II. Regional Assessments

G. Region G - Mid-South Assessment

1. Executive Summary

Region G. Mid-South Assessment

This module of the Organophosphate (OP) cumulative risk assessment focuses on risks from OP uses in the Mid-South Region (area shown to right). Information is included in this module only if it is specific to the Mid-South, or is necessary for clarifying the results of the Mid-South assessment. A comprehensive description of the OP cumulative assessment comprises the body of the main document; background and other supporting information for this regional assessment can be found there.

This module focuses on the two components of the OP cumulative assessment which are likely to have the greatest regional variability: drinking water and residential exposures. Dietary food exposure is likely to have significantly less regional variability, and is assumed to be nationally uniform. An extensive discussion of food exposure is included in the main document. Pesticides and uses which were considered in the drinking water and residential assessments are summarized in Table II.G.1 below. The OP uses included in the drinking water assessment generally accounted for 95% or more of the total OPs applied in that selected area. Various uses that account for a relatively low percent of the total amount applied in that area were not included in the assessment.

Table II.G.1. Pesticides and Use Sites/Scenarios Considered in Mid-South Residential/Non-Occupational and Drinking Water Assessment

Pesticide	OP Residential Use Scenarios	OP Drinking Water Scenario Uses
Acephate	Golf Courses, Ornamental Gardens	Cotton
Bensulide	Golf Courses	None
Chlorpyrifos	None	Corn
DDVP	Pest Strips	None
Dicrotophos	None	Cotton
Dimethoate	None	Corn, Cotton
Disulfoton	Ornamental Gardens	Cotton
Fenamiphos	Golf Courses	None
Fenthion	Public Health	None
Malathion	Home Fruit & Vegetables, Ornamental Gardens, Public Health	Cotton
Methamidophos	None	Cotton
Methyl-parathion	None	Cotton, Soybean
Phorate	None	Cotton
Profenofos	None	Cotton
Terbufos	None	Corn
TCVP	Pet Uses	None
Trichlorfon	Golf Courses, Lawn applications	None
Tribufos	None	Cotton
Tebupirimphos	None	Corn

This module will first address residential exposures. The residential section describes the reasons for selecting or excluding various use scenarios from the assessment, followed by a description of region-specific inputs. Detailed information regarding the selection of generic data inputs common to all the residential assessments (e.g., contact rates, transfer coefficients, and breathing rate distributions, etc.) are included in the main document.

Drinking water exposures are discussed next. This will include criteria for the selection of a sub-region within the Mid-South for modeling drinking water residues, followed by modeling results, and finally characterization of the available monitoring data which support use of the modeling results. This assessment accounted for all OP uses within the selected location that are anticipated to contribute significantly to drinking water exposure.

Finally a characterization of the overall risks for the Mid-South region is presented, focusing on aspects which are specific to this region.

In general, the risks estimated for the Mid-South show a similar pattern to those observed for other regions. Drinking water does not contribute to the risk picture in any significant way at the upper percentiles of exposure. At these higher percentiles of exposure, residential inhalation exposures are the major source of risk due to use of DDVP Pest Strips. These patterns occur for all population sub-groups, although potential risks appear to be higher for children than for adults regardless of the percentile considered.

2. Development of Residential Exposure Aspects of Mid-South Region G

In developing this aspect of the assessment, the residential exposure component of Calendex was used to evaluate predicted exposures from residential uses. Except for golf course uses, this assessment is limited to the home as are most current single chemical assessments. Additional work is needed to account for an individual's time spent in areas outside of the home (e.g., schools, workplace ,etc.). The residential component of the assessment incorporates dermal, inhalation, and non-dietary ingestion exposure routes which result from applications made to residential lawns (dermal and non-dietary ingestion), golf courses, ornamental gardens, home fruit and vegetable gardens, public health uses, pet uses, and indoor uses. These scenarios were selected because they are expected to be the most prominent contributors to exposure in this region. Additional details regarding the selection of the scenario-pesticide pairs can be found in Part I of this document. OPP believes that the majority of exposures (and all significant exposures) in this region have been addressed by the scenarios selected.

The data inputs to the residential exposure assessment come from a variety of sources including the published, peer reviewed literature and data submitted to the Agency to support registration and re-registration of pesticides. Generic scenario issues and data sources are discussed in Part I of this report. However, a variety of additional region-specific ancillary data was required for this assessment of the Mid-South. This information includes region-specific data on pesticide application rates and timing, pesticide use practices, and seasonal applications patterns, among others. The Gaant chart shown in Figure II.G.1 displays and summarizes the various region-specific residential applications and their timing (including repeated applications) over the course of a year which were used in this assessment. Specific information and further details regarding these scenarios, the Calendex input parameters, and the pesticides for which these scenarios were used is presented in Table II.G.2 which summarizes all relevant region-specific scenarios.

Table II.G.2. Use Scenarios and Calendex Input Parameters for Mid-South Residential Exposure Assessment

Chemical	Use Scenario	Application Method	Amt. Applied lb ai/A	Max. No./ Frequency Of Apps.	App. Schedule	% Use LCO	% Use HO	% Users	Residue Persistence (Days)	Routes of Exposure
Acephate	Golf Course	NA	5	2/yr, 2 wks. Between Apps.	Mar.-Oct. 13-44 wks.	100	--	6	10	dermal(p)
	Ornamental	hand pump sprayer	0.9-2	4/yr, 2 wks. Between Apps.	Mar.-Oct. 13-44 wks.	--	100	6	1	inhalation(a), dermal(a)
Bensulide	Golf Course	NA	12.5	2/yr, 26 wks. Between Apps.	Mar.-Apr. and Sept.-Oct.	100	--	1	14	dermal(p)
DDVP	Pest Strip	closet strip	NA	16 wks., Regular App. Schedule	Jan.-Dec. 1-52 wks.	--	100	2	120	inhalation(p)
		cupboard strip	NA	16 wks., Regular App. Schedule	Jan.-Dec. 1-52 wks.	--	100	2	120	inhalation(p)
Disulfoton	Ornamental	granular	8.7	3/yr, 6 wks. Between Apps.	Apr.-Nov. 16-48 wks.	--	100	2	1	inhalation(a), dermal(a)
Fenamiphos	Golf Course	NA	10	1/yr	Apr.-Nov. 14-48 wks.	100	--	1	2	dermal(p)
Fenthion	Public Health	aerial and ground	NA	15/yr, 2 wks. Between Apps.	Mar.-Oct. 10-44 wks.	100	--	5	2	oral(p), dermal(p)
Malathion	Ornamental	hand pump spray	0.9-2	4/yr, 2 wks. Between Apps.	Apr.-Nov. 14-46 wks.	--	100	4	1	inhalation(a), dermal(a)
	Public Health	aerial and ground	NA	9/yr, 2 wks. Between Apps.	Apr.-Nov. 14-46 wks.	100	--	13	2	oral(p), dermal(p)

Chemical	Use Scenario	Application Method	Amt. Applied lb ai/A	Max. No./ Frequency Of Apps.	App. Schedule	% Use LCO	% Use HO	% Users	Residue Persistence (Days)	Routes of Exposure
	Vegetable Garden	hand pump sprayer	1.5	5/yr, 2 wks. Between Apps.	Apr.-Nov. 14-46 wks.	--	100	1	1 7	inhalation(a), dermal(a)(p)
TCVP	Pet Aerosol	aerosol spray	2.4×10^{-5}- 3.3×10^{-5} lb ai/lb dog	1/8 wks., Regular App. Schedule	Jan.-Dec. 1-52 wks.	--	100	5	1 32	inhalation(a), oral(p), dermal(a)(p)
	Pet Powder	shaker can	4.6×10^{-5}- 5.5×10^{-5} lb ai/lb dog	1/8 wks., Regular App. Schedule	Jan.-Dec. 1-52 wks.	--	100	5	1 32	inhalation(a), oral(p), dermal(a)(p)
	Pet Spray	hand pump sprayer	2.0×10^{-5}- 2.2×10^{-5} lb ai/lb dog	1/8 wks., Regular App. Schedule	Jan.-Dec. 1-52 wks.	--	100	5	1 32	inhalation(a), oral(p), dermal(a)(p)
Trichlorfon	Golf Course	NA	8	1/yr	Jul.-Nov. 27-45 wks.	100	--	1	2	dermal(p)
	Lawn Granular	rotary spreader	8	1/yr	Jul.-Nov. 27-45 wks.	8	92	1	1 2	inhalation(a), oral(p), dermal(a)(p)
	Lawn Spray	NA	8	1/yr	Jul.-Nov. 27-45 wks.	100	--	2	2	oral(p), dermal(p)

Figure II.G.1 Residential Scenario Application and Usage Schedules for the Mid-South Region (Region G)

<table>
<tr><th>January</th><th>February</th><th>March</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>September</th><th>October</th><th>November</th><th>December</th></tr>
<tr><td></td><td></td><td colspan="8">Acephate Golf</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="8">Acephate Ornamental Spray</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="2">Bensulide Golf</td><td></td><td></td><td></td><td></td><td colspan="2">Bensulide Golf</td><td></td><td></td></tr>
<tr><td colspan="12">DDVP Pest Strip (Closet)</td></tr>
<tr><td colspan="12">DDVP Pest Strip (Cupboard)</td></tr>
<tr><td></td><td></td><td></td><td colspan="8">Disulfoton Ornamental Granular</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="8">Fenamiphos Golf</td><td></td></tr>
<tr><td></td><td></td><td colspan="8">Fenthion</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="8">Malathion Ornamental Spray</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="8">Malathion Public Health</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="8">Malathion Vegetable Garden Spray</td><td></td></tr>
<tr><td colspan="12">TCVP Aerosol Spray</td></tr>
<tr><td colspan="12">TCVP Powder</td></tr>
<tr><td colspan="12">TCVP Hand Pump Spray</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Trichlorfon Golf</td><td></td></tr>
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<tr><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Trichlorfon Spray</td><td></td></tr>
</table>

a. Dissipation Data Sources and Assumptions

i. Acephate

A residue dissipation study was conducted on Bahia grass in Florida with multiple residue measurements collected for a period of 10 days after treatment (Days 0, 1, 2, 3, 5, 7, and 10 days). A uniform distribution bounded by the high and low residue measurements of each day was used to represent these daily measurements. No half-life value or other degradation parameter was used, with the current assessment based instead on the time-series distribution of actual residue measurements.

ii. Bensulide

A residue dissipation study was conducted with multiple residue measurements collected for up to 14 days after treatment. For each day following application, a residue value from a uniform distribution bounded by the low and high measurements was selected (the day zero distribution consisted of measurements collected immediately after application and 0.42 day after treatment). No half-life value or other degradation parameter was used, with the current assessment based instead on the time-series distribution of actual measurements. Residues measured at day 7 were assumed to be available and to persist to day 10 and day 10 measurements to persist to day 14.

iii. Malathion

A residue dissipation study was conducted with multiple residue measurements collected up to 7 days after treatment in Pennsylvania. A value selected from a uniform distribution bounded by the low and high measurements was used for each day after the application. Since the study was conducted at a one pound ai per acre treatment rate, the residues were adjusted upwards by a 1.5 factor to account for the 1.5 pound ai per acre rate for vegetables.

iv. Fenamiphos

Snyder et al., 1999 collected residue dissipation data on the day of and day after application following the application of fenamiphos on a golf course. Only mean measurements were collected.

v. Trichlorfon

Residue values from a residue degradation study for the granular and sprayable formulations were collected for the “day of” and “day following” the application. This was used for both the lawn and golf course post-application exposure scenarios. For dermal exposure scenarios, a uniform distribution bounded by the low and high residue measurements was used, with these residue values adjusted upwards to simulate the higher active ingredient concentrations in use (i.e., adjusted to 0.5% and 1% for granular and sprayable formulations respectively). These distributions also reflect actual measurements including those based on directions to water in the product. For use on home lawns, these values were multiplied by a value selected from a uniform distribution bounded by 1.5 and 3 to account for wet hand transfer for assessing non-dietary ingestion for children.

3. Development of Water Exposure Aspects of Mississippi Portal Region

Because of the localized nature of drinking water exposure, the water exposure component of this assessment focused on a specific geographic area within the region. This region combines the Mississippi Portal region with the western sections of the Eastern Uplands and Southern Seaboard (those areas located to the west of the Mississippi Portal) regions from the preliminary assessment. The selection process considers OP use, relative potencies of those OP pesticides, and location, nature, and vulnerability of the drinking water sources. The methods used to identify a specific location within the region are described in the main document (Section I.E). The following discussion provides the details specific to the Midsouth regional assessment for OP cumulative drinking water exposure. The discussion centers on four main aspects of the assessment: (1) the selection of a specific location in northeastern Louisiana and west-central Mississippi (on either side of the Mississippi River) for the drinking water assessment, (2) predicted cumulative concentrations of OPs in surface water for those OP-crop uses included in this regional assessment, (3) a comparison of the predicted concentrations with surface water monitoring data for the region, and (4) a summary of water monitoring data used for site selection and evaluation of the estimated drinking water concentrations for the region.

a. Selection of Northeastern Louisiana for Drinking Water Assessment

While drinking water derived from surface water is more likely to be contaminated with OPs than ground water in the region, the majority of the surface water intakes for drinking water are located outside the major OP-use area in the region. The high-use region around northeastern Louisiana and west central Mississippi has few surface water intakes, but represents the most vulnerable area in the region in terms of OP usage and runoff vulnerability. Transport of pesticides in surface water is complicated by leveeing of the Mississippi River and a system of drainage canals. The ground-water aquifers used for drinking water in this region tend to be protected by relatively impermeable overlying materials. While a surface water assessment using the index reservoir may be less representative of actual drinking water sources in this region than in other regions, it is likely to be health-protective for the region.

Total OP usage is relatively high in the Mississippi Portal region and low in the western portion of the Eastern Upland and Southern Seaboard regions.

In 1997, approximately 8.5 million pounds (ai) of OPs were applied in on agricultural crops in this region, with use on cotton accounting for approximately 90 percent of the total use (Table II.G.3).

Table II.G.3. General overview of OP usage in the Mississippi Portal Portion of the Midsouth Region.

Crops	Primary Production Areas	Total Pounds Applied	Percent of Total OP Use
Cotton	Either side of the Mississippi River, from northeastern LA northward	7,695,000	90
Rice	West side of Mississippi River, from eastern AR to southwest LA	273,000	3
Corn	Northeastern LA, western MS and north	161,000	2
Soybeans	Higher use on west side of Mississippi River	199,000	2
Sugarcane	Southern LA	99,000	1
		8,562,000	98

(1) Source: NCFAP, 1997.

The highest OP-use areas are on either side of the Mississippi River, predominantly in western Mississippi and northeastern Louisiana (Figure II.G.2). Because of the high OP use and vulnerability to runoff, OPP focused on this areas for its drinking water assessment.

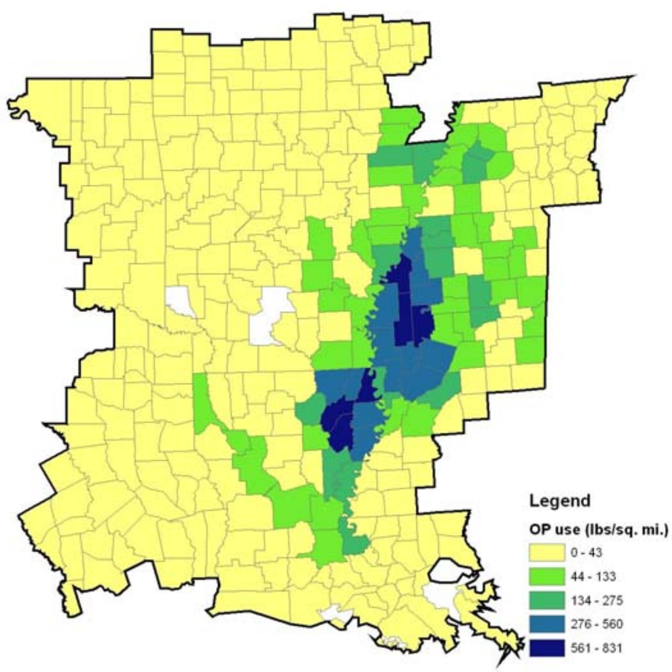

Figure II.G.2. Total OP usage (pounds per area) in the Midsouth Region (source: NCFAP, 1997)

Surface water sources of drinking water occur primarily in western Tennessee, in the northeast corner of the region, in southern Louisiana, in the southeast corner of the region, and throughout the western half of the region. The central portion of the region, on either side of the Mississippi River, is more vulnerable to runoff (Figure II.G.3). The largest concentration of people drinking from surface water is in southeastern Louisiana (including New Orleans), drawing from the Mississippi River. About one-third of the drainage of the Mississippi Embayment is to the Mississippi River. The remainder of the surface drainage is to the Gulf of Mexico through rivers and streams in southern Louisiana, Mississippi and Alabama.

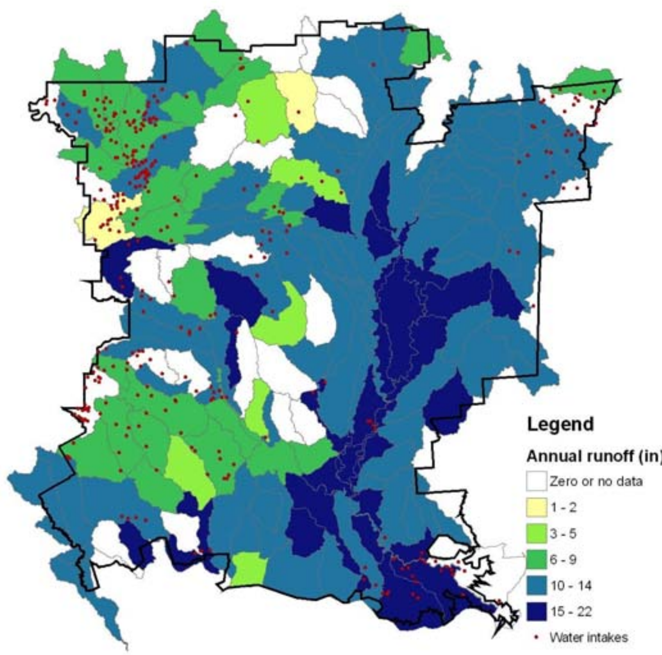

Figure II.G.3. Locations of surface water intakes of drinking water in relation to average annual runoff in the Midsouth Region.

The Atchafalaya River, which drains to the Gulf of Mexico, is the drinking water source for more than 60,000 people, through ox-bow lakes. The Red, Black and Ouachita Rivers all drain to the Atchafalaya at least indirectly. Another 70,000 or so in the Monroe, LA, area drink from reservoirs located in cotton areas. There are plans for a new treatment plant there with advanced treatment facilities.

Ground water is the major source of drinking water for a significant area of the region, north of Baton Rouge, LA, and south of western Tennessee. Ground water is derived predominantly from confined or semi-confined aquifers which underlie the entire Mississippi embayment. Significant amounts of water are also drawn from younger alluvium which occurs at the surface or under 10 to 50 feet of relatively recently deposited silt and clay. Although the alluvial aquifer is mostly used for irrigation, there is some domestic use for drinking water. In general, while OP contamination is possible, ground-water contamination with pesticides is less likely in the Midsouth than most of the rest of the nation.

Three distinct aquifer systems make up the Mississipi Embayment Aquifer system. The majority of drinking water north of Baton Rouge is drawn from Tertiary age aquifers which are both deep and confined throughout most of the region. This aquifer system, which includes multiple confining layers, is overlain in much of the region by the Mississippi River Valley Alluvial Aquifer. In central to southern Louisiana, the Vicksburg-Jackson confining layer separates the Mississippi Embayment Aquifer system from the coastal lowlands aquifer system defined by the USGS Regional Aquifer-System Analysis program.

The Mississippi Embayment aquifer system extends 160,000 square miles in parts of six states, including much of the Midsouth Region. This system includes six regional aquifers which constitute the most important source of ground water used for drinking water in the Mississippi Embayment. The main recharge area for the five aquifers below the alluvial aquifer occurs at their eastern outcrops in Mississippi and western Tennessee, although ground-water pumping has reversed natural flow to draw water down from the Mississippi River alluvial aquifer.

Natural ground-water flow in the five aquifers is southwest and down from the recharge area, then up in the center of the basin. The five aquifers are hydraulically interconnected, although flow within individual aquifers is much quicker than that between aquifers, due to lower permeability in the confining layers that separate them.

The structure of the aquifer system, and the presence of multiple confining layers, reduces the likelihood of drinking-water contamination for large sections of the Midsouth region. The middle Claiborne aquifer, for instance, accounts for 76% of pumpage from the Embayment aquifers. This aquifer is in hydrologic connection with the surface in outcrop areas in Mississippi and western Louisiana. However, OPs used in the center of the basin are much less likely to contaminate water drawn from that same aquifer, due to depth and the intervening confining layers. Given the amount of time needed to travel from the recharge area to the deeper center of the syncline, the water would likely have infiltrated the surface before OPs were in use.

The Tertiary aquifers are only in direct hydraulic connection with the overlying alluvial aquifer in a small portion of the Embayment. However, pumping has increased the possibility of contamination traveling from the alluvial aquifer to the underlying Embayment aquifers. Natural recharge was from the Embayment aquifers up to the alluvial aquifer. However, due to the influence of groundwater pumping for irrigation and public supply, water from the alluvial aquifer now recharges the Embayment aquifer in some areas.

USGS sampled from the Tertiary aquifers in the NAWQA program. Thirty sampling sites throughout the Mississippi Embayment were sampled one time in 1996. Only the shallowest of the wells, which ranged in depth from 208 to 1460 feet, had any detections of pesticides. Bromacil and de-ethyl atrazine were both detected at sub part-per-billion concentrations. OPs were not among the pesticides detected in domestic and public supply wells.

The Mississippi River Valley Alluvial aquifer system extends from northeastern Louisiana to the northernmost extent of the Mississippi Embayment in southeastern Missouri (http://capp.water.usgs.gov/gwa/ch_f/gif/F066.GIF). This sand and gravel aquifer, which ranges from 60 to 140 feet in thickness, overlies the less permeable aquifers and confining layers of the Tertiary-age Mississippi Embayment aquifer system. The Mississippi Valley Alluvial aquifer system is itself overlain over most of its extent by a 10 to 50-foot confining unit of silt, clay and fine-grained sand which is thicker to the south(USGS Professional Paper 1416-D).

Water from this alluvial aquifer "is used for public supply, usually with treatment, only where an adequate supply of water of better quality is not available from deeper aquifers" (USGS Prof. Paper 1416-D). Domestic wells in the alluvial aquifer are at least 50 to 200 feet deep in Louisiana (Karen Irion, personal communication). Eighty percent of the water withdrawn from this aquifer (in 1988) was for rice irrigation, and another 10% for other crops. A significant portion of the remaining use is for aquaculture. Pesticides detected more often by NAWQA in alluvial wells than in the Tertiary supply wells. However, there were no detections of OPs in ground water.

The Coastal Lowlands aquifer system overlies both the Tertiary and Mississippi River Valley Alluvial aquifers from Texas through southern and central Louisiana into southern Mississippi (Water Atlas 730-F). Included in the Coastal Lowlands system are the Chicot aquifer of southwest Louisiana and the Southern Hills aquifer, which extends from southeastern Louisiana north of Baton Rouge up into southwestern Mississippi. These aquifers are "sole source" aquifers that are susceptible to contamination (see http://www.epa.gov/earth1r6/6wq/swp/ssa/gif/ssa.gif).

In summary, drinking water derived from surface water is more likely to be contaminated with OPs than ground water. OPs have been detected in surface water at low concentrations. Transport of pesticides in surface water is complicated by leveeing of the Mississippi River in Lousiana and the system of drainage canals in southern Louisiana. While agricultural areas around tributaries can potentially contribute to contamination of drinking water supplies, drainage from fields along leveed portions of the Mississippi River may follow the longer path through drainage canals to a potential drinking water supply.

In the high-use counties in northeastern Louisiana and those counties directly across the Mississippi River in west-central Mississippi, OP use on cotton accounted for 95 percent of total agricultural use. The latest NASS usage data found that 15 OP-crop combinations accounted for 98 percent of OP usage in these counties (Table II.G.4).

Table II.G.4. OP Usage on Agricultural Crops in Northeast Louisiana .

OP Usage/ Agricultural Crops				Cropland Acreage, Assessment Area	
Crop Group	**Crops**	**OP Usage x 1000 lb**	**Percent of Total OP Use**	**Acres**	**Pct of total Cropland**
Cotton	Cotton	3,678	95	533	34
Corn	Corn, sweet corn	38	1	241	15
Soybeans	Soybeans	78	2	370	24
			98	1,144	73

Pesticide use based on latest data collected by USDA National Agricultural Statistics Service (NASS). Acreage estimates based on LA Agricultural Statistics Service and reflect only the acreage in the eastern LA counties. Details on the sources of usage information are found in Appendix III.E.8.

b. Cumulative OP Concentration Distribution in Surface Water

The Agency estimated drinking water concentrations in the Midsouth regional assessment using PRZM-EXAMS with input parameters specific to northeast Louisiana or west-central Mississippi. Table II.G.5 summarizes pesticide use information for the OP-crop combinations which were modeled in this regional assessment. Chemical-, application- and site-specific inputs into the assessments are found in Appendices III.E.5-7. Sources of usage information can be found in Appendix III.E.8.

Table II.G.5. OP-Crop combinations and application information for the Midsouth Region Assessment.

Chemical	Crop/ Use	Pct. Acres Treated	App. Rate, lb ai/A	App Meth/ Timing	Application Date(s)	Range in Dates (most active dates)
Chlorpyrifos	Corn	4	0.76	Ground; Planting	Mar 27	Mar 10-Apr28 (Mar 19- Apr 4)
Dimethoate	Corn	5	0.43	Aerial; Foliar	Jun 23	May15-Jul31
Phostebupirim (Tebupirimphos)	Corn	8	0.08	Ground; Planting	Mar 27	Mar 10-Apr28 (Mar 19- Apr 4)
Terbufos	Corn	12	0.82	Ground; Planting	Mar 27	Mar10-Apr28 (Mar 19- Apr 4)
Acephate	Cotton	41	0.35	Ground; Planting-Foliar	May 6	Apr17-Aug31
				Air; Planting-Foliar	Jun 24	
Dicrotophos	Cotton	20	0.27	Ground; Foliar	May 1	May1-Aug 31
				Air; Foliar	Jul 1	
Dimethoate	Cotton	3	0.26	Ground; Foliar	Jun15	Jun15-Jul31
				Air; Foliar	Jul 8	
Malathion	Cotton	77	0.87	Ground; Foliar	May 1, May 20, Jun 8	May1-Oct20
				Air; Foliar	Jun 27, Jul 16, Aug 4, Aug 23, Sep 11, Sep 30	
Methamidophos	Cotton	4	0.38	Air; Foliar	Jul 1	May 1-Aug 31
Methyl parathion	Cotton	4	0.39	Ground; Foliar	Jun 15	Jun15-Aug31
				Air; Foliar	Jul 4, Jul 23, Aug 11	
Phorate	Cotton	3	0.61	Ground; Planting	May 6	Apr17-Jun15 (Apr 26-May 16)
Profenofos	Cotton	2	0.86	Ground; Foliar	Jun 15	Jun15-Aug31
Tribufos	Cotton	49	0.68	Air; Harvest	Sep. 2	Sep15-Nov13 (Sep 28 - Oct 20)
Disulfoton	Cotton	2	0.74	Ground; Foliar	May 23	May1-Jun15
Methyl parathion	Soybean	32	0.46	Air; Foliar	Aug. 31	Aug1-Sep30

The estimated OP cumulative concentration (methamidophos equivalents) was 1 ppb or greater at the 90th percentile and higher. 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 II.G.6).

Table II.G.6. 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

Figure II.G.4 displays 19 years of predicted OP cumulative concentrations in drinking water sources for the region. Peak cumulative concentrations (in methamidophos equivalents) exceeded 5 ppb 26% of the time (5 out of 19 years of weather patterns).

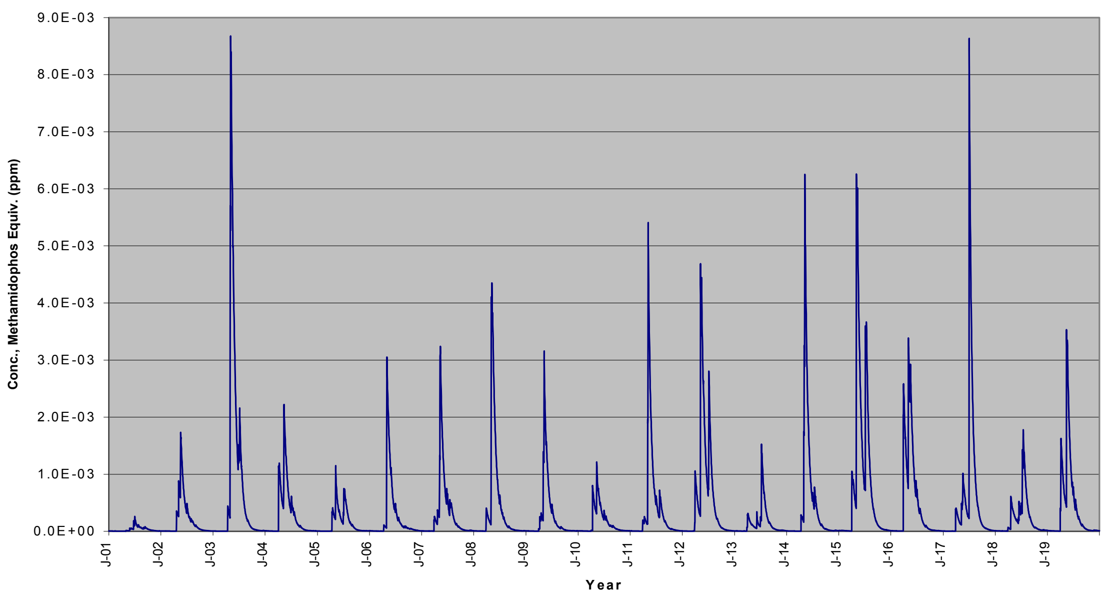

Figure II.G.4. Cumulative OP distribution in water in the Midsouth Region across 19 years of weather patterns.

An overlay of all 19 years of predicted values in the year-frame shows three distinct pulses: a small, early peak of 2 ppb (methamidophos equivalents) or less in late March or early April) and two bigger peaks of 8 ppb or less in late April and again in late June. The appearance and magnitude of these peaks vary from year to year, depending on the timing, magnitude, and duration of rain relative to OP applications.

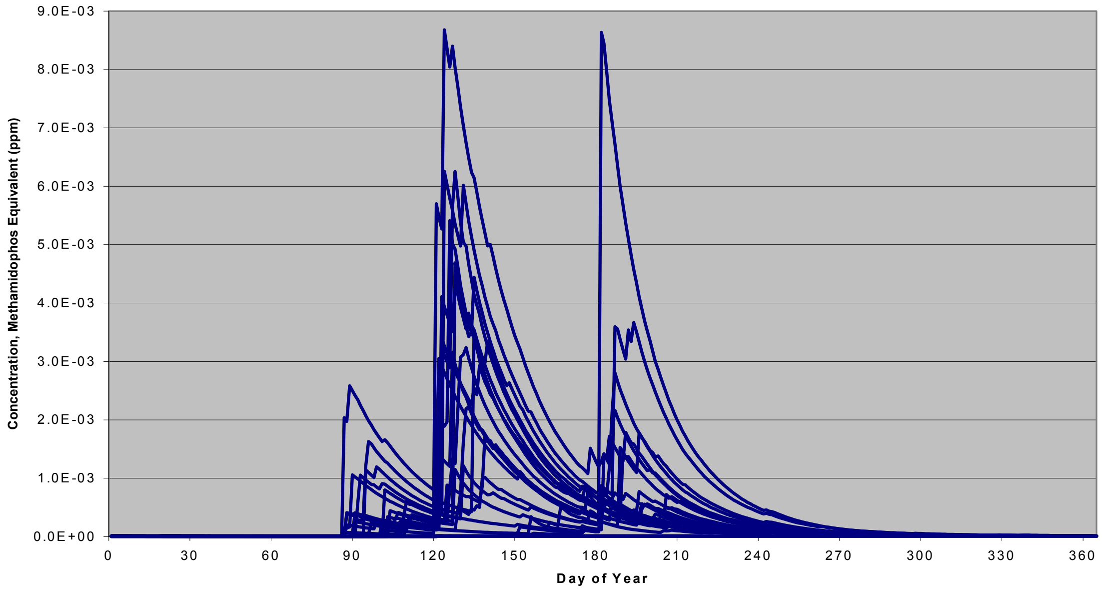

Figure II.G.5. Variations in yearly pattern of cumulative OP concentrations in water in the Midsouth Region (19 years of varying weather patterns)

The early, smaller pulse in the cumulative OP load in water is primarily due to terbufos use on corn (Figure II.G.6) while the larger peaks are dominated by dicrotophos, which is applied to cotton (early in the season by ground application; later by aerial spray). The relative contributions are the result of both individual chemical concentrations in water and their relative potency and safety factors.

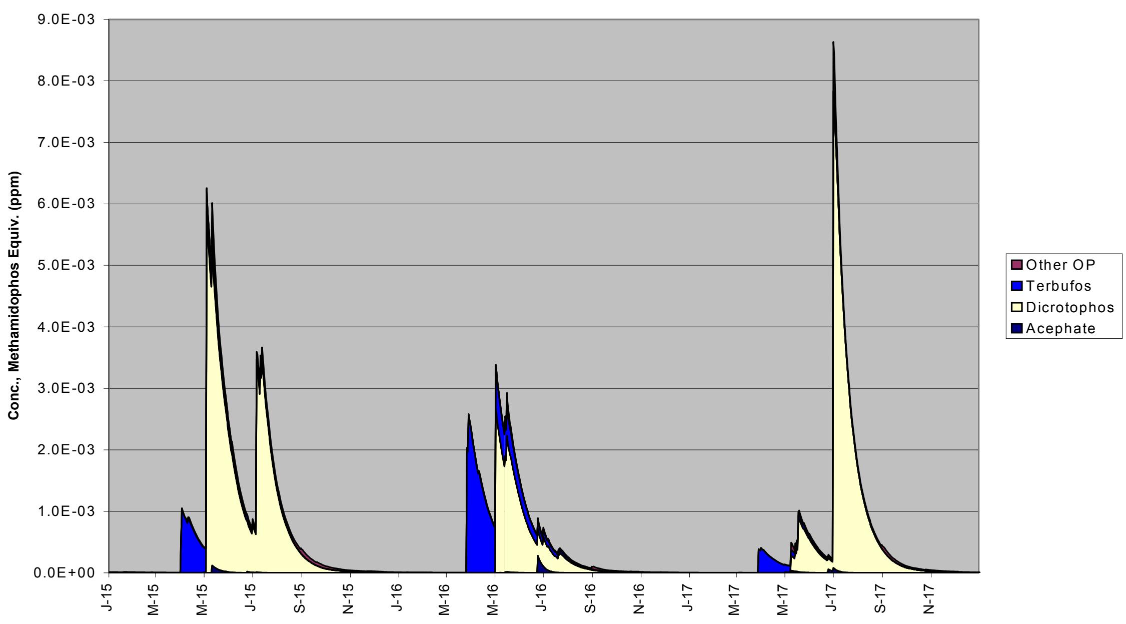

Figure II.G.6. Cumulative OP distribution spanning 3 years (15-17) showing relative contributions of individual OPs in the Midsouth Region.

A comparison of Figure II.G.6 with Figure II.G.7 illustrates the effect of the relative potencies on individual OP contributions to the cumulative OP load. While estimated concentrations of malathion are typically much greater than that of dicrotophos, dicrotophos dominates the cumulative OP load because of its much higher relative potency (RPF of 1.91 compared to 0.0003 for malathion).

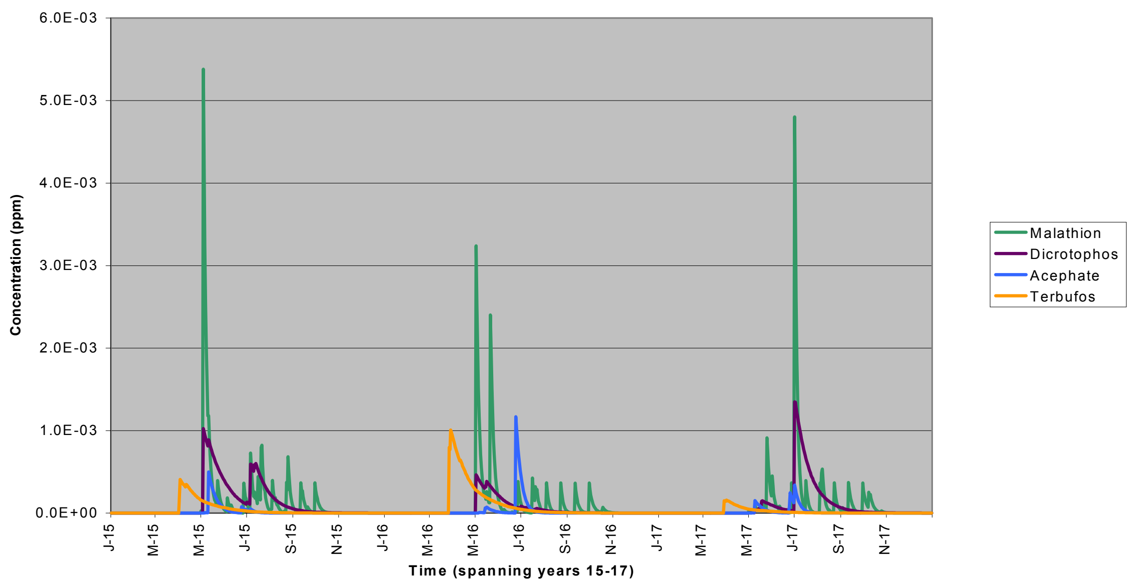

Figure II.G.7. Concentrations of selected OPs spanning 3 years (15-17) in the Midsouth Region. Contrast with Figure II.G.6 for effect of relative potency on cumulative OP concentration.

c. A Comparison of Monitoring Data versus Modeling Results

The maximum detect from the USGS NAWQA Mississippi Embayment study unit (summarized below and in Appendix III.E.1) for **chlorpyrifos** was an order of magnitude greater than the maximum estimated concentration (Table II.G.6). 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.

In evaluating these comparisons, it is important to realize that the estimated cumulative OP concentrations used in the exposure assessment 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. As noted earlier, the surface-water hydrology in this region is complicated by levees along the Mississippi River and by a system of drainage canals. The Mississippi Embayment sample sites focused on the tributaries of the Mississippi River. The degree to which these concentrations could be diluted as they move to larger water bodies is uncertain.

The USGS-EPA reservoir study (Blomquist et al, 2001; Appendix III.E.3) included Lake Bruin (LA), located within the regional assessment area. Because the Lake Bruin watershed is relatively flat and difficult to define from geographic information system (GIS) data sources and because this oxbow of the Mississippi River appears to be hydrologically connected to the Mississippi River, comparisons with the estimated cumulative OP concentrations are difficult to make and interpret. Chlorpyrifos concentrations in the reservoir were similar to the estimated concentrations, with the maximum value (0.008 ug/l) falling between the estimated 95th to 99th percentiles and the 90th percentile value (0.005 ug/l) falling between the estimated 90th and 95th percentiles. Estimated malathion concentrations, however, were 1 to 2 orders of magnitude greater than that detected in the reservoir (0.11 ug/l maximum; 0.02 ug/l 90th percentile). The single dimethoate (0.007 ug/l) detection was equivalent to the estimated 90th percentile value. The methyl parathion detection (0.06 ug/l) was equivalent to the estimated 99th percentile value.

d. Summary of Available Monitoring Data for the Midsouth 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. According to USGS, 62% of the area is used for agriculture, with this percentage rising to 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).

As mentioned above, none of the nine active OPs included as analytes were detected in ground water studies in this study unit. Thirty public-supply wells screened in the deep Tertiary aquifers, which represent the most important drinking water source in the study unit, were sampled once each in 1996. Fifty-four irrigation wells in surficial sedimentary aquifers were also sampled a single time. Another 32 wells screened in the shallow, unconfined Memphis aquifer, but this is not an area of significant OP use.

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 OPs were detected in this study above a detection limit of 0.01 ug/l (see 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 90^{th} 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.

Two sampling stations in the Mississippi Portal region are included in the NASQAN program. The results of sampling from 1996 to 1999 can be found at http://water.usgs.gov/nasqan/data/statsum/atchafalaya.html for the Lower Atchafalaya River at Melville, Louisiana site, and at http://water.usgs.gov/nasqan/data/statsum/st.francis.html for the Mississippi River at St. Francisville, Louisiana site.

Diazinon, chlorpyrifos, and malathion were the most frequently detected OPs at these sites, which is consistent with surface-water data in most monitoring studies. Diazinon was detected in 57% and 48% of the 68 and 65 samples from the Mississippi River and Atchafalaya River, respectively, with a maximum concentration of 0.024 ug/l at both sites. Malathion was detected in 10% and 12% of samples, with a maximum concentration of 0.036 ug/l (Atchafalaya River). Chlorpyrifos was detected in 3% and 9% of samples, respectively, with a maximum concentration of 0.018 ug/l (Mississippi River). The concentrations detected were not high, but the detection of these OPs at any concentration in these large rivers is significant, given their volume.

Methyl parathion was the only other OP detected in this set of samples. It was detected in 1 sample in the Mississippi River, and 3 in the Atchafalaya, with detections at the 0.006 ug/l level of detection. Ethoprop, phorate, terbufos, disulfoton and azinphos-methyl were not detected in these samples.

Little monitoring data which included OPs is available from the states in the Midsouth Region.

4. Results of Cumulative Assessment

Analyses and interpretation of the outputs of a cumulative distribution rely heavily upon examination of the results for changing patterns of exposure. Briefly, the cumulative assessment single day analysis generates multiple potential exposures (i.e., distribution of exposures for each of the 365 days of the year) for each hypothetical individual in the assessment for each of the 365 days in a year. Because multiple calculations for each individual in the CSFII population panel are conducted for each day of the year, a distribution of daily exposures is available for each route and source of exposure throughout the entire year. Each of these generated exposures is internally consistent – that is, each generated exposure appropriately considers temporal, spatial, and demographic factors such that "mismatching" (such as combining a winter drinking water exposure with an exposure that would occur through a spring lawn application) is precluded. In addition, a simultaneous calculation of MOEs for the combined risk from all routes is performed, permitting the estimation of distributions of the various percentiles of total risk across the year. Results are displayed as MOEs with the various pathways, routes, and the total exposures arrayed across the year as a time series (or time profile). Any given percentile of these (daily) exposures can be selected and evaluated as a function of time. That is, for example, a 365-day series of 95th percentile values can be arrayed, with 95th percentile exposures for each day of the year (January 1, January 2, etc.). shown. The result can be regarded as a "time-based exposure profile" in which periods of higher exposures (evidenced by low 'Margins of Exposure') and lower exposures (evidenced by high 'Margins of Exposure') can be discerned. Patterns can be observed and interpreted and exposures by different routes and pathways (e.g., dermal route through lawn application) can be seen and compared. Abrupt changes in the slope or levels of such a profile may indicate some combination of exposure conditions resulting in an altered risk profile due to a variety of factors. Factors causing this alteration may include increased pest pressure and subsequent home pesticide use, or increased use in an agricultural setting that may result in increased concentrations in water. Alternatively, a relatively stable exposure profile indicates that exposure from a given source or combination of sources is stable across time and the sources of risk may be less obvious. Different percentiles can be compared to ascertain which routes or pathways tend to be more significant contributors to total exposure at various total exposure levels for different subgroups of the Mid-South output distribution (e.g, those at the 95th percentile vs. 99th percentiles of exposure).

Figures III.P.2-1 through III.P.2-8 in Appendix P present the results of this cumulative risk analysis for Children, 1-2 years for a variety of percentiles (95, 99, 99.5, and 99.9) of the Mid-South output distribution for two averaging periods. Figure III.P.2-9 through Figure III.P.2-16 present these same figures for Children 3-5. Appendix III.P.3 presents the ungraphed data/output for Adults 20-49 and Adults 50+. The following paragraphs describe, in additional detail, the exposure profiles for each of these age groups for the 99.9th and 95th percentiles. Briefly, these figures present a series of time courses of exposure (expressed as MOEs) for various age groups at various percentiles of exposure. For example, for the 95th percentile MOEs for children 1-2 years old, the 95th percentile (total) exposure for children 1-2 is estimated for each of the 365 days of the year, with each of these (total) exposures – expressed in terms of MOEs – arrayed as a function of time. The result is a "time course" (or "profile") of exposures representing that portion of the Mid-South output distribution at the 95th percentile exposures throughout the year. In addition, the MOEs are shown for each pathway or route (e.g., oral ingestion through food, oral ingestion through hand-to-mouth activity, inhalation, dermal, etc.) for each of a variety of percentiles. This discussion represents the unmitigated exposures (i.e., exposures which have not been attempted to be reduced by discontinuing specific uses of pesticides) and no attempt is made in this assessment to evaluate potential mitigation options. The following paragraphs describe the findings and conclusions from each of the assessments performed.

a. Children 1- 2 years old

Single Day Analysis (Figure III.P.2-1 through Figure III.P.2-4): At the 99.9th percentile, total MOE ranges throughout the year from ~10 to 60 with inhalation exposures from use of DDVP pest strips acting as the substantial contributors. At the 95th percentile, total MOEs are well above 100, and no exposure through the use of DDVP pest strips occurs. It is important to express these exposures as a *range* of MOEs because there may be variability across seasons. At all percentiles examined (95th through 99.9th), MOEs associated with drinking water exposure remain below 100 throughout the year or do not substantially contribute to total exposures. Low exposures are also seen through the residential dermal and hand-to-mouth routes with MOEs generally remaining above 100 throughout the year.

Seven Day Rolling Average Analysis (Figure III.P.2-5 through Figure III.P.2-8): At the 99.9th percentile, total MOE ranges throughout the year from ~ 20 to 70; inhalation exposures from DDVP use are chiefly responsible for these MOEs. At the 95th percentile, total MOEs are well above 100, and no exposure through the use of DDVP pest strips occurs. It is important to express these exposures as a *range* of MOEs because there may be variability across seasons. At all percentiles examined (95th through 99.9th), drinking water MOEs remain above 100 except for brief periods of time during which they do not contribute substantially to total exposures. Low exposures (i.e., at or just below MOEs of 1000) are also evident at all percentiles examined from the dermal and hand-to-mouth routes arising from residential exposures.

b. Children 3-5 years old

Single Day Analysis (Figure III.P.2-9 through Figure III.P.2-12) At the 99.9th percentile, total MOE ranges throughout the year from ~ 10 to 70; inhalation exposures from DDVP use are chiefly responsible for these MOEs. At the 95th percentile, total MOEs are well above 100, and no exposure through the use of DDVP pest strips occurs. It is important to express these exposures as a *range* of MOEs because there may be variability across seasons. Although three seasonal pulses are observed, drinking water does not contribute substantially to total exposures at the higher percentiles and in general MOEs remain above 100 throughout the year. Residential exposures through the dermal and hand-to-mouth routes are a small fraction of total exposure with MOEs remaining above 100 throughout the year.

Seven Day Rolling Average Analysis (Figure III.P.2-13 through Figure III.P.2-16): At the 99.9th percentile, total MOE ranges throughout the year from ~ 30 to 100; inhalation exposures from DDVP use are chiefly responsible for these MOEs. At the 95th percentile, total MOEs are well above 100, and no exposure through the use of DDVP pest strips occurs. It is important to express these exposures as a *range* of MOEs because there may be variability across seasons. Although three seasonal peaks are evident, MOEs generally remain 100 throughout all percentiles examined (95th through 99.9th) and drinking water does not contribute substantially to total exposures at the higher percentiles. Residential exposures by the dermal and hand-to-mouth routes continue to be a small fraction of total exposure with MOE generally remaining above (or just slightly below) 1000.

c. Adults, 20-49 and Adults 50+ years old

Single Day Analysis (Appendix III.P.3) At the 99.9th percentile, total MOEs are in the ~ 40 to 160 range with inhalation exposures from DDVP pest strips responsible for the majority of this exposure. At the 95th percentile, total MOEs are well above 100, and no exposure through the use of DDVP pest strips occurs. It is important to express these exposures as a *range* of MOEs because there may be variability across seasons. Drinking water exposures continue to remain reasonably low (MOEs >100) for most of the year and do not contribute substantially to the risk picture at the higher percentiles. This is also true for residential exposures by the dermal routes which also continue to be a small fraction of total exposure and are responsible for MOEs of generally greater than 1000 for the majority of the year.

(Seven Day Rolling Average Analysis (Figures III.P.2-6 and III.P.2-8) At the 99.9th percentile, total MOEs are in the ~ 90 to 200 range with inhalation exposures from DDVP pest strips acting as the primary contributor. At the 95th percentile, total MOEs are well above 100, and no exposure through the use of DDVP pest strips occurs. It is important to express these exposures as a *range* of MOEs because there may be variability across seasons. Drinking water exposures continue to remain reasonably low for most of the year, remaining at >100 throughout the year. This is also true for residential exposures by the dermal routes which also continue to be a small fraction of total exposure and are responsible for MOEs of >1000 throughout the year.