UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460
November 10, 2005

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

MEMORANDUM

DATE: December 11, 2006

SUBJECT: Addendum to the Environmental Fate and Effects Division (EFED) Drinking Water Exposure Assessment for the Addition of Propazine Use on Sorghum to the Triazine Cumulative Dietary Risk Assessment (DP 334595)

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12-11-06

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The Environmental Fate and Effects Division (EFED) have completed an addendum to the drinking water exposure assessment conducted previously for the triazine cumulative dietary risk assessment. This addendum represents an additional drinking water exposure assessment for the principal sorghum growing areas of Kansas, Oklahoma, Texas, Colorado, and New Mexico that were not included in the previously completed triazine cumulative risk assessment. EFED recently completed a Section 3 new use risk assessment for the proposed use of propazine on sorghum. This addendum to the triazine cumulative risk assessment has been completed to augment the work already completed.

Previously EFED completed a drinking water exposure assessment for the triazine cumulative risk assessment that included an analysis of atrazine monitoring data from community water systems (CWS) in the Midwest, and modeling of atrazine in California and Florida. Given that the recently completed assessment for propazine use on sorghum is a new use this assessment has relied exclusively on modeling using the linked Pesticide Root Zone Model (PRZM) and Exposure Analysis Modeling System (EXAMS) to predict drinking water exposures in the principal sorghum growing areas. To the extent possible, this assessment follows the methods used in the previous assessment for modeling in California and Florida.

Problem Formulation

The previous drinking water assessment for the triazine cumulative risk assessment focused on surface water exposure scenarios in the Midwest, California and Florida for simazine, atrazine, and the chloro degradates of both. Propazine was not included in the assessment because there were no outdoor uses registered at the time of that assessment. The recent addition of a registration for propazine use on sorghum required consideration of a new exposure scenario because the principal sorghum growing area is outside the geographic extent of the three areas previously considered.

Critical to modeling in the previous assessment is the selection of appropriate scenarios. In this case, only two sorghum scenarios (Kansas and Texas sorghum) and no relevant corn scenario were available for use in this assessment for the principal sorghum growing region of the United States. A single Texas corn scenario is available but this scenario was developed specifically for the organophosphate (OP) cumulative assessment and was deemed inappropriate for use here. An evaluation of the sorghum growing area indicated that corn is grown in these areas and that atrazine may be used on corn. **Figure 1** presents the location of these scenarios relative to the sorghum growing regions.

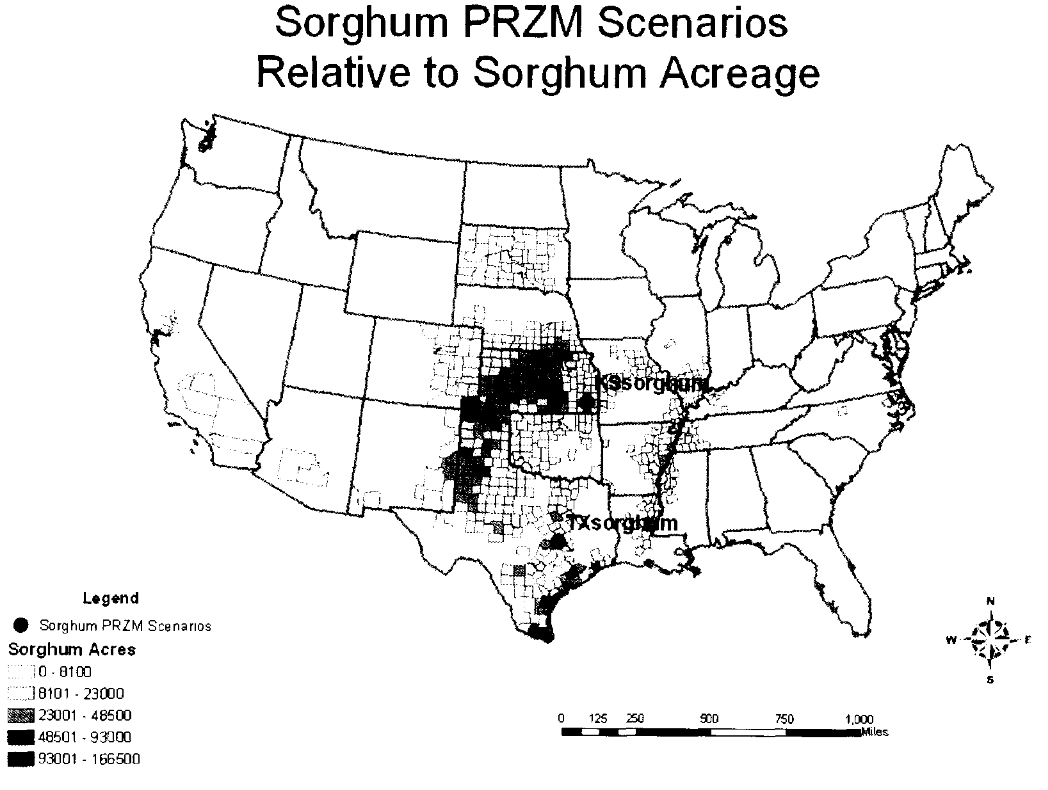

Figure 1. PRZM sorghum scenarios relative to sorghum growing areas.

Also critical to an evaluation of the relevance of modeled exposure concentration is the location of the use and modeled scenarios relative to potentially exposed populations. In the case of this assessment the potentially exposed population consists of individuals deriving drinking water from surface water sources. Figure 2 presents a generalized map showing the location of community water system CWS) surface water intakes relative to the main sorghum growing areas and the selected PRZM scenarios. In both cases (TX and KS) the scenarios are co-located with multiple surface water intakes and while not in the heart of the main sorghum growing area are located on the eastern portion of the main growing area. This is likely to be more vulnerable to runoff given the higher precipitation that occurs in the eastern Great Plains compared to the western plains.

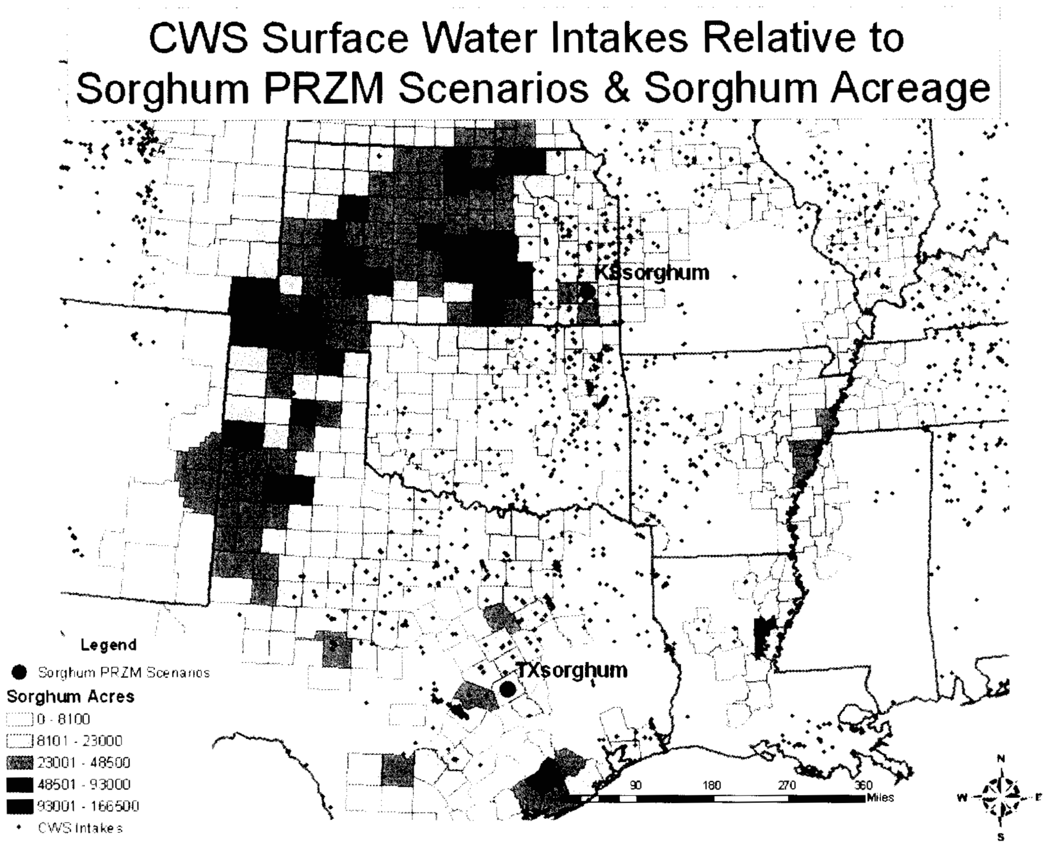

Figure 2. Location of Surface Water Intakes for Drinking Water and PRZM sorghum scenarios used in this assessment.

Analysis Plan

Daily drinking water exposure from surface water sources was estimated using the simulation models PRZM/EXAMS. PRZM is used to simulate pesticide transport as a result of runoff and erosion from a standardized watershed, and EXAMS estimates environmental fate and transport of pesticides in surface waters. The linkage program shell - PE4v01.pl, which incorporates the standard scenarios developed by EFED, was used to run these models. PRZM/EXAMS modeling can account for the potential co-occurrence of triazines and their degradates by modeling all uses in a given region; combining daily time-series over multiple years using 30 years of weather data to account for year to year variations in weather and to separate out peak concentrations not likely to occur together in time; evaluating the impact of typical versus maximum label rates; focusing on vulnerable areas to estimate highly vulnerable settings; and adjust for crop area and acres treated.

Linked crop-specific scenarios and meteorological data were used to estimate exposure as a result of specific use for each modeling scenario. Simulations were done using the Index Reservoir scenario in EXAMS, which is a surrogate for a drinking water source drawn from surface water. Weather and agricultural practices are simulated over 30 years so that the 1 in10 year exceedence probability at the site can be estimated. The values generated by the models for drinking water were multiplied by a percent crop area factor (PCA), which accounts for the fact that it is unlikely for any watershed basin to be completely planted to agricultural crops. No specific PCA values are available for sorghum, so the agricultural default factor of 0.87 was applied.

Specifically for this assessment, three modeling runs for each location selected (Kansas and Texas) including propazine on sorghum, atrazine on sorghum, and atrazine on corn were completed. Simazine was included in the previous assessment but is not expected to be significant with limited use on sorghum overall and limited use on all crops in the principal sorghum states of Kansas (< 1% percent cropped treated), Colorado, Oklahoma, Texas, and New Mexico (Kaul and Kiely, 2005). An exception to this is simazine use on citrus and sugarcane in Texas, however these uses are in Southern Texas which is far removed from the main sorghum growing regions in Northern Texas and thus simazine has not been not included in this regional assessment for the sorghum growing region of the Midwest. The sorghum PRZM scenarios have been used as surrogates for corn to account for the use of atrazine on corn in these areas.

Further information on these models may be found at the following website,

http://www.epa.gov/oppefed1/models/water/index.htm

In the previous assessment, results are reported for the parent compound (atrazine and simazine) plus the total chloro degradates (G28273 + G28279 + G30033 for atrazine and G28273 + G28279 for simazine). During completion of the interim reregistration eligibility decision (IRED) for atrazine and the reregistation eligibility decision (RED) for simazine a regression equation was calculated independently for each pesticide using available monitoring data. The regression equation for atrazine was incorporated into all atrazine modeling runs. However, no monitoring data is available for propazine and thus no regression equation was used to adjust for the total chloro degradates of propazine likely to be present in drinking water. This is not expected to result in an under-estimation of exposure because propazine is more persistent than atrazine. The chloro degradates are only found in the aerobic soil metabolism study at less than 6% of applied, and only occur after greater than 100 days of metabolism.

PRZM is a field scale model, while the cumulative water assessment focuses on watershed scale impacts. PRZM was used to model multiple fields in a watershed and while this approach provides more realistic depiction of multiple chemical usages in a watershed, it provides no spatial context for where those fields are within the watershed. It also assumes that all runoff from those fields goes into the drinking water reservoir.

To adapt PRZM for this watershed approach, the estimated pesticide concentrations predicted by PRZM were adjusted for each crop/chemical combination to account for the portion of the watershed that is treated by a particular triazine. The resulting adjustment factor is called the cumulative adjustment factor (CAF) and accounts for the fraction of the watershed that is in the crop being modeled and by the percentage of the crop treated. The resulting crop/chemical specific CAF was multiplied against the daily distribution of concentrations predicted by PRZM. In previous assessments the CAF adjusted daily output was then further adjusted using a relative potency factor (RPF) to account for differences in toxicity between compounds; however in this assessment, no RPF factor has been applied to modeled output and all compounds are assumed of equal toxicity. Finally, all resulting CAF adjusted model outputs for each crop/chemical combination within the watershed are summed across all days to yield a distribution of cumulative daily residues in drinking water for use in the dietary assessment.

To account for the potential co-occurrence of propazine and atrazine use within a given drinking watershed within the sorghum growing area a CAF was estimated specific to the sorghum growing areas being assessed. The CAF relies on an analysis of the most appropriate regional percent cropped area (PCA) factor, the percentage of a given crop within the area, and the percent cropped treated for each crop. Analysis of the regional PCA (website here) indicates that a portion of the sorghum growing area resides within the major watershed containing the national default PCA of 87% (for corn the maximum crop specific PCA was 46%). These PCA's represent the maximum percentage of a drinking watershed that is covered in general cropland. The United States Department of Agriculture (USDA) Census of Agriculture (AgCensus) data was obtained and analyzed at the county level to derive an estimate of the percentage of cropped land within the sorghum growing areas that are grown in sorghum and corn. County level data was evaluated for the top sorghum growing counties to determine the percentage of all cropland in sorghum and corn. These values were estimated by averaging across the selected counties and yielded estimates of 25% for sorghum and 11% for corn.

The percent crop treated (PCT) was derived from available data (Kiely, 2006) and indicated two possible scenarios for the registration of propazine on sorghum. The first scenario indicates that propazine could completely replace atrazine use on sorghum that currently is at 70% of all sorghum grown. The second option indicated that propazine might not replace atrazine use but could fill a niche where atrazine use is not currently occurring and estimated this at 29% of all sorghum acres. Finally, without current data, it is assumed that 100% of all corn grown in the sorghum growing areas would be treated with atrazine. It was assumed that the "niche" option would lead to higher overall exposures because more of the watershed is being treated and thus this scenario was modeled (this assumption was tested by running one scenario with the "replacement

PCT's which yielded lower overall EEC). Although not anticipated given the analysis by BEAD, if propazine were to be applied to 100% of sorghum acres (with no atrazine use) exposures would likely be lower given the lower application rate for propazine relative to atrazine. Multiplying these factors together yielded CAF's for propazine on sorghum of 0.063075 (6.3%), atrazine on sorghum of 0.15225 (15.2%), and atrazine on corn of 0.0506 (5.1%). All of the factors used in this assessment are summarized in **Table 1**.

Table 1. Factors used in Modeling to Derive the Cumulative Adjustment Factor (CAF) for each Scenario Modeled

	Propazine on Sorghum	Atrazine on Sorghum	Atrazine on Corn
Number of Applications	1	1	2
Maximum Application Rate from Label	1.2 lbs/acre	2.0 lbs/acre	2.0 lbs/acre
Typical Application Rate	1.2 lbs/acre	1.0 lbs/acre[1]	1.0 lbs/acre[2]
Application Type	aerial	aerial	Aerial
Maximum Percent Cropped Area for Sorghum Growing Region Assessed	87%	87%	46%
Degradate Adjustment	NA	0.24+1.418*ppb[3]	0.24+1.418*ppb[3]
Percentage of Crop in Growing Area	25%	25%	11%
Percent Cropped Treated – Option #1	70%	0%	100%
Percent Cropped Treated – Option #2	29%	70%	100%
Cumulative Adjustment Factor – Option #1	0.15225	0.0000	0.0506
Cumulative Adjustment Factor – Option #2	0.063075	0.15225	0.0506

1 – From BEAD memorandum "Atrazine and Propazine Use Rates in Sorghum for Potential Co-occurrence (DP 308550)" from Phillips and Kiely dated October 5, 2005.
2 – from BEAD Table 1 included with memorandum "Triazine Pesticides Usage Data and Maps for Cumulative Risk Assessment, D317992" from Kaul and Kiely dated November 2, 2005
3 – ppb represents modeled concentration of atrazine in parts per billion, or micrograms per liter.

Model Inputs

Consistent with previous modeling both label maximum and typical application rates are available at the state level for atrazine (Kaul and Kiely, 2005, Phillips and Kiely, 2005). Propazine is a new use and as such no typical application rate information was available for use in this assessment. Both the typical and maximum application rates for atrazine use were modeled and provided separately. In addition, both the new propazine use and the existing atrazine uses allow for both ground and aerial applications. In this assessment, only the aerial application method has been modeled given that it is expected to yield higher EEC.

One outcome of the 2003 atrazine IRED process was a modification to all existing atrazine labels that requires setback distances around intermittent/perennial streams and lakes/reservoirs. The label changes specify setback distances of 66 feet and 200 feet for atrazine applications surrounding intermittent/perennial streams and lakes/reservoirs, respectively. The Agency incorporated these distances into this assessment and has modified the standard spray drift assumptions accordingly using AgDrift to estimate the impact of a setback distance of 66 feet on the fraction of drift reaching a surface water body. The revised spray drift percentages, which are incorporated into the PRZM/EXAMS modeling, are 0.6% for ground applications and 6.5% for aerial applications. The proposed propazine label contains similar language and the AgDrift derived spray drift values have been incorporated into this assessment as well.

Models to estimate the effect of setbacks on load reduction for runoff are not currently available. It is well documented that vegetated setbacks can result in a substantial reduction in pesticide load to surface water (USDA, NRCS, 2000). Specifically for atrazine, data reported in the USDA study indicate that well vegetated setbacks have been documented to reduce atrazine loading to surface water by as little as 11% and as much as 100% of total runoff without a setback. It is expected that the presence of a well-vegetated setback between the site of atrazine application and receiving water bodies could result in reduction in loading. Therefore, the aquatic EECs presented in this assessment are likely to over-estimate exposure in areas with well-vegetated setbacks. While the extent of load reduction cannot be accurately predicted through each relevant stream reach in the action area, data from USDA (USDA, 2000) suggest reductions could range from 11 to 100%.

The appropriate PRZM input parameters for both atrazine and propazine were selected from the environmental fate data submitted by the registrant and in accordance with US EPA-OPP EFED water model parameter selection guidelines, Guidance for Selecting Input Parameters in Modeling the Environmental Fate and Transport of Pesticides, Version 2.3, February 28, 2002. The propazine input parameters are consistent with those used in the recent Section 3 new use risk assessment (D310326) and are summarized in **Table 2**. The atrazine input parameters are consistent with those used in both the 2003 IRED (U.S. EPA, 2003a) and the cumulative triazine risk assessment (U.S. EPA, 2006a) and are summarized in **Table 3**. More detail on the atrazine assessments may be found at:

http://www.epa.gov/oppsrrd1/REDs/atrazine_ired.pdf

http://www.epa.gov/pesticides/cumulative/common_mech_groups.htm#chloro

Table 2. Propazine Inputs Used in PRZM Modeling

Parameter	Value	Source
Application Rate per Event	1.2 lb a.i./A	Propazine 4L label
Number of Applications per Crop Season	1 application per year	Propazine 4L label
Henry's constant	1.02 x10 -9	Product Chemistry
Molecular Weight	230 g/mole	Product Chemistry
Vapor Pressure	2.9E-8 torr	Product Chemistry
Water Solubility @ 20°C	2.9 mg/L	Product Chemistry
Aqueous Photolysis t ½	Stable	MRID 441848-05
Aerobic Soil Metabolism t ½	480 days [1]	MRID 441848-07
Hydrolysis t ½	Stable	MRID 436898-02
Aerobic Aquatic Degradation t ½	960 days [2]	EFED Guidance, 2002
Anaerobic Aquatic Degradation t ½	112 days [3]	EFED Guidance, 2002
Koc	125 mL/g [4]	MRIDs 001529-97, 436898-04
Application Efficiency	0.99 / 0.95	EFED Guidance, 2002
Spray Drift Fraction	0.006 / 0.065	AgDrift Modeling for label specified buffers

[1] Upper 90^{th} Percentile based on mean half-lives of 289 and 105 days.
[2] 2x aerobic soil metabolism half-life (EFED Modeling Input Parameter Guidance, 2002).
[3] 2x anaerobic soil metabolism half-life (EFED Modeling Input Parameter Guidance, 2002).
[4] Average from all acceptable adsorption/desorption data including K_{oc} values of 65, 83, 123, 158, 79, 96, 128, and 268 (MRIDs 001529-97 and 436898-04).

Table 3. Atrazine Inputs Used in PRZM Modeling		
Fate Property	**Value**	**MRID (or source)**
Application Rate per Event	1.2 lb a.i./A	Atrazine Label
Number of Applications per Crop Season	1 application per year	Atrazine Label
Molecular Weight	215.7	MRID 41379803
Henry's constant	2.58 x10 -9	MRID 41379803
Vapor Pressure	3 x 10 -7	MRID 41379803
Solubility in Water	33 mg/l	MRID 41379803
Photolysis in Water	335 days	MRID 42089904
Aerobic Soil Metabolism Half-lives	152 days	MRID 40431301 MRID 40629303 MRID 42089906
Hydrolysis	stable	MRID 40431319
Aerobic Aquatic Metabolism (water column)	304 days	2x aerobic soil metabolism rate constant
Anaerobic Aquatic Metabolism (benthic)	608 days	MRID 40431323
Koc	88.78 ml/g	MRID 40431324 MRID 41257901 MRID 41257902 MRID 41257904 MRID 41257905 MRID 41257906
Application Efficiency	95 % for aerial 99 % for ground	default value[1]
Spray Drift Fraction	6.5 % for aerial 0.6 % for ground	AgDrift adjusted values based on label restrictions

[1] – Inputs determined in accordance with EFED "*Guidance for Chemistry and Management Practice Input Parameters for Use in Modeling the Environmental Fate and Transport of Pesticides*" dated February 28, 2002

Characterization

Model runs were completed using both maximum labeled application rates and typical application rates as reported by BEAD. No typical application rate data was available for propazine because the use has not yet been registered. Typical application rates represent an "average" of the available reported data compiled by BEAD and should be used with caution. Typical application rates imply that a substantial number of applications are occurring above this value and therefore, some watersheds could have higher exposures than those estimated with a typical application rate. For atrazine, usage data indicates typical or average application rates, for both sorghum and corn in the principal sorghum growing areas being assessed. In order to provide a range of daily concentrations both the typical and labeled maximum rates were modeled for atrazine. Each daily distribution was then adjusted for degradate co-occurrence (for atrazine only) and for the relevant CAF. The CAF represents the percentage of treated crop within the watershed being modeled. In this case, BEAD provided two estimates of potential PCT for propazine and atrazine on sorghum. In the output provided and described above it is assumed that propazine will not replace current atrazine use on sorghum (at 70% of all sorghum grown) but will fill a niche of the remaining sorghum at 29% of all sorghum grown. The alternative to this assumption is that propazine use will not fill the niche but will entirely replace atrazine use on sorghum such that the PCT for propazine use on sorghum will be 70% and the PCT for atrazine use on sorghum will be 0%. Both scenarios assume that the PCT for atrazine on corn in the same area is 100%. In order to test the conservativeness of the assumption that the niche scenario for propazine will yield the highest exposures the alternative scenario was modeled using the Texas sorghum scenario modeled at the label maximum application rates (the highest exposure scenario modeled). The evaluation involved a comparison of the maximum single daily concentration predicted from the 30 years of CAF adjusted EEC. Modeling with the alternative CAF assumptions for the "replacement" scenario for propazine yielded peak concentrations that are roughly 3 times lower than the "niche" scenario suggesting that the "niche" scenario for propazine PCT is conservative.

Propazine represents a new use relative to atrazine and thus two alternative approaches were completed for modeling. First, propazine use on sorghum was modeled at the proposed label maximum rate and these daily values were summed with exposure concentrations predicted using labeled maximum application rates for atrazine on sorghum and corn. These are the maximum scenarios delivered. The alternative approach was to combine propazine exposure estimates with atrazine exposure estimates modeled using typical application rates for use of atrazine on sorghum and corn using data provided by BEAD. These are the typical CAF adjusted model outputs provided. Previous cumulative assessments have relied on modeling using typical application rates where that data is available.

Modeling was completed using both the Texas and Kansas sorghum scenarios for propazine use on sorghum, atrazine use on sorghum, and atrazine use on corn. Typically, model runs are reported as deterministic, or point estimates, for a variety of exposure durations (e.g. peak and annual average). However, for the triazine cumulative assessment daily distributions are required as input to dietary models. Current dietary models for use in human health risk assessments including DEEM, CALENDEX, LIFELINE, and CARES require daily distributions of EEC. The Tier II drinking water model (PRZM/EXAMS) does generate daily values and this model was used to predict a daily distribution of EECs as described previously.

Consideration should be given to the requirements of the individual dietary exposure model when deciding which daily distribution to use. The principal difference between the point estimate and the daily distribution is that the daily distribution provides information on seasonality (what time of year the peak concentration occurs), duration of exposure (how long the peaks occur), and the cumulative impact of multiple applications on exposure (how does each application extend the duration of exposure). None of these factors are captured when relying on the point estimate for comparison against the DWLOC. Such timing of exposures may be critical in the dietary exposure if other time-sensitive routes of exposure, such as residential use, are also important. This fact would be missed if choosing a distribution simply based on the point estimate.

PRZM/EXAMS was used to estimate surface water concentrations in a small reservoir and makes certain assumptions regarding the nature of the drinking water source, watershed, and year to year variability. The modeled reservoir (Index Reservoir) is based on the specific geometry of an actual reservoir in the Midwestern US and as such is more representative of similar drinking water sources in the high rainfall areas of the east and Midwest than the west. PRZM is a field scale model being used at the watershed scale. PRZM does not explicitly account for the relative contribution of fields within a watershed; however, a CAF has been applied to model output to estimate this variability. PRZM also does not account for the location of treated fields within the watershed and assumes a single soil type represents the entire watershed. When possible, the scenario used has been developed using a benchmark soil that is prone to runoff. In actuality, soils will vary across the watershed with soils present that are both higher and lower in runoff vulnerability. Application rates, timing and frequency are held constant in PRZM but variability is accounted for by using 30 years of weather data from recent periods for comparison with monitoring data.

Finally, typical application rate information has been used in this assessment for modeling purposes. This assumes that all applications within the watershed are at the typical, or average, rate. Using the typical application rate may underestimate exposure in years when pest pressures are higher than those reported and may overestimate when lower amounts of pesticide are used. These data have been derived from state level data and assume uniform practices across the entire state, while in reality it is expected that a more uneven distribution of application practices (e.g. rates, timing, and frequency) will occur in response to different pest pressures.

Conclusions

Daily distributions of the modeled output for all scenario locations (Texas and Kansas) and the alternative application assumptions (Maximum versus typical application rates) have been provided electronically and thus are not summarized in this memorandum (copies of all the modeled output will be stored electronically along with this report on the EFED share drive). Given the facts outlined above, it may be best for all daily distributions to be run to determine which scenario predicts the greatest risk when considered in conjunction with food and residential/occupational exposures.