cotton pesticide monitoring study, the results of which are published as the May 1998 USGS Fact Sheet 022-98, "Occurrence of Cotton Pesticides in Surface Water of the Mississippi Embayment." The OGRG collected weekly samples at 8 fixed sites, and collected single samples at another 56 sites in 1996.

Seven different OPs were detected in this study above a detection limit of 0.01 ug/l (http://ks.water.usgs.gov/Kansas/pubs/fact-sheets/fs.022-98.fig.8.gif). Dicrotophos was detected in 35% of samples, methyl parathion in 18%, and profenofos and malathion in 12%. Sulprofos, chlorpyrifos and azinphos-methyl were also detected. The 90th percentile concentration detected for all OPs was 0.3 ug/l or less.

The high rate of detection in this study correlates to high use of these OPs on cotton. Methyl parathion, profenofos and dicrotophos are applied extensively to cotton. The OGRG reported that although profenofos was used three times as much as dicrotophos, dicrotophos was much more frequently detected. This is consistent with the shorter persistence of profenofos.

Table III.E.1-18. Magnitude and Frequency of Occurrence of OP Pesticides Analyzed in the NAWQA Study Units in the Mid-South Region.

Land Use	Value	chlorpyrifos	diazinon	disulfoton	ethoprop	malathion	azinphos methyl	methyl parathion	phorate	terbufos
		Concentation (ug/L)								
Mississippi Embayment										
All Locations	Maximum	0.251	1.050	0.213	0.206	0.616	1.000	0.422	0.244	0.173
	99th	0.134	0.376	0.021	0.005	0.488	0.521	0.274	0.011	0.017
	95th	0.041	0.125	0.021	0.005	0.147	0.146	0.082	0.011	0.017
	90th	0.019	0.010	0.017	0.003	0.047	0.050	0.022	0.002	0.013
	80th	0.005	0.003	0.017	0.003	0.017	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	13.2%	14.3%	0.9%	0.3%	26.2%	1.5%	10.1%	0.3%	0.6%
Agriculture	Maximum	0.200	0.020	0.071	0.005	0.616	0.0654	0.422	0.011	0.017
	99th	0.049	0.017	0.021	0.005	0.311	0.500	0.285	0.011	0.017
	95th	0.010	0.005	0.017	0.003	0.062	0.106	0.108	0.002	0.013
	90th	0.004	0.002	0.017	0.003	0.020	0.020	0.044	0.002	0.013
	80th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	5.2%	4.2%	0.9%	0.0%	15.6%	0.5%	10.4%	0.0%	0.0%
Urban	Maximum	0.251	1.050	0.021	0.005	0.560	0.0427	0.061	0.011	0.017
	99th	0.223	0.897	0.021	0.005	0.511	0.0427	0.058	0.011	0.016
	95th	0.133	0.451	0.020	0.004	0.334	0.048	0.035	0.008	0.013
	90th	0.089	0.380	0.017	0.003	0.173	0.018	0.006	0.002	0.013
	80th	0.077	0.342	0.017	0.003	0.072	0.001	0.006	0.002	0.013
	75th	0.069	0.319	0.017	0.003	0.050	0.001	0.006	0.002	0.013
	50th	0.036	0.154	0.017	0.003	0.012	0.001	0.006	0.002	0.013
	Frequency	92.9%	96.4%	0.0%	0.0%	57.1%	3.7%	7.1%	0.0%	3.6%
Mixed	Maximum	0.186	0.242	0.213	0.206	0.560	0.900	0.312	0.244	0.173
	99th	0.052	0.042	0.036	0.021	0.526	0.630	0.126	0.030	0.029
	95th	0.011	0.010	0.021	0.005	0.217	0.300	0.055	0.011	0.017
	90th	0.005	0.006	0.020	0.005	0.095	0.120	0.020	0.009	0.017
	80th	0.004	0.004	0.017	0.003	0.027	0.050	0.006	0.002	0.013
	75th	0.004	0.002	0.017	0.003	0.024	0.029	0.006	0.002	0.013
	50th	0.004	0.002	0.017	0.003	0.005	0.001	0.006	0.002	0.013
	Frequency	7.5%	12.9%	1.1%	1.1%	41.9%	3.3%	10.8%	1.1%	1.1%