Pesticide Science Policy

Drinking Water Screening Level Assessment

Part A: Guidance for Use of the Index Reservoir in Drinking Water Exposure Assessments

Office of Pesticide Programs
Environmental Protection Agency

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Executive Summary

The purpose of this document is to provide guidance on using the index reservoir scenario for use in estimating pesticide concentrations in drinking water derived from vulnerable surface water supplies. Since the passage of FQPA, the Agency has been using a standard "farm pond" as an interim scenario for estimating a potential upper bound on drinking water exposure until more appropriate tools could be developed. The index reservoir is being implemented in conjunction with the percent cropped treated (PCA) to replace the farm pond scenario. These two steps are intended to improve the quality and accuracy of OPP's modeling of high-end drinking water exposure for pesticides.

The index reservoir is intended as a drop-in replacement for the farm pond for use in drinking water exposure modeling. It is used in a similar manner to the farm pond except that flow rates have been calibrated for local weather conditions. Instructions for using the index reservoir are provided in this document. The Exposure Analysis Modeling System (EXAMS) parameters for the standard index reservoir are provided in Appendix C of this document.

Background

The Pesticide Root Zone Model (PRZM) and Exposure Analysis Modeling System (EXAMS) are linked field-scale screening models being used to estimate pesticide concentrations in surface water. Since surface water is used as a source of drinking water for a large part of the U. S. population, the Office of Pesticide Programs (OPP) uses the PRZM-EXAMS estimates in its human health risk assessments. OPP has intentionally designed the PRZM-EXAMS models to simulate a vulnerable drinking water system and thus to produce estimates of pesticide concentrations in surface water that are expected to be conservative – that is, values which are usually higher than expected to occur in surface water near the large majority of pesticide use sites.

Because, with relatively low resource cost, the PRZM-EXAMS models produce conservative estimates of pesticide concentrations in surface water, they are used as part of a screening process to assess the potential for drinking water-related exposures exceeding the human health-based levels of concern. If PRZM-EXAMS estimates do not exceed levels that would be of health concern in drinking water, then OPP is able, in a very efficient manner, to "clear" the pesticide from the drinking water perspective. In cases where PRZM-EXAMS estimates do exceed levels of health concern, more refined estimates of surface water concentrations using more sophisticated and resource intensive approaches need to be employed. (More detailed information about OPP's overall approach to assessing potential drinking water exposure appears in the Science Policy Paper: "Estimating the Drinking Water Component of a Dietary Exposure Assessment." This is available via the internet at: http://www.epa.gov/fedrgstr/EPA-PEST/1999/November/Day-10/6044.pdf) This screening approach has served OPP well, as on the order of 50% of compounds have been cleared using this cost-effective screening method.

The PRZM component of the model is designed to predict the pesticide concentration dissolved in runoff waters and carried on entrained sediments from the field where a pesticide has

been applied into an adjoining edge-of-field surface water body. The model can simulate specific site, pesticide, and management properties including soil properties (organic matter, water holding capacity, bulk density), site characteristics (slope, surface roughness, field geometry), pesticide application parameters (application rate, frequency, spray drift, application depth, application efficiency, application methods), agricultural management practices (tillage practices, irrigation, crop rotation sequences), and pesticide environmental fate and transport properties (aerobic soil metabolism half-life, soil:water partitioning coefficients, foliar degradation and dissipation, and volatilization). OPP selects a combination of these different properties to represent a site-specific scenario for a particular pesticide-crop regime. Generally, PRZM modeling is conducted using standard scenarios which approximate a 90th percentile site for runoff vulnerability.

The EXAMS component of the model is used to simulate environmental fate and transport processes of pesticides in surface water, including: abiotic and biotic degradation, sediment:water partitioning, and volatilization. Currently, OPP is using an index reservoir and a farm pond as benchmark surface water bodies for human health and aquatic exposure assessments, respectively.

For each component, the values used are derived from real world data. For example, the EPA approved product label is the source of the application rate, frequency, and method of pesticide application. Pesticide environmental fate properties used in the PRZM modeling come from registrant-submitted data used for pesticide registration or reregistration. The values used for soil properties and site characteristics are chosen from real world databases appropriate for the sites on which the pesticide may be used. For example, if the pesticide is approved for use on cotton, OPP uses data reflecting the soil types in the Cotton Belt. The index reservoir being modeled is based on and represents an actual, small flow-though reservoir used for drinking water. Finally, the weather inputs for the model are taken from regional specific weather data, based on the USDA Major Land Resource Areas. PRZM modeling is generally simulated for 20 to 36 years in order to calculate a return frequency of concentration in surface water body.

The conservative estimates result from OPP's approach of choosing values from real world data which are likely not to underestimate the potential levels of pesticide residue in surface water. For example, the application rate and frequency used in the model are the highest allowed by the product label. In addition, PRZM-EXAMS modeling is assumed to be conservative because the index reservoir represents a "vulnerable" water supply reservoir; conservative fate parameters are used in the model; 100% of the cropped area in the watershed is assumed to be treated with pesticide; and the site properties are representative of vulnerable runoff conditions. All these factors lead to an assessment that PRZM-EXAMS is expected to predict conservative pesticide concentrations for exposure assessment.

Pesticide fate and transport in the environment is a very complex phenomenon, and therefore no model will predict perfectly what occurs in the real world. Nonetheless, EPA has compared surface water monitoring data with the estimates produced by PRZM-EXAMS, and concludes that the model outputs are, in fact, usually higher than monitoring data. The analysis is available at: http://www.epa.gov/scipoly/sap/1999/may/pca_sap.pdf . Because of limitations in monitoring data bases, however, it is not feasible at this time to predict for any particular chemical whether the model output represents an upper bound or high end estimate.

The Agency recognizes that at some, and perhaps many, locations pesticide concentrations in surface water are lower than the model estimates. For example, although users may lawfully apply a pesticide at the highest rate and frequency allowed on a product label, typical rates and frequencies may be lower than the values used in the model. Moreover, while not required by the pesticide label, users may engage in practices which may reduce pesticide runoff, such as soil-incorporation of the pesticide or the use of “no-application” zones or filter strips around water bodies. Thus, where typical application practices are lower than label maximum, where runoff prevention practices are widespread, or where soil properties and site characteristics are less conducive to runoff, actual concentrations in surface water may be significantly lower than the values for the sites and conditions modeled.

Finally, to the extent that PRZM/EXAMS outputs are used in assessing the potential for risk to human health from pesticide residues in drinking water, it is important to recognize that the possible impact on residue levels of treatment by drinking water supply systems has not been reflected. While certain types of treatment will reduce the concentration of certain classes of pesticides (e.g. continuous granular activated carbon filtration will reduce levels of organic compounds), it should also be noted that a substantial proportion of the U. S. population consumes water that has undergone either no treatment or only types of treatment that have little or no effect on the levels of pesticides in drinking water.

Guidance for Use

Step 1. Get the Index Reservoir for Crop Being Simulated

Check and determine if there is an index reservoir set up for the scenario you are going to model. Currently, there are five standard scenarios for which there are index reservoirs: Ohio for corn, Yazoo County, Mississippi for cotton, Georgia for soybeans, a northern California scenario that can be used for irrigated walnuts, and North Dakota for wheat (See Table 1). These scenarios [PRZM input (.INP) and EXAMS environment (.EXV)] are available on the LAN at F:\User\Share\Std_Scen. If you are modeling one of these crops with these standard scenarios, use the index reservoir for that scenario. The flow rate out the reservoir has been adjusted to reflect local rainfall conditions. If you are modeling a scenario that does not yet have an index reservoir, you will need to develop the flow rate. This is described in Appendix A.

Table 1. Scenarios with currently available index reservoirs.

Crop	Scenario
Corn	Cardington soil in Ohio
Cotton	Loring silt loam in Yazoo County, Mississippi
Soybeans	Lynchburg loamy sand in Georgia
Walnuts	irrigated Kimberlina silt loam in California

Wheat	**Fargo silt loam in Cass County, North Dakota**

The PRZM input file is identical to that used with the standard pond except for the area of the field (AFIELD), hydraulic length (HL) and the spray drift (DRFT) parameters. **These are described in the next two steps.**

Step 2. Set the AFIELD and HL Parameters in PRZM.

Set the AFIELD parameter, the fourth parameter on record 7 of the PRZM 3 input (.INP) file, to 172.8. This is the number of hectares in the index reservoir watershed. The seventh parameter in the same record is the hydraulic length (HL). This parameter is used to calculate the eroded sediment load from the watershed. The value for the index reservoir is 464 m.

Note: It is important that separate files be kept for the index reservoir and for the standard pond since both simulations will be done. Name the PRZM files used for the index reservoir and for the standard pond separately.

Step 3. Spray Drift

DRFT parameter in record 16 of the PRZM input file is set to reflect the spray drift loading for that is put in the PRZM-EXAMS transfer files. For aerial and spray blast applications, use a value of 0.86. Use a value of 0.34 for ground spray. An explanation for how these values were developed is in Appendix B. The spray drift parameter does not need to be set for granular applications.

Step 4. Loading the Index Reservoir Scenario into EXAMS

If you run EXAMS with the scenario stored in the internal 'user' database, you need to load the environment file for the index reservoir you are using into the data base. Before loading the file, you need to put EXAMS in continuous mode by issuing the command:

set mode = 3

The file can the be loaded into EXAMS by typing:

Read env filename.exv

at the EXAMS command prompt and pressing return. "filename.exv" should be replaced with the name of the version of the index reservoir you intend to use in the simulation. Note that the index reservoir file has to be in the current directory. Otherwise, include the directory along with the file name on the command line. For example:

read env C:\MYFILES\filename.exv

Next type the command:

store env nn

followed by the Return key. nn is the position in the database you wish to store the scenario. For more information see the "Read" and "Store" commands in the EXAMS manual (Burns, 1997).

Step 5. Setting Up The EXAMS Command File

The EXAMS command file, which usually has a '.EXA' extension, needs to be modified slightly so that EXAMS loads the index reservoir rather than the standard pond. (Note the difference here, EXAMS environment files often have 'EXV' extensions.) If you read the EXAMS scenario from an external file, use the index reservoir environment file rather than the standard pond file. For example:

read env indexres.exv

If you use the internal user database use the load command and the number of the position of the index reservoir in the data base. If the index reservoir was saved in position 6 instep 4 above then use:

recall env 6

in your EXAMS command file to load the index reservoir.

From this point on, running a simulation with the index reservoir is identical to using the standard pond.

Reporting Results

Results from simulations using the index reservoir and the standard pond should still be included in RED and Registration assessments. Only results from index reservoir simulations need to be reported in the drinking water memo to HED. Be sure to include a discussion of the strengths and weaknesses of the index reservoir for assessing drinking water. For each crop simulated, report the one-in-ten-year peak value for use in assessing acute risk and report the one-in-ten-year annual mean value for use in assessing chronic and cancer risks. Identify the crop with the highest peak and mean values and indicate that these are specific values to use in the risk assessment unless good judgement suggests that the value for some other crop is more appropriate. In that case, be sure to explain your rationale for selecting the alternative values.

Below is some boiler plate for describing the uncertainties in using modeling with the index reservoir for describing the exposure to pesticides in surface water source drinking water. This boiler plate should be modified to suit your particular circumstances.

The index reservoir represents potential drinking water exposure from a specific area (Illinois) with specific cropping patterns, weather, soils, and other factors. Use of an index reservoir for areas with different climates, crops, pesticides used, sources of water (e.g. rivers instead of reservoirs, etc), and hydrogeology creates uncertainties. If a community derives its drinking water from a large river, then the estimated exposure would likely be higher than the actual exposure. Conversely, a community that derives its drinking water from smaller bodies of water with minimal outflow would likely get higher drinking water exposure that estimated using the index reservoir. Areas with a more humid climate that use a similar reservoir and cropping patterns would likely get more pesticides in their drinking water than predicted levels. A single steady flow has been used to represent the flow through the reservoir. Discharge from the reservoir also removes chemical from it so this assumption will underestimate removal from the reservoir during wet periods and overestimates removal during dry periods. This assumption can both underestimate or overestimate the concentration in the pond depending upon the annual precipitation pattern at the site. The index reservoir scenario uses the characteristic of a single soil to represent the soil in the basin. In fact, soils can vary substantially across even small areas, and thus, this variation is not reflected in these simulations. The index reservoir scenario does not consider tile drainage. Areas that are prone to substantial runoff are often tile drained. This may underestimate exposure, particularly on a chronic basis. EXAMS is unable to easily model spring and fall turnover which results in complete mixing of the chemical through the water column at these times. Because of this inability, Shipman City Lake has been simulated without stratification. There is data to suggest that Shipman City Lake does indeed stratify in the deepest parts of the lake at least in some years. This may result in both over and underestimation of the concentration in drinking water depending upon the time of the year and the depth the drinking water intake is drawing from.

Policy Not Rules

The policy document discussed in this notice is intended to provide guidance to EPA personnel and decision-makers, and to the public. As a guidance document and not a rule, the policy in this guidance is not binding on either EPA or any outside parties. Although this guidance provides a starting point for EPA risk assessments, EPA will depart from its policy where the facts or circumstances warrant. In such cases, EPA will explain why a different course was taken. Similarly, outside parties remain free to assert that a policy is not appropriate for a specific pesticide or that the circumstances surrounding a specific risk assessment demonstrate that a policy should not be applied.

Literature Cited

Burns, Lawrence A. 1997. *Exposure Analysis Modeling System (EXAMS II) User's Guide for Version 2.97.5.* **United States Environmental Protection Agency. Athens, Georgia. EPA/600/R-97-047.**

Appendix A.

Developing the flow rate from the reservoir for new standard scenarios

A major difference between the index reservoir and the standard pond is that the index reservoir has flow through of the water body, whereas the standard pond is static (no flow). The flow rate parameter is estimated using PRZM and the weather file for the local weather where the scenario is located. The mean runoff from the watershed is used to estimate the flow through the reservoir. The use of the mean overall discharge is justified on the basis that the variation in daily flows is small relative to the reservoir storage (residence time is long compared with the duration of runoff pulses) and the reservoir volume is constant over the long term. (This ignores volume losses due to silting in of the reservoir.)

Since EXAMS assumes that the volume of the water body is constant, flow out of the reservoir is equal to the flow into the reservoir and the discharge rate is set by setting the flow rate in. The STFLO (or STream FLows) parameter is used to set the flow into the reservoir from upstream. STFLO can be set into each segment for each month during the year. All the flow is set to enter the water column (segment 1). Currently all monthly flow values are set to the same value. The units on STFLO are $m^3 \bullet hr^{-1}$. The instructions for setting the STFLO parameter follow:

Step 1. Run PRZM to Obtain the Runoff Volume for the Watershed.

1) Run PRZM 3.12 with the scenario set up for the index reservoir for the site you wish to simulate. It is not necessary to have any pesticide applications simulated during this run. You will need to modify records 45, which the card for setting turning on and specifying the optional outputs, and record 46, which specifies which optional outputs to produce. In Record 45 of the input (.INP) file, set the NPLOTS variable to 1 for one output variable. In record 46, set the PLNAME variable to RUNF and MODE to TSER. Other variables in record 46 should not be set to any value. This will cause PRZM to place the daily runoff depth in centimeters in the times series output file. The name of this file is designated in the PRZM command (.RUN), and usually is given a default 'ZTS' extension. The units on the output are cm, not cm per day as indicated in the PRZM manual. This file can be loaded into a spreadsheet and the mean flow rate calculated.

Step 2. Calculate the Mean Overall Stream Flow Rate

Sum the annual depths of runoff and divide by 100 to convert to meters. Multiply by the area of the index reservoir water shed in square meters (1,728,000 m^2) to obtain the total volume of runoff from the watershed over the period of the simulation. Divide by the number years in the simulation to get the mean annual runoff value. Divide by 365 d/yr * 24 h/d = 8760 h/yr to obtain the overall mean flow on hourly basis.

Step 3. Set the STFLO Parameter for the Scenario in EXAMS

Start EXAMS and set the Mode variable equal to 3 or continuous mode. Then, read the Standard Index Reservoir, IndexRes.Exv into EXAMS using the command READ Env IndexRes.Exv. Note that you must be in the directory where Exv file is located, otherwise you must include the directory location along with the filename. STFLO is an array variable with two dimensions. The first dimension is an index which indicates the compartment the stream is flowing into, and the second index is the month of the year. The STFLO for compartment 1 (the water column) is set to the mean runoff flow, obtained in Step 2, for each month and the STFLO for compartment 2 (the benthic layer) is set to 0. The commands to set this are

Set STFLO(1,*) = nnn.n
Set STFLO(2,*) = 0

where nnn.n is the hourly runoff flow. The '*' set all cells for all months equal to that specified value.

Step 4. Rename the Scenario.

First, you set the EXAMS database name command to give the scenario a new name. This is the name that is shown when the scenario is in the EXAMS User Database (UDB) and appears when you issue the CATALOG command. Include the crop and location in the name. For example, an index reservoir name for use with almonds might be "Index reservoir for Kern Co, CA almonds". The command to set the name using this example is:

Env Name is Index reservoir for Kern Co, CA almonds

After setting the name, you need to save the scenario to an external file using the WRITE command. For example:

WRITE Env IRCAAlmd.Exv

It recommended that the name start with 'IR' to indicate that it is an index reservoir scenario and the extension be 'EXV' for <u>EX</u>AMS en<u>V</u>ironment file

If you wish to place the scenario in the EXAMS user data base, use the STORE command:

STORE Env nn

where nn is the number of the location in the database where you want to store the scenario. Make sure you are not overwriting some other scenario you want to keep in the database when you save it the scenario in the database.

Step 5. Getting the Scenario Approved

After constructing the scenario, it must be approved by the Water Quality Tech Team (WQTT). Provide a brief writeup including the PRZM input file and a description of the STFLO output from PRZM. Include a copy of the new index reservoir scenario and PRZM input file in electronic format. The WQTT will approve or disprove the file in 1 week. Approved scenarios will be placed on the OPP Internet site.

Appendix B
Spray Drift Scenario for the Index Reservoir

The spray drift scenario for the index reservoir is based on the geometric characteristics of the watershed and the reservoir. The approach described here follows an approach developed by Lin for modeling aquatic exposure in apples (personal communication, 1997). As an initial assumption, the watershed is assumed to be 100% cropped. This assumption is then relaxed with application of a PCA factor which is applied to the final result of the modeling. The spray drift can enter the reservoir from fields along side the reservoir both directly from application to fields along side the reservoir and from the streams in the watershed. Our approach to estimating the spray drift for the index reservoir was to estimate the drift component for these two section separately and then combine the results. A schematic diagram for the index reservoir is in Figure B-1. The

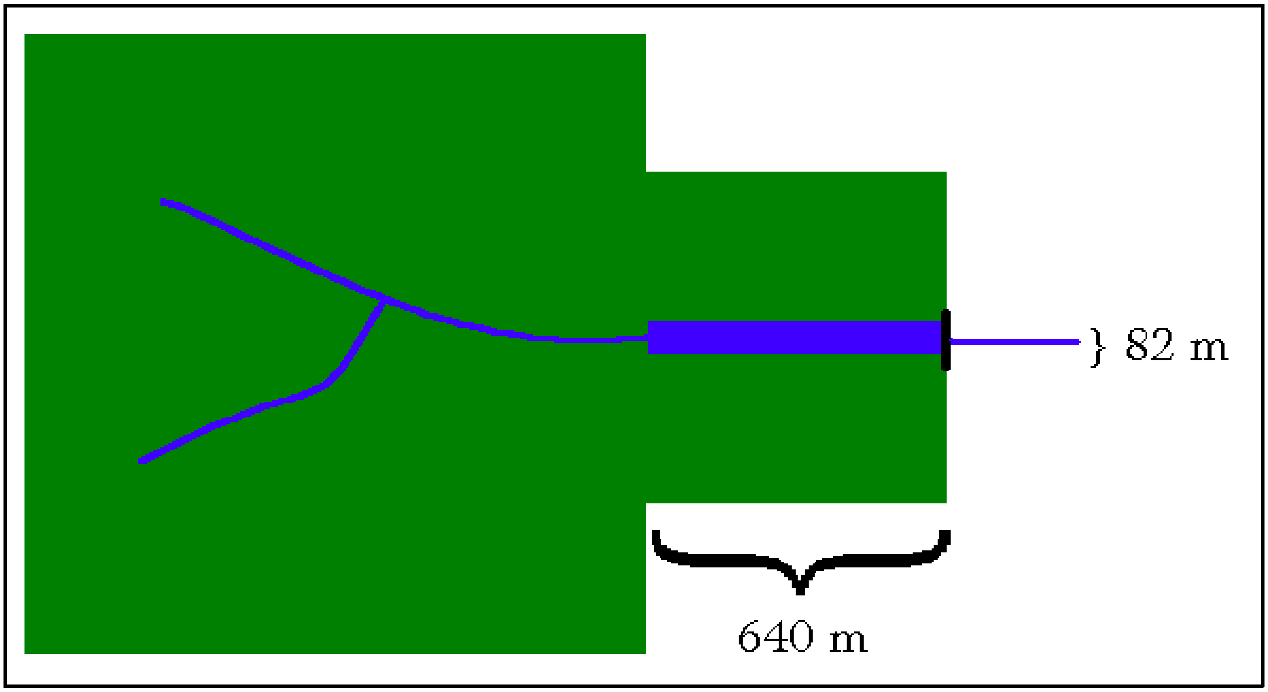

Figure 1. Schematic of the index reservoir. The reservoir is 640 m long and 82 m wide. The area of the reservoir is 5.3 ha and watershed is 172.8 ha. An estimate of the length of the stream network in the watershed is 1500 for all streams and 600 m for perennial streams. There is crop land around both the stream network and the reservoir.

reservoir is approximately 82 m wide and 640 m long, with an area of 5.3 ha. (See Jones *et al., 1998***). The area of the entire watershed is 172.8 ha.**

In order to estimate the length of streams in the Shipman watershed, it was assumed that the density of streams above Shipman City Lake was similar to that for the Macoupin Creek drainage of which the Shipman Watershed is part. The estimate of stream density of Macoupin Creek watershed and several other representative watersheds is in Table B-1. Estimates were made

for perennial streams and for all streams. Macoupin Creek has the lowest density of perennial streams and the highest density of all streams in the watershed. Perennial streams have flow year round. All streams includes perennial streams plus ephemeral streams that only flow during times when there has been substantial precipitation or snow melt in the basin. In neither case is the estimate dramatically different from that for the other watersheds. Based on this density estimate for Macoupin Creek watershed, and the area of the Shipman watershed, the index reservoir would be expected to have 550 m of perennial streams and 1500 m of all streams.

Table B-1. Stream to Watershed Area Ratios for Some Representative Watersheds.*

Watershed	Total Stream Length (m)		Area m^2	Drainage Density $m \cdot m^{-2}$	
	Perennial	All		Perennial	All
Macoupin Creek**, IL	804,600	2,188,700	25,278,000	3.18×10^{-4}	8.66×10^{-4}
Blue Marsh Reservoir, PA	2,478,400	3,089,900	49,469,000	5.01×10^{-4}	6.25×10^{-4}
Occoquan Creek, VA	1,717,200	2,397,900	34,188,000	5.02×10^{-4}	7.01×10^{-4}
South Pacolet Reservoir, SC	3,749,800	4,136,000	64,750,000	5.79×10^{-4}	6.39×10^{-4}
Lake Decatur, IL	1,264,900	2,586,200	37,011,000	3.42×10^{-4}	6.99×10^{-4}
Eagle Creek, IN	2,558,900	2,853,400	70,499,000	5.74×10^{-4}	6.40×10^{-4}

* From EPA's Surf Your Watershed Website, http://www.epa.gov/surf/ , data collected October 8, 1999
** Macoupin Creek watershed contains Shipman City Lake.

The mean width of the streams in the index reservoir was estimated using a nomogram (Dunne and Leopold, 1978.) Estimates on the nomogram are available for several regions. The estimate is representative of the Eastern United States. Based on the drainage area of the Index Reservoir watershed, the mean stream width is estimated as 4 m. A stream bank of the same width where crops cannot be planted is assumed to be present. The total area of the stream network is 2200 m^2 for perennial streams and 6000 m^2 for all streams.

AgDrift 1.03 (Teske *et al.*, 1997) in Tier 1 mode was used to generate the per cent of applied which would be expected to drift into the water in the watershed. For aerial, the estimates represent the upper bound drift (90th percentile) from a medium size spray. Note that this includes a swath displacement of one half of a swath width (6.7 m) as this is standard practice for aerial application. For ground, the estimates were based on a high boom application. Note that no buffer was assumed to be around the reservoir while a 4 m stream bank served as a buffer around

the streams, as noted above. In both cases, the spray drift direction was assumed to be perpendicular to the shore of the water body. The estimate for the stream network was 28% of the application rate for aerial and 12% for ground spray. For the reservoir, the aerial application resulted in 12.8% of the application rate and the ground application percentage was 5.0.

Estimates for the total spray drift load to the index reservoir are in Table B-2. The values are derived by multiplying the per cent spray drift times the area of the water body. The recommended values are for the reservoir plus all streams. This was chosen over the reservoir plus perennial streams because there is a high likelihood that the ephemeral streams will be active in the spring when most applications are made.

Table B-2. Estimates of spray drift loading to the index reservoir as a fraction of the application rate in mass per unit area.

Scenario	Loading as Per cent of Applied	
	Aerial	Ground Spray
Reservoir	67.8	26.5
Perennial Streams	6.2	2.4
All Streams	16.8	7.2
Reservoir + Perennial Stream	74.0	28.9
Reservoir + All Streams	84.6	33.7

Note that these values are substantially higher than for the standard pond and may, on first glance appear to be unreasonable. It is important to remember than these values represent the per cent of application rate rather than the total applied. So, if you make an aerial application of 1 kg ha^{-1} to the index reservoir watershed, or 172.8 kg, the drift loading is 0.86 lb, or 0.5% of the total applied, not 149 lb (86% of the total loading). The resulting concentration in the reservoir from the event is 6 µg • L^{-1}. For comparison, the drift load based on the same drift curve is 15% of the application rate. This results in a drift loading of 0.15 kg to the pond, or 1.5% of the total applied. The resulting concentration in the pond is 7.5 µg • L^{-1}.

Literature Cited

Dunne, Thomas and Luna B. Leopold. 1978. *Water in Environmental Planning.* **W. H. Freeman and Company, New York.**

Jones, R. David, Sidney Abel, William Effland, Robert Matzner, and Ronald Parker IV. 1998. An Index Reservoir for Use in Assessing Drinking Water Exposure. Chapter IV in *Proposed Methods for Basin-Scale Estimation of Pesticide Concentrations in Flowing Water and Reservoirs for Tolerance Reassessment.***, presented to the FIFRA**

Science Advisory Panel, July 29, 1998.
http://www.epa.gov/pesticides/SAP/1998/index.htm

Teske, Milton E., Sandra L. Bird, David M Esterly, Scott L. Ray, and Steven G. Perry. 1997. *A User's Guide to AgDRIFT 1.0: A Tiered Approach for the Assessment of Spray Drift of Pesticides. Eight Draft.* **Spray Drift Task Force, Macon Georgia.**

Appendix C
Input Parameters for the Standard Index Reservoir

Table C-1. EXAMS II geometry for Index Reservoir.			
	Littoral	Benthic	Source
Area (AREA)	**52,609 m^2**	**52,609 m^2**	**Jones** *et al., 1998*
Depth (DEPTH)	**2.74 m**	**0.05 m**	Jones *et al., 1998*
Volume (VOL)	144,000 m^3	2630 m^3	Jones *et al., 1998*
Length (LENG)	640 m	640 m	estimated from map
Width (WIDTH)	82.2 m	82.2 m	estimated from map
Stream Flow (STFLO)	25.01 $m^3 \bullet h^{-1}$	0 $m^3 \bullet h^{-1}$	see text

Table C-2. EXAMS II dispersive transport parameters between benthic and littoral layers in the Index Reservoir.		
Parameter	Path 1*	Source
Turbulent Cross-section (XSTUR)	52609 m^2	Burns, 1997
Characteristic Length (CHARL)	1.395 m	Burns, 1997
Dispersion Coefficient for Eddy Diffusivity (DSP)**	3.0 x 10^{-5}	standard pond
* JTURB(1) = 1, ITURB(1) = 2; ** each monthly parameter set to this value.		

Table C-3. EXAMS II sediment properties for the Index Reservoir.			
Parameter	Littoral	Benthic	Source
Suspended Sediment (SUSED)	30 mg L^{-1}		standard pond
Bulk Density (BULKD)		1.85 g cm^{-3}	standard pond
Per cent Water in Benthic Sediments (PCTWA)		137%	standard pond
Fraction of Organic Matter (FROC)	0.04	0.04	standard pond

Table C-4. EXAMS II external environmental and location parameters for the Index Reservoir.		
Parameter	**Value**	**Source**
Precipitation (RAIN)	0 mm $\cdot month^{-1}$	
Atmospheric Turbulence (ATURB)	2.00 km	standard pond
Evaporation Rate (EVAP)	0 mm $\cdot month^{-1}$	
Wind Speed (WIND)	1 m $\cdot sec^{-1}$	standard pond
Air Mass Type (AMASS)	Rural (R)	
Elevation (ELEV)	54.9 m	USGS map
Latitude (LAT)	39.12º N	USGS map
Longitude (LONG)	90.05º W	USGS map

Table C-5. EXAMS II biological characterization parameters for the Index Reservoir.			
Parameter	**Limnic**	**Benthic**	**Source**
Bacterial Plankton Population Density (BACPL)	1 cfu $\cdot cm^{-3}$		see text
Benthic Bacteria Population Density (BNBAC)		37 cfu $\cdot(100\ g)^{-1}$	see text
Bacterial Plankton Biomass (PLMAS)	0.40 mg $\cdot L^{-1}$		standard pond
Benthic Bacteria Biomass (BNMAS)		$6.0x10^{-3}$ g $\cdot m^{-2}$	standard pond

Table C-6. EXAMS water quality parameters for the Index Reservoir.		
Parameter	**Value**	**Source**
Optical path length distribution factor (DFAC)	1.19	Standard pond
Dissolved organic carbon (DOC)	5 mg $\cdot L^{-1}$	standard pond
chlorophylls and pheophytins (CHL)	$5x10^{-3}$ mg $\cdot L^{-1}$	standard pond
pH (PH)	7	standard pond
pOH (POH)	7	standard pond

Table C-7. EXAMS mean monthly water temperatures (TCEL) for the Index Reservoir. (See text for development of values.)

Month	Temperature (Celsius)
January	0
February	1.09
March	6.26
April	13.21
May	18.61
June	23.73
July	26.09
August	25.04
September	20.91
October	14.5
November	7.04
December	0.99

Pesticide Science Policy

Drinking Water Screening Level Assessment

Part B: Applying a Percent Crop Area Adjustment to Tier 2 Surface Water Model Estimates for Pesticide Drinking Water Exposure Assessments

Office of Pesticide Programs
Environmental Protection Agency

PUBLIC COMMENT DRAFT
September 1, 2000

Executive Summary

EPA currently compares two numbers when evaluating the potential exposure of humans from pesticides in drinking water derived from surface water. For pesticides used on foods and potentially found in water, EPA compares pesticide concentrations estimated by GENERIC Estimated Environmental Concentration (GENEEC)/First Index Reservoir Screening Tool (FIRST)(Tier 1 screening models) to a Drinking Water Level of Comparison (DWLOC). If the Tier 1 (GENEEC) concentrations exceed the DWLOC, then a Tier 2 screening models Pesticide Root Zone Model /EXposure Analysis Modeling System (PRZM/EXAMS) are run to derive more refined estimates. When running PRZM/EXAMS for drinking-water assessments, EPA's current policy is to select the crop use which is expected to result in the highest runoff potential (based on application rate, application method, and crop location). By issuing this guidance document, OPP is changing its Tier 2 assessment process to incorporate the Percent Crop Area (PCA) concept.

Concentrations are estimated for pesticides in surface-water derived drinking water using the "index" reservoir scenario. The output generated by PRZM/EXAMS (a Tier 2 model) is multiplied by the maximum PCA (expressed as a decimal) generated for the crop or crops of interest. The crop of interest would most typically be the one that is anticipated to result in the greatest mass of pesticide entering the surface water body via runoff. OPP is proposing to apply PCA adjustments for four major crops – corn, soybeans, wheat, and cotton. For pesticides applied to these four crops, drinking-water exposure assessments will utilize the appropriate index reservoir scenario and corresponding PCA(s). For crops without a PCA adjustment factor, a default PCA has been developed to account for the maximum agricultural land use within the watershed.

This guidance results from a May 1999 presentation to the FIFRA Scientific Advisory Panel (SAP), *Proposed Methods For Determining Watershed-derived Percent Crop Areas And Considerations For Applying Crop Area Adjustments to Surface Water Screening Models***, and the response and recommendations from the panel. A more thorough discussion of this method and comparisons of monitoring and modeling results for selected pesticide/crop/site combinations is located at http://www.epa.gov/pesticides/SAP/1999/may/pca_sap.pdf.**

EPA is considering several additional future uses for the PCA factor. One modification is applying the PCA factor to both Tier 1 and Tier 2 models. Another is the recalculation of the PCA factor to represent cropped areas of watersheds where community water systems are located.

This document provides guidance on when and how to apply the PCA to model estimates, describes the methods used to derive the PCA, and discusses some of the assumptions and limitations of the process.

Background

The Pesticide Root Zone Model (PRZM) and Exposure Analysis Modeling System (EXAMS) are linked field-scale screening models being used to estimate pesticide concentrations in surface water. Since surface water is used as a source of drinking water for a large part of the U. S. population, the Office of Pesticide Programs (OPP) uses the PRZM-EXAMS estimates in its human health risk assessments. By design, the PRZM-EXAMS model estimates are expected to provide conservative values – that is,"high end" or "upper bound" estimates -- of pesticide concentrations in surface water. (An "upper bound" estimate represents a level which is not likely to be exceeded in actual practice. A "high end" estimate is a value that is expected to be at the upper percentiles of acutal exposure, e.g., above the 90^{th} percentile of observed values, but not significantly above the highest value that actually occurs.)

Because, with relatively low resource cost, the PRZM-EXAMS model produces conservative estimates of pesticide concentrations in surface water, they are used as part of a screening process to assess the potential for drinking water-related exposures exceeding the human health-based levels of concern. If PRZM-EXAMS estimates do not exceed levels that would be of health concern in drinking water, then OPP is able, in a very efficient manner, to "clear" the pesticide from the drinking water perspective. In cases where PRZM-EXAMS estimates do exceed levels of health concern, more refined estimates of surface water concentrations using more sophisticated and resource intensive approaches need to be employed. (More detailed information about OPP's overall approach to assessing potential drinking water exposure appears in the Science Policy Paper: "Estimating the Drinking Water Component of a Dietary Exposure Assessment." This is available via the internet at: http://www.epa.gov/fedrgstr/EPA-PEST/1999/November/Day-10/6044.pdf) This screening approach has served OPP well, as on the order of 50% of compounds have been cleared using this cost-effective screening method.

The PRZM component of the model is designed to predict the pesticide concentration dissolved in runoff waters and carried on entrained sediments from the field where a pesticide has been applied into an adjoining edge-of-field surface water body. The model can simulate specific site, pesticide, and management properties including soil properties (organic matter, water holding capacity, bulk density), site characteristics (slope, surface roughness, field geometry), pesticide application parameters (application rate, frequency, spray drift, application depth, application efficiency, application methods), agricultural management practices (tillage practices, irrigation, crop rotation sequences), and pesticide environmental fate and transport properties (aerobic soil metabolism half-life, soil:water partitioning coefficients, foliar degradation and dissipation, and volatilization). OPP selects a combination of these different properties to represent a site-specific scenario for a particular pesticide-crop regime. Generally, PRZM modeling is conducted using standard scenarios which approximate a 90^{th} percentile site for runoff vulnerability.

The EXAMS component of the model is used to simulate environmental fate and transport processes of pesticides in surface water, including: abiotic and biotic degradation, sediment:water partitioning, and volatilization. Currently, OPP is using an index reservoir and a farm pond as benchmark surface water bodies for human health and aquatic exposure assessments, respectively.

For each component, the values used are derived from real world data. For example, the EPA approved product label is the source of the application rate, frequency, and method of pesticide application. Pesticide environmental fate properties used in the PRZM modeling come from registrant-submitted data used for pesticide registration or reregistration. The values used for soil properties and site characteristics are chosen from real world databases appropriate for the sites on which the pesticide may be used. For example, if the pesticide is approved for use on cotton, OPP uses data reflecting the soil types in the Cotton Belt. The index reservoir being modeled is based on and represents an actual, fairly typical, small flow-though reservoir used for drinking water. Finally, the weather inputs for the model are taken from regional specific weather data, based on the USDA Major Land Resource Areas. PRZM modeling is generally simulated for 20 to 36 years in order to calculate a return frequency of concentration in surface water body.

The high end/upper bound estimates result from the conservative manner in which PRZM-EXAMS selects and combines values derived from real world data. OPP intentionally chooses values for the model which are likely not to underestimate the potential levels of pesticide residue in surface water. For example, the application rate and frequency used in the model are the highest allowed by the product label. In addition, PRZM-EXAMS modeling is assumed to be conservative because the index reservoir represents a "vulnerable" water supply reservoir; conservative fate parameters are used in the model; 100% of the watershed is assumed to be treated with pesticide; and the site properties are representative of vulnerable runoff conditions. All these factors lead to an assessment that PRZM-EXAMS is expected to predict high end or upper bound concentrations.

Pesticide movement in the environment -- particularly runoff into surface water -- is a very complex phenomenon, and no model will predict perfectly what occurs in the real world. Nonetheless, EPA has compared surface water monitoring data with the estimates produced by PRZM-EXAMS, and concludes that the model outputs are, in fact, usually upper bound estimates. The analysis is available at: http://www.epa.gov/scipoly/sap/1999/may/pca_sap.pdf The Agency presented its analysis to the Scientific Advisory Panel (SAP), and the Panel endorsed the use of PRZM-EXAMS to produce upper bound/high end estimates of pesticide residues in surface water. See the SAP Final Report at: http://www.epa.gov/scipoly/sap/1999/may/final.pdf Because of limitations in monitoring data bases, however, it is not feasible at this time to predict for any particular chemical whether the model output represents an upper bound or high end estimate.

The Agency recognizes that at some, and perhaps many, locations pesticide concentrations in surface water are lower than the model estimates. For example, although users may lawfully apply a pesticide at the highest rate and frequency allowed on a product label, typical rates and frequencies may be lower than the values used in the model. Moreover, while not required by the pesticide label, users may engage in practices which may reduce pesticide runoff, such as soil-incorporation of the pesticide or the use of “no-application” zones or filter strips around water bodies. Thus, where typical application practices are lower than label maximum, where runoff prevention practices are widespread, or where soil properties and site characteristics are less conducive to runoff, actual concentrations in surface water may be significantly lower than the values for the sites and conditions modeled.

Finally, to the extent that PRZM/EXAMS outputs are used in assessing the potential for risk to human health from pesticide residues in drinking water, it is important to recognize that the possible impact on residue levels of treatment by drinking water supply systems has not been reflected. While certain types of treatment will reduce the concentration of certain classes of pesticides (e.g. continuous granular activated carbon filtration will reduce levels of organic compounds), it should also be noted that a significant proportion of the U. S. population consumes water that has undergone either no treatment or only types of treatment that have little or no effect on the levels of pesticides in drinking water.

When to Apply the PCA Adjustment

PRZM/EXAMS are a linked fate and transport models which approximates watersheds as large fields. The previous model configuration assumes the entire area of the watershed is planted with the crop of interest (i.e., 100% crop coverage). This assumption is generally not true for areas larger than a few hectares, such as watersheds containing drinking water reservoirs. Therefore, when pesticide concentrations (peak and long-term average) are estimated using PRZM/EXAMS for the "index" reservoir, the model's results are adjusted by a factor that represents the maximum percent of the area within the watershed that is planted in the crop(s) under evaluation. The 1992 Agriculture Census is used to determine this cropped amount.

Which Crops and Uses?

When using the PCA factor, the modeler will need to select an appropriate crop for Tier 2 model input. Because PRZM/EXAMS are screening models, the first step has not changed; i.e., the modeler selects the crop use(s) that is expected to produce the maximum loading of a pesticide into the surface water body via runoff. In order to select an appropriate crop(s) for modeling, the modeler must consider the maximum pesticide application rate and frequency, application method, location in terms of the potential for runoff, and the impact of applying the PCA on the PRZM/EXAMS output. In some cases, PRZM/EXAMS simulations will be needed on more than one crop to decide which use pattern produces the highest estimate of surface water concentrations.

Because the PCA adjustment has a major effect on the estimates of pesticide concentrations in drinking water, the maximum labeled application rate may not always produce the highest estimated pesticide concentrations. For example, a pesticide may have an application rate of 8 lb/A on wheat and 10 lb/A on cotton. While the application rate suggests that the assessment should be conducted on cotton, wheat has a greater PCA (0.56 vs. 0.20) and may result in a higher estimated pesticide concentration in water.

Based on recommendations from the May 1999 FIFRA SAP, OPP will apply PCA adjustments for pesticide concentrations estimated for the four major crops listed in Table 1. The PCAs in the table represent the maximum PCAs found in any 8-digit Hydrologic Unit Code

(HUC) in the U.S. (see the appendix for a brief description of how each PCA was derived). In its review, the SAP concluded that "the model appeared to perform reasonably well with major crops in the Midwest and can be comfortably applied under those conditions." Because this is a screening model, the values in the table represent the potential maximum PCAs for the crop or crop combinations, no matter where that crop is modeled. A default PCA for all agricultural land has been adopted when a major crop PCA is not applicable as discussed in the next section. This default PCA is used for the largest amount of land in agricultural production in any 8-digit hydrologic unit in the continental United States. Estimates for regional PCAs may be undertaken in the future. Such regional assessments may be more appropriate for advanced exposure refinements rather than for a Tier 2 screening assessment.

Table 1. Summary of Maximum Percent Crop Areas Without Land Use Coverage

CROP	MAXIMUM PERCENT CROP AREA (as a decimal)	HYDROLOGIC UNIT CODE (8-DIGIT HUC)	STATE
Corn	0.46	07090007 07100003	Illinois Iowa
Soybeans	0.41	08020201	Missouri
Wheat	0.56	09010001	North Dakota
Cotton	0.20	08030207	Mississippi
Corn-Soybeans	0.83 (0.43 corn, 0.40 soybeans)	07130002	Illinois
Corn-Wheat	0.56 (0.00 corn, 0.56 wheat)	09010001	North Dakota
Corn-Cotton	0.46 (0.46 corn, 0.00 cotton)	07100003	Iowa
Soybeans-Wheat	0.56 (0.00 soybeans, 0.56 wheat)	09010001	North Dakota
Soybeans-Cotton	0.49 (0.31 soybeans, 0.18 cotton)	08020204	Missouri
Wheat-Cotton	0.56 (0.56 wheat, 0.00 cotton)	09010001	North Dakota
Corn-Soybeans-Wheat	0.83 (0.43 corn, 0.40 soybeans, 0.00 wheat)	07130002	Illinois
Corn-Soybeans-Cotton	0.83 (0.43 corn, 0.40 soybeans, 0.00 cotton)	07130002	Illinois
Soybeans-Wheat-Cotton	0.58 (0.31 soybeans, 0.09 wheat, 0.18 cotton)	08020204	Missouri
All Agricultural Land	0.87	10230002	Iowa

What About the Other Crops?

OPP will develop PCAs for other major crops in the same manner as was described in the May 1999 SAP presentation. For minor-use crops, the SAP found that the use of PCAs produced less than satisfactory results and advised OPP to further investigate possible sources of error. OPP has developed a default (all agricultural land) PCA that is used for the largest amount of land in agricultural production in any 8-digit hydrologic unit in the continental United States. The default PCA is 0.87. This PCA will be used for all major and minor crops not listed in Table 1.

Applying the PCA Adjustment

1. The first step in any screening-level drinking-water assessment is to determine the use that is expected to result in the maximum potential pesticide loading into a surface water body. As in the past, this step may involve a combination of best professional judgment and several PRZM/EXAMS runs. The PCA approach confounds this evaluation since an adjustment factor may affect some uses and not others. In addition, multiple evaluations are needed when more than one potential use may occur within the same watershed.

2. If the use with the maximum potential loading is for one of the crops with a PCA, then the output from the PRZM/EXAMS modeling (using the index reservoir) would be multiplied by the maximum PCA for the crop (Table 1). As an example, for a pesticide used only on corn, the estimated environmental concentrations from PRZM/EXAMS would be multiplied by 0.46. As noted earlier, this factor would be applied to the standard PRZM/EXAMS scenario for corn. However, if Tier 2 modeling is done for an area other than the standard scenario, the PCA would still be applied, since it represents the maximum percent crop area for that particular crop. As regional modeling efforts are expanded, regional PCAs could be developed.

3. If the use with the maximum potential loading is for a crop that does not have a PCA, then the default PCA (0.87) will be used as an adjustment factor.

Considerations for Multiple Crop Uses in a Watershed

Potential problems can occur when the PCA adjustment is used for a pesticide that is applied to several crops in the same watershed. The PCA approach assumes that the adjustment factor represents the maximum potential percentage of the watershed that could be treated. If, for example, a pesticide is only used on corn, then the assumption that no more than 46% of the watershed (at the current HUC scale) would be treated with the pesticide is likely to hold true. However, if the pesticide is used on both corn and soybeans, then this assumption is no longer valid since watersheds often contain both crops with a combined percentage of up to 83% (Table 1). In this case, the model estimates should be readjusted to reflect the combined PCA.

The SAP provided limited guidance on applying the PCA adjustment for pesticides used on multiple crops in a watershed. They recommended that the PCA for multiple crops be based on the single watershed with the highest percentage of the combination of the crops being modeled, rather than on summing the maximum PCAs for the individual crops. For example, for a pesticide which is used on corn, soybeans, and wheat, the PCA would be selected for the single watershed which had the highest combined PCA . In this case, it would be a PCA of 0.83 for the HUC of 07130002, which contains 43% corn, 40% soybean, and no wheat (Table 1). Summing the individual maximum PCAs for each crop would result in a combined PCA of 1.45 (0.46 for corn + 0.43 for soybeans + 0.56 for wheat), which would not be an appropriate adjustment factor because more than 100% of the area would be cropped. The SAP made no recommendations about applying PCAs when a pesticide is used on both crops which have a PCA and crops which have no PCA in one watershed.

The complexity of issues that must be considered in determining how or whether to apply a PCA for a pesticide that is used on multiple crops does not lend itself to a cookbook approach. Some thinking and analysis have to be done to ensure that the appropriate crops are selected to provide a screening estimate of pesticide concentrations in surface-water sources of drinking water to compare to the DWLOC. Based on the SAP's recommendations, model estimates should be made for each crop separately, multiplied by the PCA for each crop in the watershed that has the maximum combined PCA, and then summed. This is illustrated in the example below for a pesticide which is used on both corn and soybeans.

Example: Test pesticide has an application rate of 2 lb/A on corn and 1 lb/A on soybeans.
(1) Run PRZM/EXAMS for each individual crop:
1-in-10-year peak EEC: 60 µg/l for corn, 35 µg/l for soybeans
(2) Multiply the EECs by the component PCA
Corn: 60 µg/l x 0.43 = 26 µg/l
Soybean: 35 µg/l x 0.40 = 14 µg/l
(3) Sum the components for the composite 1-in-10-year peak EEC:
Total EEC = 26 µg/l + 14 µg/l = 40 µg/l

Assumptions and Limitations

The PCA is a watershed-based modification to account for the cropped area within a 8-digit-HUC watershed. Implicit in its application is the assumption that currently-used field-scale models reflect basin-scale processes consistently for all pesticides and uses. In other words, OPP assumes that the large field simulated by the coupled PRZM and EXAMS models is a reasonable approximation of pesticide fate and transport within a watershed containing a drinking-water reservoir. If the models fail to capture pertinent basin-scale fate and transport processes consistently for all pesticides and all uses, the application of a factor that reduces the estimated concentrations predicted by modeling could, in some instances, result in inadvertently passing a chemical through the screen that may actually pose a risk. Some preliminary assessments made in the development of the PCA suggest that PRZM/EXAMS may not realistically capture basin-scale processes for all pesticides or for all uses. A preliminary survey of water assessments that compared screening model estimates to readily available monitoring data suggests uneven model results. In some instances, the screening model estimates are more than an order of magnitude greater than the highest concentrations reported in the monitoring data; in other instances, the model estimates are less than monitoring concentrations. Because of these concerns, the SAP recommended using the PCA only for "major" crops in the Midwest. For other crops, a default PCA of 0.87 will be used to represent the largest amount of land in agricultural production in any 8-digit hydrologic unit in the continental United States.

The spatial data used for the PCA came from readily-available sources and have a number of inherent limitations:

- The size of the 8-digit HUC [mean = 366,989 ha; range = 6.7-2,282,081 ha; n = 2,111] may not provide reasonable estimates of actual PCAs for smaller watersheds. The watersheds that drain into drinking-water reservoirs are generally smaller than the 8-digit HUC and may be better represented by watersheds defined for drinking-water intakes.

- Converting the county-level data to watershed-based percent crop areas assumes that the distribution of the crops within a county is uniform and homogeneous. In addition, the distance between the treated fields and the water body is not addressed.

- The PCAs in Table 1 were generated using data from the 1992 Census of Agriculture. However, recent changes in the agriculture sector from farm bill legislation may significantly impact the distribution of crops throughout the country. The methods described in this report can rapidly be updated as more current agricultural crops data are obtained. This assumption that yearly changes in cropping patterns will cause minimal impact on PCAs needs to be evaluated.

The PCA adjustment can only be used for pesticides applied to agricultural crops. Currently, non-agricultural uses are not included in the screening model assessments for drinking water.

The PCA does not consider percent crop treated because detailed pesticide usage data are extremely limited at this time. Detailed pesticide usage data are currently only available for two states: New York and California.

"Drop-in" Description on PCA for Drinking Water Exposure Assessments Used in REDs, etc.

When the PCA is applied as an adjustment factor for drinking water assessments, the following explanation should be included with the refined estimate:

> "PRZM/EXAMS are field-scale models which treat watersheds as large fields. They assume that the entire area of the watershed is planted with the crop of interest (i.e., 100% crop coverage). This assumption may not be true for areas larger than a few hectares, such as watersheds containing drinking water reservoirs. Therefore, pesticide concentrations (peak and/or long-term average) were estimated with PRZM/EXAMS (the index reservoir modification changes the surface water body parameters used in EXAMS) and the model results from PRZM/EXAMS were adjusted by a factor that represents the maximum percent crop area found for the crop or crops being evaluated.
>
> Percent crop areas (PCAs) were derived on a watershed basis with Geographic Information System (GIS) tools using 1992 Census of Agriculture data and 8-digit HUC coverage for the coterminous United States. The maximum PCA derived from this project was selected to represent the modeled crop or crops. This default PCA represents the largest amount of land in agricultural production in any 8-digit hydrologic unit in the continental United States. The PCA assumes the distribution of the crops or agricultural land area within a county is uniform and homogeneous throughout the county area. Distance between the treated fields and the water body is not addressed."

The pesticide-specific processes that were used to select the particular uses for modeling also need to be included in the discussion and characterization of the drinking water assessment.

Policy Not Rules

The policy document discussed in this notice is intended to provide guidance to EPA personnel and decision-makers, and to the public. As a guidance document and not a rule, the policy in this guidance is not binding on either EPA or any outside parties. Although this guidance provides a starting point for EPA risk assessments, EPA will depart from its policy where the facts or circumstances warrant. In such cases, EPA will explain why a different course was taken. Similarly, outside parties remain free to assert that a policy is not appropriate for a specific pesticide or that the circumstances surrounding a specific risk assessment demonstrate that a policy should be abandoned.

APPENDIX A: How the Watershed-Based Percent Crop Areas Were Derived

This appendix provides a brief description of how the watershed-based percent crop areas (PCA) were derived. A more detailed description can be found in the May 1999 presentation to the FIFRA Scientific Advisory Panel (SAP), *Proposed Methods For Determining Watershed-derived Percent Crop Areas And Considerations For Applying Crop Area Adjustments to Surface Water Screening Models*. This document is available through the OPP home page at http://www.epa.gov/pesticides/SAP/1999/may/pca_sap.pdf.

Development of the PCA adjustment required two principal Geographic Information System (GIS) coverages:

(1) 8-digit Hydrologic Unit Codes (HUCs) obtained from the 1:2,000,000-scale hydrologic unit map of the United States (Allord, 1992); http://water.usgs.gov/lookup/getcover?huc2m)

(2) County boundaries obtained from the 1:2,000,000-scale map of county boundaries for the United States (Lanfear, 1994; http://water.usgs.gov/lookup/getcover?county2m). This coverage was derived from the Digital Line Graph (DLG) files representing the 1:2,000,000-scale map in the National Atlas of the United States and used as the base map for the county crops information.

The watershed-derived percent crop areas (PCA) for each crop were calculated by intersecting the HUC watershed coverage and the County Crop coverage in Arc-View 3.1 using the geoprocessing analysis tool. The areas for the resulting polygons within each 8-digit HUC were updated using the "Update Area" feature to indicate the corrected hectares of the new polygons.

The PCA calculation proceeds as follows: For each county in the hydrologic unit, calculate the fraction of the county's area in the unit. Multiply this fraction by the acreage of the crop in the county to get an estimate of the total area of the county's crop inside the hydrologic unit. Sum the areas calculated for each county within the HUC and divide by the total area of the hydrologic unit to get an estimate of the fraction of cropped area in the unit.

The PCAs for the crops listed in Table 1 were calculated without considering land use or land cover information. Land use/land cover data may provide a more refined estimate of a PCA because it can help to better define the crop distribution within a county. This refinement can be important in areas where geography limits crops to one area of a county, but may not be important in areas such as the Midwest where crops are more evenly distributed with respect to geography.

Default PCA Calculation

The default PCA was calculated as follows. First a map was created by overlaying the 8-digit hydrologic unit (HUC) boundaries and county boundaries (creating a county "parcel"). The fraction of the cropped area of each county was recorded, and used to calculate the total cropped area in each county parcel. Then, a total cropped area for each 8-digit hydrologic unit was calculated by summing up the cropped area for the parcels in the unit. A percent cropped area (PCA) was then calculated by dividing the cropped area by the total area in the hydrologic unit.

The following procedure was used for the few counties for which there were no data in the 1997 Agricultural Census. If the 1992 Census of Agriculture did contain crop area values for the county, then that number was substituted for the missing 1997 value. In cases where the cropped area was not reported in either the 1992 or 1997 Agricultural Census, the area of the county with missing data was not used in the PCA calculation. In this case, the parcels for the county were simply ignored in the calculations, and the area of the Hydrologic Unit in the county correspondingly reduced. Any hydrologic units missing more than 33% of their area were considered to have insufficient data and no PCA was calculated.

After all the above calculations were completed, the maximum PCA for an 8-digit hydrologic unit was chosen as the default value. This value was calculated to be 87% in HUC 10230002, located in northwestern Iowa.