UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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ENVIRONMENTAL FATE AND EFFECTS DIVISION OFFICE OF PESTICIDE PROGRAMS

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SUBJECT: Reregistration of sodium acifluorfen (PC Code 114402 / Company: 007969 BASF Corporation) for uses on soybeans, peanuts and rice (D252561).

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SUMMARY

Attached is EFED's ecological risk assessment and drinking water assessment for sodium acifluorfen. The present review considers: peanuts, soybeans and rice. Lawn uses are for spot treatment and are considered a minimal risk. In addition to being a registered herbicide, acifluorfen is also the primary degradate of the herbicide lactofen (Chemical Code 128888). Acifluorfen accounted for approximately 52 percent of the applied lactofen in an aerobic metabolism soil study. Sodium acifluorfen and lactofen also both share the common degradate amino acifluorfen. This memo highlights EFED's concerns and provides suggestions for product labeling. It also identifies data requirements to reduce uncertainties in the assessment.

DATA REQUIREMENTS

Environmental Fate Data Requirements:

Even though all guideline data requirements have been fulfilled, the characterization of the environmental fate of acifluorfen and the other degradates may not be as straight forward as would be indicated by the basic fate properties (*e.g.*, half-life and K_{oc}). Thus, our ability to predict the fate or concentrations of acifluorfen in soil or water has considerable uncertainty. Additional studies are needed to better define the variability of the persistence and mobility of acifluorfen, amino acifluorfen, and desnitroacifluorfen and what site factors may be able to better predict behavior of the acifluorfen residues in the environment.

A simple example of can be made if one looks at the persistence and mobility of acifluorfen. The aerobic soil metabolism half-live values of acifluorfen generally range between 100 and 200 days, it is stable to hydrolysis, it does not readily photo-degrade and it is mobile (K_{ads} range between 0.1 and 5.3 mL/g). These fate properties triggered a small-scale prospective ground-water study which occurred in the central sand region of Wisconsin on soybeans. The occurrence of acifluorfen residues in ground water was not unexpected based upon its fate attributes. Although, the frequency (20 percent) and range of detections (1 to 46 µg/L) with a long term average of 7.33 µg/L was not necessarily expected. The prospective study included acifluorfen and two soil and water degradates (amino acifluorfen and desnitroacifluorfen). Neither of the two degradates were detected.

A field dissipation half-life of about 15 days was calculated for the disappearance of acifluorfen from the upper 0.2 or 0.3 meters depending upon sampling date (sampling increment varied with time). In this study leaching was the major dissipation pathway of acifluorfen. The occurrence of acifluorfen residues in the soil-pore water and ground water confirmed this pathway. The registrant also conducted a small-scale retrospective ground-water monitoring study at five locations. Soil samples were also collect for acifluorfen analysis. The dissipation half-lives varied from 7 to 66 days depending upon study location and what value was used for initial acifluorfen concentrations. There was no evidence of leaching from soil samples collected and no residues were detected in ground water. Since degradates were not measured it is not possible to determine whether acifluorfen concentrations declined by being leached out of the surface soil, were degraded in place, or were redistributed within the soil profile to levels below the detection limit.

Acifluorfen has been included in other ground water and surface water studies. While additional residues have been found, residues are not found at all of the surface or ground water studies or locations. Assuming that these studies were conducted in actual use areas, at hydrologically vulnerable sites, and with sufficient detections limits, the fate data suggest there would be more frequent detections. Monitoring data for the degradates is too limited for any type of assessment.

With a pK_a of 3.5 (acid dissociation constant), acifluorfen exists in the dissociated anion form in most agricultural soils since the pH of these soils usually exceeds the pK_a of the acid. Sodium-acifluorfen dissociates resulting in the negatively charged acifluorfen. Negatively charged sorption sites, such as clay minerals, are therefore expected to have little contribution to the adsorption process. Despite charges that would result in repulsion effects, some acifluorfen is apparently sorbed by soil or soil constituents. The adsorption/desorption of acifluorfen is dependent upon pH, organic carbon content, and ammonium oxalate extractable iron content of the soil (positively charged), but not necessarily the percent of clay but mineral type. Acifluorfen may be sorbed or precipitated by forming complexes with divalent or trivalent cations. Acifluorfen sorption appears to be a non-equilibrium, time-dependent process. Under anaerobic conditions acifluorfen is more rapidly reduced to amino acifluorfen, which may be less mobile (K_{ads} 1.25 to 47.01 sand to loamy sand) depending on soil texture. The K_{ads} from the laboratory studies suggest a higher leaching potential for the parent and variable leaching potential for the amino acifluorfen.

The environmental fate studies and published literature suggest that under different conditions the persistence and the mobility may be less than that indicated by most of the laboratory and field (variable field dissipation half-lives, K_{ads}) study data. Additional fate studies should be conducted to determine whether relationships between specific soil and/or environmental conditions could provide information to further refine the exposure assessment.

It is recommended that the registrant meet with the Agency to develop an approach to develop the necessary information to address the uncertainties surrounding the fate of acifluorfen. Some or all of the following studies would be useful in reducing some of the uncertainty.

Guideline Number	Study	Discussion
There is a need to tie the individual terrestrial and soil fate processes into a comprehensive understanding. Data are necessary to be able to understand the importance of the different processes under different environmental conditions.		
163-1	Soil Partition Coefficient for acifluorfen, amino acifluorfen, and desnitro acifluorfen	This study is necessary to support the registration of the herbicide. Because the sorption of acifluorfen depends upon a number of soil properties. Acifluorfen sorption is also a non-equilibrium, time-dependent process. The mobility of acifluorfen in soil is affected by the rate as well as the maximum extent of sorption. Amino acifluorfen is highly variable, depending upon soil texture. By better understanding the conditions that influence sorption, management options to prevent water contamination would be easier. This information is also needed for subsoils.
162-1	Aerobic soil metabolism	The line between metabolic and chemical degradation of acifluorfen is quite blurry. Acifluorfen also degrades to amino acifluorfen and a number of identified polar substances. The fate of these needs to better characterized.

162-2	Anaerobic soil metabolism	Acifluorfen is rapidly transformed to amino acifluorfen. The fate of acifluorfen beyond this point is not clear. Its mobility is quite variable - high to low, with apparent persistence.

There is a need to tie the individual studies into a comprehensive understanding to the fate of acifluorfen and degradates under different environmental conditions.

162-3	Anaerobic Aquatic Metabolism	Need to tie into the aerobic conditions better.
162-4	Aerobic Aquatic Metabolism	The aerobic aquatic half-life suggest that acifluorfen is persistent in an aquatic environment. Aqueous photolysis is quite rapid.
164-1	Terrestrial Field Dissipation	This study may be necessary to relate laboratory results to actual field conditions.
164-2	Aquatic Dissipation	The rice studies showed rapid degradation of acifluorfen with low concentrations of degradates formed. The importance of aqueous photolysis (e.g., the rice pond was only 4 inches deep) and reducing (anaerobic processes) conditions is unclear in other water bodies.

Ecological Effects Data Requirements:

Guideline Number	Study	Discussion
123-1(a)	Seedling Emergence	The two studies above are required to support the registration of an herbicide. The "value added" is high, because as an herbicide, acifluorfen is expected to injure plants. Previously submitted studies were consider invalid, because the acifluorfen solution applied to the experimental plants was too dilute and the water may have washed the chemical away from the plant. This caused uncertainty about the exposure.
123-1(b)	Vegetative Vigor	

141-1	Honey Bee Acute Contact	Acifluorfen will be applied in the spring by air to major crops such as rice, soybeans, and peanuts, resulting in potential exposure to bees, especially off site. The "value added" would be medium, because acifluorfen is an herbicide and is not applied to a crop in bloom.

UNCERTAINTY:

Acifluorfen acts through inhibition of Protox (protoporphyrinogen oxidase). Protox is a membrane-bound protein located in the chloroplast envelope where it inhibits photosynthesis in plants and energy and oxygen transport in animals. This could result in higher toxicity.

LABELING

Manufacturing Use Products

> "Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA."

End Use Products

All uses except for rice-

> "Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate."

Rice use-

> "Do not apply directly to water except to rice patties, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment washwaters or rinsate."

Surface Water Advisory

> “This product may contaminate water through drift. This product has a high potential for runoff for several months or more after application. Poorly draining soils and soils with shallow watertables are more prone to produce runoff that contains this product.
>
> A level, well maintained vegetative buffer strip between areas to which this

product is applied and surface water features such as ponds, streams, and springs will reduce the potential for contamination of water from rainfall-runoff. Runoff of this product will be reduced by avoiding applications when rainfall is forecasted to occur within 48 hours.

Ground Water Advisory

Acifluorfen, a degradate of sodium acifluorfen, is known to leach through soil into ground water under certain conditions as a result of label use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination.

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CHAPTER 1.

ENVIRONMENTAL RISK CONCLUSIONS

Sodium acifluorfen is used as a post emergent herbicide to control a variety of weeds in soybeans, peanuts and rice and as a spot treatment on lawns. Sodium acifluorfen is typically applied when weeds are small (< 4" tall), when acifluorfen is more effective at low rates. BASF claims there is no residual herbicide activity at the current rates (0.125 to 0.375 lbs ai/A). Maximum season rate is 0.5 lbs ai/A. For this assessment, it will be assumed that acifluorfen acid and sodium acifluorfen are equivalent and the name “acifluorfen” will be used. Sodium acifluorfen will be used when discussing the registered products containing sodium acifluorfen as an active ingredient or acifluorfen, but not lactofen. Acifluorfen refers to the sodium salt of acifluorfen and the acid form of acifluorfen which is a break-down product of both sodium acifluorfen and lactofen.

Acute levels of concern are not exceeded for terrestrial animals, freshwater and estuarine animals, or aquatic plants. Based upon maximum exposure scenarios, chronic risk is anticipated for herbivorous and insectivorous birds but not for mammals. Insectivorous birds would not be at chronic risk at less than maximum exposure levels. Chronic risk is uncertain for freshwater and estuarine animals. Sodium acifluorfen and carfentrazone-ethyl are classified as a light-dependent peroxidizing herbicides (LDPHs). The preliminary phototoxicity study with carfentrazone-ethyl showed a nearly 20-fold increase in toxicity when natural wavelength light was used (the intensity was low though). Standard EFED toxicity guideline studies (72 series) do not include light with the same wavelength or intensity as sunlight. LDPHs may be more toxic to animals exposed to natural light than guideline toxicity data conducted under relatively low-light conditions.

Terrestrial plant risk assessment could not be conducted due to lack of adequate data. Since sodium acifluorfen is an herbicide, an assumption is made that there is a risk to nontarget plants. The magnitude of this risk is unknown.

The potential impact to water quality from the use of sodium acifluorfen and its degradates also considers the herbicide lactofen. Lactofen and sodium acifluorfen have many of the same degradates or break-down products including acifluorfen and amino acifluorfen. The likelihood of water contamination by acifluorfen from uses of sodium acifluorfen or lactofen is high due to the low sorption of acifluorfen and it's long persistence under many conditions. The likelihood of water contamination from lactofen is low. Lactofen has a high binding potential. Thus, it will sorb to soil or sediment. Lactofen breaks down rapidly to form acifluorfen and other degradates.

The potential for acifluorfen to contaminate water is confirmed by monitoring studies that found acifluorfen residues in ground water and surface water. Generally, there was inadequate usage information to determine whether the detections resulted from the use of sodium acifluorfen or lactofen. The modeling used in this assessment relies upon several models (GENEECx, PRZM/EXAMS, and SCI-GROW). Modeled estimates of surface water concentrations for ecological effects were estimated in a standard farm pond and drinking water estimates used the Index Reservoir (IR) and Percent Crop Area (PCA) concepts. The groundwater screening model, SCI-GROW, was used for a Tier I ground water assessment. The model GENEECx was used for the rice to provide some information of possible exposure from rice uses, even though this version of the GENEEC model has yet to be accepted by the OPP.

Several conservative scenarios were considered for the drinking water exposures assessment for acifluorfen. These consisted of a sodium acifluorfen applied to soybeans in Mississippi and Georgia and acifluorfen converted from lactofen applied to cotton. The maximum 1-in-10 year peak acifluorfen concentration simulated in the Index Reservoirs (IR) adjusted by the percent crop area (PCA) was 14.03 µg/L. This occurred when sodium acifluorfen was applied twice at the maximum 0.25 lb ai/A to soybeans in Mississippi. The 1-in-10 year annual average Acifluorfen concentration simulated with the IRs with the PCAs was 2.97 µg/L from sodium Acifluorfen applied to soybeans in Mississippi. The simulated long term mean was 1.40 µg/L. Although, there is limited surface water monitoring data for acifluorfen, the maximum value reported in NAWQA is 2.2 µg/L. The estimated concentrations correspond reasonably well with the maximum concentrations seen in NAWQA monitoring data. The estimated acute, chronic and long term mean concentrations for estimating exposure from drinking water from surface and ground water sources are presented in the following table.

Estimated acifluorfen concentrations in drinking water[1] in Index Reservoir

Water Source	Concentration (µg/L)		
	Acute	Chronic	Long term annual
Surface Water	14.0	3.0	1.4
Ground Water	10.3	10.3	10.3

[1] PRZM/EXAMS estimated concentrations have been multiplied by percent crop area (PCA - 0.41).

Monitoring data demonstrates the potential for acifluorfen to contaminate ground water. Considerable variability was seen in the acifluorfen concentrations observed in the different monitoring studies. The highest concentrations observed in ground water were 46 µg/L in the prospective groundwater study, 0.19 µg/L in the NAWQA study, and 0.025 µg/L in the Pesticide Groundwater Data Base (PGWDB). The long term average acifluorfen concentration at the prospective study site was 7.33 µg/L.

The SCI-GROW estimate of groundwater concentration of acifluorfen depends upon the following inputs: $K_{oc,}$ aerobic soil metabolism half-life, the assumptions used concerning the formation of acifluorfen and lactofen decline, and the application rate and number of applications. The estimated acifluorfen concentrations ranged from 0.19 to 10.33 µg/L, depending upon K_{oc} (10 and 100), half-life ($T_{½}$ = 84 or 121 days), and application rate. SCI-GROW was also used to estimate the ground water concentration at the prospective groundwater study site. Using the same input values (K_{oc} = 10, $T_{½}$= 121 days) used to obtain the concentration of 10.33 μg/L except for the half life values and the inclusion the application rate used on the study site (0.75 lb ai/A). When compared to the long term average concentration (7.33 μg/L) the concentrations estimated by SCI-GROW (8.00 and 15.55 μg/L for $T_{½}$ = 84 and 121 days) were in good agreement with the monitoring results.

The environmental fate data for acifluorfen are limited. It probably is not adequate for more refined exposure assessments or mitigation. Fate data for lactofen show that it has a high binding potential and that it rapidly is transformed to acifluorfen. It is not clear whether bound lactofen can be degraded and released as acifluorfen. The ultimate fate of the acifluorfen degradation products in soil and water cannot be determined.

Both surfacewater and groundwater monitoring was limited. Major limitations associated with much of the monitoring data are the lack of detailed usage information and hydrology of the study area. Many of these limitations were reduced or eliminated in the small-scale prospective study. However, the prospective study was conducted at a highly vulnerable area in Wisconsin (*e.g.*, Central sands), thus groundwater contamination potential may be lower in the majority of the use area.

CHAPTER 2.
INTRODUCTION

MODE OF ACTION

Sodium acifluorfen is classified as a diphenyl ether (nitrophenyl ether) herbicide. This class of herbicide is a nontranslocated contact herbicide that enters through the leaves and acts as cell membrane destroyer. Compounds in this group result in rapid disruption of cell membranes and a very rapid kill. The diphenyl ethers penetrate into the cytoplasm, cause the formation of peroxides and free electrons (light is required) that destroy the cell membranes almost immediately. Rapid destruction of cell membranes prevents translocation to other regions of the plant.

The chemical name of sodium acifluorfen is sodium 5-[2-chloro-4-(trifluoromethyl)-phenoxy]-2-nitrobenzoate. The formulas for the following break-down products or degradates have been identified. Acifluorfen (5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-nitrobenzoic acid) is the first break-down product of sodium Acifluorfen. The primary degradate of acifluorfen under anaerobic conditions was the corresponding amine from the reduction of the nitro group (amino acifluorfen (5-[2-chloro-4-(trifluoromethyl) phenoxy]-2-aminobenzoic) acid). Other degradates include acifluorfen acetamide (5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-acetamidobenzoic acid) and desnitro acifluorfen (3-[2-chloro-4-(trifluoromethyl)phenoxy]-benzoic acid). The structures for sodium acifluorfen and the major break-down products and degradates are shown in Appendix A.

The following sodium acifluorfen formulations will be included in the Agency's reregistration risk assessment:

MANUFACTURING PRODUCT	
FORM NOT IDENTIFIED/SOLID	39.6000%
END USE PRODUCT	
LIQUID-READY TO USE	0.1200%

SOLUBLE CONCENTRATE/LIQUID 6.8000 to 21.4000%

Methods and Rates of Application:

Types of Treatment:

Band treatment; Directed spray; Low volume spray (concentrate); Spot soil treatment

Equipment:

Aircraft; Ground; Hand held sprayer

Timing:

At cracking; Early boot; Foliar; Late tillering; Postemergence; Postplant; Preemergence; When needed

USE CHARACTERIZATION

Sodium acifluorfen is used primarily as a post emergent herbicide to control a variety of weeds in soybeans, peanuts and rice and as a spot treatment on lawns. BASF says there is no residual herbicide activity at the current rates (0.125 to 0.375 lbs ai/A). The seasonal maximum is 0.50 lbs ai/A. Sodium acifluorfen is applied as a ground spray (broadcast and banded) and aerial spray. Typically it is applied with spray adjuvants (crop oil or ionic surfactant) for improved leaf cuticle penetration. Sodium acifluorfen is typically applied when weeds are small (< 4 " tall), when it is more effective at low rates. Sodium acifluorfen is used as part of a total weed management program. The largest markets in terms of total pounds of active ingredients are allocated to soybeans (93%- 7,257,000 acres), peanuts (4%- 307,000 acres), and rice (2%- 183,000 acres). Most of the usage is in Arkansas, Mississippi, Illinois, Missouri, Indiana, North Carolina, Virginia, Texas, and Alabama (see Appendix F). Use sites and maximum and typical use rates are given in the following table.

Application rates of sodium acifluorfen by crop.

Crop/Formulation	Maximum Rate lbs ai/A	Typical Rate per Season lbs ai/A	Maximum Rate per Season lbs ai/A
Peanuts	0.375	0.250	0.500
Soybeans	0.375	0.188	0.500
Rice	0.250	0.125	0.250
Lawns	Spot treatment	Spot treatment	Spot treatment

No more than two applications are recommended. If a repeat application is necessary, label directions for peanuts and soybeans require a 15-day interval. No interval was specified for rice.

Estimates of acifluorfen concentrations in water were developed for both sodium acifluorfen and lactofen uses. Lactofen has been included because sodium acifluorfen and lactofen have a number of common degradates including acifluorfen acid and amino acifluorfen.

The major uses for lactofen are cotton and soybeans. The maximum label (EPA Reg. No. 59639-34) rate is 0.40 lbs ai/A. The maximum rates at vulnerable sites were considered in exposure estimates for aquatic risk assessment is conducted, using PRZM/EXAMS models, by comparing Tier II water concentration estimates in a "standard" farm pond. The drinking water assessments used both monitoring and modeling results. The modeling for drinking water exposure estimates used OPP standard scenarios for Mississippi and Georgia soybeans and cotton (lactofen) and the corresponding index reservoir (IR) and percent crop area (PCA). Rice was evaluated with GENEECx estimates and the results of two rice use aquatic field dissipation study results.

Terrestrial risk assessment was conducted by comparing maximum Fletcher/Kenaga values to acute LC_{50}s and chronic No Observed Adverse Effect Concentration (NOAEC). Since chronic Levels of Concern (LOC) were exceeded for birds, the NOAECs were compared to the mean Fletcher/Kenaga residue values from a dissipation curve derived from the FATE model (Appendix B) to show the length of time the NOAEC was exceeded.

CHAPTER 3.

INTEGRATED ENVIRONMENTAL RISK CHARACTERIZATION

INTEGRATED OVERVIEW

The major risk associated with the use of sodium acifluorfen and lactofen (which degrades to acifluorfen) is the contamination of surface water and ground water by acifluorfen. The likelihood of water contamination by acifluorfen from sodium acifluorfen and lactofen (a primary degradate of lactofen is acifluorfen) is high due to the low sorption of acifluorfen and the persistence acifluorfen under many conditions. The degradate, amino acifluorfen, appears to be more persistent under anaerobic conditions. Aqueous photolysis appears to be an important degradation route when water is shallow and clear for light penetration. Although these characteristics suggest that acifluorfen residues can remain in terrestrial and aquatic environments when light cannot penetrate, risk quotients calculated from exposure to acifluorfen are not exceeded for acute levels of concern for terrestrial animals, freshwater and estuarine animals, or aquatic plants. Chronic risk is anticipated for insectivorous and herbivorous birds but not mammals.

Acifluorfen has been detected in both surface and ground water samples collected by the USGS in the National Water Quality Assessment (NAWQA) program. Surface water monitoring data for acifluorfen is limited to the NAWQA which reports a maximum detection of acifluorfen in surface water as 2.2 µg/L. The NAWQA study reports that 0.12 percent of samples collected from major aquifers and 0.04 percent for all ground water samples had detectable levels of acifluorfen (0.035 to 0.19 µg/L). Low concentrations (0.003 to 0.025 µg/L) were found in four of 1,185 wells sampled in other groundwater monitoring studies (as summarized in PGWDB; USEPA, 1992). None of these studies were specifically targeted for acifluorfen.

A small-scale prospective groundwater monitoring for acifluorfen was conducted in the Central Sands region of Wisconsin. Acifluorfen was detected in 56 out of 283 samples (20%) with concentrations ranging from 1 to 46 µg/L. The overall mean for the 56 detections was 8.36 µg/L. Due to multiple detections, an understanding of the site's hydrology, and known sodium acifluorfen use (targeted study), EFED is highly confident that acifluorfen residues can contaminate shallow ground water.

Based upon risk quotients for exposure to acifluorfen, acute levels of concern are not exceeded for terrestrial animals, freshwater and estuarine animals, or aquatic plants. Chronic risk is anticipated for herbivorous birds but not for mammals. No chronic risk is anticipated for freshwater and estuarine animals. Plant risk assessment could not be conducted due to lack of adequate data. Since sodium acifluorfen is an herbicide, an assumption is made that there is a risk for toxicity to nontarget plants. The magnitude of this risk is unknown.

KEY FATE AND TRANSPORT CONCLUSIONS

The fate data, although not very robust, is adequate to assess the fate of acifluorfen. Fate of the degradates is less clear. For this assessment, it will be assumed that acifluorfen acid and sodium acifluorfen are equivalent and acifluorfen will be used. “Sodium acifluorfen” will be used when discussing the registered products containing sodium acifluorfen as an active ingredient or acifluorfen, but not lactofen. “Acifluorfen” refers to the sodium salt of acifluorfen and the acid form of acifluorfen, which is a break-down product of both sodium acifluorfen and lactofen.

Parent sodium acifluorfen is stable to hydrolysis, and is extremely water soluble (2.50 X 10^5 mg/L at 20.0°C). Volatilization does not appear to be a significant dissipation pathway for acifluorfen (vapor pressure is 7.5 x 10^{-8} torrs, Henry's constant is 1.51 x 10^{-13} atm. m^3/mole). Acifluorfen is a relatively persistent chemical as the aerobic soil metabolism study demonstrates ($T_{½}$ = 108 - 200 days). In the aerobic aquatic study, acifluorfen was relatively stable, the half-life was estimated to be about 117 days. In anaerobic soils, acifluorfen shows fairly rapid degradation under those conditions giving a half-life of 30 days. In anaerobic aquatic systems, a half-life of 2.75 days was estimated. Amino acifluorfen was the primary degradate under anaerobic conditions was the corresponding amine from the reduction of the nitro group. Amino acifluorfen averaged 64 - 71% of the amount applied at 25 through 375 days. In this and in an additional experiment, samples were incubated under similar conditions for up to 375 days, the degradates, amino acifluorfen, acifluorfen acetamide, and desnitro acifluorfen were identified in the soil/water systems. Little formation of $^{14}CO_2$ was observed in this system. Thus, these degradates were formed but their fate is not clearly defined. Acifluorfen appears to be rather persistent under aerobic conditions. But under anaerobic conditions acifluorfen is transformed fairly rapidly from acifluorfen to amino acifluorfen, which can also be fairly persistent.

Sodium acifluorfen undergoes photolytic degradation in water with a half-life of between 21.7 hours and 352 hours with the different concentrations, pH, and buffer systems used. Data were insufficient to determine if any of these factors influenced the rate photolytic degradation. Thus in clear and/or shallow water that is able to transmit adequate light, acifluorfen should degrade rapidly in surface water bodies. In soils acifluorfen is more photolytically stable. Photodegradation on soil is not considered a major degradation route in the environment for acifluorfen.

The unaged batch equilibrium study gives a strong indication of the high mobility of parent acifluorfen. Acifluorfen has an acid dissociation constant (pK_a) of about 3.8; thus it is negatively charge when dissociated. Acifluorfen appears to be highly mobile (Freundlich K_{ads} values of 0.148-3.10 mL/g) on sand, sandy loam, loam, and clay soils,. The corresponding K_{oc} values ranged from 50.22 to 168.9 mL/g OC. Adsorption and desorption of acifluorfen were strongly correlated with soil clay content in permeable soils (*i.e.*, sands, loamy sands, sandy loam) and organic carbon content. Sorption is also influence by pH. The low K_{ads} indicate that acifluorfen will be in the runoff water rather than being bound to the eroded sediment.

The K_{ads} values for acifluorfen amine (amino acifluorfen) were 47.01, 19.34, 12.11, and 1.25 mL/g for loamy sand, loam, clay, and sand soil, respectively. K_{oc} values were 7368, 741, 652 and 431 mL/g OC for loamy sand, loam, clay, and sand soil, respectively. In McCall‘s relative mobility classification, acifluorfen amine is classified as “immobile” in loamy sand, “low mobility” in loam and clay, and “medium mobility” in sand. The mobility of the other degradates has not been characterized.

When acifluorfen reaches ground water the compound will be persist due to its stability to abiotic hydrolysis. Sodium acifluorfen may reach surface water from runoff events, or from discharge of acifluorfen coontaminated groundwater into surfacewateer. Acifluorfen should be persistent for extended periods of time, when photo-degradation is restricted. The compound could be a threat to nontarget plants if it moves off-site. Sodium acifluorfen would not be expected to bioaccumulate in fish because of the low K_{ow} value.

ESTIMATED DRINKING WATER CONCENTRATIONS

Environmental fate data and modeling results indicate acifluorfen's potential to contaminate ground water and surface water. This assessment relies upon several models (GENEECx, PRZM/EXAMS, and SCI-GROW). Modeled estimates of surface water concentrations for ecological effects were estimated in a standard farm pond and drinking water estimates utilized the Index Reservoir (IR) and Percent Crop Area (PCA) concepts. The groundscreening model, SCI-GROW, was used for a Tier I ground water assessment. Fate data and modeling suggests that acifluorfen derived from the degradation of lactofen also potentially can contaminate water. Drinking water estimates are discussed in the few paragraphs. Surface water concentrations for ecological exposure are presented later in this document.

Several conservative scenarios were considered for the drinking water exposures assessment for acifluorfen. These consisted of a sodium acifluorfen applied to soybeans in Mississippi and Georgia and acifluorfen converted from lactofen applied to cotton. The maximum 1-in-10 year peak acifluorfen concentration simulated in the Index Reservoirs (IR) adjusted by the percent crop area (PCA) was 14.03 µg/L which occurred when sodium acifluorfen was applied to soybeans in Mississippi. The 1-in-10 year annual average acifluorfen concentrations simulated with the IRs with the PCAs was 2.97 µg/L which occurred when sodium acifluorfen was applied to soybeans in Mississippi. The simulated long term mean was 1.40 µg/L. Although, there is limited surface water monitoring data for acifluorfen, the maximum value reported in NAWQA is 2.2 µg/L. The estimated concentrations correspond reasonably well with the maximum concentrations seen in NAWQA monitoring data. The estimated acute, chronic and long term mean concentrations for estimating exposure from drinking water from surface and ground water sources are presented in the following table.

Estimated acifluorfen concentrations in drinking water[1] in Index Reservoir, soybean scenario.

Water Source	Concentration (µg/L)		
	Acute Peak	Chronic Avg.	Long term annual
Surface Water	14.0	3.0	1.4
Ground Water	10.3	10.3	10.3

[1] PRZM/EXAMS estimated concentrations have been multiplied by percent crop area (PCA - 0.41).

The estimated concentrations correspond reasonably well with the maximum concentrations seen in NAWQA monitoring data. An acute concentration of 14.0 µg/L should be used to evaluate risk to human heath. Because of the mobility and persistence of acifluorfen in water, potentially "high" concentrations of acifluorfen exist in surface water bodies. Without specifically targeted monitoring data it is not possible to verify peak environmental concentration. For chronic health risk evaluation 3.0 µg/L should be used. The long-term average concentration for cancer is 1.4 µg/L. This value is based upon the 1-in-10 year average annual concentration calculated using PRZM and EXAMS, and is in agreement with the monitoring data.

The monitoring data demonstrates the potential for acifluorfen to contaminate ground water. Considerable variability was seen in the acifluorfen concentrations observed by monitoring. The highest concentrations observed in the prospective study were 46 µg/L, in the NAWQA study 0.19 µg/L, and in the PGWDB 0.025 µg/L. The long term average acifluorfen concentration at the prospective study site was 7.33 µg/L.

The SCI-GROW estimates of groundwater concentrations of acifluorfen depend upon inputs of K_{oc}, the aerobic soil metabolism half-life selected, the assumptions used concerning the formation of acifluorfen and lactofen decline, and the application rate and number. Since K_{oc} varies depending upon clay content, pH, and organic carbon content, two values (10 and

100) were considered. The estimated acifluorfen concentrations ranged from 0.19 to 10.33 µg/L, depending upon half-life, K_{oc} value used, application rate and number, and the conversion of lactofen to acifluorfen. It is recommended that 10.33 µg/L be used for the drinking water assessment. This represents the highest SCI-GROW estimates for acifluorfen assuming maximum seasonal application rate (0.5 lb ai/A). This value is recommended because using the K_{oc} of 10 and the same application rate of acifluorfen (0.75 lb ai/A) used in the Wisconsin prospective groundwater study, SCI-GROW's estimates of acifluorfen concentrations in ground water (8.00, 15.5 µg/L) were similar to the measured concentrations (7.33 µg/L). The application rate in the Wisconsin study (0.75 lbs ai/A) is higher than the application rates used in this Drinking Water Assessment (0.4 lb ai/A lactofen and 0.5 lb ai/A acifluorfen on soybean).

The Wisconsin prospective groundwater monitoring study was conducted in a highly vulnerable use area that does not typify the entire use area. However, the type of aquifer contaminated by acifluorfen in the prospective monitoring study is used for drinking water in Wisconsin. Thus, the potential exists for aquifers tapped by shallow drinking water wells to be contaminated by acifluorfen residues as high as 46 µg/L.

ISSUES UNCERTAINTIES

A number of acifluorfen degradates were identified in water during the laboratory studies; their persistence is not known. The amino acifluorfen has a greater binding potential in some soils than acifluorfen, but the mobility of the other degradates are not known. Aquatic degradation information for lactofen is lacking. This increases the uncertainty of our understanding of the fate of these compounds in surface water. Lactofen is not mobile or persistent. It is unlikely to leach to ground water. Lactofen's fate in an aquatic system (surface water) is less clear, since there are no data available. It is not persistent (in soil) and would have an affinity to bind to sediment rather than remain in solution. Whether bound lactofen will degrade to acifluorfen is not known.

CHARACTERIZATION OF RISK

Nontarget species environmental risk

Based upon risk quotients for exposure to acifluorfen, acute levels of concern are not exceeded for terrestrial animals, freshwater and estuarine animals, or aquatic plants. Chronic risk is anticipated for insectivorous and herbivorous birds but not for mammals. The uncertainty for the chronic risk to birds relates to the timing and exposure to potentially toxic residues levels. The major uses peanuts, soybean and rice are treated in the spring, when birds are likely to be breeding. Birds are not likely to consume vegetation once it begins to desiccate. However the treated crops, if emerged, would not be adversely affected by the pesticide at the time of application. Wildlife may find this vegetation attractive as a food source and therefore, would be exposed potentially chronic toxic residues. In the absence of foliar dissipation studies, the Agency has assumed a half life of 30 days in order to determine the duration of exposure to treated foliage. Another uncertainty is “when during their breeding period are the birds are most susceptible to Acifluorfen.”

No chronic risk is anticipated for freshwater and estuarine animals. A terrestrial plant risk assessment could not be conducted due to lack of adequate data. Since sodium acifluorfen is an herbicide, an assumption is made that there is a risk for toxicity to nontarget plants. The magnitude of this risk is unknown.

Endangered Species Conclusions

The Risk Quotients did not exceed the Levels of Concern for an endangered mammals, fish and aquatic invertebrates. The chronic avian NOAEC of 20 ppm is exceeded for the maximum and mean residues for short grass, long grass, and broadleaf plants. Therefore, there is a potential for chronic effects and endangered birds may be at risk. A full risk characterization for endangered arthropods or plants cannot be completed until all the data have been received.

The Endangered Species Protection Program is expected to become final in the future. Limitations in the use of acifluorfen will be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the U.S. Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.

CHAPTER 4.

ENVIRONMENTAL FATE ASSESSMENT

Parent sodium acifluorfen is stable to hydrolysis and is extremely water soluble (2.50 x 10^5 ppm at 20.0°C). Acifluorfen is a relatively persistent chemical as indicated by the aerobic soil metabolism study ($t_{½}$= 108 - 200 days). In the aerobic aquatic study, acifluorfen was relatively stable decreasing from 89% TAR at day 0 to 81.8% TAR at day 35. A half-life of 117 days was estimated. An anaerobic soil metabolism study shows fairly rapid degradation giving a half-life of 30 days. In an anaerobic aquatic metabolism study, a half-life of 2.75 days was determined. The primary degradate under anaerobic conditions was the corresponding amine from the reduction of the nitro group (amino acifluorfen (5-[2-chloro-4-(trifluoromethyl) phenoxy]-2-aminobenzoic) acid). Amino acifluorfen averaged 64 - 71% of the amount applied at 25 through 375 days. In this and in an additional experiment in which samples were incubated under similar conditions for up to 375 days, the degradates, amino acifluorfen (5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-aminobenzoic acid), acifluorfen acetamide (5-[2-chloro-4-(trifluoromethyl) phenoxy]-2-acetamidobenzoic acid), and desnitro acifluorfen (3-[2-chloro-4-(trifluoromethyl)phenoxy]-benzoic acid) were identified in the soil:water systems. Little formation of $^{14}CO_2$ was observed in this system.

Sodium acifluorfen undergoes photolytic degradation in water with a half-lives ranging from 21.7 hours to 352 hours depending on the pH and buffer systems used. In soils, acifluorfen is more photolytically stable. The DT_{50} for BAS 9048H in both irradiated and dark controls was significantly greater than 30 days (12 hour light/12 hr dark cycle). Photodegradation on soil is not a major degradation route in the environment.

The unaged batch equilibrium study gives a strong indication of the high mobility of parent acifluorfen. Acifluorfen on four soils (sand, sandy loam, loam, and clay soils), appears to be highly mobile with Freundlich K_{ads} values of 0.148-3.10. Adsorption and desorption were strongly correlated with soil clay content. Corresponding Koc values were 50.22, 73.52 56.96, 198.7 and 168.9. The percentage of acifluorfen amine absorbed was 92.7, 85.5, 79.2 and 28.7%TAR for loamy sand, loam, clay, and sand soil, respectively. R^2 values were 0.988, 0.999, 0.869, 0.999 and 0.951, respectively (1/n values were 0.936, 0.893, 0.869 and 0.802). K_{ads} values were 47.01, 19.34, 12.11, and 1.25 for loamy sand, loam, clay, and sand soil, respectively. K_{oc} values were 7368, 741, 652, and 431 for loamy sand, loam, clay, and sand soil, respectively.

In McCall‘s relative mobility classification, acifluorfen amine is classified as “immobile” in loamy sand, “low mobility” in loam and clay, and “medium mobility” in sand. However, due to the mobility characteristics of parent sodium acifluorfen and a number of ground water detections in Mississippi (1) and Virginia (3), five Small Scale Retrospective Ground Water Monitoring studies were reviewed by Agency. These studies indicate that parent sodium acifluorfen is persistent and mobile in permeable soils (*i.e.*, sands, loamy sands, and sandy loams) low in clay content. Overall, the reviewed ground water studies as well as an earlier reviewed prospective study indicate that under certain conditions residues are able to leach through the soil profile and reach ground water.

When sodium acifluorfen reaches ground water the compound will persist due to its stability to abiotic hydrolysis. During runoff events, sodium acifluorfen may reach surface waters from ground water where it also would persist for some time (unless there is some photodegradation; 3 to 4 day half-life). The compound could be a threat to nontarget plants if it moves off-site. Sodium acifluorfen would not be expected to bioaccumulate in fish because of the low K_{ow} value.

Please see appendix G for fate data summaries.

CHAPTER 5.

AQUATIC EXPOSURE AND RISK ASSESSMENT

TOXICITY TO FRESHWATER AQUATIC ANIMALS

Many of the studies on the effect of acifluorfen on aquatic animals were done under static conditions and nominal concentrations. The percent active ingredient of the technical product ranged from 39.8% to 43%. These studies will satisfy the data requirements for the following reasons:

1. The water solubility is approximately 250,000 ppm
2. It is stable to hydrolysis in the pH range of 4.5 to 9.7
3. The half life for photolysis in water in a bicarbonate buffer system was 98 to 352 hours

Because of these three factors, acifluorfen is not likely to degrade or precipitate during the acute studies. Please see Appendix D for detailed tables of toxicity data.

Acute and Chronic Toxicity to Freshwater Fish

Acifluorfen is categorized as slightly toxic to freshwater fish on an acute basis. The Bluegill sunfish LC_{50} is 31 ppm ai for the technical grade (MRID 071901) and the Rainbow trout LC_{50} is 17 ppm ai for a 25% formulation (MRID 122752).

Data were submitted (MRID 124222) for the freshwater Fish Early life stage using the Fathead minnow (*Pimephales promelas*). Reduced larval weight was reported at 1.5 ppm (the lowest level tested). The study is supplemental because no level below 1.5 ppm was used, therefore there was no NOEAC.

Acute and Chronic Toxicity to Freshwater Invertebrates

Acifluorfen is categorized as slightly toxic to freshwater invertebrates. The *Daphnia magna* LC_{50} is 28.1 ppm ai for the technical grade (MRID 071901) and is 77 ppm ai for a 25% a formulation (MRID 122754). No freshwater invertebrate life-cycle study is required for acifluorfen because 1) none of the criteria were exceeded except reproductive impairment in birds and 2) the 21-day PRZM/EXAMS value was less than 21 ppb ai, which is below 1/100 of the lowest LC_{50} of (28 ppm ai).

TOXICITY TO ESTUARINE AND MARINE ANIMALS

Acute and Chronic Toxicity to Estuarine and Marine Fish

Acifluorfen is categorized as slightly toxic to estuarine fish on an acute basis. The Sheepshead minnow LC_{50} is 39 ppm ai for the technical grade (MRID 122753). There are no data from estuarine and marine fish early life-stage or life-cycle studies. However, none are required, as discussed for freshwater invertebrates.

Acute Toxicity to Estuarine and Marine Invertebrates

Acifluorfen is categorized as slightly toxic to practically nontoxic to estuarine mollusks on an acute basis. The Eastern oyster LC_{50} is 74 ppm ai for the technical grade (MRID 111964).

Acifluorfen is categorized as practically nontoxic to crustaceans on an acute basis. The Grass shrimp LC_{50} is 446 ppm for the technical grade (MRID 111962). The Mysid LC_{50} is 3.8 ppm ai for a 25% formulation (MRID 122755). However, no freshwater invertebrate life cycle studies are required, as discussed for freshwater invertebrates.

TOXICITY TO AQUATIC PLANTS

The concentration of the doses was equivalent to the maximum label rate (355 μg/L), but caused no reduction in growth after 120 hours in the Tier I studies.

In the Tier II studies Duckweed, with an EC_{50} of 378 ppb, was the most sensitive aquatic vascular plant. Nonvascular aquatic plants were not sensitive to acifluorfen at maximum label rates.

AQUATIC EXPOSURE

Peanuts and Soybeans

Sodium acifluorfen EECs in aquatic environments are based on PRZM-EXAM. The current maximum rate is 0.375 lbs ai/A with a maximum seasonal rate of 0.5 lbs ai/A. The values provided below assume the worst case scenario of a single application at a rate of 0.50 lb ai/A, with 95% efficiency and 5% spray drift.

Acifluorfen concentration (µg/L) in standard pond using PRZM/EXAMS with input from peanuts and soybeans.

Peak	96 hr	21 day	60 day	90 day	Yearly Mean	20-year Mean	Standard Deviation	Upper CI at 90%
21.11	21.00	20.69	19.55	18.56	11.53	6.72	3.22	8.05

Rice

Rice EECs were developed using a modified GENEEC model, GENEECx. This model has not been fully validated and provides only a rough approximation of EEC from use in rice cultivation. The current maximum rate is 0.250 lbs ai/A with a maximum seasonal rate of 0.25 lbs ai/A.

Sodium acifluorfen expected environmental concentrations (ppb) in rice

Application Rate	Maximum	4-Day Average	21-Day Average	56-Day Average
0.250 lbs/Acre	26.60	24.47	15.96	8.24

RISK TO AQUATIC ANIMALS

Risk Characterization for Freshwater Fish

Comparing the Rainbow trout LC_{50} of 17 ppm to the peak EEC for soy beans and peanuts (21 ppb) the RQ (EEC ÷ LC50) is less than 0.01. The RQ for rice is less than 0.01. No acute LOCs were exceeded for freshwater fish.

A definitive quantitative chronic risk assessment cannot be conducted, because a NOAEC was not established in the Fathead minnow early life stage study. However, there does not appear to be a chronic risk to freshwater fish. The lowest level tested (1.5 ppm) resulted in reduced larval weight. A comparison of the 60-day average EEC for Soy beans and peanuts (approximately 20 ppb) and the 56-day average EEC for rice (approximately 8 ppb) to the lowest level tested (1.5 ppm) does not result in a chronic risk excedence. Although the likelihood that levels equal to the average EEC or even peak EECs would cause larval weight reduction is assumed to be slight, some concern remains because of the effects seen in a fish early life study on carfentrazone-ethyl. Sodium acifluorfen and carfentrazone-ethyl are classified as a light-dependent peroxidizing herbicides (LDPHs).

The preliminary phototoxicity study with carfentrazone-ethyl showed a nearly 20-fold increase in toxicity when natural wavelength light was used (the intensity was low though). Standard EFED toxicity guideline studies (72 series) do not include light with the same wavelength or intensity as sunlight. LDPHs may be more toxic to animals exposed to natural light than guideline toxicity data conducted under relatively low-light conditions.

Risk Characterization for Freshwater Invertebrates

Comparing the *Daphnia magna* EC_{50} of 28 ppm to the peak EEC for soy beans and peanuts (21 ppb) the RQ (EEC ÷ LC50) is less than 0.01. Based on a peak EEC of 26 ppb, the RQ for rice is less than 0.01. No acute LOCs were exceeded for freshwater invertebrates.

Risk Characterization for Estuarine and Marine Fish

Comparing the Sheepshead minnow LC_{50} of 39 ppm to the peak EEC for soy beans and peanuts (21 ppb) the RQ (EEC ÷ LC50) is less than 0.01. Based on a peak EEC of 26 ppb, the RQ for rice is less than 0.01. No acute LOCs were exceeded for estuarine fish.

There were no chronic data for estuarine and marine fish. The data will not be required because the acute RQ is less than 0.01.

Risk Characterization for Estuarine and Marine Invertebrates

Comparing the Mysid shrimp EC_{50} of 3.8 ppm to the peak EEC for soy beans and peanuts (21 ppb) the RQ (EEC ÷ LC50) is less than 0.01. Based on a peak EEC of 26 ppb, the RQ for rice is less than 0.01. No acute LOCs were exceeded for estuarine invertebrates.

There were no chronic data for estuarine invertebrates. The data will not be required because the acute RQ is less than 0.01.

Risk Characterization for Aquatic Plants

Comparing the vascular aquatic plant EC_{50} of 180 ppb and the green algae EC_{50} (>265 ppb) to the peak Tier II EEC for soy beans and peanuts (21 ppb), the RQ (EEC ÷ LC50) is less than 1.0. Based on a peak EEC of 26 ppb, the RQ for rice is less than 1.0. No acute LOCs were exceeded for aquatic plants.

CHAPTER 6.

WATER RESOURCES ASSESSMENT

A drinking water exposure assessment for sodium acifluorfen, lactofen and acifluorfen derived from lactofen was previously conducted by the Agency (D239268 - 6/1/98; Appendix J). Additional fate studies and ground and surface water monitoring have become available since the earlier assessment and the Index Reservoir (IR) and Percent Crop Area (PCA) have been implemented.

The water resource assessment presented here has been updated since the earlier assessment to incorporate the additional information. The environmental fate parameters used in this assessment are the same that were used in the earlier assessment (which followed Agency Guidance (4/22/97) at the time) for aerobic soil metabolism (121 d) and aqueous photolysis (3.8 d) half-lives, and sorption coefficients (K_{ads} = 1). Additional information has been considered. Following current Agency guidance (7/15/99) and considering the additional information, the following values would be used for aerobic soil metabolism (158 d), aqueous photolysis (11.2 d), and sorption (2.22 mL/g). Using the input values following current guidelines would result in greater EECs and estimates of drinking water concentrations (EDWCs).

The input parameters for PRZM and EXAMS are present in the table below. The scenarios are defined and chemical and water body input files for PRZM and EXAMS are included in Appendix L. EECs have not been recalculated because health concerns have been raised by HED for drinking water using earlier input guidance.

Chemical properties and environmental fate characteristics indicate that acifluorfen has the potential to leach to ground water and to enter surface water via leaching and run off.

Acifluorfen is highly soluble, persistent under aerobic conditions (soil metabolism $T_{½}$ - 108 to 200 days; aquatic metabolism $T_{½}$ - 117 days; stable to hydrolysis; soil photolysis $T_{½}$ - 57 days, volatilization is not significant - Henry's constant 1.51×10^{-13} atm. m^3/mole). Acifluorfen is also very mobile, K_{ads} range from 0.1 to 5.33mL/g. Aqueous photolysis maybe a means of acifluorfen degradation in surface water as the aqueous photolysis $T_{½}$ is less than 15 days.

The anaerobic soil metabolism ($T_{½}$ - 30 days) and the anaerobic aquatic metabolism ($T_{½}$ - 2.75 days) study show that acifluorfen is rapidly reduced to amino acifluorfen. In an aquatic use study (rice) the DT_{50} of acifluorfen was calculated to be 284 days in sediment.

Monitoring studies have confirmed the presence of acifluorfen in ground and surface water. The degradates such as amino acifluorfen and desnitroacifluorfen may also have some potential to contaminate ground and surface water but are generally not included in monitoring studies. Lactofen is not expected to leach to ground water because of its high binding potential and rapid degradation.

Environmental fate properties suggest that once acifluorfen reaches ground water it can be quite persistent. Monitoring data from a prospective groundwater study confirm the persistence in ground water. Acifluorfen can also be persistent in surface water due to a long aerobic aquatic metabolism half-life and its stability to hydrolysis, unless aqueous photolysis occurs. Aqueous photo-degradation may be an important degradation process for acifluorfen in surface water, but in not ground water. The rice study demonstrated the rapid decline in shallow water (4 inches). However, when light penetration is restricted (*e.g.*, non-clear water, deep) photolysis may not be important. The anaerobic soil metabolism and aquatic metabolism study shows that acifluorfen is rapidly reduced to amino acifluorfen. But the remaining amino acifluorfen degrades slowly. Lactofen that enters surface water in solution is not expected to be persistent because of rapid soil metabolism and hydrolysis. It is assumed that, in an aquatic environment, lactofen will be degraded to acifluorfen.

Selected acifluorfen environmental fate properties and model inputs used in PRZM/EXAMS

Acifluorfen Property	Fate Data	Model Input Calculations	Model Input Value	Source
Solubility (ppm)	2.50E+05		2.50 E+05	EFED One-liner
Molecular Weight	383.70		383.70	EFED One-liner
Hydrolysis (days)	stable at pH 5,7,9		considered stable	EFED One-liner
Henry's Constant (atm.m^3/mol)	1.51E-13 (calculated)		1.51 E-13	EFED One-liner
Photolysis half-life (days)	Water: 3.8 Soil: 57 @pH4		0.0075/hr	EFED One-liner
Aerobic Soil Metabolism half-life (days)	30, 60 - 180, 170, 59, 6 (60 and 180 were used to cover the range 60 - 180)	upper 90%=mean + t90 x std/√n; single tail student t, á=0.1 and n = number of samples	121 (5.7E-03/d)	EFED One-liner
Anaerobic Soil Metabolism half-life (days)	<28 days	multiply value by 3	84 (8.3E-04/d)	EFED One-liner
Aerobic Aquatic half-life (days)	98%-day 0, 82%-day 35: half-life estimated to be 117 days	multiple value by 3	351 (8.23E-05/hr)	EFED One-liner
Anaerobic Aquatic half-life (days)	no data	estimate by multiplying anaerobic soil half-life by 6 (28 x 3 x 2)	168 (1.72E-04/hr)	EFED One-liner
Soil Water Partition (Kd)mL/g	1		1 (assume OC=1%) K_{oc} = 100	EFED One-liner

PERSISTENCE

Acifluorfen is quite persistent as aerobic soil metabolism half-lives ranged from 100 to 200 days. Several incomplete or unacceptable aerobic metabolism studies reported somewhat shorter half-lives of 30 to 60 days. This suggests the possibility that degradation rates for other soils may be more rapid than the soils tested, but there not enough information to confirm this. Acifluorfen is the major residue under aerobic conditions (declining to 43% TRR (total radioactive residues) at 6 months). Amino acifluorfen and desnitroacifluorfen were minor metabolites that accounted for 2.4 to 3.1% TRR, respectively at six months. A number of unidentified bound materials also were present. Acifluorfen is stable to hydrolysis. The photolysis half-lives ranged from 0.9 to 14.7 days in water and was 57 days on soil. Volatilization also does not appear to be an significant dissipation pathway for acifluorfen (vapor pressure is 7.5×10^{-8} torrs, Henry's constant is 1.51×10^{-13} atm. m^3/mole). Aerobic metabolism may be one of the degradation processes occurring in aerobic soil conditions but it is rather slow.

In the aerobic aquatic study, acifluorfen was relatively stable, the half-life was estimated to be 117 days. An anaerobic soil metabolism study shows more rapid degradation with a half-life of 30 days. In an anaerobic aquatic metabolism study, a half-life of 2.75 days was determined. The primary degradate under anaerobic conditions was the corresponding amine from the reduction of the nitro group (amino acifluorfen). Amino acifluorfen averaged 64 - 71% of the amount applied at 25 through 375 days. In this and in an additional experiment in which samples were incubated under similar conditions for up to 375 days, the degradates, amino acifluorfen, acifluorfen acetamide, and desnitro acifluorfen were identified in the soil/water systems. Little formation of $^{14}CO_2$ was observed in this system. Data is not adequate to evaluate the fate of the degradates in the water.

MOBILITY

Acifluorfen is very soluble in water (2.5×10^5 mg/L) and also is highly mobile in many mineral soils. Understanding why acifluorfen is mobile or under what conditions it is the most mobile may be beneficial in developing mitigation strategies. Acifluorfen contains a carboxylic acid group with a pKa of 2.5 to 3.5 (acid dissociation constant). Thus, acifluorfen exists in the dissociated anion form in most agricultural soils since the pH of these soils usually exceeds the pKa of the acid (Celi *et al.*, 1997). For sodium-acifluorfen the Na^+ will dissociate resulting in negatively charged acifluorfen. Negatively charged sorption sites, such as clays, are therefore expected to have little contribution to the adsorption process. The adsorption/desorption of acifluorfen is dependent upon pH, organic carbon content, and ammonium oxalate extractable iron content of the soil (positively charged) but not clay content (Celi, *et al.*, 1996). Freundlich adsorption isotherms (K_{ads}) are generally quite low for mineral soils, ranging from about 0.1 to 5.33 and an average of about 1.8 mL/g of carbon (Locke *et al.*, 1997; Suter, 1993). The K_{oc}s ranged from about 50 to 200 mL/gC. The slope, or 1/n term of the Freundlich isotherm range is less than one, ranging between 0.75 and 0.89.

Thus the potential for acifluorfen to sorb is highly variable depending upon the soil mineralogy, organic carbon content, and pH of the soil conditions where it is used.

The K_{ads} values for amino acifluorfen were 47.01, 19.34, 12.11, and 1.25 for loamy sand, loam, clay, and sand soils, respectively (1/n values ranged from 0.802 to 0.936). K_{oc} values were 7368, 741, 652, and 431 for loamy sand, loam, clay, and sand soils, respectively. In McCall‘s relative mobility classification, amino acifluorfen is classified "immobile" in loamy sand, "low mobility" in loam and clay, and "medium mobility" in sand. Thus the potential for amino acifluorfen to sorb is also highly variable depending upon the soil conditions where it is used.

In addition to being a registered herbicide, acifluorfen is also the primary degradate of the herbicide lactofen (SN 128888). Lactofen is not persistent with aerobic soil metabolism half-lives ($T_{½}$) between 1 and 3 days. The primary degradate of lactofen is acifluorfen. Acifluorfen accounted for approximately 52 percent of the applied lactofen seven days after application in an aerobic metabolism soil study. A second degradate (PPG-947 desethyl lactofen) accounted for 16.2 percent of applied lactofen one day after application in an aerobic metabolism soil study. Amino acifluorfen also was identified, but not quantified. Lactofen appears to be susceptible to hydrolysis, as the half-lives for pH 5, 7, and 9 were 10.7, 4.6, and <1.0 days (@40°C), respectively. Although, hydrolysis may actually proceed with lower rates when temperatures (of less than 40°C) better reflect environmental temperatures. Lactofen's solubility (0.94 mg/L) is low and is not mobile (K_{oc} = 6,600 to 15,000), but eroded soil with lactofen bound to soil particles may be transported to surface water.

WATER EXPOSURE ASSESSMENT APPROACH

Chemical properties, environmental fate characteristics and available monitoring data indicate that acifluorfen has the potential to leach to ground water and to enter surface water via leaching and run off. The water assessment includes monitoring data and modeling to estimate acifluorfen concentrations, from both the application of acifluorfen and lactofen, in both surface and ground water. Surface water bodies were simulated using PRZM and EXAMS to represent a small farm pond for ecological exposure and the Index Reservoir (IR) with percent crop treated (PCA) for drinking water assessment. The groundscreening model, SCI-GROW, was used for a Tier I ground water assessment. The models and scenarios are briefly discussed below. The selection of model input parameters generally followed EFED guidance (although previous guidance was used for several fate properties) for input selection. Current guidance results in longer estimated half-lives than would result in higher concentrations. Scenarios included the application of sodium acifluorfen to soybeans in Georgia and Mississippi and lactofen applied to cotton and converted to acifluorfen (52% conversion). For example, if lactofen was applied at the rate of 0.25 lb ai/A, acifluorfen would be simulated by applying acifluorfen 3 days following the lactofen application at the rate of 0.13 lb ai/A (0.25 lb ai/A * 0.523). It was assumed that there would be no spray drift.

DRINKING WATER EXPOSURE

Overview:

Based on the chemical and fate properties, existing monitoring data, and computer modeled simulated estimates of acifluorfen contamination of drinking water supplies resulting from normal agricultural practices have been determined. The peak acifluorfen concentrations simulated for the Index Reservoirs (IR) adjusted by the percent crop area (PCA) were 4.9 and 14.0 µg/L from lactofen applied to cotton and for sodium acifluorfen applied to soybeans in Mississippi, respectively. The peak values presented represent approximately the 90% exceedence values. Since only 20-years of data were available for Mississippi, the confidence is lower. The 1-in-10 year average acifluorfen concentrations simulated with PRZM and EXAMS for the IRs with the PCAs were 0.99 and 2.97µg/L from lactofen applied (degrades to acifluorfen) to cotton and for acifluorfen applied to soybeans in Mississippi, respectively. The long term average (multiple years) simulated with PRZM and EXAMS with the PCAs were 0.34 and 1.40 µg/L from lactofen applied (degrades to acifluorfen) to cotton and for acifluorfen applied to soybeans in Mississippi, respectively

There is limited number of detections (0.12% of 3408 samples from 1058 sites) surface water monitoring data for acifluorfen, the maximum value reported in NAWQA is 2.2 µg/L. The estimated values from PRZM/EXAMS correspond reasonably well with the maximum concentration seen in NAWQA monitoring data. Because of the high mobility and long persistence of acifluorfen in water, potentially "high" concentrations of acifluorfen may exist in surface water bodies. Without specifically targeted monitoring data it is not possible to determine peak environmental concentration. Therefore, the drinking water originating in surface water sources, an acute concentration of 14.0 µg/L should be used to evaluate risk to human heath. For chronic health risk evaluation 2.97 µg/L should be used. This value is based upon the 1-in-10 year average annual concentration calculated using PRZM/EXAMS, and agrees with the monitoring data. The multi-year mean for acifluorfen of 1.40 µg/L should be used for cancer risk evaluation.

The monitoring data demonstrates the potential for acifluorfen to contaminate ground water. Considerable variability was seen in the acifluorfen concentrations observed by monitoring. The highest concentrations observed in the prospective study were of 46 µg/L. It was 0.19μg/L (0.04% of 2604 samples) in the NAWQA study and in the PGWDB it was 0.025 µg/L. The long term average acifluorfen concentration at the prospective study site was 7.33 µg/L.

The SCI-GROW estimates of groundwater concentrations of acifluorfen depend upon inputs of $K_{oc,}$ the aerobic soil metabolism half-life selected, the assumptions used concerning the formation of acifluorfen and lactofen decline, and the application rate and number. The sorption of acifluorfen is influence by clay content, organic carbon content, and pH. Because of this K_{oc}s can be quite variable. Two values were considered, 10 and 100. The estimated acifluorfen concentrations ranged from 0.19 to 10.33 µg/L, depending upon half-life, K_{oc} value selected, the application rate and number, and for lactofen, the conversion rate of lactofen to acifluorfen. It is recommended that 10.33 µg/L be used for the drinking water assessment.

Since lactofen has a 52.3 percent conversion rate,, the concentration of acifluorfen would be 5.4 µg/L. This represents the highest SCI-GROW estimates for acifluorfen assuming the maximum possible sodium acifluorfen application per season and a K_{oc} of 10 and a half-life of 121 days. This value is recommended because using the same fate properties (K_{oc}=10) and the application rate of acifluorfen (0.75 lb ai/A) used in the Wisconsin prospective groundwater study, SCI-GROW's estimates of acifluorfen concentrations in ground water (8.00, 15.5 µg/L with 84 and 121 day half-life, respectively) were similar to the measured concentrations (7.33 µg/L). The application rate in the Wisconsin study (0.75 lbs ai/A) is higher than the application rates used in this Drinking Water Assessment (0.4 lb ai/A lactofen and 0.5 lb ai/A acifluorfen on soybean).

The Wisconsin prospective groundwater monitoring study was conducted in a highly vulnerable use area that does not typify the entire use area. However, the type of aquifer contaminated by acifluorfen in the prospective monitoring study is used for drinking water in Wisconsin. Thus, the potential exists for aquifers tapped by shallow drinking water wells to be contaminated by acifluorfen residues as high as 46 µg/L.

Monitoring

Acifluorfen has been detected in surface water and ground water. Degradates of acifluorfen (amino acifluorfen and desnitroacifluorfen) have generally not been included in monitoring studies. Lactofen is not routinely included in water monitoring studies due to its short half-life and low mobility. There have been no reported detections of lactofen in surface or ground water. The registrant of lactofen sponsored a small-scale, prospective groundwater monitoring study for lactofen in Ohio. The study was inconclusive because the study did not provide confirmation that leaching actually occurred at the site. Currently the registrant is conducting a second small-scale prospective groundwater monitoring study. The first progress report had been submitted, but lactofen and acifluorfen residue data have not been submitted to the Agency.

Acifluorfen has been detected in both surface and ground water samples collected by the USGS in the National Water Quality Assessment (NAWQA) program. The USGS NAWQA study reports 0.12 percent of samples collected from major aquifers had detectable levels of acifluorfen. The maximum detected level was of 0.19 µg/L. Acifluorfen was detected (in a range of 0.035 to 0.19 µg/L) in 0.04 percent of all ground water samples collected byNAWQA. The study's goal was to assess water quality in general and did not specially search for lactofen and acifluorfen. The only surface water monitoring data available is that collected by NAWQA. The maximum level of acifluorfen detected in surface water was 2.2 µg/L.

Acifluorfen residues in ground water were reported in the Pesticides in Ground Water Data Base, PGWDB (USEPA, 1992), a summary of other groundwater monitoring studies. The PGWDB (USEPA, 1992) reports four of 1185 wells sampled with concentrations ranging from 0.003 to 0.025 µg/L. Because the studies summarized in the PGWDB were conducted with many objectives and study designs, the results may reflect conditions where no lactofen or acifluorfen had been used or where there is a low susceptibility to ground water contamination. Therefore, EFED has low confidence that the monitoring reflects the potential contamination of ground water from acifluorfen.

A small-scale prospective groundwater monitoring study was conducted for sodium acifluorfen in a vulnerable area of Wisconsin. Acifluorfen was detected in 56 out of 283 samples (20%) with concentrations ranging from 1 to 46 µg/L. The study duration was from 4/20/88 to 4/12/89 and acifluorfen detections occurred from 9/14/88 through 4/12/89 (final sampling). The average concentration for the five detections on 4/12/89, the last sampling time, was 15.2 µg/L. The overall mean for the 56 detections was 8.36 µg/L. The (long term) average of the 10 sampling dates during this period was 7.33 µg/L. The registrant also conducted a retrospective monitoring study. Residues from shallow soil samples from five monitoring wells were analyzed. No acifluorfen was detected in the wells sampled in the retrospective monitoring study.

The highest levels were from the small-scale prospective groundwater study which was conducted in a vulnerable area with maximum use rates. Thus the prospective study was a targeted study (use was known). This study provided information with the highest degree of confidence, because the hydrology and acifluorfen use were known (*e.g.,* the detection came from a known use). What is not as well known is how this site compares to other use sites. Although the EPA is confident that the prospective study was conducted at a vulnerable site, the other monitoring studies were not specifically conducted for acifluorfen (excluding the retrospective study). Some sampling or study sites were probably in vulnerable areas, but the relationship between acifluorfen use and the monitoring sites, sampling dates, and so on are not well known (or not known). Use rates were not known.

Ground Water Modeling

Tier I modeling for ground water used the SCI-GROW model to estimate potential ground water concentrations for acifluorfen and acifluorfen as a degradate lactofen under hydrologically vulnerable conditions. SCI-GROW (Screening Concentration in Ground Water) is screening model developed in OPP (Barrett, 1997) to estimate pesticide concentrations under hydrologically vulnerable conditions.

There is greater uncertainty associated with the ground water acifluorfen concentrations predicted by SCI-GROW, because of the uncertainty of the K_{oc} and K_{ads} value and since acifluorfen is an anion (negative charge) sorption is influenced by pH and clay and mineral type and organic carbon content.

A number of examples of estimated acifluorfen concentrations with different fate parameters are provided in the table below. Two half-life values were used, the mean and the upper 90th percent value of the aerobic soil metabolism half-life. The concentrations predicted assuming 100 percent conversion from lactofen to acifluorfen is presented as an "upper bound," because the rate of acifluorfen formation is not known (or considered). So the SCI-GROW requires K_{oc} rather than K_d, a K_{oc} of 100 was used. Since K_d may decrease with increasing pH, the specific value of K_d or K_{oc} would depend upon site characteristics. When a K_{oc} of 10, an application rate of 0.75 lb ai/A for sodium acifluorfen (rate used in the Wisconsin prospective study), and half-lives of 84 and 121 days, concentrations of 8.0 and 15.5 µg/L, respectively, were estimated by SCI-GROW. These values are similar to the mean concentration observed in the Wisconsin prospective ground water study. If the Wisconsin application rate for acifluorfen, a K_{oc} of 100, and half-lives of 84 or 121 days were used, the estimated SCI-GROW concentrations would be 0.84 and 1.34 µg/L. Thus SCI-GROW underestimates the concentrations observed in the Wisconsin prospective groundwater study

Estimated ground water concentrations for acifluorfen using SCI-GROW with different assumptions concerning fate parameters and application rate (or % of lactofen converted to acifluorfen.

Application (lb ai/A)	Half-life (days)	K_{oc} (assume OC=1%)	Concentration (µg/L)
0.17[1]	84	100 (K_d = 1)	0.19
0.17	121	100 (K_d = 1)	0.30
0.17	84	10 (K_d = 0.1)	1.81
0.17	121	10 (K_d = 0.1)	3.51
0.40[2]	84	10 (K_d = 0.1)	4.26
0.40	121	100 (K_d = 1)	0.71
0.40	84	10 (K_d = 0.1)	8.27
0.40	121	100 (K_d = 1)	0.45
0.50[3]	84	10 (K_d = 0.1)	5.33
0.50	121	10 (K_d = 0.1)	10.33
0.50	84	100 (K_d = 1)	0.56
0.50	121	100 (K_d = 1)	0.89

[1] Application rate reflects conversion from 0.4 lb ai/A to 0.32 lb ai/A for banding, and multiplied by 0.523 (proportion of Acifluorfen/applied lactofen).

[2] Maximum lactofen rate (and amount) on cotton, assume 100 percent conversion to Acifluorfen.

[3] Maximum Acifluorfen application (and amount) allowed per season for Acifluorfen on soybeans.

The concentration of acifluorfen in ground water as simulated by SCI-GROW depends upon the input parameters. The table shows the result of changing the K_{oc} and aerobic soil metabolism half-life values used can dramatically influence the estimated concentrations. SCI-GROW underestimates the Acifluorfen concentrations seen at the prospective groundwater monitoring site in Wisconsin when making normal assumptions about the fate properties selected.

Surface Water Resources

Acifluorfen has a potential to contaminate through run-off and ground water discharge to surface water bodies. Because acifluorfen does not readily bind to sediment and degrades by hydrolysis and degrades slowly by microbial activity, aquatic photolysis appears to be a major route of dissipation of acifluorfen in surface water. Thus, acifluorfen may persist where light penetration is limited. Environmental factors such as soil temperature and soil water content influences soil microbial activity and thus, may influence acifluorfen's degradation rate in soil and possibly in water.

Surface Water Modeling

PRZM and EXAMS models were used to provide additional estimates of potential surface water concentrations for acifluorfen used on soybeans and from lactofen converted to acifluorfen on cotton and soybeans. Standard scenarios and guidance modeling input parameters that were developed by OPP (4/22/97) were used. Input parameters for each PRZM simulation, with the input files, and descriptions of scenarios modeled for Acifluorfen can be found in Appendix L. Soil, cropping and management inputs were obtained from local agricultural personnel or from the PIC (PRZM Input Collator) data base. EXAMS environmental inputs were taken from the Georgia Pond scenario (for ecological exposure) and the Index Reservoirs for the Loring Silt Loam in Yazoo County, Mississippi for cotton and soybeans and the Lynchburg loamy sand in Georgia for soybeans (for drinking water exposure). The concentrations predicted in the Index Reservoir by PRZM/EXAMS are then multiplied by the percent crop area for each crop. The maximum percent (as a decimal fraction) crop area (PCA) that have been developed by OPP are 0.41 for soybeans and 0.20 for cotton. The estimated acifluorfen concentrations for the different scenarios are summarized in the following table.

Estimated environmental concentrations (ecological exposure and drinking water) for acifluorfen on cotton (degradate of lactofen) and acifluorfen on soybeans with PRZM/EXAMS and index reservoir concentrations adjusted for maximum percent crop areas (PCA).

		Surface Water Acifluorfen Concentration (µg/L)		
Crop (chemical)	Water Body	1-in-10 year Maximum	1-in-10 year Average	Multi-Year Average
Cotton (lactofen)	Pond	11.29[1]	5.68[1]	3.21[1]
Cotton (lactofen)	Index Reservoir	24.60 [4.92][2]	4.93 [0.99][2]	1.72 [0.34][2]
Soybean (Acifluorfen)	Pond (MS)	21.11[1]	11.53[1]	6.72[1]
Soybean (Acifluorfen)	Index Reservoir (MS)	34.21 [14.03][3]	7.24 [2.97][3]	3.41 [1.40][3]
Soybean (Acifluorfen)	Pond (GA)	9.76[1]	5.34[1]	3.33[1]
Soybean (Acifluorfen)	Index Reservoir (GA)	18.40 [7.54][3]	4.19[1.72][3]	2.48 [1.02][3]

[1] Estimated Environmental Concentrations for ecological exposure assessments.

[2] Estimated Drinking Water Concentration (EDWC) Unadjusted and [Adjusted] for PCA of 0.20.

[3] Estimated Drinking Water Concentration (EDWC) Unadjusted and [Adjusted] for PCA of 0.41.

Several acifluorfen degradates were identified in water; but the persistence is not known. Aquatic degradation information for lactofen is lacking. This increases the uncertainty of our understanding of the fate of these compounds in surface water. Lactofen is not mobile or persistent. It is unlikely to leach to ground water. Lactofen's fate in an aquatic system (surface water) is less clear, but it is not persistent in soil and would have an affinity to bind to sediment rather than remain in solution. Whether bound lactofen will degrade to acifluorfen is not known.

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CHAPTER 7.

TERRESTRIAL EXPOSURE AND RISK

TOXICITY TO TERRESTRIAL ANIMALS

Please see Appendix D for detailed tables of toxicity data.

Acute, Sub-Acute, and Chronic Toxicity in Birds

Acifluorfen is moderately to practically nontoxic to avian species on an acute oral basis. The Mallard duck's LD_{50} (MRID 083059) was 4,187 mg/kg. The Bobwhite quail LD_{50} (MRID 122747) was 325 mg/kg.

Four subacute dietary studies found that acifluorfen is practically nontoxic to the Bobwhite quail (MRID 083059) and to the Mallard duck (MRID 083060 and MRID 122749). The LC_{50} ranged from >5620 to >10,000 ppm without mortality.

The Bobwhite quail's NOAEC was 20 ppm (MRID 107491) and its LOAEC was 100 ppm based on a reduced number of viable embryos. The Mallard duck's NOAEC was >100 ppm (the highest dose level tested). An LOAEC was not determined (MRID 107492).

Acute and Chronic Toxicity to Mammals

Wild mammal testing was not done for acifluorfen. Studies done on laboratory rats were substituted. An acute oral study found an LD_{50} of 1540 mg/kg (MRID 071887), which classifies acifluorfen as slightly toxic to rats.

A rat reproductive study found a NOAEC of >2,500 ppm (MRID 155548) with no reproductive effects. In a rat developmental study (MRID 0122743) the NOAEC was 20 mg/kg/day (400 ppm) based on decreased fetal body weight.

Toxicity to Insects

There are no data for the honey bee acute contact study. The study is required, because of wide spread use and possible drift to off site vegetation in bloom.

Toxicity to Terrestrial Plants

The data for toxicity (MRID 4168907-01) to nontarget terrestrial plants were not found to be scientifically sound, because the acifluorfen solution applied to the experimental plants was too dilute and the water may have washed the chemical away from the plant. This caused uncertainty about the exposure. These studies must be repeated.

EXPOSURE

Predicted maximum and mean residues are based on a per lb ai/A application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher, *et al.* (1994). No monitoring data were used in the development of terrestrial EECs. The labeling permits maximum single application rates of 0.25 to 0.375 lbs ai/A and up to two 0.25 lb ai/A applications per season for a total of 0.5 lb ai/A. The following table depicts the maximum and mean residues immediately upon the second of two 0.25 lbs ai/A applications. The values in this table assume no dilution due to the growth of the plants or degradation of the chemical.

Estimated Environmental Concentrations (EECs) on avian and mammalian food items (ppm) immediately following the second of two applications of 0.25 lb ai/A.

Food Items	EEC (ppm) Predicted Maximum Residue	EEC (ppm) Predicted Mean Residue
Short grass	120	43
Tall grass	55	18
Broadleaf plants / Insects[1]	68	23
Seeds	8	4

[1] The surface to volume ratios of broadleaf plants and insects are similar, therefore, the residues may be similar.

RISK TO TERRESTRIAL ANIMALS

Acute and Subacute Risk Characterization for Birds

The sum of the two 0.25 lbs ai/A applications equaling 0.5 lb ai/A would result in maximum residues on short grass of 120 ppm, which is below the highest dose level tested in the dietary studies (10,000 ppm). This level did not show any mortality. Therefore, it is determined that no acute LOCs will be exceeded for any registered use.

Chronic Risk Characterization for Birds

In a preliminary screening assessment, based upon the above exposure table, the NOAEC of 20 ppm is exceeded for the maximum and mean residues for short grass, long grass, and broadleaf plants. Therefore, there is a potential for chronic effects. A refinement of this assessment uses a 30-day half-life for foliar degradation and the FATE model for estimating residues in the terrestrial environment (see Appendices B, C, and E).

Chronic risk for insectivorous and herbivorous birds is a potential problem from both single and multiple applications at 0.25 lbs ai/A or more. A comparison over time of maximum residue levels to the NOAEC indicates birds may be at risk for more than 30 days. The risk is from eating the treated crop and the weeds in and around the edge of the field and insects in the field.

When risk is based on mean residue levels in peanuts and soy beans, birds that eat short grass are at risk for 21 days from a single application (at 0.375 lbs ai/A). Risk to birds from a single application to rice (at 0.25 lbs ai/A) is for four days when they eat the rice seedlings and short grass in and around the field. Birds that eat short grass also will be at risk for two applications at 0.25 lbs ai/A. The duration of the chronic risk will be for three days after the first application and more than 15 days after the second application.

Although, sensitive vegetation may become unpalatable a few days after spraying, tolerant weeds and crop foliage would remain palatable. This effect may occur within hours to a week or less. The residues may decline more rapidly than the dissipation curve suggests due to dilution resulting from a biomass increase as the plants grow. Therefore, the chronic risk may not be as severe as described in EFED's initial screen.

Acute and Chronic Risk Characterization for Mammals

The sum of two 0.25 lbs ai/A applications equaling 0.5 lb ai/A would result in maximum residues on short grass of 120 ppm, which is below the estimated one day dietary LC_{50} (1,621 ppm) for a 15-g mammal that consumes 95% of its body weight. This LC_{50} is derived from an acute rat LD_{50} of 1,540 mg/kg. The RQ is <0.01, therefore, therefore, no acute LOCs have been exceeded for any registered use.

Comparing the developmental toxicity NOAEC of 400 ppm with the maximum residues on grass (120 ppm), no mammalian chronic level of concern (LOC) was exceeded at any registered use.

RISK CHARACTERIZATION FOR TERRESTRIAL PLANTS

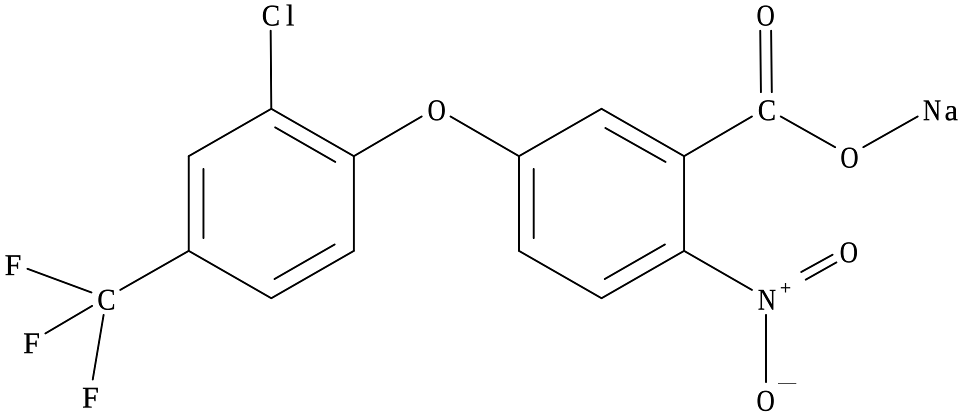
There are no data for the toxicity of acifluorfen to terrestrial plants. Until the emergence and vegetative vigor studies (123-1 and 123-2) are submitted, a quantitative risk assessment cannot be conducted. However, we anticipate that there will a risk to offsite, nontarget plants, although the magnitude is uncertain.

PHOTOTOXICITY

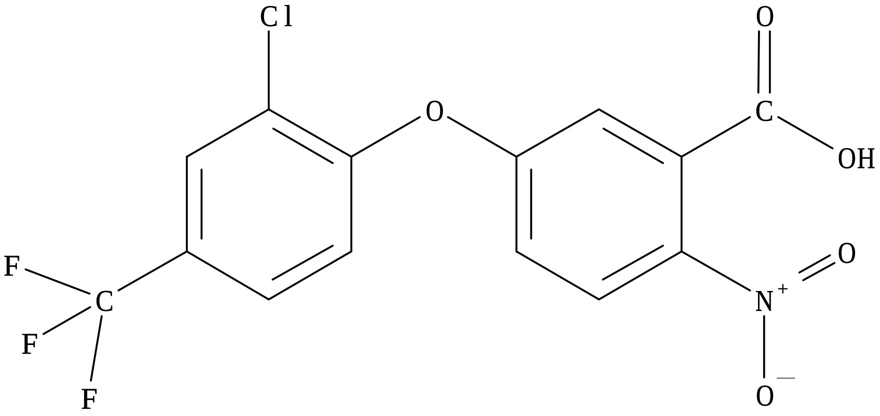
Sodium Acifluorfen is classified as a light-dependent peroxidizing herbicides (LDPH s) that acts by blocking heme and chlorophyll biosynthesis resulting in an endogenous accumulation of phototoxic porphyrins. Herbicides in this class are known to have a phototoxic mode of action in plants and animals.

APPENDIX A.

THE STRUCTURE OF SODIUM ACIFLUORFEN AND ITS DEGRADATES

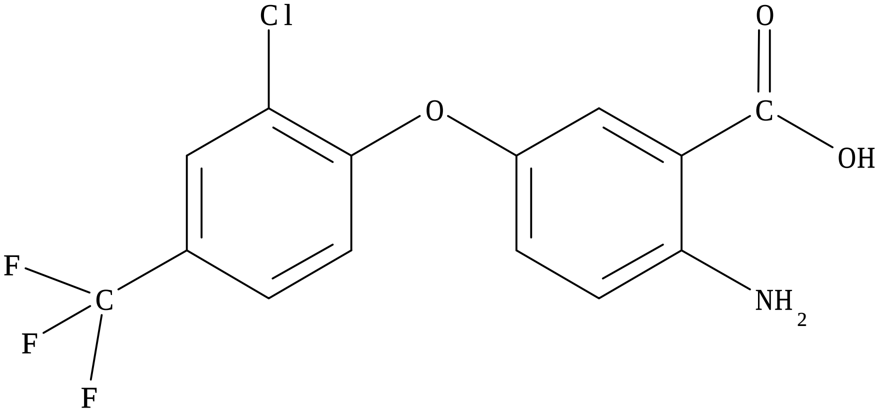


Sodium 5-(2-chloro-á,á,á-trifluoro-p-tolyloxy)-2-nitrobenzoate (Sodium acifluorfen)



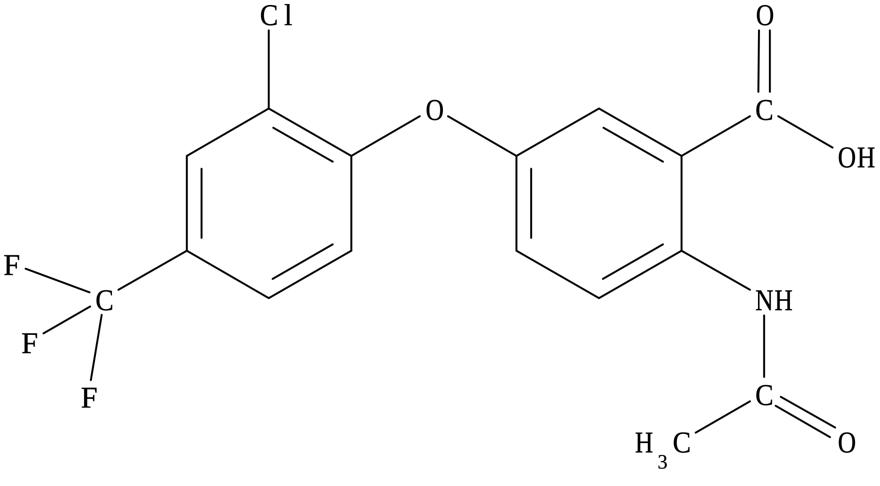
5-(2-Chloro-á,á,á-trifluoro-p-tolyloxy)-2-nitrobenzoic acid

(Acifluorfen)



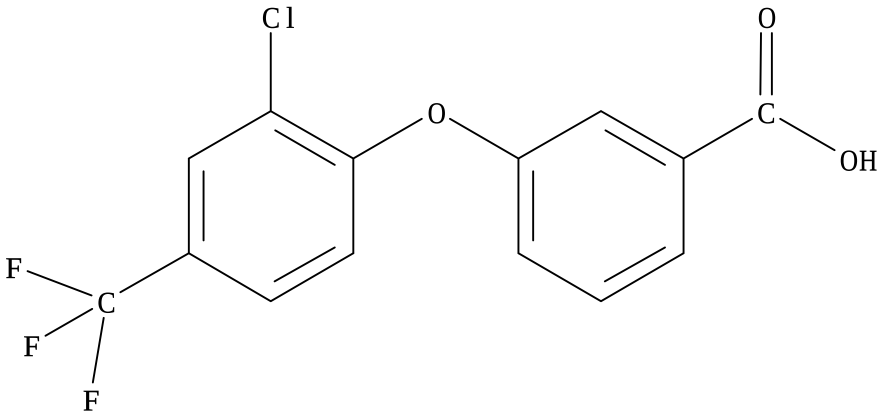
5-[2-Chloro-4-(trifluoromethyl)phenoxy]-2-aminobenzoic acid

(Acifluorfen amine; amino acifluorfen)



5-[2-Chloro-4-(trifluoromethyl)phenoxy]-2-acetamidobenzoic acid

(Acifluorfen acetamide)



3-[2-Chloro-4-(trifluoromethyl)phenoxy]benzoic acid

(Desnitro acifluorfen)

APPENDIX B.

FATE MODEL AND FATE MODEL RUNS

The Agency estimates the residues on terrestrial food items from multiple applications and over time by taking into account:

- application rate for a single application,
- number of applications,
- application interval, and
- dissipation rate

The model of Hoerger and Kenega (1972), as modified by Fletcher *et al.* (1994) was used to estimate pesticide concentrations on selected avian or mammalian food items. This model predicts the maximum concentrations that may occur immediately following a direct application at 1 lb ai/A. For 1 lb ai/A applications, concentrations on short grass, broadleaf plants, and fruits are predicted to be 240 and 85 ppm, 135 and 45 ppm, and 15 and 7 ppm for maximum and mean residues, respectively. The predicted maximum concentration for broadleaf plants and fruits are used to represent maximum concentrations that may occur on small and large insects, respectively. Linear extrapolation is then used to estimate maximum terrestrial EEC's for single applications at other application rates.

The Agency uses this as a screening level exposure assessment tool to determine peak terrestrial EECs resulting from multiple applications. After application, residues on food items are predicted to decline according to a first-order exponential model. If the maximum initial concentration is C_0 and the half-life for the exponential dissipation of the active ingredient is $t_{1/2}$, the remaining concentration at time t is given by the following formula:

$C_t = C_0 e^{-\frac{t \ln 2}{t_{1/2}}}$ or $C_t = C_0(½)^{t/t1/2}$ (the latter form shows the direct use of the half-life concept).

The general formula for the peak EEC (C_{peak}) following multiple applications is:

$C_{peak} = \sum_{i=1}^{n} C_0 e^{-\frac{I(n-i)\ln 2}{t_{1/2}}}$ or in simpler, directly calculable, single equation form,

$$C_{peak} = \frac{C_0[1-(½)^{nI/t1/2}]}{[1-(½)^{I/t1/2}]}$$

where C_0 is the maximum initial concentration after one application, I is the time interval between applications, n is the number of applications, and $t_{1/2}$ is the half-life of the active ingredient.

```
RUN No.   1 FOR Acifluorfen      ON peanuts     *INPUT VALUES*

--------------------------------------------------------------------------------------------
 RATE(#/AC)       APPLICATIONS       HALF-LIFE    AVERAGING         NOAEL
  ONE(MAX)        NO.-INTERVAL       (DAYS)       PERIOD (DAYS)     (PPM)
--------------------------------------------------------------------------------------------
  .375 ( .375)        1          1          30.0               30              20.0



MAXIMUM & 30 DAY AVERAGE KENAGA/FLETCHER RESIDUES:
95Th   PERCENTILE  (MEAN) in PPM
------------------------------------------------------------------------------------------


   SHORT              BROADLEAF         TALL                  SEED
   GRASS              & INSECTS         GRASS                 FRUIT
  MAXIMUM             MAXIMUM           MAXIMUM               MAXIMUM
__________________ __________________ __________________ __________________
  90.00 (31.88)       50.63 (16.88)       41.25 (13.50)       5.63  (2.63)



   AVERAGE              AVERAGE           AVERAGE              AVERAGE
__________________ __________________ __________________ __________________
  65.67 (23.26)       36.94 (12.31)       30.10 ( 9.85)        4.10 (1.92)
```

```
RUN No.   2 FOR Acifluorfen      ON rice        *INPUT VALUES*
--------------------------------------------------------------
 RATE(#/AC)    APPLICATIONS    HALF-LIFE    AVERAGING    NOAEL
  ONE(MAX)     NO.-INTERVAL     (DAYS)    PERIOD (DAYS)  (PPM)
--------------------------------------------------------------
  .250 (.250)             1    1         30.0        30        20.000

MAX & 30 DAY AVERAGE KENAGA/FLETCHER RESIDUES:95Th% (MEAN) in PPM
--------------------------------------------------------------


    SHORT          BROADLEAF          TALL            SEED
    GRASS          & INSECTS          GRASS           FRUIT
   MAXIMUM          MAXIMUM          MAXIMUM          MAXIMUM
________________  ________________  ________________  ________________
  60.00  (21.25)    33.75 (11.25)    27.50  ( 9.00)     3.75   ( .75)

   AVERAGE          AVERAGE          AVERAGE          AVERAGE
________________  ________________  ________________  ________________
  43.78  (15.51)    24.63  ( 8.21)    20.07  ( 6.57)     2.74  ( 1.28)
```

```
RUN No.   1 FOR acifluorfen      ON peanuts and soybeans      *INPUT VALUES*
--------------------------------------------------------------------
 RATE(#/AC)    APPLICATIONS    HALF-LIFE    AVERAGING    NOAEL
  ONE(MAX)     NO.-INTERVAL     (DAYS)    PERIOD (DAYS)  (PPM)
--------------------------------------------------------------------
  .250   (.427)   2   15         30.0        30        20.000

MAX & 30 DAY AVERAGE KENAGA/FLETCHER RESIDUES:95Th% (MEAN) in PPM
--------------------------------------------------------------------

     SHORT         BROADLEAF         TALL           SEED
     GRASS         & INSECTS         GRASS          FRUIT
    MAXIMUM          MAXIMUM          MAXIMUM         MAXIMUM
________________ ________________ ________________ ________________
 102.43  ( 36.28)    57.61  ( 19.20)    46.95  (15.36)     6.40  ( 2.99)

30-day AVERAGE         AVERAGE          AVERAGE         AVERAGE
________________ ________________ ________________ ________________
  69.43(  24.59)    39.05(  13.02)    31.82(  10.41)     4.34(   2.03)
```

APPENDIX C.

TERRESTRIAL RESIDUES

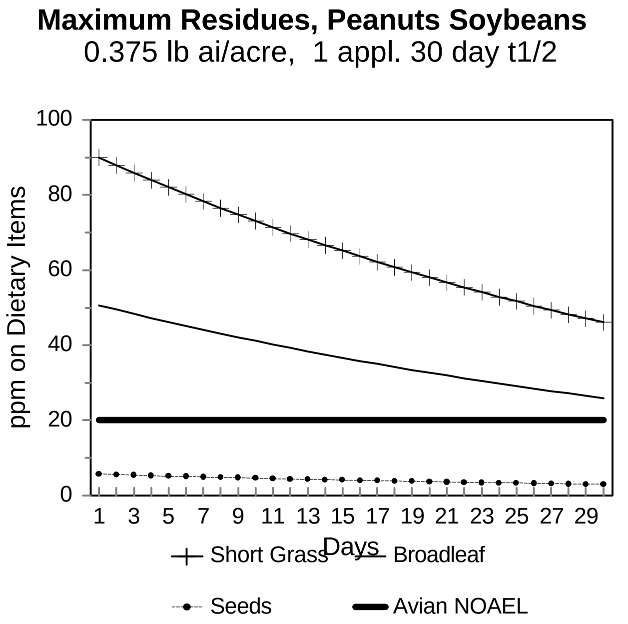


Figure 3.1. Estimated maximum and mean residues on avian food items over 30 days following a single application to peanuts or soybeans at the maximum single application rate. It is recognized that being a herbicide, some green vegetation may be killed and become unpalatable after a few days exposure. However, seeds, and tolerant plants may survive and remain palatable.

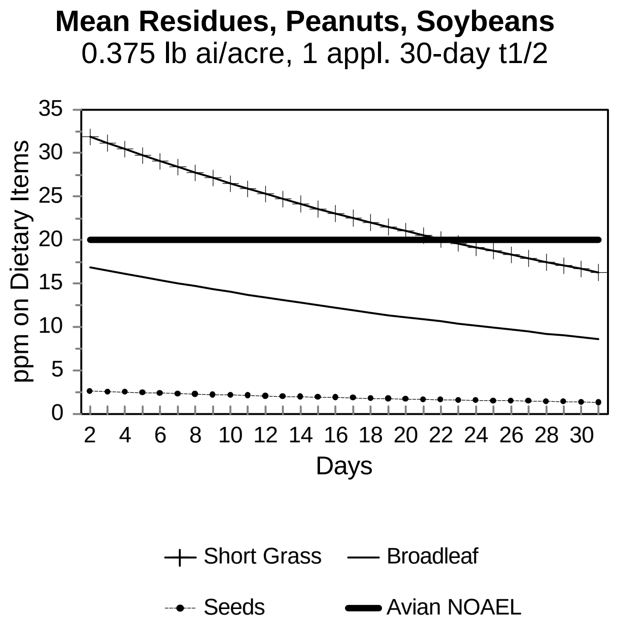
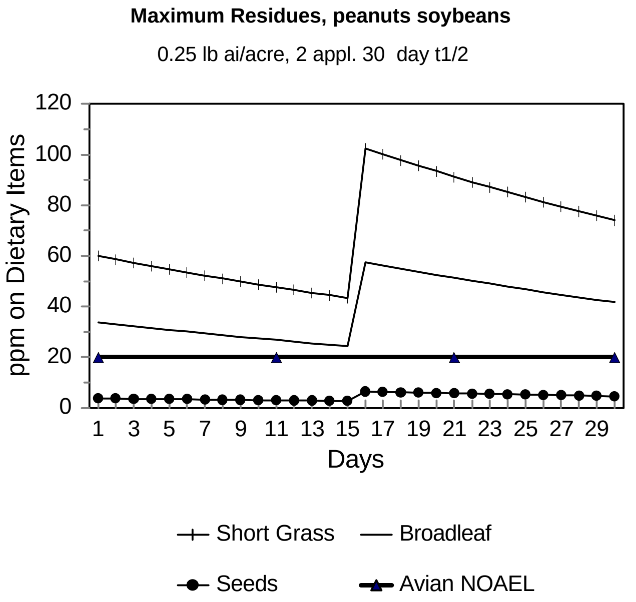
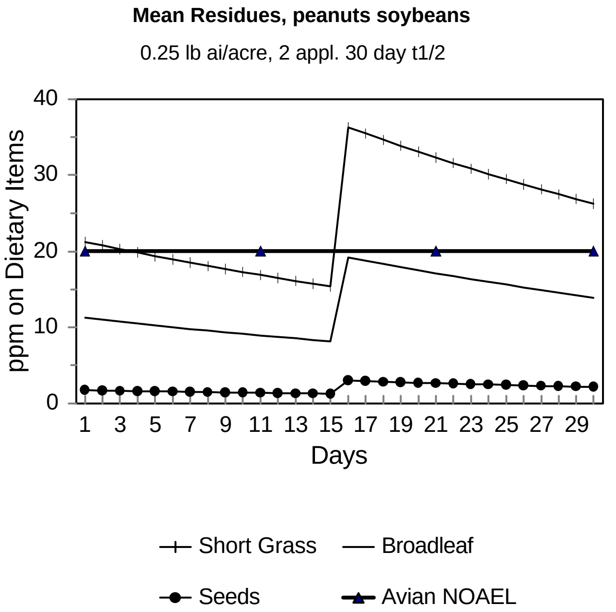


Figure 3.2. Estimated maximum and mean residues on avian food items over 30 days following two applications to peanuts or soybeans at 0.25 lb ai/acre. It is recognized that being a herbicide, some green vegetation may be killed and become unpalatable after a few days exposure. However, seeds, and tolerant plants may survive and remain palatable.





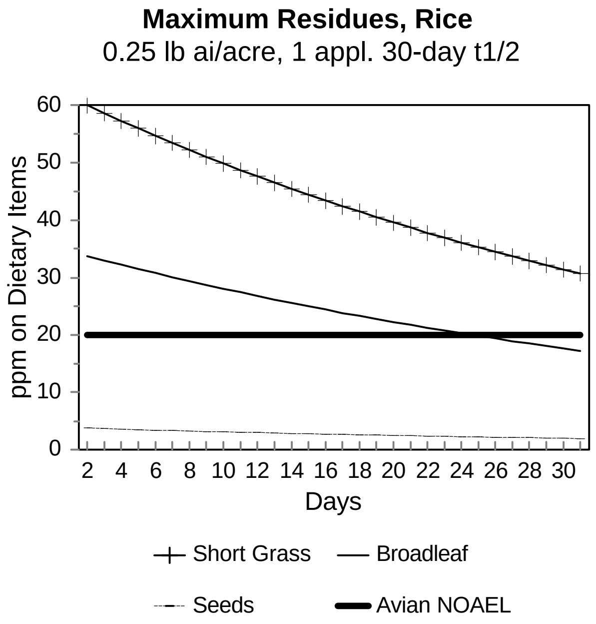
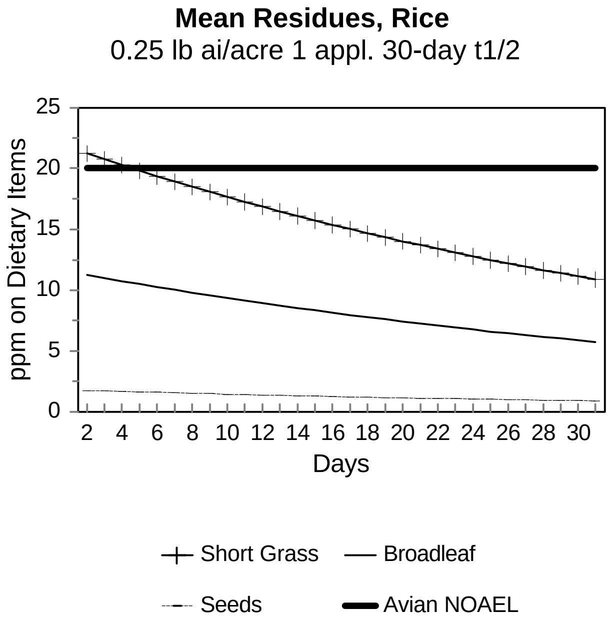


Figure 3.2. Estimated maximum and mean residues on avian food items over 30 days following a single application to peanuts or soybeans at the maximum single application rate. It is recognized that being a herbicide, some green vegetation may be killed and become unpalatable after a few days exposure. However, seeds, and tolerant plants may survive and remain palatable.



APPENDIX D.

ECOLOGICAL TOXICITY DATA

TOXICITY TO TERRESTRIAL ANIMALS

Acute and Subacute Toxicity in Birds

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of acifluorfen to birds. The preferred test species is either mallard duck (a waterfowl) or bobwhite quail (an upland gamebird). Results of this test are tabulated below.

Acifluorfen is categorized as moderately to practically nontoxic to avian species on an acute oral basis. The guideline (71-1) is fulfilled (MRID 083058).

Avian acute oral toxicity.

Species	% ai	LD50 (mg/kg)	Toxicity Category	MRID Author/Year	Study Classification[1]
Mallard duck *(Anas platyrhynchos)*	39.8 Technical	4187	Practically nontoxic	083058 Fink, 1976	Core
Northern bobwhite quail *(Colinus virginianus)*	25.6 Formulated	325	Moderately toxic	122747 Fink, 1981	Core for formulation

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)

Two subacute dietary studies using the TGAI are required to establish the toxicity of acifluorfen to birds. The preferred test species are mallard duck and bobwhite quail. Results of these tests are tabulated below.

Avian subacute dietary toxicity.

Species	% ai	LC50 (ppm)	Toxicity Category	MRID Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	39.8 Technical	>10000	Practically nontoxic	083059 Fink, 1976	Core
Mallard duck *(Anas platyrhynchos)*	39.8 Technical	>10000	Practically nontoxic	083060 Fink, 1976	Core
Northern bobwhite quail *(Colinus virginianus)*	25.6 Tackle	>5620	Practically nontoxic	122750 Fink, 1981	Core for formulation
Mallard duck *(Anas platyrhynchos)*	25.6 Tackle	>5620	Practically nontoxic	122749 Fink, 1981	Core for formulation

Acifluorfen is categorized as practically nontoxic to avian species on a subacute dietary basis. The guideline (71-2) is fulfilled (MRID 083059 and 083060).

Chronic Toxicity to Birds

Avian reproduction studies using the TGAI are required for acifluorfen because the following conditions are met: (1) birds may be subject to repeated or continuous exposure to the pesticide, especially preceding or during the breeding season, and (2) the pesticide is stable in the environment to the extent that potentially toxic amounts may persist in animal feed. The preferred test species are mallard duck and bobwhite quail. Results of these tests are tabulated below.

The guideline (71-4) is fulfilled (MRID 107491 and 107492).

Avian reproduction.

Species/ Study Duration	% ai	NOAEC (ppm)	LOAEC Endpoints	MRID Author/Year	Study Classification
Northern bobwhite quail *(Colinus virginianus)*	39.8 Technical	20	100 Reduced number of viable embryos	107491 Najarian, 1978	Core
Mallard duck *(Anas platyrhynchos)*	39.8 Technical	>100	N/A (>100)	107492 Najarian, 1978	Core

Acute and Chronic Toxicity to Mammals

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's

Health Effects Division (HED) substitute for wild mammal testing. These toxicity values are reported below.

The results categorize acifluorfen as slightly toxic to small mammals on an acute oral and acute dietary basis.

Acute and chronic toxicity to mammals using a laboratory rat (*Rattus norwegicus*).

% ai	Test Type	Toxicity Value	Affected Endpoints	MRID
40% Technical	Acute	LD50 = 1540 mg/kg		071887
21.4% Tackle 2S	Developmental	LOAEC = 90 mg/kg/day = 1800 ppm NOEAC = 20 mg/kg/day = 400 ppm	Decreased fetal body weight	122743
21.4 % Tackle 2S	Reproductive	NOEAC = 2500 ppm	No reproductive effect	155548

Toxicity to Insects

There are no data for the honey bee acute contact study. The study is required, because of wide spread use and possible drift to off site vegetation in bloom.

TOXICITY TO FRESHWATER AQUATIC ANIMALS

Acute Toxicity to Freshwater Fish

Two freshwater fish toxicity studies using the TGAI are required to establish the toxicity of acifluorfen to fish. The preferred test species are rainbow trout (a coldwater fish) and bluegill sunfish (a warmwater fish). Results of these tests are tabulated below.

Acifluorfen is categorized as slightly to practically nontoxic to freshwater fish on an acute basis. The guideline (72-1) is fulfilled (MRID 071901, 122751, and 107493

Freshwater fish acute toxicity.

Species Type study	% ai	96-hour LC50 (ppm) Nominal	Toxicity Category	MRID Author/Year	Study Classification
Channel catfish *(Ictalurus punctatus)*	42.4 Technical	80	practically nontoxic	107494 Kuc, 1977	Core
Rainbow trout (*Oncorhynchus mykiss*) Static	39.8 Technical	54	slightly toxic	071901 Buccafusco, 1976	Core
Bluegill sunfish (*Lepomis macrochirus*) Flow through	42.4 Technical	>32	slightly toxic	107493 Buccafusco, 1976	Core
Bluegill sunfish (*Lepomis macrochirus*) Static	39.8 Technical	31	slightly toxic	071901 Buccafusco, 1976	Core
Bluegill sunfish (*Lepomis macrochirus*)	25 Tackle	62	slightly toxic	122751 LeBlanc, 1981	Core for formulation
Rainbow trout (*Oncorhynchus mykiss*)	25 Tackle	17	slightly toxic	122752 LeBlanc, 1981	Core for formulation

Chronic Toxicity to Freshwater Fish

No freshwater Fish Life Cycle study (72-5) is required, because acifluorfen didn't meet any of the criteria except reproduction impairment in birds and the 60-day PRSM/EXAMS value was less than 20 ppb, which is below 1/100 of the lowest LC_{50} (17 ppm).

Data were submitted (MRID 124222) for the freshwater Fish Early life stage (72-4a) using the Fathead minnow (*Pimephales promelas*). Reduced larval weight was reported at 1.5 ppm (the lowest level tested). The study is supplemental because no level below 1.5 ppm was used, therefore there was no NOEAC.

Acute Toxicity to Freshwater Invertebrates

A freshwater aquatic invertebrate toxicity test using the TGAI is required to establish the toxicity of acifluorfen to aquatic invertebrates. The preferred test species is *Daphnia magna*. Results of this test are tabulated below.

Acifluorfen is categorized slightly toxic to aquatic invertebrates on an acute basis for the TGAI and TEP. The guideline (72-2) is fulfilled (MRID 071901 and 122754).

Freshwater invertebrate acute toxicity.

Species Study type	% ai	48-hour LC50/ EC50 (ppm) nominal or measured	Toxicity Category	MRID Author/Year	Study Classification

Freshwater invertebrate acute toxicity.

Freshwater clam (*Elliptio complanata*)	42.4 Technical	149.7	practically nontoxic	111963 Vilkas, 1977	Supplemental[1]
Daphnia magna static	39.8 Technical	28.1 nominal	slightly toxic	071901 Buccafusco, 1976	Core
static	25.6 Tackle	77 nominal	slightly toxic	122754 LeBlanc, 1981	Core for formulation

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[1] Not a recommended species

Chronic Toxicity to Freshwater Invertebrates

No freshwater invertebrate life-cycle study (72-4b) is required for acifluorfen because it didn't meet any of the criteria except reproduction impairment in birds and the 21-day PRSM/EXAMS value was less than 21 ppb, which is below 1/100 of the lowest LC_{50} of (28 ppm).

TOXICITY TO ESTUARINE AND MARINE ANIMALS

Acute Toxicity to Estuarine and Marine Fish

Acute toxicity testing with estuarine/marine fish using the TGAI is required for acifluorfen because the end-use product is intended for direct application to the marine/estuarine environment or the active ingredient is expected to reach this environment because of its use in coastal counties. The preferred species is sheepshead minnow. Results of these studies are below.

Acifluorfen is categorized practically nontoxic to estuarine/marine fish on an acute basis. The guideline (72-3a) is fulfilled (MRID 124223).

Estuarine/marine fish acute toxicity.

Species	% ai	96-hour LC50 (ppm)	Toxicity Category	MRID Author/Year	Study Classification
Sheepshead minnow (*Cyprinodon variegatus*) Static	43 Technical	204 Initial Nominal	Practically nontoxic	124223 Spare, 1982	Core
Static	25.6 Formulated	39 Initial Nominal	Slightly toxic	122753 Ward, 1981	Core for formulation

Chronic Toxicity to Estuarine and Marine Fish

No estuarine fish early life-stage (72-4a) Fish Life Cycle study (72-5) is required, because acifluorfen didn't meet any of the criteria except reproduction impairment in birds and the 60-day PRSM/EXAMS value was less than 20 μg/L, which is below 1/100 of the lowest LC_{50} (17 ppm).

Acute Toxicity to Estuarine and Marine Invertebrates

Acute toxicity testing with estuarine/marine invertebrates using the TGAI is required for acifluorfen because the end-use product is expected to reach this environment because of its use in coastal counties from the use on soybeans, peanuts, and rice. The preferred species are mysid shrimp and eastern oyster. Results of these studies are tabulated below.

Acifluorfen is categorized moderately toxic to practically nontoxic to estuarine/marine invertebrates on an acute basis. The guidelines (72-3b and 72-3c) are fulfilled (MRIDs 111962, 111964, and 418912-01).

Estuarine/marine invertebrate acute toxicity.

Species Study type	% ai.	96-hour LC50/EC50 (ppm)	Toxicity Category	MRID Author/Year	Study Classification
Grass shrimp (*Palaemonetes pugio*)	42.4 Technical	446	practically nontoxic	111962 Vilkas, 1977	Core
Eastern oyster, embryo-larvae (*Crassostrea virginica*)	42.4 Technical	74	slightly toxic	111964 Vilkas, 1977	Core
Eastern oyster shell deposition *(Crassostrea virginica)*	43.9 Technical	EC50 = 101	practically nontoxic	418912-01 Dionne, 1991	Core
Fiddler crab (*Uca pugilator*)	39.8 Formulated	>1000	practically nontoxic	107495 Calmbacher, 1978	Supplemental[1]
Mysid *(Americamysis bahia)* Static	25 Formulated	3.8	moderately toxic	122755 Holister, 1981	Core for formulation

[1] Not a recommended species

TOXICITY TO PLANTS

Toxicity to Terrestrial Plants

Terrestrial plant testing is required for acifluorfen because, Terrestrial Tier II studies are required for all low dose herbicides (those with the maximum use rate of 0.5 lbs ai/A or less) and any pesticide showing a negative response equal to or greater than 25% in Tier I studies.

For seedling emergence and vegetative vigor testing the following plant species and groups should be studied: (1) six species of at least four dicotyledonous families, one species of which is soybean (*Glycine max*) and the second is a root crop, and (2) four species of at least two monocotyledonous families, one of which is corn (*Zea mays*).

The data for toxicity of acifluorfen to nontarget terrestrial plants were not scientifically sound (MRID 416807-01), because the acifluorfen solution applied to the experimental plants was too dilute and the water may have washed the chemical away from the plant. This caused uncertainty about the exposure. Guideline 123-1 has not been fulfilled.

Toxicity Aquatic Plants

Aquatic plant testing is required for acifluorfen because it has uses that may move off-site by runoff, by drift (aerial or irrigation).

Results of Tier I toxicity testing on the technical/TEP material are tabulated below.

Nontarget aquatic plant toxicity (Tier I).

Species	% ai	EC_{50} ppm	MRID Author, Year	Study Classification
Skeletonema costatum	43.9	>300 measured	416807-02 Giddings, 1990	Core
Anabaena flos-aquae	43.9	>355 measured	416807-02 Giddings, 1990	Core
Navicula pelliculosa	43.9	>345 measured	416807-02 Giddings, 1990	Core

The guideline (122-2) is fulfilled. Since the concentration that is equivalent to the maximum label rate caused no reduction in growth after 120 hours, acifluorfen is considered to be practically nontoxic to algae at the Tier I level. *Selenastrum capricornutum* and *Lemna gibba* will be done as Tier II studies.

Aquatic Tier II studies are required for all low dose herbicides (those with the maximum use rate of 0.5 lbs ai/A or less) (acifluorfen application rate is 0.375 lbs ai/A) and any pesticide showing a negative response equal to or greater than 50% in Tier I studies. *Selenastrum capricornutum* and *Lemna gibba* should be studied at Tier II

Results of Tier II toxicity testing on the technical material are tabulated below.

Nontarget aquatic plant toxicity (Tier II).

Species	% ai	EC50 ppm	NOAEC ppm	MRID Author, Year	Study Classification
Vascular Plants					
Duckweed *Lemna gibba*	43.9	378	180	416807-02 Giddings, 1990	Core
Nonvascular Plants					
Green algae *Selenastrum capricornutum*	43.9	> 265	> 265	416807-02 Giddings, 1990	Core

The Tier II results show that *Selenastrum capricornutum* is the most sensitive nonvascular aquatic plant. The guideline (123-2) is fulfilled (MRID 416807-02).

APPENDIX E.
EXPOSURE AND RISK CHARACTERIZATION

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of this integration is called the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by acute and chronic ecotoxicity values.

RQ = EXPOSURE/TOXICITY

RQs are then compared to OPP's levels of concern (LOCs). These LOCs are used by OPP to analyze potential risk to nontarget organisms and the need to consider regulatory action. The criteria indicate that a pesticide used as directed has the potential to cause adverse effects on nontarget organisms. LOCs currently address the following risk presumption categories: (1) **acute high** -- potential for acute risk is high; regulatory action may be warranted in addition to restricted use classification, (2) **acute restricted use** -- the potential for acute risk is high, but may be mitigated through restricted use classification, (3) **acute endangered species** - endangered species may be adversely affected, and (4) **chronic risk** - the potential for chronic risk is high regulatory action may be warranted. Currently, EFED does not perform assessments for chronic risk to plants, acute or chronic risks to nontarget insects, or chronic risk from granular/bait formulations to birds or mammals.

The ecotoxicity test values (measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. Examples of ecotoxicity values derived from short-term laboratory studies that assess acute effects are: (1) LC_{50} (fish and birds), (2) LD_{50} (birds and mammals), (3) EC_{50} (aquatic plants and aquatic invertebrates) and (4) EC25 (terrestrial plants). Examples of toxicity test effect levels derived from the results of long-term laboratory studies that assess chronic effects are: (1) LOAEC (birds, fish, and aquatic invertebrates), (2) NOAEC (birds, fish and aquatic invertebrates), and (3) MATC (fish and aquatic invertebrates). For birds and mammals, the NOAEC generally is used as the ecotoxicity test value in assessing chronic effects, although other values may be used when justified. Generally, the MATC (defined as the geometric mean of the NOAEC and LOAEC) is used as the ecotoxicity test value in assessing chronic effects to fish and aquatic invertebrates. However, the NOAEC is used if the measurement end point is production of offspring or survival.

Risk presumptions and the corresponding RQs and LOCs, are tabulated below.

Risk presumptions for terrestrial animals

Risk Presumption	RQ	LOC
Birds		
Acute High Risk	EEC[1]/LC_{50} or LD_{50}/sq ft or LD_{50}/day[3]	0.5
Acute Restricted Use	EEC/LD_{50} or LD_{50}/sq ft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LC_{50}/sq ft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1
Wild Mammals		
Acute High Risk	EEC/LC_{50} or LD_{50}/sq ft or LD_{50}/day	0.5
Acute Restricted Use	EEC/LC_{50} or LD_{50}/sq ft or LD_{50}/day (or LD_{50} < 50 mg/kg)	0.2
Acute Endangered Species	EEC/LC_{50} or LD_{50}/sq ft or LD_{50}/day	0.1
Chronic Risk	EEC/NOAEC	1

[1] abbreviation for Estimated Environmental Concentration (ppm) on avian/mammalian food items
[2] mg/ft^2 [3] mg of toxicant consumed/day
LD50 * wt. of bird LD50 * wt. of bird

Risk presumptions for aquatic animals.

Risk Presumption	RQ	LOC
Acute High Risk	EEC[1]/LC50 or EC50	0.5
Acute Restricted Use	EEC/LC50 or EC50	0.1
Acute Endangered Species	EEC/LC50 or EC50	0.05
Chronic Risk	EEC/MATC or NOAEC	1

[1] EEC = (ppm or ppb) in water

Risk presumptions for plants.

Risk Presumption	RQ	LOC
Terrestrial and Semi-Aquatic Plants		
Acute High Risk	EEC[1]/EC25	1
Acute Endangered Species	EEC/EC05 or NOAEC	1
	Aquatic Plants	
Acute High Risk	EEC[2]/EC50	1
Acute Endangered Species	EEC/EC05 or NOAEC	1

[1] EEC = lbs ai/A
[2] EEC = (ppb/ppm) in water

EXPOSURE TO NONTARGET TERRESTRIAL ANIMALS

For pesticides applied as a nongranular product (*e.g.*, liquid, dust), the estimated environmental concentrations (EECs) on food items following product application are compared to LC_{50} values to assess risk. The predicted 0-day maximum and mean residues of a pesticide that may be expected to occur on selected avian or mammalian food items immediately following a direct single application at 1 lb ai/A are tabulated below.

Estimated Environmental Concentrations on avian and mammalian food items (ppm) following a single application at 1 lb ai/A.

Food Items	EEC (ppm) Predicted Maximum Residue[1]	EEC (ppm) Predicted Mean Residue[1]
Short grass	240	85
Tall grass	110	36
Broadleaf/forage plants and small insects	135	45
Fruits, pods, seeds, and large insects	15	7

[1] Predicted maximum and mean residues are for a 1 lb ai/A application rate and are based on Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994).

Residues (EECs) from multiple applications are calculated using a 30-day half-life for foliar dissipation, because acifluorfen is stable to hydrolysis and has the following half-lives: aerobic soil metabolism (100 - 200 days), aerobic aquatic metabolism (117 days), anaerobic metabolism (30 days). The FATE model was used to determine the peak residue and decline values for 30 days based on a maximum and mean Fletcher values.

RISK TO NONTARGET TERRESTRIAL ANIMALS

Risk to Birds

The Risk Quotients (RQ) were calculated based upon the ecological toxicity data (Appendix D).

The acute risk quotients for a single broadcast application of acifluorfen are tabulated below.

Avian acute risk quotients for single application of acifluorfen.

Site/App. Method	App. Rate (lbs ai/A)	Food Items	Maximum EEC (ppm)	LC50 (ppm)	Acute RQ (EEC/LC50)
Aerial or ground broadcast	0.375	Short grass	90	>5620	0.02
		Tall grass	41	>5620	0.01
		Broadleaf plants and Insects	51	>5620	0.01
		Seeds	5.6	>5620	<0.01

Avian acute risk quotients for multiple applications of acifluorfen.

Site/App. Method	App. Rate (lbs ai/A/Season)	Food Items	Maximum EEC (ppm)[1]	LC50 (ppm)	Acute RQ (EEC/LC50)
Aerial or ground broadcast	0.50	Short grass	120	>5620	0.04
		Tall grass	55	>5620	0.02
		Broadleaf plants and Insects	68	>5620	0.02
		Seeds	8	>5620	<0.01

[1] EEC using Fletcher *et al.* (1994) without degradation.

No avian LOCs are exceeded for multiple broadcast applications at the rate of 0.50 lbs ai/A/season.

Risk to Mammals

Birds and mammals have similar responses to xenobiotics, their differences being more quantitative rather than qualitative. Since acifluorfen does not present an acute risk to endangered birds, mammals are also presumed to be protected.

Estimating the potential for adverse effects to wild mammals is based upon EFED's draft 1995 SOP of mammalian risk assessments and methods used by Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994). The concentration of acifluorfen in the diet that is expected to be acutely lethal to 50% of the test population (LC_{50}) is determined by dividing the LD_{50} value (usually a rat LD_{50}) by the % (decimal of) body weight consumed. A risk quotient is then determined by dividing the EEC by the derived LC_{50} value. Risk quotients are calculated for three separate weight classes of mammals (15, 35, and 1,000 g), each presumed to consume four different kinds of food (grass, forage, insects, and seeds). The acute risk quotients for broadcast applications of nongranular products are tabulated below.

Mammalian (herbivore/insectivore) acute risk quotients for single application (0.375 lbs ai/A) of acifluorfen based on a Norway rat LD50 of 1540 mg/kg.

Body Weight (g)	% Body Weight Consumed	LC50	EEC (ppm) Short Grass	EEC (ppm) Forage & Sm Insects	EEC (ppm) Lg Insects	Acute RQ[1] Short Grass	Acute RQ Forage & Sm Insects	Acute RQ Lg Insects
15	95	1,621	90	51	5.6	0.06	0.03	<0.01
35	66	2,333	90	51	5.6	0.02	0.02	<0.01
1,000	15	10,266	90	51	5.6	0.01	0.01	>0.00

[1] RQ = EEC (ppm) ÷ LD50 (mg/kg) ÷ (% Body Weight Consumed)

Mammalian (herbivore / insectivore) acute risk quotients for two applications (for a total of 0.50 lbs ai/A/Season) of acifluorfen based on a Norway rat LD50 of 1540 mg/kg.

Body Weight (g)	% Body Weight Consumed	LC50	EEC (ppm) Short Grass	EEC (ppm) Forage & Sm Insects	EEC (ppm) Lg Insects	Acute RQ[1] Short Grass	Acute RQ Forage & Sm Insects	Acute RQ Lg Insects
15	95	1,621	120	68	8	0.07	0.04	< 0.01
35	66	2,333	120	68	8	0.05	0.03	< 0.01
1,000	15	10,266	120	68	8	0.01	0.01	< 0.01

[1] RQ = EEC (ppm) ÷ (LD50 (mg/kg) ÷ % Body Weight Consumed)

Mammalian chronic risk quotients for two applications (for a total of 0.50 lbs ai/A/season) of acifluorfen.

Food Items	Max. EEC (ppm)	Rat Reproductive NOAEC (ppm)	Chronic RQ[1]
Short grass	120	>2500	< 0.05
Tall grass	55	>2500	< 0.02
Broadleaf plants/Insects	68	>2500	< 0.03
Seeds	8	>2500	< 0.01

[1]RQ = Maximum EEC ÷ NOAEC

No mammalian acute or chronic levels of concern are exceeded at any registered rate of broadcast application.

Risk to Insects

There are no data for the honey bee acute contact study. The study is required, because of wide spread use and possible drift to off site vegetation in bloom.

RISK TO NONTARGET PLANTS

Dry and Semi-aquatic Areas

There were no acute data for terrestrial plants, therefore a risk assessment cannot be conducted. However, because acifluorfen is an herbicide used to control there could be an impact in adjacent areas.

Aquatic Plants

Exposure to nontarget aquatic plants may occur through runoff or spray drift from adjacent treated sites. An aquatic plant risk assessment for acute high risk is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. Nonvascular acute high aquatic plant risk assessments are performed using either algae or a diatom, whichever is the most sensitive species. An aquatic plant risk assessment for acute- endangered species is usually made for aquatic vascular plants from the surrogate duckweed *Lemna gibba*. To date, there are no known nonvascular plant species on the endangered species list. Runoff and drift exposure is computed from GENEECx for rice. The risk quotient is determined by dividing the pesticide's initial or peak concentration in water by the plant EC_{50} value.

Acute risk quotients for vascular and nonvascular plants are tabulated below.

Acute Risk Quotients for aquatic plants based upon Duckweed and a nonvascular plant. For endangered species, the Duckweed NOAEC of 0.0011 ppm ai was used.

Site/ Rate of Application (lbs ai/A)	Species	EC50 (ppm)	EEC (ppm)	NOAEC (ppm)	Endangered Species RQ (EEC/NOAEC)	Nontarget plant RQ (EEC/EC50)
Two direct applications, Total of 0.5 lbs ai/A	Duckweed (*Lemna gibba*)	0.378	0.021	0.180	0.12	0.06
	Green alga *Selenastrum capricornutum*	0.11	0.021	0.265	0.08	0.19
Rice 0.25 lbs ai/A	Duckweed	0.378	0.054	0.180	0.30	0.14
	Green algae	0.11	0.054	0.265	0.20	0.49

None of the vascular aquatic plant or algal acute, high risk and endangered species levels of concern are exceeded at registered maximum rates (0.5 lbs as/A and 0.25 lbs as/A). Currently, EFED does not perform assessments for chronic risk to aquatic plants. No aquatic plant RQs were exceeded.

APPENDIX F.
QUALITATIVE USE ASSESSMENT.

Based on available pesticide survey usage information for the years of 1987 through 1998, an annual estimate of acifluorfen total domestic usage averaged approximately one and a half million pounds active ingredient (a.i.) for more than six million acres treated. Acifluorfen is an herbicide with its largest markets in terms of total pounds active ingredient allocated to soybeans (93%), peanuts (4%), and rice (2%). Most of the usage is in Arkansas, Mississippi, *Illinois*, Missouri, Indiana, North Carolina, Virginia, Texas, and Alabama

Quantitative usage analysis for acifluorfen [1]

		Acres Treated	Percent Crop Treated	Lbs AI Applied	Average Application Rate			States of Most Usage
Site	Acres Grown (000)	Est. Max. (000)	Est. Max.	Est Max (000)	Lb ai/ A/yr	Number appl/yr	Lb ai/ A/appl	Percent of total lb ai used on this site
Idle Cropland	7,461	299	4.01	299	0.0	1.0	0.0	IA 100%
Farmsteads, Lots, etc	24,815	498	2.01	132	0.3	1.0	0.3	AR LA MN 100%
Other Crops	2,515	132	5.25	132	1.0	2.0	0.5	MN 100%
Peanuts	1,610	307	19.04	113	0.3	1.2	0.3	NC GA VA TX AL MS 85%
Rice	2,921	183	6.27	48	0.2	1.1	0.2	AR MS MO 90%
Set aside Acres	21,802	661	3.03	149	0.2	1.1	0.2	AR SC 100%
Soybeans	62,879	7,257	11.54	1,710	0.2	1.1	0.2	AR MS IL MO MN IN 60%
Woodland	62,825	1	0.00	0	0.6	1.0	0.6	SC 100%
Total		7,842		2,022				

[1] Calculations of the above numbers may not appear to agree because they are displayed as rounded to the nearest 1,000 for acres treated or lb. a.i. (Therefore 0 = < 500) to two decimal percentage points for percent of the crop treated.

Other/Crop Groups Other Crops include ornamentals, popcorn, rapeseed/canola, and safflower.

SOURCES: EPA data, USDA, and National Center for Food and Agricultural Policy.

APPENDIX G.
ENVIRONMENTAL FATE SUMMARY

Sodium Acifluorfen Environmental Fate Studies

Hydrolysis (GDLN 161-1)

92168032

Keene, E. 1991. BASF Corporation Phase 3 Summary of MRID 00107479: A Hydrolysis study with ^{14}C-RH-6201 in Water. Accession No. 095735, BASF Registration Doc. No. 75/5009, Rohm & Haas Report no. 3423-75-6.

^{14}C Sodium acifluorfen was stable to hydrolysis in pH 4.5, 7.2 and 9.7 buffer solutions at 25 °C and two concentrations of the active ingredient (1 and 50 ppm).

Photodegradation in Water (GDLN 161-2)

41891208

Panek, M. 1991. Aqueous Photolysis of ^{14}C-Sodium Acifluorfen". BASF Report # M9118.

42793502

Panek, M. 1993. Aqueous Photolysis of ^{14}C-Sodium Acifluorfen: Supplementary report to MRID 41891208. Suter, P. 1993. Artificial Sunlight Photolysis of Acifluorfen in Aqueous Media at pH 7.0. BASF Report # M9311.

44195002

Venkatesh, K. 1996. Further Characterization of Photolytic Degradation Products from the ^{14}C-Acifluorfen [NO_2 Label] Artificial Sunlight Photolysis. 6/28/96. BASF Reg. Doc. No. 96/5112.

An aqueous photolysis study (MRID 41891208) was submitted to the EPA for the photodegradation in water requirements, 161-2, in May, 1991 and reviewed in December 1991. A half-life of about 21.7 hours (0.025 M phosphate buffer; pH 7; 18 ppm) was estimated. This study was not accepted by the Agency because only one of the two phenol rings (F-label) was used and 50% of the radioactivity described as polar material went uncharacterized and unquantitated. However, the study showed that the ethyl acetate extract of the photolysis mixture to be a complex mixture of photolytic degradation products in which no single product constituted more than 10% of the initial photolysis solution. Therefore, a new aqueous photolysis study was conducted using both N and F-label acifluorfen (MRID 42793502). This study also showed that the photolytic degradation products to be a complex mixture of products consisting of one major polar (24 to 35%) and 4 minor polar products (2 to 8%) by HPLC analysis. The major polar product was shown to be a complex mixture of components. The half-life values for the N and the F-labels were shown to be between 78 to 94 hours (0.025 M phosphate buffer; pH 7; 4-5 ppm). The mass spectral analysis of the reaction products was inconclusive. The basic conclusion from these studies is that acifluorfen rapidly undergoes photolytic degradation in water to a complex mixture of components, none of which is abundant enough to be a major concern for environmental residues. This study was reviewed by the EPA in October 8, 1998 and was not acceptable for the following reasons: 1) The artificial light was not properly characterized and, 2) an appropriate solvent system was not used to identify a polar degradate "complex" that was present at up to 35% of the applied radioactivity. Attempts to quantify or identify the individual components in this mixture comprising of >10% of the applied radioactivity were not attempted. The agency believed that the photodegradation in water data requirement could be upgraded by providing additional characterization of the light source, and by demonstrating that no single compound was present in the polar "complex" at >10% of the applied radioactivity.

In response to Agency's review of the first study, a supplementary report (MRID 41891208) has been written to provide additional evidence from that photolysis leads to numerous polar photoproducts none of which are formed in significant amounts. For this supplementary study, the photolysis samples from the first study were reanalyzed by 2D TLC and ion-pair chromatography. These additional analyses also showed that the photolytic degradation products to be a complex mixture of components none of which exceeded >6.5% of the total applied radioactivity.

This study (MRID 44195002) was conducted with ^{14}C-acifluorfen (N-label) at a concentration of 21 and 102 ppm for 0 to 360 hours of continuous illumination at a light intensity of 1800 uEinsteins m^{-2} s^{-1} at 25°C. The study also compared the photolysis of ^{14}C-acifluorfen (F-label) for 360 hours to the photolysis products produced by the N-label.

The major degradation product was CO_2, reaching a maximum of 7% TAR in the 102 ppm series and 10% TAR in the 21 ppm series. The half-life of acifluorfen was estimated to be 352 and 298 hours in the 102 and 21 ppm series (0.1% bicarbonate buffer at pH 8.3), respectively. The parent concentration declined to about 38 to 46% with an increase in polar peaks to 31 to 38% TAR after 360 hours of continuous irradiation. Extensive HPLC and LC/MS methods showed polar peaks to consist of multiple components with twelve non-distinct peaks with concentrations ranging from 0.55 to 4.83% TAR, whereas parent peak was unaffected by the same techniques.

Photolysis of CF_3-labeled acifluorfen yielded similar reaction products and there was no ring cleavage under aqueous photolysis conditions. The results of the new study are similar to the previous reports showing only the presence of a polar peak and parent peak in the irradiated solutions. As reported in the previous studies, the polar product consisted of multiple components none of which were present at significant concentrations.

A summary of the aqueous photolysis half-lives and the conditions of the study are listed in Table G-1.

Table G-1. Summary of aqueous photolysis half-life values for sodium acifluorfen from different conditions imposed in three studies (MRIDs)

MRID	Half-life (hrs)	Buffer System	pH	Concentration (mg/L)
418912-08	21.7	0.025 M phosphate buffer	7	18
427935-02	77.7 to 99.9	0.025 M phosphate buffer	7	4 to 5

441950-02	352 298	0.01 % bicarbonate buffer 0.01 % bicarbonate buffer	8.3 8.3	102 21

In conclusion, acifluorfen undergoes photolytic degradation in water to a complex mixture of components none of which exceed 10% TAR. Half-life values ranged from 21 to 352 hours with the different concentrations, pH, and buffer systems used. Data were not adequate to determine whether any of these factors influence the rate of aqueous photolysis. The rate of degradation via photolysis in water maybe to be quite variable depending upon the chemical quality of the water. The ability of the water to transmit light would also influence the rate of aquatic photolysis.

Photodegradation on Soil (GDLN 161-3)

41688501

Looper, G. 1990. Phase 3 summary of Phone-Poulenc Report by Gerecke, D. R. and J. P. Wargo, August 1982, Rhone Poulenc Report No. ASD 82/045 (Accession No. 071323). Acifluorfen: Photodegradation on soil. BASF Registration Document No. 90/5096. Unpublished study originally performed and submitted by Rhone-Poulenc Agriculture Company, Research Triangle Park, NC; then rewritten and resubmitted by BASF Corporation, Research Triangle Park, NC.

44412901

Venkatesh, K. and Oakley, W. 1997. Photolysis of ^{14}C-Acifluorfen (NO_2 and CF_3 Label) on Soil. BASF Registration Document No.: 97/5057. 5/08/97.

A soil photolysis study was performed by Rhone Poulenc using silt loam soil on thin glass plates. The report was originally submitted by Rhone-Poulenc Agriculture Company, RTP, NC which was rewritten and resubmitted by BASF Corporation, RTP, NC (MRID 41688501). In a phase IV review of 3/7/91, the EFGWB noted that the study was unacceptable and a new study was required. A data call-in for the study was issued by the Agency on 10/08/96 since the original photodegradation study on soil (MRID 41688501) was not acceptable. The study showed acifluorfen to be the only extractable residue from soil irradiated continuously for 30 days. According to the EPA’s letter of Oct. 8, 1996, the study was not accepted for the following reasons: 1) the artificial light source used was not an accepted substitute for sunlight, 2) irradiated samples were incubated 20 degrees higher than the dark controls, 3) the soil was not sieved properly, and 4) both rings were not adequately labeled to follow the mass balance.

A new soil photolysis study was conducted to fulfill the requirements for the photolysis on soil according to US EPA’s Pesticide Assessment Guidelines, Subdivision N, Chemistry: Environmental Fate, Guideline 161-3.

A loamy sand soil was treated with ^{14}C-acifluorfen (N and F labels) at a concentration of approximately 3.5 to 3.8 ppm and subjected to photolysis at 25°C at a light intensity of 1700 uEinsteins $m^{-2} s^{-1}$. Control samples were similarly treated - soil samples were maintained in the dark at the same temperature. Treated soil samples were subjected to 0 to 15 days of continuous illumination (equivalent to 30 days, 12 hours light and 12 hours dark per day). Control samples were analyzed at the same sampling times as the irradiated samples.

In the – label irradiated soil, the ^{14}C-CO_2 was the major residue occurring at a maximum concentration of 7.72% TAR at 15 DAT whereas in the dark control soils, the ^{14}C-CO_2 accounted for less than 0.2% TAR. The majority of radioactivity in extractable residues was associated with the parent, BAS 9048H (acifluorfen acid) peak. The amount of BAS 9048H declined from 93.5% TAR in 0 DAT soil to 81% TAR in 15 DAT soil. There were two unknowns, UK1 and UK2, and their concentration ranged from 1.1 to 2.7% TAR for all time periods. In the dark control soils, the majority of the extractable radioactivity was also associated with BAS 9048H. The radioactivity in BAS 9048H ranged from 93.5 to 95.8% TAR in 0 to 15 DAT soils and unknowns UK1 and UK2 were found at a concentration of less than 3% TAR.

In the F label, the parent concentration accounted for 93.1% TAR at 0 DAT which declined to 82.4% TAR by 15 DAT. In the dark controls, the BAS 9048H accounted for 86.7% TAR at 15 DAT. There were two unknowns, UK1 and UK2, and the concentrations of each was less than 2.3% TAR.

The mass balance for both irradiated and dark control samples in both N and F labels were between 87.8 and 109% TAR. The non-extractable residues did not exceed 7% TAR in any irradiated and dark control samples of N and F label treated soils. The half-life values for BAS 9048H in the irradiated soil or dark controls were not determined since the BAS 9048H remained at 81 and 95.2% TAR at 15 DAT in irradiated and dark controls, respectively. The half-life for BAS 9048H under soil photolysis conditions is greater than 15 days.

The results obtained with the CF_3-label for both the irradiated and dark controls are similar to that observed with the NO_2-label. Results from both the NO_2 and the CF_3-label studies indicate that BAS 9048H is photolytically stable on soil and therefore, photolysis is not considered a major degradation pathway for the metabolism of BAS 9048H in soil.

In conclusion, results of the NO_2 and CF_3 -labeled photodegradation studies on soil indicate that acifluorfen is photolytically stable on soil. The DT_{50} for BAS 9048H in both irradiated and dark controls was significantly greater than 30 days (12 hour light/12 hr dark cycle). Photo-degradation on soil is not considered a major degradation route in the environment for acifluorfen.

Aerobic Soil Metabolism (GDLN 162-1)

00122760

Wargo, J. P., Ku, C., Norris, F. 1982. Metabolism of Carbon-14 Labeled MC-10978 in Kansas, Virginia, Georgia and New Jersey Soils under Aerobic and Anaerobic Conditions Accession No. 07134, Rhone-Poulenc Report no. ASD 82/040, 7/30/82.

00143572

Gemma, A. A. and J. P. Wargo. 1984. Metabolism of ^{14}C-MC-10978 (Tackle) in Soil under Aerobic and Anaerobic Conditions”. Accession No. 254534. 1982.

00143572

Looper, G. 1990. Phase 3 summary of Rhone-Poulenc Report No. ASD 82/040 (Accession No. 071324) and Report No. ASD 84/088. BASF Reg. Doc. No. 5095. 10/29/90.

The original aerobic soil metabolism study (MRID 00122760) was reviewed by the agency and considered as supplemental because due to the efficacy of the extraction procedure. A new study by Gemma and Wargo was submitted in August 1984 (MRID 00143572) which was reviewed and accepted in 11/7/84. A phase three summary report combining the aerobic soil metabolism portion of the study from both the reports, ASD 82/040 and 84/088 was written in 1990 and submitted to the Agency (MRID 00143572).

Aerobic and anaerobic soil metabolism was conducted with ^{14}C-sodium acifluorfen labeled in the NO_2 ring using a Mississippi/New Jersey loam soil mixture. The soil was treated at an application rate of 1.0 ppm and incubated between 22 and 24°C. The soils from the aerobic portion of the study were sampled at 0, 1, 3, 7, and 14 days and at 1, 2, 3, 4, and 6 months. After one month of aerobic aging, four treated samples were taken and amended with 2 g of D-glucose and flooded with distilled water for the anaerobic portion of the study. The anaerobic soils were sampled one and two months after flooding.

In the aerobic soil metabolism study, extractable residues declined from 98% TAR at 0 DAT to 76% after 6 months. Non-extractable residues accounted for 2.5% TAR at 0 DAT and 24% after six months. Volatiles accounted for less than 1% TAR. The TLC analysis of extractable residues showed that parent acifluorfen was the major metabolite which accounted for 90% TAR at 0 DAT and declined to 43% after six months. The amino and desnitro analogs were minor metabolites each accounting for 2.4 to 3.1% TAR at six months. TLC origin materials (polar metabolites) were 5 to 7% and non polar-metabolites were 3% TAR. The half-life value for the parent was estimated to be 170 days by first order reaction in the Mississippi/New Jersey loam soil mixture (ASD 84/088). The half-life of acifluorfen was also estimated from an average of two ring-labeled treatments in the original study (ASD 82/040) for four soil types. The half-lives were: Georgia sandy loam 111 days; Kansas clay loam 200 days; New Jersey silt loam 108 days and Virginia sandy loam 193 days.

Fisher, J.D., and W.M. Pierson. 1976. RH-6201 Laboratory Soil Metabolism Soil Study (unpublished report for Rohm and Haas Co. Philadelphia, PA. Technical Report 34H-76-18. In Final Report dated 8/29/79. Review of Blazer. Contract 68-0105830. Submitted to EPA, Arlington, VA. Submitted by Enviro Control, Inc. Rockville, MD.

The EFGWB "One-Liner Data Base" reports the results of an earlier study submitted to the Agency. The reported half-lives of 30 and 60 days respectively for a sandy soil and silty soil, respectively (Fisher and Pierson, 1976). Radio-labeled sodium acifluorfen (at the trifluoromethyl group for one batch and the carboxyl group for the second batch). Total CO_2 was measured with a scintillation counter. Soils samples collect on days 10, 15, 30, 60, 107, and 180 (or 182) were analyzed for ^{14}C. Break-down products or degradates included acifluorfen acid and amino acifluorfen.

Anaerobic Soil (GDLN 162-2) or Anaerobic Aquatic Metabolism (GDLN 162-3)

00143572

Gemma, A. A. and J. P. Wargo. 1984. Metabolism of ^{14}C-MC-10978 (Tackle) in Soil under Aerobic and Anaerobic Conditions". Accession No. 254534.

43155201

Panek M. G. and C. E. Reese. 1994. Anaerobic Aquatic Metabolism of ^{14}C-Sodium Acifluorfen. BASF Report No. M9326. BASF Reg. Doc. No. 92/5073.

An anaerobic soil metabolism study was conducted as a part of the aerobic soil metabolism with ^{14}C-sodium acifluorfen labeled in the NO_2 ring using a Mississippi/New Jersey mixture of loam soil (Report ASD 84/088). The loam soil was treated at an application rate of 1.0 ppm and incubated between 22 and 24^{o}C. After one month of aerobic aging, four treated samples were amended with 2 g of D-glucose and flooded with distilled water for the anaerobic portion of the study. The anaerobic soils were sampled at one and two months after flooding.

In the anaerobic soil, extractable residues declined from 79% at 30 DAT to 62% at 60 DAT. An additional 5.6% and 2.6% TAR were recovered in the flooded water at 30 and 60 DAT, respectively. Non-extractable residues accounted for 15% at 30 DAT and 35% TAR at 60 DAT. The metabolites in the extractable residues were acetamine of the amine analog (9.8 and 12.1% TAR at one and two months, respectively), parent (9.0 and 4.0% TAR), amino analog (7.3 and 5.7% TAR) and the desnitro analog (6.6 and 7.8% TAR). The desnitro, amino and the acetamide residues in the anaerobic soil extracts was confirmed by either GLC or GC/MS analysis.

However, the agency in its letter of 10/14/1996 indicated that the anaerobic soil metabolism study was submitted previous to the 1982 Subdivision N guidelines. The study gave an indication that the major product (38% TAR) was the corresponding amine from the reduction of the nitro group. The agency indicated that the guideline 162-2 is not satisfied and that, therefore, a new anaerobic soil metabolism study (162-2) or the anaerobic aquatic metabolism study (162-3) was required. A new anaerobic aquatic metabolism study was conducted and submitted to the agency on 3/9/94 (MRID 43155201).

A clay soil flooded with well water was treated with ^{14}C-sodium acifluorfen labeled in the CF_3 ring after establishing anaerobic conditions for 30 days. Samples were analyzed for a period of 1 year. Acifluorfen rapidly declined from 95.5% TAR at 0 DAT to 6.3% TAR at 10 DAT with a half-life of 2.75 days. The amino analog of acifluorfen formed by rapid reduction of the nitro group increased from 1.6% TAR at 0 DAT to 76.9% TAR at 10 DAT and then declined to 64.6% TAR at 375 DAT. Acetamide was a minor metabolite found at a maximum concentration of 3.12% TAR at 375 DAT. The volatiles, humic acids, fulvic acids and humin fractions each accounted for 0.8, 12.0, 3.0 and 4.6% TAR, respectively at 375 DAT.

In conclusion, acifluorfen degraded in an anaerobic (nitrogen atmosphere) clay soil:water system that was treated with approximately 25 ppm sodium acifluorfen and incubated in the dark at 25°C for 10 days. The major transformation product, amino acifluorfen, was generated by a reduction of the nitro group to an amino group. In this and in an additional experiment in which samples were incubated under similar conditions for up to 375 days, the degradates, amino acifluorfen, acifluorfen acetamide, and desnitro acifluorfen were identified in the soil:water systems. Little formation of $^{14}CO_2$ was observed in this system.

Based on the decline of the parent compound, the calculated half-life was 2.75 days. It is important to note that only minor modification of the parent compound was observed in this study and, therefore, the metabolites may be biologically active. The behavior of the metabolites must be considered when using the provided half-life value.

Aerobic Aquatic Metabolism (GDLN 162-4)

42330601

Panek G. 1992. Aerobic Aquatic Metabolism of ^{14}C-Sodium Acifluorfen. BASF Reg Doc. No. 92/5066.

An aerobic aquatic metabolism study (MRID 42330601) was submitted and EPA responded on 10/8/96 indicating that the study was acceptable and completely satisfied the aerobic aquatic metabolism data requirement for sodium acifluorfen.

A clay soil was flooded with well water and immediately treated with ^{14}C-sodium acifluorfen labeled in the CF_3 ring and incubated in dark at 25°C for 35 days. Acifluorfen was relatively stable decreasing from 98% TAR at 0 DAT to 81.8% TAR at 35 DAT. The ratio of ^{14}C-residues in the water:soil changed from approximately 9:1 immediately post-treatment to 5.5:1 at 35 days. At 35 DAT, non-extractable residues were 10.8 to 11.3% TAR, $^{14}CO_2$ was 4.39% TAR and 0.12% TAR were other [^{14}C] volatiles. There were 10 minor metabolites in the soil extracts at 35 DAT and their combined total did not exceed 3.7% TAR. The material balance was 93.4 to 106.0% TAR.

Leaching and Adsorption/Desorption (GDLN 163-1)

42793501

Suter, P. 1993. Adsorption and Desorption of Acifluorfen on Representative Agricultural Soils. BASF Report No. M9312. BASF Reg. Doc. No. 93/5042.

Trifluoromethyl labeled parent acifluorfen-free acid had very low affinity for all four soils used in the study. Solution concentrations at 0.19, 0.39, 0.58, 0.77, 0.97, 1.35, 1.55, 1.94, 3.87, 5.80, 7.74, 9.67, 11.61, 13.54, 15.48, 17.41, and 19.35 mg/L, were very mobile in sand, sandy loam, loam, and clay soil:calcium nitrate solution slurries (1:2 w:v) that were equilibrated for 24 hours at 25°C. K_{ads} values were 0.148 for the sand soil, 0.346 for the sandy loam soil, 1.51 for the loam soil, 1.87 for the low organic (1.6%) clay soil and 3.1 for the high organic (3.2%) clay soil. The K_{oc} values for sand, sandy loam, loam, low organic clay, and high organic clay soils were 50.22, 73.52, 56.96, 198.7, and 168.89, respectively. K_{des} values were 0.461 for the sand soil, 0.649 for the sandy loam soil, 3.06 for the loam soil, 2.95 for the low organic clay soil, and 4.47 for the high organic clay soil. Adsorption and desorption 1/n values ranged from 0.752 to 0.888. Adsorption and desorption were strongly correlated with soil organic matter content, clay content, and CEC.

Leaching and Adsorption/Desorption of Degradates (GDLN 163-1)

44412902

Mills, C. and A. G. Goetz. 1997. Adsorption/Desorption of ^{14}C-BH 9048-A (Amino Acifluorfen) on Soil. BASF Reg. Doc. No. 97/5334.

The Agency in its letter of 10/08/96 indicated that study MRID 427935-01 satisfied the unaged leaching/adsorption/desorption portion of the data requirements by providing acceptable adsorption/desorption data on four soils. Acceptable mobility data were required on the degradates of sodium acifluorfen to satisfy the aged leaching portion of the data requirements.

An adsorption/desorption study was conducted with ^{14}C-acifluorfen amine on four soils. Acifluorfen amine was the only major metabolite found at >10% - 76.8% in anaerobic aquatic system at 10 DAT (MRID 431552-01). The K_{ads} values for the sand, clay, loam, and loamy sand were 1.25, 12.11, 19.34, and 47.01% TAR, respectively. The K_{oc} values were 431 for sand, 652 for clay, 741 for loam and 7368 for the loamy sand indicating that amine acifluorfen is immobile in loamy sand, had low mobility in loam and clay soils, and medium mobility in sand soil. The percentage of acifluorfen amine absorbed was 92.7, 85.5, 79.2, and 28.7 %TAR for loamy sand, loam, clay, and sand soils, respectively. R^2 values were 0.988, 0.999, 0.869, 0.999, and 0.951, respectively (1/n values were 0.936, 0.893, 0.869, and 0.802). K_{ads} values were 47.01, 19.34, 12.11, and 1.25 for loamy sand, loam, clay, and sand soils, respectively. K_{oc} values were 7368, 741, 652, and 431 for loamy sand, loam, clay, and sand soils, respectively. In McCall's relative mobility classification , acifluorfen amine is classified "immobile" in loamy sand, "low mobility" in loam and clay, and "medium mobility" in sand.

Terrestrial Field Dissipation (GDLN 164-1), Prospective Groundwater Monitoring (GDLN 166-1), and Small-Scale Retrospective Groundwater Monitoring (GDLN 166-2) Studies

The terrestrial field dissipation data requirement was study was met by the limited retrospective and prospective ground water studies (MRID 42152201). The Agency in its letter of 10/8/96 indicated (D192233, D179053, D178920) that the terrestrial field dissipation (164-1) requirement has been addressed in submitted ground water monitoring study D173298 (MRID 42152200, 42152201).

421522-00

Hiscock, A. M. 1991. A Small Scale Retrospective Groundwater Monitoring Study and Limited Prospective Groundwater Monitoring Study with Acifluorfen-Sodium, the Active Ingredient of Tackle™ Brand Herbicide and Blazer™ Brand Herbicide. BASF Reg. Doc # 91/5031.

421522-01

Hiscock, A. and S. C Cooper. 1991. A Small Scale Retrospective and Limited Prospective Groundwater Monitoring Study with Acifluorfen-Sodium, the Active Ingredient of Tackle™ Herbicide and Blazer™ Herbicide. BASF Reg. Doc # 91/5206.

41833201

Blundell, K. A Small Scale Retrospective and Limited Prospective Groundwater Monitoring Study with Acifluorfen-Sodium, the Active Ingredient of Tackle™ Herbicide and Blazer™ Herbicide: Interim Report. BASF Reg. Doc # 91/5048.

USEPA. 1993. Review of Small Scale Retrospective Groundwater Monitoring Studies. EFGWB# 92-0428 (D173298) dated Jan 26, 1993, USEPA, Washington, DC.

USEPA. 1996. Review of photodegradation in water, aerobic aquatic and Adsorption/Desorption studies EFGWB#s 92-0968, 92-1014, 93-0807 (D192233, D179053, D178920) dated Sept. 17, 1996. Sent with a letter, dated Oct. 8, 1996, from Lois A. Rossi to Karen R. Blundell. USEPA, Washington, DC.

42152201
Hiscock, A. M. and S. C. Cooper. A small-scale retrospective and limited prospective groundwater monitoring study with acifluorfen-sodium, the active ingredient of Tackle® and Blazer®: Final Report BASF Registration Document No. 91/5206. EFGWB No. 92-0428

41160001
Norris, F. A small-scale retrospective and limited prospective groundwater monitoring study with acifluorfen-sodium, the active ingredient of Tackle® Brand Herbicide and Blazer® Brand Herbicide: Progress Report Rhone-Poulenc Ag. Company and BASF Corporation. EPA review EFGWB No. 90-002.

Asc 224133
Jones, R. L. and F.A. Norris. A small-scale retrospective monitoring study with Acifluorfen-sodium, the active ingredient of Tackle Brand herbicide and Blazer Brand herbicide: Study Protocol. EPA review EFGWB No. 80-822.

166-2 Retrospective Groundwater Study. During the retrospective groundwater study, soil samples were collected from five sites, with various sodium acifluorfen use histories, located in North Carolina, Virginia, Tennessee, Indiana, and North Dakota. Sodium acifluorfen had been applied at the test sites one to four years prior to study applications. The histories of sequential years of sodium acifluorfen treatment were as follows: Virginia - 2 years, Tennessee - 3 years, North Carolina - 4 years, and Indiana and North Dakota - 1 year each. Each test site received an additional application of sodium acifluorfen (0.21 to 0.26 lb ai/A) in 1989, the Indiana and North Dakota test sites also received second applications (0.25 lb ai/A) in 1990 resulting in a minimum of three sequential applications of sodium acifluorfen-containing products. Conducting the study at sites with a history of prior sodium acifluorfen use does not conform with the Agency's general position that there should be no prior use of the chemical at the site of the terrestrial field dissipation study.

The sites were selected to be representative of the soil and hydrogeologic conditions in soybean growing areas in the United States. The Agency did not entirely agree with the registrant as to each sites vulnerability to ground water contamination (D173298). Sites selected by the registrant had water table depths ranging from less than 1 foot (0.38 to 4.68 feet) at North Carolina to more than 15 feet at the Tennessee site. Soil textures generally were sand or loamy sand in the subsoil, some sites had higher amounts of clay and in the surface one to three foot zone than is generally acceptable to the Agency.

Generally, samples were collected and analyzed until such time as acifluorfen residues levels were non-detectable (<0.01 ppm) in all depth increments (not true for ND some residues remained). Sampling depths and intervals varied with time and site (TABLE G-2).

TABLE G-2. Location, number of sodium acifluorfen applications, and soil sampling times and depth increments.

Site Location	App.[1]	Sampling	
		Time in relation to application	Depth Intervals (in)[2]
Indiana	1 2	Pre-App, 0, 14 d, 1 m Pre-App, 0, 14 d, 1,2,3,4,5,9,10,11,12 m	0-6,0-12,12-24,24-48 0-6,6-12,12-18,18-24
North Carolina	1	Pre-App, 0, 14 d, 1,2 m	0-6,0-12,12-24,24-48
North Dakota	1 2	Pre-App, 0, 14 d, 1,2,3,10 m Pre-App, 0, 14 d, 1,2,3,4,5,10,11,12 m	0-6,0-12,12-24,24-48 0-6,6-12,12-18,18-24
Tennessee	1	Pre-App, 0, 20 d, 1 m	0-8,0-12,12-24,24-36,36-48
Virginia	1	Pre-App, 0, 14 d, 1 m	0-6,0-12,12-24,24-48

[1] Application number. Application 1 - 1989, Application 2 - 1990.

[2] Not every sampling interval was collected and sampled at each sampling time. The pre-application increments are not included

One pre-application 0 to 6-inch core at the Indiana site had a detectable level of 0.013 ppm of acifluorfen (before 1989 application). In North Dakota, acifluorfen residues were also detected in the pre-application samples before both applications. Three of four 12-inch long soil cores (0-12") at the ND site had detectable levels (0.011 to 0.057 ppm) prior to the first application (1989). All the 6-inch cores at the North Dakota site had detectable levels (0.029 to 0.052 ppm) of acifluorfen residues prior to the second application (1990).

Residues also remained in all the 0-6 inch soil sampling increments at 10-month sampling (last sampling after first application) and 13 months after the second application. Thus, acifluorfen residues (0.019 to 0.073 ppm) were still present in soil at detectable levels (detection limit 0.010 ppm) one year after it was applied at the North Dakota site. Acifluorfen residues were found in some of the 6 to 12-inch (6-inch long increments) subsurface soil samples. But when subsurface sampling increments were 12 or more inches long residues were not detected. The surface soil sampling interval also varied between 0 to 6 inches and 0 to 12 inches, thus it is not possible to determine whether acifluorfen concentrations decreased due to dissipation or dilution. The soil sampling design was not adequate (increments were too long) to determine whether acifluorfen was leaching at any of these sites.

There were no detectable residues in soil after one month at the Virginia, Tennessee, and Indiana sites and after two months at the NC site. At the ND site, residues were detected (0.01 to 0.05 ppm) in the 0 to 12-inch segment through ten months post application. After two weeks, residue levels of 0.01 to 0.026 ppm were detected in the 12 to 24-inch segment and thereafter no residues were detectable below the 12-inch level through ten months.

After the second application of sodium acifluorfen to Indiana and ND sites, soil samples were taken through 12 and 13 months. At pre-application, in the 0 to 6-inch segment maximum residue levels of 0.013 ppm and 0.05 ppm were detected in Indiana and ND sites, respectively and below 6 inches residue levels were undetectable (<0.01 ppm). In the post application soils no residues were detected below 12 inches throughout the test period at both sites. At both sites, residue levels of >0.01 ppm were detected in the 0 to 6 inch segments throughout the test period. At the Indiana site, residue levels were generally non-detectable (<0.01 ppm) in the 6 to 12-inch segment after one month except for a single detection of 0.035 and 0.021 ppm at 5 and 9 months, respectively. In the ND site, residue levels were also generally non-detectable (<0.01 ppm) in the 6 to 12-inch segment after one month except for a single detection of 0.015 and 0.016 ppm at 5 and 13 months, respectively.

Field dissipation half-lives, for the surface sampling interval, were established in TN, IN, NC, ND and VA using the first-order decay model (first order model $C = C_o e^{(kt)}$ where C_o is the initial concentration, C is the concentration at time t, k is the slope, and t is time) (USEPA, 1993). The theoretically applied and analytically determined application rates for initial concentrations were used (Hiscock and Cooper, 1991). Three different values were considered for the initial concentration (C_o) at each site, thus three models. The half-lives were as follows: 10 to 22 days for Tennessee silt loam, 7 to 38 days for Indiana sandy loam, 5 to 7 days for North Carolina loamy sand, 55 to 66 days for North Dakota sandy loam and 8 to 11 days for Virginia sandy loam. The estimated half-lives ranged from 7 to 60 days (MRID 42152201) for model 3. All the half-life values estimated ranged between 7 and 66 days. The longest half-lives occurred at the North Dakota site and shortest were at the North Carolina site.

Two clusters of monitoring wells were initially installed at each site prior to herbicide application in 1989. Each well cluster consisted of three, 1.5-inch diameter PVC cased monitoring wells with a 0.6-foot long section of slotted PVC screen (1, 5, and 10 feet below the water table on day off installation). A third well cluster was installed at each site, per an Agency request, 5 to 6 months after the 1989 sodium acifluorfen application. Groundwater samples were generally collected monthly (and later analyzed) after the 1989 sodium acifluorfen application all five sites. Sampling was also conducted generally monthly after the 1990 application at the Indiana and North Dakota sites for 12 and 13 months, respectively.
There were no detections, with a limit of detection of 1.0 µg/L, in any of the samples collected at the five retrospective sites, during the study. Although it should be noted that two possible detections occurred at the North Carolina study site, but were classified by the registrant as "false positive" detections.

Two points should be made concerning the retrospective groundwater study at the North Carolina study site. Because the water table at the NC study site was extremely shallow (0.38 to 4.68 feet), there is a possibility water move upward rather than downward. This possibly could mask or prevent the occurrence of leaching. Another point that could result in the failure to detect the leaching of acifluorfen is that with the high water table conditions, anaerobic conditions could have resulted in the rapid transformation of acifluorfen to amino acifluorfen. Degradates were not included in the retrospective portion of the study. This may explain the short half-life for acifluorfen at the NC study site.

Despite the efforts made by the registrant address issues that the Agency (D173298) identified a number of deficiencies and limitations that had been identified in earlier reviews and number of problems remained. Several issues identified by the Agency have yet to be addressed by the registrant. Issues include the study was initiated and completed prior to Agency approval of the study sites and the final study protocol. Protocol modifications were also made without

Agency approval. Deficiencies and limitations include a limited history of previous use, over-emphasis on subsoil layers, larger than desirable soil-sampling increments that would dilute acifluorfen residues, and remote weather stations. From the study it was not possible to determine whether acifluorfen concentrations decreased by degradation in the soil, or was diluted or dissipated by leaching out of the sampling zone.

411728-01

Norris, F. A. 1989. A Small-Scale Prospective Field Dissipation and Ground water Monitoring Study with Acifluorfen-Sodium, the Active Ingredient of Tackle™ Herbicide and Blazer™ Herbicides".

166-1 Prospective Ground Water Study. Dissipation of acifluorfen in soil was also evaluated by measuring acifluorfen residues in soil samples over time at the irrigated Wisconsin sandy soil as a part of the prospective groundwater monitoring study (MRID 411728-00,01). The study was conducted near Hancock in Waushara County, Wisconsin. The site is located in the central sand region of Wisconsin, an area characterized by sandy soils with low organic carbon contents and moderate to shallow water tables. The soil at the site was identified as the Plainfield loamy sand (Mixed, mesic Typic Udipsamments) with a water table at a depth of about 5.5 to 7 meters. The ground water in this region of Wisconsin has been recognized as being highly vulnerable to contamination, as other pesticides have been detected in ground water.

The maximum sodium acifluorfen label rate of 0.75 lb ai/A was applied to soybeans. The study plot was divided into four subplots. Acifluorfen residues were sampled and analyzed in three matrices, soil, soil-pore water, and ground water. A cluster of 3 suction lysimeters (1, 2, and 3-m below the surface) was placed near the center of each subplot sample soil-pore water. Later an additional 1.5-m lysimeter was added to each subplot. Five well clusters (3 wells per cluster with screened intervals at 0.3, 1.5, and 3.0 m beneath the water table at time of well installation) of monitoring wells were also installed. One cluster was placed up-gradient and off-site, two clusters were placed with the plot, and one well cluster each were placed to the south and southwest down-gradient sides the field. Soil samples (4 cores) from each subplot were collected on the day of application (time 0, 0 to 0.2-m), at 0.25 months after application (0 to 0.3-m and 0.3 to 0.6-m), at 0.5, 1, and 2 months after application (0 to 0.3-m, 0.3 to 0.6-m, 0.6 to 1.2-m).

During the course of the study, the site was irrigated with about 307 mm of water, and received about 574 mm of precipitation. During the first two months, irrigation barely replaced evapotranspiration. Irrigation was discontinued in September.

It was difficult to always follow whether the registrant was addressing sodium acifluorfen or acifluorfen (acid). The registrant is inconsistent as to specifying what compound is the parent acifluorfen. The aerobic metabolism pathway diagram, page 8 (MRID 41688501, BASF Reg. Doc. 90-5096) shows sodium acifluorfen as MC-10978, acifluorfen (acid) as MC-10109, amino acifluorfen as MC-14621, and desnitro acifluorfen as MC-10879. Pages 15 and 18 of the final prospective groundwater study report (MRID 41172801) discuss the acifluorfen metabolites LS-82-5281 and LS-82-5283 which were define elsewhere as amino acifluorfen and desnitroacifluorfen, respectively. Acifluorfen (acid) is defined as LS-82-5276 on page 18 of the final ground water report. Thus it appears that the registrant analyzed for acifluorfen (acid), amino acifluorfen and desnitroacifluorfen rather than sodium acifluorfen. Sodium acifluorfen concentrations in soil were estimated by multiplying the ratio (1.06) of atomic mass of sodium acifluorfen and acifluorfen which was adjusted for soil water content. No conversion of acifluorfen to sodium acifluorfen was presented (GC used the acifluorfen acid) for water. However, page 19 suggest that the acifluorfen concentrations are reported as the salt (sodium acifluorfen) rather than the acid (acifluorfen).

Acifluorfen (LS-82-5276) dissipated rapidly in soil with a half-life of about 15 days and after two months, residue levels were near detection levels (0.002 to 0.005 µg/g). Metabolites (amino acifluorfen - LS-82-5281 and desnitroacifluorfen - LS-82-5283) were also analyzed for with a detection limit ranging from 0.004 to 0.010 µg/g). There were no detections of the acifluorfen metabolites amino acifluorfen and desnitroacifluorfen in any soil sample. Based upon the levels of acifluorfen in ground water it would appear that a major dissipation pathway of sodium acifluorfen is the leaching of acifluorfen (acid) to ground water.

Water samples were analyzed for acifluorfen (LS-82-5276 or MC-10109), amino acifluorfen (LS-82-5281) and desnitroacifluorfen (LS-82-5283 or MC-10879) The descarboxy derivative was the primary degradate found in the solution (MRID 411728-00,01).

Acifluorfen was found in 12 of the 16 suction (porous cup) lysimeters during the study. The first detections occurred in the 2-m deep lysimeters at about 6 weeks (1.4 months) after the sodium acifluorfen application. Acifluorfen was still being detected in the 1.5 and 3-m suction lysimeters at the last sampling date (19 weeks, 4 months after the sodium acifluorfen application). Detections occurred in suction lysimeters at 14 of 17 sampling periods in 6 to 62 percent of the lysimeters. Acifluorfen concentrations, reported as sodium acifluorfen, ranged from < 1 to 22 µg/L. Many of the suction lysimeters did not collect water or did collect sufficient water for analysis.

Acifluorfen residues (reported as sodium acifluorfen) were detected in ground water in 56 out of 283 samples (20%) with concentrations ranging from 1 to 46 µg/L. The study duration was 4/20/88 to 4/12/89 with the detection of acifluorfen occurring from 9/14/88 through 4/12/89 (final sampling). The concentration for the five detections from the final sampling was 15.2 µg/L. The overall mean for the 56 detections, during an 8-month period, was 8.36 µg/L. The average of all the 10 sampling dates during this period was 7.33 µg/L. The herbicide was generally found in the shallowest monitoring well suggesting that it was moving with the ground water flow. The registrant suggested that finding the acifluorfen in the ground water without observing the movement of the product through the soil profile implied vertical movement of the chemical by preferential or by-pass flow, rather than moving through the soil matrix. The Agency concurs that will preferential flow may have occurred the occurrence of pesticide residues in multiple suction lysimeters at multiple sampling dates suggest that matrix flow was also occurring on site. The large number of suction lysimeter with no water or limited water volumes is more likely due the physics of system based upon the pore geometry of the soil and the suction cup (in ability to hold suction).

Aquatic Field Dissipation Study (GDLN 164-2)

43270801

Jordan, J. M. and T. R. Nelsen 1994. Blazer Herbicide Aquatic Use Dissipation Study. BASF Report # ER94017, BASF Reg. Doc. No. 94/5075.

An aquatic field dissipation study was conducted in rice paddies in Mississippi and Louisiana to determine the residue dissipation rate, mobility, and degradation profiles of sodium acifluorfen when applied under aquatic use patterns. Acifluorfen was applied twice at 0.25 lb. ai/A for a total of 0.50 lb. ai/A to plots without rice using a nearby rice indicator plot. The first application was made to dry plot, which was flooded 24 hour later, and the second application was made to the flooded plot at early boot stage for the rice. The soil and water samples were analyzed for parent acifluorfen (stated to be sodium acifluorfen) and its metabolites. The report (Appendix C Report No. 94917; page 156) says that the study achieved a level of quantitation of 1.00 ppb for acifluorfen, acifluorfen-amine, acifluorfen-acetamide, and descarboxy-acifluorfen.

Soil samples were taken to 6” depth during flooding and to 48” after removing the water at approximately 60 days after the second treatment.

No acifluorfen residues were found in soil samples below the 0-6” depth. Acifluorfen and its metabolites rapidly dissipated from the rice paddy system. The total acifluorfen residues in Mississippi soil were 0.304 lb ai/A after the second application and declined to less than quantitation limits at 180 days after application. At the Louisiana site, total acifluorfen residues were 0.24 lb ai/A after the second application, and declining to less than the quantitation limit after 30 DAT. Acifluorfen rapidly degraded in water with a small amount of residue found in the sediment. For the Mississippi site, the DT_{50} for the rice culture system was 17.7 days and for the Louisiana site, DT_{50} was 2.2 days. The dissipation rates of acifluorfen in water only for Mississippi and Louisiana sites were calculated to be 1.3 and 1.2 days, respectively.

When two applications of sodium acifluorfen were applied to rice paddies in Mississippi and Louisiana acifluorfen was observed to degrade rapidly in water (for both sites the DT_{50} was less than 2 days). The maximum acifluorfen concentration at the Mississippi site after the first application was 60.4 µg/L and 281 µg/L after the second. Concentrations dropped below the detection limit of 1 µg/L by day 9 and 13 after the first and second application, respectively. Acifluorfen acetamide was detected in four out of 27 sample dates after the second application. The maximum was 6.01 with a detection limit of 1 µg/L. Ten of 27 samples had detections of amino acifluorfen after the seconded application, ranging from 1.01 to 5.00 µg/L, none after day 9 following the application.

The maximum concentrations of acifluorfen at the Louisiana site were 51.2 and 286 µg/L after the first and second applications, respectively. Concentrations dropped below the detection limit by day 20 following both applications. Done of the three degradates were detected following the first application. The samples from eight of 25 sample dates collected after the second application had acetamide acifluorfen detections ranging from 1.15 to 2.03 µg/L, none after day 9 following the application. Amino acifluorfen residues were detected in samples collected at eleven of 25 sampling dates after the second applications ranging from 1.13 to 6.17 µg/L, none after 20 days following the application.

The two major dissipation pathways appeared to be aqueous photolysis and anaerobic aquatic metabolism. The registrant indicates that at the Louisiana site that anaerobic aquatic metabolism may not be as important because there was less amino acifluorfen produced. Acifluorfen in the sediments were reduced under anaerobic conditions to acifluorfen amine and acifluorfen acetamide. Acifluorfen amine was first detected (13 ppb) in sediment four days after the first application. The maximum concentration (56.2 ppb) was observed 30 days after the first application which declined to <10 ppb by 180 days after the second treatment. The estimated DT_{50} in sediment was calculated to be 284 days.

Sodium acifluorfen undergoes photolytic degradation in water with a half-life of ranging from 21.7 hours to 352 hours with the different concentrations, pH and buffer systems used. Data were insufficient to evaluate if any of these factors influenced the rate of degradation. In water that is able to transmit adequate light, acifluorfen may degrade rapidly in surface water bodies. In soils, acifluorfen is more photolytically stable. The DT_{50} for sodium acifluorfen (BAS 9048H) in both irradiated and dark controls was significantly greater than 30 days (12 hour light/12 hr dark cycle). Photodegradation on soil is not considered a major degradation route in the environment for acifluorfen.

In Mississippi soil, acifluorfen amine was found at a maximum concentration of 56 ppb after 30 days and steadily declined to non-detectable levels (<10 ppb) after 180 days with a DT_{50} of 284 days. In Louisiana soil, however, acifluorfen amine was detected at a maximum concentration of 12.3 and 11.9 ppb after 6 days of the 1st and 2nd application, respectively, and thereafter acifluorfen amine was undetectable in soil. In water, acifluorfen amine was found at a maximum concentration of 4.77 ppb after 48 hours and declined to <1.0 ppb after 13 days at the Mississippi site. Acifluorfen amine concentration in water was at a maximum concentration of 5.44 ppb after 4 days and declined to <1.0 ppb after 20 days at the Louisiana site.

The data suggests that acifluorfen undergoes rapid degradation in rice paddy water and is not persistent. There are very little accumulation and no persistence of acifluorfen metabolites in rice paddy water. Acifluorfen amine was the major metabolite formed in the soil sediment. The descarboxy metabolite was not detected and acetamide was found at very low concentrations (1 to 3 ppb) and was not persistent. Soil analysis up to 48-inch after the water was removed showed no acifluorfen residues below the 0 to 6-inch segment.

The registrant attributes the dissipation of acifluorfen in a rice paddy to a number of processes, including anaerobic aquatic metabolism and aqueous photolysis. The primary route of degradation in an aquatic system is through aqueous photolysis. Descarboxy acifluorfen was identified as a minor, short-lived product via aqueous photolysis. Acifluorfen that remains in sediment is reduced under anaerobic conditions to acifluorfen amine (has a higher binding potential then acifluorfen acid) and acifluorfen acetamide. Both these compounds were included in the analysis.

In conclusion, acifluorfen residues (acifluorfen, acifluorfen amine, acifluorfen acetamide) dissipated with registrant-calculated half-lives of 2.2-17.7 days from flooded unvegetated plots (water and soil) of clay soil in Mississippi and sandy loam soil in Louisiana that were treated twice in July/August at 0.25 lb ai/A/application with sodium acifluorfen [Blazer BAS 9048 OH; 2.0 lb ai/gallon SC/L]. Flooded conditions were maintained through 55 days after the second treatment; total acifluorfen residues dissipated with registrant-calculated half-lives of 1.2-1.3 days from the floodwater. Acifluorfen dissipated with observed half-lives of <2 and ≤4 days from the soil and floodwater, respectively. The degradate acifluorfen amine (amino acifluorfen; 5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-aminobenzoic acid) was detected in the floodwater and soil. The degradate acifluorfen acetamide (5-[2-chloro-4-(trifluoromethyl)phenoxy]-2-acetamidobenzoic acid) was detected in the floodwater only.

APPENDIX H.
ECOLOGICAL EFFECTS DATA REQUIREMENTS

Sodium Acifluorfen Chemical Number 114401

Guideline	Data Requirement	Are Data Requirements Satisfied?	MRID	Study Classification
71-1	Avian Oral LD_{50}	Y	083058	Core
71-2	Avian Dietary LC_{50}	Y	083059 083060	Core
71-4	Avian Reproduction	Y	1074918	Core
71-3	Wild Mammal LD_{50} & LD_{50}	Y	071887 122743	Core
72-1	Freshwater Fish LC_{50}	Y	071901 107493 122751	Core
72-2	Freshwater Invertebrate Acute LC_{50}	Y	071901	Core
72-3(a)	Estuarine/Marine Fish LC_{50}	Y	124223	Core
72-3(b)	Estuarine/Marine Mollusk EC_{50}	Y	111964	Core
72-3(c)	Estuarine/Marine Shrimp EC_{50}	Y	111962	Core
122-2	Aquatic Plant Growth- Tier I	Y	416807	Core
123-1(a)	Seed Germ./Seedling Emergence	N		
123-1(b)	Vegetative Vigor	N		
123-2	Aquatic Plant Growth- Tier II	Y	416807-02	Core
141-1	Honey bee, acute contact	N		

APPENDIX I.
ENVIRONMENTAL FATE DATA REQUIREMENTS

NA ACIFLUORFEN **Chemical No: 114402**

Data Requirement	Use Pattern[1]		Bibliographic Citation	Status	Notes
	1	4			
§158.290 ENVIRONMENTAL FATE					
Degradation Studies-Lab:					
161-1 Hydrolysis	R	R	107479 071323	**ACCEPTABLE**	Stable to hydrolysis in pH 4.5, 7.2, 9.7 buffer at 1 and 50 ppm at 25C
161-2 Photodegradation In Water	R	R	418912-08 427935-02 441950-01 441950-02	**ACCEPTABLE**	Acifluorfen undergoes photolytic degradation in water to a complex mixture of components none of which exceed 10% TAR. Half-life values ranged from 21 to 352 hours depending on concentration, pH, and buffer system.
161-3 Photodegradation On Soil	CR	---	416885-01 444129-01	**ACCEPTABLE**	NO_2 and CF_3 -labeled photodegradation studies: acifluorfen photolytically stable on soil. The DT_{50} for BAS 9048H in both irradiated and dark controls was significantly greater than 30 days
161-4 Photodegradation in Air	CR	---		**WAIVED**	
Metabolism Studies-Lab:					
162-1 Aerobic Soil	R	---	00143572	**ACCEPTABLE**	Half-lives: Georgia sandy loam; 111 days, Kansas clay loam; 200 days' New Jersey silt loam 108 days, Virginia sandy loam; 193 days. Amino and desnitro minor metabolites (max 3.1%)
162-2 Anaerobic Soil				162-3 replaces	
162-3 Anaerobic Aquatic	---	R	431552-01	**ACCEPTABLE**	Parent half-life 2.75 days. Amino analog formed by reduction of nitro group 76.9% TAR at 10 DAT, 64.6% TAR at 375 DAT. Acetamide max 3.12% TAR at 375 DAT.
162-4 Aerobic Aquatic	---	R	423306-01	**ACCEPTABLE**	Acifluorfen was relatively stable decreasing from 98% TAR at 0 DAT to 82% at 35 DT Half-life: 117 days. 10 minor metabolites total 3.7% TAR.
Mobility Studies: 163-1 Leaching - Adsorption/Desorp.	R	R	427935-01 444129-02	**ACCEPTABLE**	**Acifluorfen**: Koc sand, sandy loam, loam, low organic clay, high organic clay: 50.22, 73.52, 56.96, 198.7, 168.89 Kads sand, sandy loam, loam, low organic clay, high organic clay: 0.148, 0.346, 1.51, 1.87, 3.1 **Acifluorfen amine**: Koc sand, clay, loam, loamy sand: 431, 653, 741, 7368 Kads sand, clay, loam, loamy sand: 1.25, 12.11, 19.34, 47.01
163-2 Volatility (Lab)	CR	---		**WAIVED**	
163-3 Volatility (Field)	CR	—		**WAIVED**	

Data Requirement	Use Pattern[1] 1	4	Bibliographic Citation	Status	Notes
Dissipation Studies-Field:					
164-1 Soil	R	---		**SUPPLEMENTAL (see one-liner)**	Addressed in GW monitoring study See 10/8/96 letter
164-2 Aquatic (Sediment)	---	R	432708-01	**ACCEPTABLE**	DT_{50} for the rice culture system was 17.7 days (Mississippi) and 2.2 days (Louisiana). The dissipation rates of Acifluorfen in water only for 1.3 (Mississippi) and 1.2 days (Louisiana), respectively. Acifluorfen amine: major metabolite.
164-3 Forestry	---	---			
164-4 Combination and tank mixes	---	---			
164-5 Soil, long term	CR	CR		Reserved	
Accumulation Studies:					
165-4 In Fish				**WAIVED** 4/27/92 memo	
Ground Water Monitoring Studies:					
166-1 Small-Scale Prospective 166-2					Review of final report for small-scale retrospective groundwater monitoring studies. Decommission with recommendations DP Barcode D173298 E. Behl/1/26/93
§158.440 SPRAY DRIFT					
201-1 Droplet Size Spectrum					
202-1 Drift Field Evaluation					

FOOTNOTES:

1. 1=Terrestrial Food; 2=Terrestrial Feed; 3=Terrestrial NonFood; 4=Aquatic Food; 5=Aquatic NonFood(Outdoor);6=Aquatic NonFood (Industrial);7=Aquatic NonFood (Residential);8=Greenhouse Food; 9=Greenhouse NonFood;10= Forestry; 11=Residential Outdoor; 12=Indoor Food; 13=Indoor NonFood; 14=Indoor Medicinal; 15=Indoor Residential.

165-1 Confined Rotational Crop: Time extension granted

165-3 Accumulation in Irrigated Crops: Data Waiver granted

APPENDICES J to M.
WATER ASSESSMENT

INTRODUCTION

Details of the water assessment for sodium acifluorfen is divided into four appendices. The first, **Appendix J**, was issued as DP Barcode D239268, 06/01/98 and provides the estimated environmental concentrations (EECS) in a standard farm pond which is used for the aquatic exposure assessment, drinking water assessment based upon the EECs in the farm pond and ground water monitoring data.

The second (**Appendix K**) is a reassessment of the drinking water exposures, because additional ground water monitoring data and surface water monitoring data (USGS, National Water Quality Assessment Program, (NAWQA)) has been collected and the Agency has implemented the Index Reservoir (IR) and Percent Crop Area (PCA) concepts to better assess human drinking water exposure (USEPA, 2000). Additionally, environmental fate information, previously unavailable have been located so that the data can better be evaluated. Both assessments were conducted on sites thought to be vulnerable (*e.g.*, shallow ground water and coarse textured soil with low organic carbon content) or on soils with high runoff potential (*e.g.*, C-curve number and high intensity rainfall events). The registrant of lactofen is also conducting a small-scale prospective ground-water monitoring study to better assess the leaching potential of acifluorfen derived from the degradation of lactofen.

Appendix L contains PRZM input files, EXAMS output summary data tables, and chemical and environment files for EXAMS. **Appendix M** contains a GENEECx rice scenario acifluorfen concentrations and the calculation of a 90 percent upper bound on the mean degradation rate for rice paddies.

APPENDIX J.
Drinking water exposure assessment for lactofen, lactofen derived acifluorfen, and acifluorfen-sodium. Memorandum dated June 1, 1998 (POND Scenarios)

PC Code: 128888 (Lactofen)
PC Code: 114402 (Acifluorfen Na)
DP BARCODE: D239268

MEMORANDUM

FROM:
James K. Wolf, Ph.D.

Soil Scientist

Environmental Risk Branch 3

Environmental Fate and Effects Division (7507C)

TO:
Susan Stanton

Herbicide Branch

Registration Division (7505W)

THRU:
James C. Lin, Ph.D.

Environmental Engineer

Environmental Fate and Effects Division (7507C)

Daniel D. Rieder

Branch Chief

Environmental Fate and Effects Division (7507C)

SUBJECT:

Drinking water exposure assessment for lactofen, lactofen derived acifluorfen, and acifluorfen-sodium.

INTRODUCTION:

The Herbicide Branch of the Registration Division has requested that EFED reevaluate the drinking water exposure assessment for lactofen and lactofen derived acifluorfen using OPP's interim approach for addressing drinking water exposure with respect to cotton use. The interim approach relies upon several models (GENEEC, PRZM/EXAMS, and SCI-GROW) and monitoring data and considers both surface and ground water. Since this request deals specifically with the use of lactofen on cotton for the assessment of the time-limited tolerance for lactofen, cotton use is considered. In addition to being a degradate of lactofen, acifluorfen is also a registered herbicide. Assessments are also presented for lactofen and acifluorfen use on soybeans. A Tier 2 assessment was conducted for surface water using PRZM/EXAMS and a Tier 1 ground-water assessment was conducted using the EFED screening model SCI-GROW. The Tier 2 surface water scenario utilized the EFED standard Mississippi Cotton and Soybean Scenarios as these scenarios represent conditions favorable for high runoff.

CONCLUSIONS:

The environmental fate databases for lactofen and acifluorfen are incomplete. Therefore, considerable uncertainty exists in the estimated concentrations for both lactofen and acifluorfen in ground water and surface water.

Lactofen appears to be rarely, if ever, included in monitoring programs. There are no known detections of lactofen in ground water, excluding the possible detections in Ohio prospective ground-water study. SCI-GROW estimated lactofen concentrations to be equal to or less than the model's default concentration of 0.006 µg/L for cotton and soybean uses.

The estimated peak surface-water concentrations of lactofen from a Tier 2 PRZM/EXAMS evaluation based on the *cotton* use were 1.07 and 0.64 µg/L for one (maximum rate of 0.40 lb ai/A adjusted by band and row spacing to 0.32 lb ai/A) or two applications (0.16 lb ai/A adjusted rate per application with a 14-day interval), respectively. The estimated annual mean concentrations were 0.009 and 0.010 µg/L for one or two applications, respectively. The maximum concentration using the maximum label application rate for *soybeans* (0.40 lb ai/A) was 1.88 µg/L. The corresponding estimated annual mean concentration was 0.025 µg/L. The peak values presented in this section represent approximately the 90% exceedence value. If thirty-six years worth of meteorological data were available, the peak value would represent a 95% confidence bound on the 90% exceedence value. Since, only 20-years of data were available, the resulting confidence is less.

Acifluorfen, however, is sometimes included in monitoring programs. Several studies have detected acifluorfen residues in ground water. The prospective study in Wisconsin found acifluorfen residues as high as 46 µg/L, with a long term average of 7.33 µg/L. Survey monitoring (Pesticides in Ground Water Database; USEPA, 1992) studies have also reported acifluorfen residues in ground water, but these values tended to be lower than the prospective study. Concentrations ranged from 0.003 to 0.17 µg/L.

Considerable uncertainty exists in the estimated acifluorfen concentrations obtained from PRZM/EXAMS and SCI-GROW models for surface water and ground water, respectively. The rate of acifluorfen formation is not known, therefore, it could not be included in PRZM. SCI-GROW cannot consider parent decline-degradate formation. Acifluorfen (degradate), at time zero, was assumed to be equal to the maximum percent (52.3%) of degradate to parent times the lactofen application rate and equal to the application rate of lactofen. Acifluorfen (degradate) was also assumed to be present in the upper 1- or 2-cm of soil at time zero. Spray drift for acifluorfen (degradate) was also assumed to be zero.

Considerable uncertainty was also present in the sorption of acifluorfen. Sorption is pH dependant (decreasing with increasing pH) and only a single K_d value was available (pH not known). PRZM/EXAMS uses K_d values as inputs, but SCI-GROW requires K_{oc}. To obtain a K_{oc} value for SCI-GROW, a soil organic carbon content had to be assumed (1 percent). The peak concentrations of acifluorfen (assuming 52.3 % of lactofen is converted to acifluorfen) in surface water were 11.3, 10.47, and 4.67 µg/L, for 1 application - 1 cm deep, for 2 applications - 1 cm deep, and 2 applications - 2 cm deep, respectively. The annual mean surface water concentrations were 3.2, 1.7, and 0.76 µg/L for 1 application - 1 cm deep, for 2 applications - 1 cm deep, and 2 applications - 2 cm deep, respectively. The peak estimated concentration of acifluorfen, if all applied lactofen (0.40 lb ai/A) was converted to acifluorfen, was 23.8 µg/L with an annual mean of 6.8 µg/L. Estimated peak concentrations acifluorfen from acifluorfen-sodium used on soybeans were 15.8, 21.1, and 18.7 µg/L, depending upon application rate (0.375, 0.50, 0.25 lb ai/A) and number of applications (1,1, 2), respectively. The corresponding annual mean acifluorfen concentrations were 5.2, 6.7, and 6.5 µg/L, respectively.

The SCI-GROW estimates of ground-water concentrations of acifluorfen depend upon inputs of $K_{oc,}$ the aerobic soil metabolism half-life selected, the assumptions used concerning the formation of acifluorfen and lactofen decline, and the application rate and number. Because K_{oc} was not known, two values were considered, 10 and 100. The estimated acifluorfen concentrations ranged from 0.19 to 8.27 µg/L, depending upon half-life, K_{oc} value used and the conversion of lactofen to acifluorfen. EFED would recommend using 3.51 µg/L. This represents the highest SCI-GROW estimates for acifluorfen assuming 52 percent of lactofen becomes acifluorfen. This value is recommended because using the K_{oc} of 10 and the same application rate of acifluorfen (0.75 lb ai/A) used in the Wisconsin prospective ground-water study, SCI-GROW's estimates of acifluorfen concentrations in ground water (8.00, 15.5 µg/L) were similar to the measured concentrations (7.33 µg/L). The application rate in the Wisconsin study (0.75 lbs ai/A) is higher than the application rates used in this Drinking Water Assessment (0.4 lb ai/A lactofen and 0.5 lb ai/A acifluorfen on soybean).

BACKGROUND:

In late December 1996 and mid-January 1997, EFED provided HED with estimates of lactofen and its degradate (acifluorfen) concentrations in ground-water as part of a Time-Limited Tolerance Extension for Residues of Lactofen in/on Cotton. Three documents were prepared on the following dates: 12/20/96, 12/23/96 and 1/15/97.

Previously, HED used the maximum acifluorfen concentration detected in the PGWDB for their initial tolerance for lactofen. EFED thought that presenting the cancer risks for drinking water using only concentrations obtained from the Pesticides in Ground Water Database (PGWDB) may grossly underestimate the exposure (with a maximum value 0.025 µg/L) and risk from lactofen and acifluorfen in vulnerable areas. The studies reported in the PGWDB may reflect conditions where no lactofen or acifluorfen had been used or where there is a low susceptibility to ground water contamination. Therefore, EFED has low confidence that the monitoring reflects the potential contamination of ground water from acifluorfen.

Environmental fate properties show that lactofen has a generally low likelihood of contaminating ground water. However, the degradate acifluorfen is mobile and moderately persistent to persistent, and may contaminate ground water. In a prospective ground-water monitoring study conducted for the EPA, lactofen was not detected in ground water at or above the study limit of quantification. Several detections were suspected, but not verified, and were assumed by the registrant to be the result of analytical interference. Evidence of the metabolite acifluorfen leaching was also not observed in the prospective study with vulnerable soil conditions (USEPA, 1995). The Agency concluded that “There was no evidence to suggest the leaching of lactofen or acifluorfen. Since no tracer was used, there is no collaborative evidence to demonstrate that any leaching actually took place during the study (MRID#432183-00,01; DP Barcode D203252).”

Several low acifluorfen concentrations were reported in other ground-water monitoring studies (USEPA, 1992). The PGWDB (USEPA, 1992) reports four of 1185 wells sampled with concentrations ranging from 0.003 to 0.025 µg/L. The USGS NAWQA study reports a single acifluorfen detection of 0.17 µg/L out of 965 samples collected from major aquifers and 1 detection (0.07 µg/L) out of 314 samples collected from shallow urban ground water. There is generally less certainty associated with this type of (non targeted) “survey” monitoring, because the hydrology is not always well characterized, detailed pesticide use information is not always known, and the wells are often sampled only once.

A small-scale prospective ground-water monitoring for acifluorfen was conducted in the Central Sands region of Wisconsin. Acifluorfen was detected in 56 out of 283 samples (20%) with concentrations ranging from 1 to 46 µg/L. The average concentration for the last sampling was 15.2 µg/L, the overall mean for the 56 detections was 8.36 µg/L, and the average of the 10 sampling dates with detections was 7.33 µg/L. Due to multiple detections, an understanding of the site's hydrology, and known acifluorfen use, EFED is highly confident that acifluorfen residues can contaminate shallow ground water. Although the wells sampled during the prospective study were not specifically drinking water wells, people in Central Sands Region of Wisconsin where the study was conducted do use this type of shallow aquifer for drinking, if it is not contaminated.

Use: Lactofen, or Cobra (1-(carboethoxy) ethyl 5-[2-chloro-4-(trifluoromethyl) phenoxyl]-2-nitrobenzoate) is a selective, broad spectrum herbicide for preplant, preemergence and/or postemergence control of broadleaves and grass weeds in soybeans, cotton, and conifer seedlings. Cobra is formulated as an emulsifiable concentrate. The label indicates that the total applied should not exceed 25 fl. oz (0.4 lb. a.i. per acre per season) for non-conifer use and 26 oz. ai/A per season for conifers. The current lactofen label restricts lactofen from being applied preemergence followed by a postemergence application to crops grown on soils with soil organic matter contents more than 3.5 percent.

Lactofen can be applied in a tank mix in conventional row application timing (~14-21 days after plant), by drilled/solid seeded application (~7-10 days after plant), an early application timing (~5-7 days after planting), a broadcast ground application, a band application, a low volume ground application, by aerial application, and in a crop oil concentrate.

Environmental Fate and Ground Water Considerations: Fate properties of lactofen and acifluorfen are summarized in Tables 1 and 2, respectively. Although extremely lacking, the environmental fate properties suggest that lactofen has a generally low likelihood of contaminating ground water. The registrant provided two estimates of Koc: 1.5×10^4 ((µg/g OC)/(µg/mL)) in the protocol document (D242256) for lactofen and 6600 ((µg/g OC)/(µg/mL)) in a Pesticide Petition (3F3798) prepared by Eric Tamichi of Valent. The aerobic soil metabolism $T_{1/2}$ ranges from 1 to 3 days, and the anaerobic soil metabolism $T_{1/2}$ appears to less than 30 days (estimated as 18.5 days). Soil photolysis $T_{1/2}$ was estimated to be 23 days. Hydrolysis may contribute to rapid dissipation of lactofen, but since the reported values were measured at 40 ^{o}C, the importance of hydrolysis at environmental temperatures is unclear. Terrestrial field dissipation $T_{1/2}$ was < 5 days in an Ohio study.

Acifluorfen (a degradate of lactofen, also a registered pesticide) is mobile ($K_d = 1$) and moderately persistent to persistent (aerobic soil metabolism half-lives from 6 days up to 6 months), and under some conditions has been found in ground water.

The registrant previously conducted a small-scale prospective ground-water monitoring study, where lactofen (Cobra) was applied at the rate of 0.45 lb ai/Are, at a "hydrogeologically vulnerable" site in Ohio. Site instrumentation was standard and met minimum guideline requirements of the time (previous guidelines). Lactofen was not detected in ground water at or above the study limit of quantification (1.0 µg/L). Several detections were suspected, but not verified, and were assumed by the registrant to be the result of analytical interference. Evidence of the metabolite acifluorfen leaching was also not observed in this prospective study. The Agency concluded that “There was no evidence to suggest the leaching of lactofen or acifluorfen. Since no tracer was used, there is no collaborative evidence to demonstrate that any leaching actually took place during the study (MRID#432183-00,01; DP Barcode 203252).” EFED determined (DP Barcode D203252) that the ground-water monitoring study (MRID 432183-00,01) provided supplemental information. A number of other outstanding issues were identified by EFED (DP Barcode D203252). At this time, EFED has not reviewed any registrant responses to these issues..

Ground Water Detections: Several low acifluorfen concentrations were reported in other ground-water monitoring studies (USEPA, 1992). The PGWDB (USEPA, 1992) reports four of 1185 wells sampled with concentrations ranging from 0.003 to 0.025 µg/L. The studies reported in the PGWDB may reflect conditions where no lactofen or acifluorfen had been used or where there is a low susceptibility to ground water contamination. Therefore, EFED has low confidence that the monitoring reflects the potential contamination of ground water from acifluorfen. The USGS NAWQA study reports a single acifluorfen detection of 0.17 µg/L out of 965 samples collected from major aquifers and 1 detection (0.07 µg/L) out of 314 samples collected from shallow urban ground water. Since the USGS NAWQA study is to assess water quality in general and not specially lactofen and acifluorfen, there is less confidence in using this data to assess lactofen and acifluorfen’s potential to contaminate ground water compared to a prospective study.

A small-scale prospective ground-water monitoring study was conducted for acifluorfen-sodium in a vulnerable area of Wisconsin. Acifluorfen was detected in 56 out of 283 samples (20%) with concentrations ranging from 1 to 46 µg/L. The study duration was from 4/20/88 to 4/12/89 and acifluorfen detections occurred from 9/14/88 through 4/12/89 (final sampling). The average concentration for the 5 detections on 4/12/89, the last sampling time, was 15.2 µg/L. The overall mean for the 56 detections was 8.36 µg/L. The average of the 10 sampling dates during this period was 7.33 µg/L.

Because of the multiple detections, an understanding of the site's hydrology, and known acifluorfen use, EFED is highly confident that acifluorfen residues can contaminate shallow ground water under vulnerable conditions. Although the wells sampled during the prospective study were not specially drinking water wells, people in Central Sands region of Wisconsin where the study was conducted do use this type of shallow aquifer for drinking, if not contaminated.

ENVIRONMENTAL FATE PARAMETERS FOR MODEL INPUTS:

The chemical fate parameters for lactofen and acifluorfen and modeling input parameters are summarized in Tables 1 and 2, respectively. Some of these data have not been reviewed by EFED. Therefore, the quality of the data is not known. Also, a number of the parameters consisted of a single value. Thus, it is difficult to place a lot of confidence in the data. So several fate properties were modified following EFED interim guidelines to allow for uncertainty in parameter values. When a single half-life value was available, the value was multiplied by three. When two or more values were available, the upper 90th percent value was estimated. The hydrolysis half-lives were only available for 40^o C. The hydrolysis half-lives were increased by a factor 5 (2.5 times for each 10^o C) as shown in Table 1 (Harris, 1981) for lactofen. These values were then converted to acid, neutral, and basic rate constants (in hours) for use in EXAMS, using the EFED program H2O.EXE. Fate data shows acifluorfen to be stable at pH 5,7, 9 and therefore was not considered in EXAMS. Aquatic degradation rates were estimated from the aerobic and anaerobic soil metabolism half-lives following EFED interim guidance (multiplied by 3 for uncertainty of half-life and 2 for uncertainty for different media). The rate of lactofen degradation and the rate of acifluorfen formation were not known. The registrant submitted two K_{oc} values, with no other information (*e.g.*, K_d, organic carbon content) for lactofen. Thus, the validity of the K_{oc} model is not known. A single K_d value (1 mL/g) was available for acifluorfen. It was not possible to convert to K_{oc} due to lack of information. Thus, the validity of the K_{oc} model is also unknown for acifluorfen. The aerobic soil metabolism half-lives of acifluorfen ranges from 6 days to about 180 days.

A recent research paper (Celi, *et al.*, 1997) indicates that acifluorfen adsorption by soil depends upon the cation-exchange capacity (CEC), organic carbon content, and pH of the system. They further suggest that acifluorfen sorption to humic acids (part of organic matter) is influenced by pH and that the binding of acifluorfen to humic acid is quite low at pHs greater than 5. These bonds can also apparently be broken readily by water, so desorption may also be important. Thus in sandy soil, having a low CEC and high pH, acifluorfen may have a low potential to bind. If K_d is then influenced by pH and since the pH value of the single (measured) K_d value is not known, there are a lot of uncertainties concerning the estimated concentrations estimated for either surface or ground water.

The fate properties used in modeling are defined in Tables 1 and 2 for lactofen and acifluorfen, respectively. The model input values are presented in the units required for PRZM and EXAMS.

TABLE 1. LACTOFEN ENVIRONMENTAL FATE PROPERTIES AND MODEL INPUTS USED IN PRZM/EXAMS.

LACTOFEN PROPERTY	**FATE DATA**	**MODEL INPUT CALCULATIONS**	**MODEL INPUT VALUE**	**SOURCE**
Solubility (ppm)	0.945 0.10		0.945	E. Tamichi, Valent EFED One-liner
Molecular Weight	461.77		461.77	EFED One-liner
Hydrolysis (days) Half-life	pH 5: 10.7 @ 40° C pH 7: 4.6 @ 40° C pH 9 < 1.0 @ 40° C	all values multiple by 5, 2.5 by slower for each 10° C[1]	53.5[1] @ 20°C 23.0[1] @ 20°C 5.0[1] @ 20°C	EFED One-liner
Henry's Constant (atm. m^3/Mol)	2.43E-08 (calculated)		2.43E-08	EFED One-liner
Photolysis half-life (days)	water: 2.75 soil: 23	converted to rate in hours	0.0105/hr	E. TAMICHI, Valent EFED One-liner
Aerobic Soil Metabolism half-life (days)	1-3	max. value by 3	9 (7.70E-02/d)	EFED One-liner
Anaerobic Soil Metabolism half-life	est. 18.5	value by 3	55.5 (1.25E-02/d)	EFED One-liner
Aerobic Aquatic Half-life	no data	estimated - 3 by aerobic soil half-life and 2 time this value	18 d (1.6E-03/hr)	EFED One-liner
Anaerobic Aquatic Half-life	no data	estimated - 3 by anaerobic soil half-life and 2 by this value	111 d(2.6E-04/hr)	EFED One-liner
Soil Water Partition (Koc) mL/g	6600 15000	mean value	10800	E. TAMICHI, Valent DP Barcode D242256

[1] J.C. Harris. 1981. Rate of Hydrolysis. Pages 7-1 to 7-48. *in* Lyman, W.J. *et al.*, Research and Development of Methods for Estimating Physiochemical Properties of Organic Compounds of Environmental Concern. US Army Medical Research Development Command, Frederick, MD

The rate constants in hours are for acid, neutral, and basic hydrolysis, KAH, KNH, and KBH, are -6.71/hr, 1.21 E-03/hr, and 4.57 E+02/hr, respectively

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TABLE 2. ACIFLUORFEN ENVIRONMENTAL FATE PROPERTIES AND MODEL INPUTS USED IN PRZM/EXAMS

ACIFLUORFEN PROPERTY	FATE DATA	MODEL INPUT CALCULATIONS	MODEL INPUT VALUE	SOURCE
Solubility (ppm)	2.50E+05		2.50E+05	EFED One-liner
Molecular Weight	383.70		383.70	EFED One-liner
Hydrolysis (days)	stable at pH 5,7,9		considered stable	EFED One-liner
Henry's Constant (atm.m^3/mol)	1.51E-13 (calculated)		1.51E-13	EFED One-liner
Photolysis half-life (days)	Water: 3.8 Soil: 57 @pH4		0.0075/hr	EFED One-liner
Aerobic Soil Metabolism half-life (days)	30, 60 - 180, 170, 59, 6 (60 and 180 were used to cover the range 60 - 180)	upper 90%=mean + t90 x std/√n; single tail student t, á=0.1 and n = number of samples	121 (5.7E-03/d)	EFED One-liner
Anaerobic Soil Metabolism half-life (days)	<28 days	multiply value by 3	84 (8.3E-04/d)	EFED One-liner
Aerobic Aquatic half-life (days)	98%-day 0, 82%-day 35: half-life estimated to be 117 days	multiple value by 3	351 (8.23E-05/hr)	EFED One-liner
Anaerobic Aquatic half-life (days)	no data	estimate by multiplying anaerobic soil half-life by 6 (28 x 3 x 2)	168 (1.72E-04/hr)	EFED One-liner
Soil Water Partition (Kd)mL/g	1		1 (assume OC=1%) K_{oc} = 100	EFED One-liner

Lactofen Use and Acifluorfen in Modeling: The maximum (label) total amount of lactofen per season for all uses is 0.40 lb ai/A. For cotton, the band width was assumed to be 16 inches and row spacing 40 inches. Following the label guidance for sprayer calibration the total applied per season was adjusted to 0.32 lb ai/ac with 1 application, and 0.16 lb ai/ac per application for 2 applications. The interval between 2 applications was 14 days. Lactofen was assumed to be applied as ground spray with 95 percent efficiency and 1 percent spray drift into the pond. Lactofen use on soybeans was also considered. Acifluorfen was assumed to be applied to soybeans by aerial application with and maximum seasonal of 0.50 lb ai/ac. Spray drift for aerial application was assumed to equal to 5 percent of the applied acifluorfen.

The registrant and the EFED one-liner database indicated that acifluorfen accounted for 52.3 percent of applied lactofen. A second degradate (PPG-947) was also noted which accounted for 16.2 percent of the applied lactofen. Because the rate of formation of acifluorfen is not known, two modeling approaches were considered. The first, assumed that acifluorfen was applied 3 days (at 52.3% of the lactofen application rate) after the lactofen and incorporated 1 or 2 cm into the soil. The second, assumed that 100 percent of the applied lactofen was converted to acifluorfen (3 days after the lactofen application) and incorporated 1 or 2 cm into the soil. Spray drift into the pond was assumed to be zero for acifluorfen derived from lactofen.

Tier II Surface Water Assessment

The Tier II estimated environmental concentration (EEC) assessment in surface water uses a single site, or multiple single sites, which represents a high-end exposure scenario from pesticide use on a particular crop or non-crop use site. The EECs for lactofen and acifluorfen were generated for the standard Mississippi cotton scenario (Appendix I, 4/10/98) using PRZM3 (Carsel, 1997) which simulates the erosion and run off from an agricultural field and EXAMS 2.97.5 (Burns, 1997) which simulates the fate in a surface water body. PRZM 3.11(2/5/98) and EXAMS 2.97.5 (6/13/97) were used. The current “draft” Mississippi Soybean Scenario is the same as the Mississippi Cotton Scenario. PRZM3 and EXAMS estimates for a single site, over multiple years, EECs for a 1-ha surface area, 2 m deep pond draining an adjacent 10 ha cotton

field. Each scenario was simulated for 19 years. EFED estimated 1 in 10 year maximum peak, 4-day average, 21-day average, 60-day average, 90-day, annual average concentrations.

The PRZM/EXAMS EECs are generated for high exposure agricultural scenarios and represent one in ten year EECs in a stagnant pond with no outlet that receives pesticide loading from an adjacent 100% cropped, 100% treated field. As such, the computer generated EECs represent conservative screening levels for ponds, lakes, and flowing water and should only be used for screening purposes. The EECs have been calculated so that in any given year, there is a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site. Tier II upper tenth percentile EECs for lactofen are presented in Table 3 and acifluorfen in Table 4. Applying lactofen as a preemergence and postemergence to cotton appears to result in slightly lower concentrations of lactofen in surface water.

Table 3. Lactofen concentrations (μg/L) in standard pond using PRZM/EXAMS..

Input	Peak	96 hr	21 day	60 day	90 day	Yearly	Annual Mean	Standard Deviation	Upper CI at 90%
cot 1lac[1]	1.07	0.70	0.29	0.13	0.087	0.023	0.010	0.008	0.012
cot 2lac[2]	0.64	0.41	0.19	0.10	0.072	0.018	0.009	0.006	0.011
soybean[3]	1.88	1.22	0.55	0.23	0.16	0.041	0.025	0.010	0.028

[1] Cotton, One application @ 0.32 lb ai/ac, 95% application efficiency, 1% spray drift.
[2] Cotton, Two applications @ 0.18 lb ai/ac per application, 95% application efficiency, 1% spray drift.
[3] Soybeans, One application @ 0.40 lb ai/ac, 95% application efficiency, 5% spray drift.

Table 4. Acifluorfen concentrations (μg/L) in standard pond using PRZM/EXAMS.

Input	Peak	96 hr	21 day	60 day	90 day	Yearly	Annual Mean	Standard Deviation	Upper CI at 90%
Cotton: Acifluorfen as a degradate of lactofen									
cot 1-1 acf[1]	**11.29**	**11.21**	**10.87**	**10.23**	**9.73**	**5.68**	**3.21**	**1.92**	**3.85**
cot 2-1 acf[2]	10.47	10.39	10.28	9.67	9.16	5.57	2.72	1.73	3.33
cot 2-2 acf[3]	4.67	4.65	4.57	4.29	4.07	2.41	1.21	0.76	1.47
cot 5-1 acf[4]	23.78	23.59	22.89	21.55	20.48	11.96	6.75	4.04	8.10
Soybeans: Acifluorfen-sodium as source									
soy6-acf[5]	15.83	15.76	15.52	14.66	13.93	8.65	5.23	2.41	6.04
soy1-acf[6]	**21.11**	**21.00**	**20.69**	**19.55**	**18.56**	**11.53**	**6.72**	**3.22**	**8.05**
soy2-acf[7]	18.69	18.55	18.29	17.23	16.35	10.45	6.48	3.04	7.50

[1] Cotton, Acifluorfen assumed to 52.3% of applied lactofen, 1 application, 3 days after lactofen application, incorporated 1 cm, with no drift.
[2] Cotton, Acifluorfen assumed to 52.3% of applied lactofen, 2 applications, 3 days after each lactofen application, incorporated 1 cm, with no drift.
[3] Cotton, Acifluorfen assumed to 52.3% of applied lactofen, 2 applications, 3 days after each lactofen application, incorporated 2 cm, with no drift.
[4] Cotton, acifluorfen assumed to be equal to 100% of applied lactofen, 1 application 0.40 lb ai/ai, incorporated 1 cm with no drift.
[5] Soybean, acifluorfen applied once at a rate of 0.375 lb ai/ac, assumed 95% efficiency and 5% spray drift.
[6] Soybean, acifluorfen applied once at a rate of 0.50 lb ai/ac, assumed 95% efficiency and 5% spray drift.
[7] Soybean, acifluorfen applied twice at 0.25 lb ai/ac per application, assumed 95% efficiency and 5% spray drift.

TIER 1 GROUND WATER ASSESSMENT

The SCI-GROW (Screening Concentration in Ground Water) screening model developed in EFED (Barrett, 1997) was used to estimate potential ground water concentrations for lactofen and the degradate acifluorfen under hydrologically vulnerable conditions. The maximum lactofen ground-water concentration predicted by the SCI-GROW using the maximum application rates (and seasonal amounts) for cotton (1 application) of 0.32 lb. a.i./ac and for soybeans of 0.50 lb. a.i./ac (1 application) was 0.006 µg/L (low default value). There is much more uncertainty associated with the ground water acifluorfen concentrations, because of the uncertainty of the K_{oc} and K_d values and the degradation of lactofen and formation of acifluorfen.

A number of examples of acifluorfen concentrations are provided in Table 5. Two half-life values were used, the mean and the upper 90th percent value of the aerobic soil metabolism half-life. The concentrations predicted assuming 100 percent conversion from lactofen to acifluorfen is also presented as an “upper bound”, because the rate of acifluorfen formation is not known (or considered). Since SCI-GROW requires K_{oc} rather than K_d, the organic carbon content of 1 percent was assumed. K_d may also depend upon pH, decreasing with increasing pH. Assuming a K_d of 0.1 rather than 1, there is a 10 percent or more increase in the estimated acifluorfen concentration. Using a K_{oc} of 10, an application rate of 0.75 lb ai/ac for acifluorfen (rate used in the WI prospective study), and half-lives of 84 and 121 days, concentrations of 8.0 and 15.5 µg/L, respectively, were estimated by SCI-GROW. These values are similar to the concentrations observed in the Wisconsin prospective ground water study. Using the same Wisconsin application rate for acifluorfen, a K_{oc} of 100, and half-lives of 84 or 121 days, the estimated SCI-GROW concentrations would be 0.84 and 1.34 µg/L, respectively.

Table 5. Estimated ground water concentrations for acifluorfen using SCI-GROW with different assumptions concerning fate parameters and application rate (or % of lactofen converted to acifluorfen.

Application (lb ai/ac)	Half-life (days)	K_{oc} (assume OC=1%)	Concentration (µg/L)
0.17[1]	84	100 (K_d = 1)	0.19
0.17	121	100 (K_d = 1)	0.30
0.17	84	10 (K_d = 0.1)	1.81
0.17	121	10 (K_d = 0.1)	3.51
0.40[2]	84	10 (K_d = 0.1)	4.26
0.40	121	100 (K_d = 1)	0.71
0.40	84	10 (K_d = 0.1)	8.27
0.40	121	100 (K_d = 1)	0.45
0.50[3]	84	10 (K_d = 0.1)	5.33
0.50	121	10 (K_d = 0.1)	10.33
0.50	84	100 (K_d = 1)	0.56
0.50	121	100 (K_d = 1)	0.89

[1] Application rate reflects conversion from 0.4 lb ai/ac to 0.32 lb ai/ac for banding, and multiplied by 0.523 (proportion of acifluorfen/applied lactofen).
[2] Maximum lactofen rate (and amount) on cotton, assume 100 percent conversion to acifluorfen.
[3] Maximum acifluorfen application (and amount) allowed per season for acifluorfen on soybeans.

The concentration of acifluorfen in ground water as simulated by SCI-GROW depends upon the input parameters. Table 5 shows the result of changing the K_{oc} and aerobic soil metabolism half-life values used can dramatically influence the estimated concentrations.

Limitations of this Modeling Analysis

There are several factors which limit the accuracy and precision of this modeling analysis including the selection of the high-end exposure scenarios, the quality of the data, the ability of the model to represent the real world, and the number of years that were modeled. There are additional limitations on the use of these numbers as an estimate of drinking water exposure.

Tier II scenarios are also ones that are likely to produce high concentrations in aquatic environments. The scenarios were intended to represent sites that actually exist and are likely to be treated with a pesticide. These sites should be extreme enough to provide a conservative estimates of the EEC, but not so extreme that the model cannot properly simulate the fate and transport processes at the site. Currently, sites are chosen by best professional judgement to represent sites which generally produce EECs larger than 90% of all sites used for that crop. The EECs in this analysis are accurate only to the extent that the sites represent the hypothetical high exposure sites. The most limiting aspect of the site selection is the use of the "standard pond" which has no outlet. It also should be noted that the standard pond scenario used here would be expected to generate higher EECs than most water bodies; although, some water bodies would likely have higher concentrations (*e.g.*, a shallow water bodies near agriculture fields that receive direct runoff from the treated field).

The quality of the analysis is also directly related to the quality of the chemical and fate parameters available for lactofen and acifluorfen. There are data gaps for both lactofen and acifluorfen. The aquatic aerobic metabolism rate was not known, but estimated. The range of measured aerobic soil metabolism data for acifluorfen is fairly broad, but is extremely limited for lactofen. The sample size is probably sufficient to establish an upper 90% confidence bound on the mean of half-lives for acifluorfen. The use of the 90%-upper bound value may be sufficient to capture the probable estimated environmental concentration when limited data are available.

The models themselves represent a limitation on the analysis quality. These models were not specifically developed to estimate environmental exposure in drinking water so they may have limitations in their ability to estimate drinking water concentrations. Ground spray drift reaching the pond is assumed to be 1 percent of the lactofen application rate. No drift was assumed for acifluorfen. Another limitation is the lack of field data to validate the predicted pesticide run off. Although, several of the algorithms (volume of run off water, eroded sediment mass) are validated and understood, the estimates of pesticide transport by PRZM3 has not yet been fully validated. From limited analysis it appears that PRZM3 generates pesticide loadings that are somewhat higher than really occur. This would result in conservative EEC estimates. Other limitations of the models are the inability to handle within site variation (spatial variability), crop growth, and the overly simple soil water balance. Another limitation is that 20 years of weather data was available for the analysis. Consequently there is a 1 in 20 chance that the true 10% exceedence EECs are larger than the maximum EEC in the analysis. If the number of years of weather data were increased, it would increase the level of confidence that the estimated value for the 10% exceedence EEC would close to the true value.

EXAMS is primarily limited because it is a steady-state model and cannot accurately characterize the dynamic nature of water flow. A model with dynamic hydrology would more accurately reflect concentration changes due to pond overflow and evaporation. Thus, the estimates derived from the current model simulates a pond having no-outlets, flowing water, or turnover. Another major limitation in the current EXAMS simulations is that the aquatic (microbial) degradation pathway was not considered due to lack of data. Direct aquatic photolysis was however included.

Another important limitation of the Tier II EECs for drinking water exposure estimate is the use of a single 10 hectare drainage basin with a 1 hectare pond. It is unlikely that this small of a system accurately represents the dynamics in a watershed large enough to support a drinking water utility. It is unlikely that an entire basin, with an adequate size to support a drinking water utility would be planted completely in a single crop or be represented by scenario being modeled. The pesticides would more than likely be applied over several days to weeks rather than on a single day. This would reduce the magnitude of the conservative concentration peaks, but also make them broader, reducing the acute exposure, but perhaps increasing the chronic exposure.

Monitoring data is limited by the lack of correlation between sampling date and the use patterns of the pesticide within the study's drainage basin. Additionally, the sample locations were not associated with actual drinking water intakes for surface water nor were the monitored wells associated with known ground water drinking water sources. Also, due to many different analytical detection limits, no specified detection limits, or extremely high detection limits, a detailed interpretation of the monitoring data is not always possible.

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APPENDIX 1. *[of APPENDIX J, memo of June 1, 1998]*

The Mississippi Cotton Scenario

The standard cotton scenario represents a cotton field located in Yazoo County, Mississippi. It has a Loring silt loam soil, a fine-silty, mixed, mesic Thermic Typic Fragiudalf, in MLRA O-134. The Loring silt loam is a moderately well drained soil with a fragipan formed in loess on level to strongly sloping upland and stream terraces on slopes of 0-20 percent. The Loring silt loam is a Hydrologic Group C soil with SCS curve numbers that were measured on a real field in Yazoo County, Mississippi under cotton culture. There are approximately 101,000 acres of cotton grown in Yazoo County, which is the most of any county in Mississippi and among the top 10 percent in the U.S. (US Department of Commerce, 1994a). USLE C Factors were developed by George Foster at the University of Mississippi in consultation with Ronald Parker of the US EPA to represent a cotton field with one year tilled followed by two years under conservation tillage using RUSLE. The weather data is from weather station W03940 in Jackson, Mississippi. The weather data file is also part of the PIRANHA shell and is used to represent the weather for MLRA 131. This weather data was used rather than the MLRA 134 weather data as it was expected to better represent the weather in Yazoo County. The PRZM 3.1 parameters describing this site are in following Tables 1-1 to 1-5.

The pond used is modified for generic use from the Richard Lee pond that is distributed with EXAMS and is the standard pond used for all EEC calculations. Modifications were made to convert the pond from 1 acre, 6 ft deep to 1 ha, 2 m deep. Additionally, adjustments were made to the standard pond by changing the water temperature to that which was more appropriate for the region being simulated. The temperature in the pond for each month was set to the average monthly air temperature over all 36 years calculated from the meteorological file that was used in the simulation. Additionally, the latitude and longitude were changed for each pond to values appropriate for the site. Finally, all transport into and out of the pond has been set to zero. The non-chemical specific parameters describing the ponds are listed in Tables 2-1 to 2-7.

PRZM 3.1 Scenario Parameters

Table 1-1. PRZM 3.1 climate and time parameters for a cotton field in Yazoo County, Mississippi.

Parameter	Value	Source	Quality
Starting Date	January 1, 1964	Met File	
Ending Date	December 31, 1983	Met File	
Pan Evaporation Factor (PFAC)	0.760	PIC[1]	good
Snowmelt Factor (SFAC)	$0.150\ \mathrm{cm} \cdot \mathrm{K}^{-1}$	PIC	good
Minimum Depth of Evaporation (ANETD)	17.0 cm	PIC	good
Average Duration of Runoff Hydrograph (TR)	5.80 h	PIC	good

Table 1-2. PRZM 3.1 model state flags for a cotton field in Yazoo County, Mississippi.

Parameter	Value
Pan Factor Flag (IPEIND)	0
Chemical Application Model Flag (CAM)	user defined 2 - lactofen cotton 5- degradate acifluorfen 2 - lactofen soybean
Bulk Density Flag (BDFLAG)	0
Water Content Flag (THFLAG)	0
Kd Flag (KDFLAG)	0
Drainage model flag (HSWZT)	0
Method of characteristics flag (MOC)	0
Irrigation Flag (IRFLAG)	0
Soil Temperature Flag (ITFLAG)	0
Thermal Conductivity Flag (IDFLAG)	0
Biodegradation Flag (BIOFLAG)	0
Partition Coefficient Model (PCMC)	NA
Initial Pesticide Concentration Flag (ILP)	0
Erosion Calculation Flag (ERFLAG)	4

Table 1-3. Erosion and landscape parameters for a cotton field in Yazoo County, Mississippi.

Parameter	Value	Source	Quality
USLE K Factor (USLEK)	0.49 tons EI^{-1*}	PIC	good
USLE LS Factor (USLELS)	0.40	PIC	fair
USLE P Factor (USLEP)	0.75	**	fair
Field Area (AFIELD)	10 ha	standard	
NRCS Hyetograph (IREG)	4	PRZM Manual	Good
Slope (SLP)	6%	USDA-NRCS	Good
Hydraulic Length (HL)	354 m	PRZM-Manual	Good

* EI = 100 ft-tons * in/ acre*hr
** P Factor represent compromise for 1 year of conventional tillage and two years of no till.

Table 1-4. PRZM 3.1 crop parameters for a cotton field in Yazoo County, Mississippi.

Parameter	Value			Source	Quality
Initial Crop (INICRP)	1				
Initial Surface Condition (ISCOND)	1 (fallow)				
Number of Different Crops (NDC)	3				
Number of Cropping Periods (NCPDS)	20				
Parameters For First Crop (ICNCN = 1)					
Maximum rainfall interception storage of crop (CINTCP)	0.20 cm			PIC	fair
Maximum Active Root Depth (AMAXDR)	125 cm			PIC	fair
Maximum Canopy Coverage (COVMAX)	98%				
Soil Surface Condition After Harvest (ICNAH)	3 (residue)			PIC	
Date of Crop Emergence (EMD, EMM, IRYEM)	May 1			PIC	good
Date of Crop Maturity (MAD, MAM, IYRMAT)	September 7			PIC	good
Date of Crop Harvest (HAD, HAM,IYRHAR)	September 22			PIC	good
Maximum Dry Weight	0 kg m^{-2}				
Maximum canopy height (HTMAX)	120 cm				
	Fallow	Cropped	Residue		
SCS Curve Number (CN)	99	93	92	measurement	good
USLE C Factor (USLEC)	0.63	0.16	0.18	RUSLE*	good
Parameters For First Crop (ICNCN = 2)					
Maximum rainfall interception storage of crop (CINTCP)	0.20 cm			PIC	fair
Maximum Active Root Depth (AMAXDR)	125 cm			PIC	fair
Maximum Canopy Coverage (COVMAX)	98%				
Soil Surface Condition After Harvest (ICNAH)	3 (residue)			PIC	
Date of Crop Emergence (EMD, EMM, IRYEM)	May 1			PIC	good
Date of Crop Maturity (MAD, MAM, IYRMAT)	September 7			PIC	good

Table 1-4. PRZM 3.1 crop parameters for a cotton field in Yazoo County, Mississippi.

Parameter	Value			Source	Quality
Date of Crop Harvest (HAD, HAM,IYRHAR)	September 22			PIC	good
Maximum Dry Weight	0 kg m^{-2}				
Maximum canopy height (HTMAX)	120 cm				
	Fallow	Cropped	Residue		
SCS Curve Number (CN)	94	84	83	PIC	fair
USLE C Factor (USLEC)	0.16	0.13	0.13	PIC	good
Parameters For First Crop (ICNCN = 3)					
Maximum rainfall interception storage of crop (CINTCP)	0.20 cm			PIC	fair
Maximum Active Root Depth (AMAXDR)	125 cm			PIC	fair
Maximum Canopy Coverage (COVMAX)	98%				
Soil Surface Condition After Harvest (ICNAH)	3 (residue)			PIC	
Date of Crop Emergence (EMD, EMM, IRYEM)	May 1			PIC	good
Date of Crop Maturity (MAD, MAM, IYRMAT)	September 7			PIC	good
Date of Crop Harvest (HAD, HAM,IYRHAR)	September 22			PIC	good
Maximum Dry Weight	0 kg m^{-2}				
Maximum canopy height (HTMAX)	120 cm				
	Fallow	Cropped	Residue		
SCS Curve Number (CN)	99	83	83	Measurement	good
USLE C Factor (USLEC)	0.16	0.12	0.09	RUSLE**	good

** developed by George Foster at the University of Mississippi, Oxford in consultation with Ronald Parker of US EPA using RUSLE.

Table 1-5. PRZM 3.1 soil parameters for a cotton field in Yazoo County, Mississippi.

Parameter	Value	Source	Quality
Total Soil Depth (CORED)	155 cm	*	good
Number of Horizons (NHORIZ)	6	*	good
First, Second and Third Soil Horizons (HORIZN = 1, 2 , 3)			
Horizon Thickness (THKNS)	13.0 cm (HORIZN = 1) 23.0 cm (HORIZN = 2) 33.0 cm (HORIZN = 3)	PIC	good
Bulk Density (BD)	1.4 g ·cm^{-3}	*	good
Initial Water Content (THETO)	0.385 cm^3-H$_2$O ·cm^3-soil (HZ1) 0.370 cm^3-H$_2$O ·cm^3-soil (HZ2) 0.370 cm^3-H$_2$O ·cm^3-soil (HZ3)	*	good
Compartment Thickness (DPN)	0.1 cm (HORIZN = 1) 1.0 cm (HORIZN = 2, 3)	standard	
Field Capacity (THEFC)	0.385 cm^3-H$_2$O ·cm^3-soil (HZ1) 0.370 cm^3-H$_2$O ·cm^3-soil (HZ2) 0.370 cm^3-H$_2$O ·cm^3-soil (HZ3)	*	good
Wilting Point	0.151 cm^3-H$_2$O ·cm^3-soil (HZ1) 0.146 cm^3-H$_2$O ·cm^3-soil (HZ2) 0.146 cm^3-H$_2$O ·cm^3-soil (HZ3)	*	good
Organic Carbon Content	2.18% (HORIZN = 1) 0.49% (HORIZN = 2) 0.16% (HORIZN = 3)	*	good
Second Soil Horizon (HORIZN = 4, 5, 6)			
Horizon Thickness (THKNS)	30.0 cm (HORIZN = 4) 23.0 cm (HORIZN = 5) 33.0 cm (HORIZN = 6)	PIC	good
Bulk Density (BD)	1.45 g ·cm^{-3} (HORIZ = 4) 1.49 g ·cm^{-3} (HORIZ = 5) 1.51 g ·cm^{-3} (HORIZ = 6)	*	good
Initial Water Content (THETO)	0.340 cm^3-H$_2$O ·cm^3-soil (HZ4) 0.335 cm^3-H$_2$O ·cm^3-soil (HZ5) 0.343 cm^3-H$_2$O ·cm^3-soil (HZ6)	*	good
Compartment Thickness (DPN)	1.0 cm	Standard	
Field Capacity (THEFC)	0.340 cm^3-H$_2$O ·cm^3-soil (HZ4) 0.335 cm^3-H$_2$O ·cm^3-soil (HZ5) 0.343 cm^3-H$_2$O ·cm^3-soil (HZ6)	*	good
Wilting Point	0.125 cm^3-H$_2$O ·cm^3-soil (HZ4) 0.137 cm^3-H$_2$O ·cm^3-soil (HZ5) 0.147 cm^3-H$_2$O ·cm^3-soil (HZ6)	*	good
Organic Carbon Content	0.12% (HORIZN = 1) 0.07% (HORIZN = 2) 0.06% (HORIZN = 3)	*	good

*USDA, Natural Resources Conservation Service, Soil Survey Laboratory, Pedon Database, Soil Series ID: 581MS-049-001, Hinds County, Mississippi. 1998. Location of data: http://vmhost.cdp.state.ne.us/~nslsoil/htbin/dbfnd4?series=loring.

EXAMS Scenario Input Parameters

Table 2-1. EXAMS II pond geometry for standard pond.

	Littoral	Benthic
Area (AREA)	10000 m^2	10000 m^2
Depth (DEPTH)	2 m	0.05 m
Volume (VOL)	20000 m^3	500 m^3
Length (LENG)	100 m	100 m
Width (WIDTH)	100 m	100 m

Table 2-2. EXAMS II dispersive transport parameters between benthic and littoral layers in each segment for standard pond.

Parameter	Pond*	Stream 1**	Stream 2***
Turbulent Cross-section (XSTUR)	10000 m^2	300 m^2	1200 m^2
Characteristic Length (CHARL)	1.01, 1.025 m	0.275 m	0.275 m
Dispersion Coefficient for Eddy Diffusivity (DSP)	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}
* JTURB = 1, ITURB = 2; ** JTURB = 3, ITURB = 4; *** JTURB = 5, ITURB = 6			

Table 2-3. EXAMS II sediment properties for standard pond.

	Littoral	Benthic
Suspended Sediment (SUSED)	30 mg L^{-1}	
Bulk Density (BULKD)		1.85 g cm^{-3}
Per cent Water in Benthic Sediments (PCTWA)		137%
Fraction of Organic Matter (FROC)	0.04	0.04

Table 2-4. EXAMS II external environmental parameters for standard pond.

Precipitation (RAIN)	90 mm $\cdot$month^{-1}
Atmospheric Turbulence (ATURB)	2.00 km
Evaporation Rate (EVAP)	90 mm $\cdot$month^{-1}
Wind Speed (WIND)	1 m $\cdot$sec^{-1}
Air Mass Type (AMASS)	Rural (R)

Table 2-5. EXAMS II biological characterization parameters for standard pond.

Parameter	Limnic	Benthic
Bacterial Plankton Population Density (BACPL)	1 cfu $\cdot$cm^{-3}	
Benthic Bacteria Population Density (BNBAC)		37 cfu $\cdot$(100 g)$^{-1}$
Bacterial Plankton Biomass (PLMAS)	0.40 mg $\cdot$L^{-1}	
Benthic Bacteria Biomass (BNMAS)		6.0x10^{-3} g $\cdot$m^{-2}

Table 2-6. EXAMS water quality parameters for standard pond.

Parameter	Value
Optical path length distribution factor (DFAC)	1.19
Dissolved organic carbon (DOC)	5 mg $\cdot$L^{-1}
chlorophylls and pheophytins (CHL)	5x10^{-3} mg $\cdot$L^{-1}
pH (PH)	7
pOH (POH)	7

Table 2-7. EXAMS mean monthly water temperatures and location parameters for a cotton field pond in Yazoo County, Mississippi.

Month	Temperature (Celsius)
January	6
February	9
March	12
April	16
May	20
June	24
July	26
August	28
September	25
October	18
November	13
December	10
Latitude	34^{o} N
Longitude	83^{o} W

[1.] PIC, PRZM Input Collator. PIRANHA, 1992. Pesticide and Industrial Chemical Risk Analysis and Hazard Assessment, Version 3.0, Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, GA.

APPENDIX K.
Drinking Water Assessment with Index Reservoir and Percent Crop Area

The estimated drinking water concentrations (EDWCs) were reevaluated using the methodology outlined in EPA-OPP *draft* Guidance for Use of the Index Reservoir and Percent Crop Area Factor in Drinking Water Exposure Assessments (USEPA, 2000).

The purpose the Index Reservoir (IR) scenario and the Percent Crop Area (PCA) for use in estimating the exposure in drinking water derived from vulnerable surface water supplies. Since the passage of the Food Quality Protection Act (FQPA) in 1997, the Agency has been using the standard farm pond as an interim scenario for drinking water exposure and has been assuming that 100% of this small watershed is planted in a single crop. The Agency is now implementing the index reservoir to represent a watershed prone to generating high pesticide concentrations that is capable of supporting a drinking water facility in conjunction with the percent cropped area (PCA) which accounts for the fact that a watershed large enough to support a drinking water facility will not usually be planted completely to a single crop. These two steps are intended to improve the quality and accuracy of OPP's modeling of drinking water exposure for pesticides.

The Index Reservoir (IR): IR is intended as a drop-in replacement for the standard pond for use in drinking water exposure assessment. It is used in a manner similar to the standard pond, except that flow rates have been modified to reflect local weather conditions. The EXAMS parameters for the standard index reservoir are in Appendix J. This guidance results from a July, 1998 presentation to the FIFRA Science Advisory Panel. The materials for that presentation are at: http://www.epa.gov/scipoly/sap/1998/index.htm

Percent Crop Area (PCA): PCA is a generic watershed-based adjustment factor that will be applied to pesticide concentrations estimated for the surface water component of the drinking water exposure assessment using PRZM/EXAMS with the index reservoir scenario. The output generated by the PRZM/EXAMS model is multiplied by the maximum percent of crop area (PCA) in any watershed (expressed as a decimal) generated for the crop or crops of interest. Currently, OPP will apply PCA adjustments for four major crops – corn, soybeans, wheat, and cotton. Two are appropriate for acifluorfen, cotton and soybeans. For pesticides applied to soybeans and cotton, Tier 2 drinking water exposure assessments should utilize the appropriate index reservoir scenario and corresponding PCAs. For pesticides applied to other crops, a default PCA adjustment will be made.

The concept of a factor to adjust the concentrations reported from modeling to account for land use was first proposed in a presentation to the SAP in December 1997 (Jones and Abel, 1997). 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/scipoly/sap/1999/may/pca_sap.pdf.

The Agency will continue to develop PCAs for other major crops in the same manner as was described in the May 1999 SAP presentation. However, the Agency expects that it will use smaller watersheds for these calculations in the near future. 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. Thus, for the near term, OPP will not be using PCAs in a crop-specific manner for both major crops that do not yet have PCAs and minor-use crops. Instead it will use a default PCA that reflects the total agricultural land in an 8-digit Hydrologic Unit Code (HUC). The PCA values used in this assessment are listed in Table 1.

The OPP guidance document provides information on when and how to apply the PCA to model estimates, describes the methods used to derive the PCA, discusses some of the assumptions and limitations with the process, and spells out the next steps in expanding the PCA implementation beyond the initial crops. Instructions for using the index reservoir and PCA are provided below. Discussion on some of the assumptions and limitations for both the PCA and Index Reservoir are included in the Reporting section.

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
Soybeans	0.41	08020201	Missouri
Cotton	0.20	08030207	Mississippi
Soybeans-Cotton	0.49 (0.31 soybeans, 0.18 cotton)	08020204	Missouri
All Agricultural Land	0.87	10230002	Iowa

Note that there is an entry for ‘All Agricultural Land’ in Table 1. This is a default value to use for crops for which no specific PCA is available. It represents the largest amount of land in agricultural production in any 8-digit hydrologic unit code (HUC) watershed in the continental United States.

The unadjusted EDWC is multiplied by the appropriate PCA for that crop to obtain the final EDWC (Table 5). Note that 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 in the future.) As an example, for a pesticide used only on cotton, the PRZM/EXAMS estimated environmental concentrations would be multiplied by 0.20. This factor would be applied to the standard PRZM/EXAMS scenario for cotton or any non-standard cotton scenario until such time as regional PCAs are developed.

When multiple crops occur in the watershed, the co-occurrence of these crops needs to be considered. The PCA approach assumes that the adjustment factor represents the maximum potential percentage of the watershed that could be planted to a crop. If, for example, a pesticide is only used on cotton, then the assumption that no more than 20% of the watershed (at the current HUC scale used) would be planted to the crop is likely to hold true. However, if the pesticide is used on both cotton and soybeans, then this assumption no longer holds true, since watersheds often contain both crops, with a combined percentage of up to 61% (Table 1). In this case, the model estimates should be re-adjusted to reflect the combined PCA.

Cotton and soybeans were considered because they represent significant uses, maximum application rates, and are grown in vulnerable regions of the United States. For the PRZM, the input files for each IR scenario are essentially the same as its farm pond scenario. Three parameters, AFIELD, HL, and DRFT require modification. These changes are shown in Table 2.

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Table 2. PRZM input parameters where modifications were necessary for the Index Reservoir (IR) Scenario

PRZM variable	Farm Pond Value	IR Scenario	Definition
AFIELD	10 ha	172.8 ha	area of plot or field
HL	374 m	464[1] m	Hydraulic length
DRFT	0.01 ground 0.05 aerial	0.064 ground 0.16 aerial	Spray drift

[1] This value changed between versions Guidance document and modeling of data during the development of the Guidance document.

As noted above in Table 2, the value for the variable HL changed between Guidance document versions and modeling. The HL (hydraulic length) value changed from 464 m to 600 m. A comparison was made to evaluate the effect of HL on estimated acifluorfen and lactofen concentration. For lactofen, the estimated peak lactofen concentration changed from 3.089 to 3.04 µg/L when the HL value increased from 484 m to 600 m, respectively. For acifluorfen on soybeans, when the HL was increased from 484 m to 600 m, the peak acifluorfen concentrations decreased from 21.358 µg/L to 21.355 µg/L, respectively. Thus, for the acifluorfen and lactofen the value selected for HL made very little difference in the scenarios selected. The parameters for the standard Index Reservoir are listed below in Tables 6 to 12.

Drinking water assessment with Index Reservoir and Percent Crop Area.

Environmental fate information not available during the initial (D239268, 06/01/98) water assessment was considered in the drinking water assessment conducted in part two of the water assessment appendices.

Chemical properties, environmental fate characteristics and available monitoring data indicate that acifluorfen has the potential to leach to ground water and to enter surface water via leaching and run-off. Acifluorfen is very soluble in water (2.5×10^5 mg/L) and also is highly mobile in mineral soils. Understanding why acifluorfen is mobile or under what conditions it is mobile may be beneficial in developing mitigation strategies. Acifluorfen contains a carboxylic acid group with an acid dissociation constant (pK_a) of 3.8. Thus, acifluorfen exists as an anion in most agricultural soils since the pH of these soils usually exceeds the pK_a of the acid.

The sodium (Na^+) on sodium-acifluorfen will dissociate resulting in negatively charged acifluorfen. Negatively charged sorption sites, such as clays, are therefore expected to have little contribution to the adsorption process. The adsorption/desorption of acifluorfen is dependent upon pH, organic carbon content, and ammonium oxalate extractable iron content of the soil (positively charged), but not clay content. Freundlich adsorption isotherms (K_{ads}) are generally quite low for mineral soils, ranging from about 0.1 to 5.33 and an average of about 1.8 mL/g of soil. The K_{oc}s ranged from about 50 to 200 mL/g of soil organic carbon. The slope, or 1/n term of the Freundlich isotherm range between 0.75 and 0.89. It is therefore mobile to highly mobile. Acifluorfen is quite persistent as aerobic soil metabolism half-lives ranged from 30 to 180 days. Acifluorfen is stable to hydrolysis. The photolysis half-lives ranged from 0.9 to 14.7 days in water and 57 days on soil.

In the aerobic aquatic study, acifluorfen was relatively stable, the half-life was estimated to be 117 days. An anaerobic soil metabolism study shows fairly rapid degradation giving a half-life of 30 days. In an anaerobic aquatic metabolism study, a half-life of 2.75 days was determined. The primary degradate under anaerobic conditions was the corresponding amine from the reduction of the nitro group (amino acifluorfen). Amino acifluorfen averaged 64 - 71% of the amount applied at 25 through 375 days. In this and additional experiments in which samples were incubated under similar conditions for up to 375 days, the degradates, amino acifluorfen, acifluorfen acetamide, and desnitro acifluorfen were identified in the soil/water systems. Little formation of $^{14}CO_2$ was observed in this system. Data is not adequate to evaluate the fate of the degradates in the water.

A drinking water exposure assessment for sodium acifluorfen, lactofen and acifluorfen derived from lactofen was previously conducted by the Agency (DP Barcode D239268 - 6/1/98; Appendix J) before the development and implementation of the IR and PCA concepts. Additional fate studies and ground and surface water monitoring have become available since the earlier assessment. The water resource assessment presented here has been updated since the earlier assessment to incorporate the additional information.

The environmental fate parameters used (PRZM and EXAMS) in this assessment (Table 3) are the same that were used in the earlier assessment (Appendix J). These parameters were developed following Agency guidance (4/22/97) at the time for aerobic soil metabolism (121 d) and aqueous photolysis (3.8 d) half-lives, and sorption coefficients (K_{ads} = 1 mL/g) . the additional information has been considered. Following current Agency guidance (7/15/99) and the additional, the following values would be used for aerobic soil metabolism (158 d), aqueous photolysis (11.2 d), and sorption (2.22 mL/g). Using the input values developed following current guidelines would result in greater EECs and estimates of drinking water concentrations (EDWCs). The scenarios are defined and chemical and water body input files for PRZM and EXAMS are included in Appendices. EECs have not been determined because these levels of acifluorfen in exceeded HED's level of concern.

TABLE 3. SELECTED ACIFLUORFEN ENVIRONMENTAL FATE PROPERTIES AND MODEL INPUTS USED IN PRZM/EXAMS

ACIFLUORFEN PROPERTY	FATE DATA	MODEL INPUT CALCULATIONS	MODEL INPUT VALUE	SOURCE
Solubility (ppm)	2.50E+05		2.50E+05	EFED One-liner
Molecular Weight	383.70		383.70	EFED One-liner
Hydrolysis (days)	stable at pH 5,7,9		considered stable	EFED One-liner
Henry’s Constant (atm.m^3/mol)	1.51E-13 (calculated)		1.51E-13	EFED One-liner
Photolysis half-life (days)	Water: 3.8 Soil: 57 @pH4		0.0075/hr	EFED One-liner

ACIFLUORFEN PROPERTY	**FATE DATA**	**MODEL INPUT CALCULATIONS**	**MODEL INPUT VALUE**	**SOURCE**
Aerobic Soil Metabolism half-life (days)	30, 60 - 180, 170, 59, 6 (60 and 180 were used to cover the range 60 - 180)	upper 90%=mean + t90 x std/√n; single tail student t, á=0.1 and n = number of samples	121 (5.7E-03/d)	EFED One-liner
Anaerobic Soil Metabolism half-life (days)	<28 days	multiply value by 3	84 (8.3E-04/d)	EFED One-liner
Aerobic Aquatic half-life (days)	98%-day 0, 82%-day 35: half-life estimated to be 117 days	multiple value by 3	351 (8.23E-05/hr)	EFED One-liner
Anaerobic Aquatic half-life (days)	no data	estimate by multiplying anaerobic soil half-life by 6 (28 x 3 x 2)	168 (1.72E-04/hr)	EFED One-liner
Soil Water Partition (Kd)mL/g	1		1 (assume OC=1%) K_{oc} = 100	EFED One-liner

The K_{ads} values for acifluorfen amine (amino acifluorfen) were 47.01, 19.34, 12.11, and 1.25 for loamy sand, loam, clay, and sand soils, respectively (1/n values ranged from 0.802 to 0.936). K_{oc} values were 7368, 741, 652, and 431 for loamy sand, loam, clay, and sand soils, respectively. Using the relative mobility classification of McCall *et al.*, acifluorfen amine has a mobility classification of “immobile” in loamy sand, “low mobility” in loam and clay, and “medium mobility” in sand.

In addition to being a registered herbicide, acifluorfen is also the primary degradate of the herbicide lactofen (chemical code 128888). Lactofen is not persistent. Its aerobic soil metabolism half-lives ($T_{½}$) are between 1 and 3 days. The primary degradate of lactofen is acifluorfen. Acifluorfen accounted for approximately 52 percent of the applied lactofen seven days after application in an aerobic metabolism soil study. A second degradate (PPG-947 desethyl lactofen) accounted for 16.2 percent of applied lactofen one day after application in an aerobic metabolism soil study. Amino acifluorfen was also present.

Lactofen is susceptible to hydrolysis, as the half-lives for pH 5, 7, and 9 were 10.7, 4.6, and <1.0 days (@40°C), respectively. Hydrolysis may proceed more slowly with lower temperatures that better reflect environmental temperatures. Lactofen's solubility (0.94 mg/L) is low and is not mobile (K_{oc} 6600 to 15000), but eroded soil with lactofen bound to soil particles may be transported to surface water.

Environmental fate properties suggest that once acifluorfen reaches ground water it is quite persistent. Monitoring data from a prospective ground-water study confirm its persistence in ground water. It also appears that acifluorfen will be persistent in surface water due to a long aerobic aquatic half-life and its stability to hydrolysis. Photolysis in water maybe one of the possible means of acifluorfen degradation in water as the aqueous photolysis half-lives range from 0.9 to 15 days. When light penetration is restricted the rate of photolysis would reduced. Photodegradation may be an important process in surface water, but in not ground water.

Because of rapid soil metabolism and hydrolysis, lactofen that enters surface water in solution is not expected to be persistent. It is assumed that, in an aquatic environment, lactofen will degrade to acifluorfen. Lactofen is not expected to leach to ground water because of its high binding potential and short half-life. The degradate amino acifluorfen appears to be persistent but less mobile than acifluorfen in some soils.

Water Exposure Assessment Approach

Chemical properties, environmental fate characteristics and available monitoring data indicate that acifluorfen has the potential to leach to ground water and to enter surface water via leaching and run-off. The water assessment includes monitoring data and modeling to estimate acifluorfen concentrations, from both the application of acifluorfen and lactofen, in both surface and ground water. Surface water bodies were simulated using PRZM and EXAMS to represent a small farm pond via standard farm pond for ecological exposure and the Index Reservoir (IR) with percent crop treated (PCA) for drinking water exposure assessment. The ground-screening model, SCI-GROW, was used for a Tier I ground water assessment. The models and scenarios are discussed briefly below. The selection of model input parameters generally followed EFED guidance for input selection. Scenarios had sodium acifluorfen being applied to soybeans in Georgia and Mississippi and lactofen applied to cotton and converted to acifluorfen (52% conversion).

Drinking Water Exposure
Overview:

Based on the chemical and fate properties, monitoring data, and computer simulated estimates of acifluorfen, the level of contamination of drinking water supplies resulting from normal agricultural practices has been determined. The peak acifluorfen concentrations simulated in the Index Reservoirs (IR) adjusted by the percent crop area (PCA) were 4.9, 14.0, and 7.5 µg/L, for lactofen applied to cotton, and for acifluorfen applied to soybeans in Mississippi and Georgia, respectively. The peak values presented represent approximately the 90% exceedence values. If 36 years of meteorological data (as with Georgia) were available, the peak value would represent a 95% confidence bound on the 90% exceedence value. Since only 20 years of data were available for Mississippi, the confidence is lower. The 1-in-10 year average acifluorfen concentrations simulated with PRZM and EXAMS using the IRs with PCA factor were 0.99, 2.97, and 1.72 µg/L from lactofen applied (degrades to acifluorfen) to cotton in Mississippi, and for acifluorfen applied to soybeans in Mississippi and Georgia, respectively. The multiple year, or long term means were 0.34, 1.40, and 1.02 µg/L for lactofen applied to cotton, and for acifluorfen applied to soybeans in Mississippi and Georgia, respectively

There is little surface water monitoring data for acifluorfen. The maximum value reported in NAWQA is 2.2 µg/L. The estimated values from PRZM/EXAMS correspond reasonably well with the maximum concentration seen in NAWQA monitoring data. Because of the high mobility and long persistence of acifluorfen in water, potentially "high" concentrations of acifluorfen may exist in surface water bodies. Without specifically targeted monitor data, it is not possible to verify peak environmental concentration. It is recommended that 14.0 µg/L should be used as the acute acifluorfen concentration to evaluate risk to human heath. For chronic health risk evaluation, 3.0 µg/L should be used. This value is based upon the 1-in-10 year average annual concentration calculated using PRZM/EXAMS and is in agreement with the monitoring data. The long term exposure (cancer) assessment should use the long term mean of 1.4 µg/L.

Monitoring data also demonstrates the potential for acifluorfen to contaminate ground water. Considerable variability was seen in the acifluorfen concentrations observed by monitoring. The highest concentrations observed in the prospective study was of 46 µg/L, in the NAWQA study was 0.19 µg/L, and in the PGWDB it was 0.025 µg/L. The long term average acifluorfen concentration at the prospective study site was 7.33 µg/L.

The SCI-GROW estimates of ground-water concentrations of acifluorfen depend upon inputs of K_{oc}, the aerobic soil metabolism half-life selected, the assumptions used concerning the formation of acifluorfen and lactofen decline, and the application rate and number. The sorption of acifluorfen is influenced by clay content (type), organic carbon content, and pH. Therefore, this K_{oc} can be quite variable. Two values were considered, 10 and 100. The estimated acifluorfen concentrations ranged from 0.19 to 10.33 µg/L, depending upon half-life (84 and 121 days), K_{oc} value selected, the application rate and number, and for acifluorfen derived from lactofen, the conversion rate of lactofen to acifluorfen.

It is recommended that 10.33 µg/L be used for the drinking water assessment. This represents the highest SCI-GROW estimates for acifluorfen assuming the maximum possible acifluorfen application per season and a K_{oc} of 10 and a half-life of 121 days. This value is recommended because using the same fate properties (K_{oc}=10, $T_{½}$ = 84 and 121 days) and the application rate of acifluorfen (0.75 lb ai/ac) used in the Wisconsin prospective ground-water study, SCI-GROW's estimates of acifluorfen concentrations in ground water (8.00 and 15.5 µg/L with 84 and 121 day half-life, respectively) were similar to the measured concentrations (7.33 µg/L). The application rate in the Wisconsin study (0.75 lbs ai/A) is higher than the application rates used in this Drinking Water Assessment (0.4 lb ai/A lactofen and 0.5 lb ai/A acifluorfen on soybeans).

The Wisconsin prospective ground-water monitoring study was conducted in a highly vulnerable use area thah does not typify the entire use area. However, the type of aquifer contaminated by acifluorfen in the prospective monitoring study is used for drinking water in Wisconsin. Thus, the potential exists for aquifers tapped by shallow drinking water wells to be contaminated by acifluorfen residues as high as 46 µg/L is possible.

Monitoring: Acifluorfen has been detected in surface water and ground water during monitoring surveys. Degradates of acifluorfen have not been included in monitoring studies. Lactofen is also not routinely included in water monitoring studies due to its short half-life and low mobility. There have been no reported detections of lactofen in surface or ground water. The registrant of lactofen sponsored a small-scale, prospective ground-water monitoring study for lactofen in Ohio. The study was inconclusive, because the study did not provide confirmation that leaching actually occurred at the site. The registrant is conducting a second small-scale prospective ground-water monitoring study. The first progress report had been submitted, but lactofen and acifluorfen residue data have not been submitted to the Agency.

Acifluorfen has been detected in both surface and ground water samples collected the USGS's in the National Water Quality Assessment (NAWQA) program. The USGS NAWQA study reports 0.12 percent of samples collected from major aquifers had detectable levels of acifluorfen, the maximum detection of 0.19 µg/L. For Only 0.04 percent of all the ground water samples by collected NAWQA had detectable levels of acifluorfen. Concentrations ranged between 0.035 to 0.19 µg/L. The NAWQA study's goal is to assess water quality in general, not to specifically detect lactofen and acifluorfen contamination. The only surface water monitoring data available is that which has been collected by NAWQA. The maximum detection of acifluorfen in surface water reported is 2.2 µg/L.

Acifluorfen residues in ground water were reported in the Pesticides in Ground Water Data Base, PGWDB (USEPA, 1992), a summary of other ground-water monitoring studies. The PGWDB (USEPA, 1992) reports that four of 1185 wells sampled had acifluorfen concentrations ranging from 0.003 to 0.025 µg/L. Because the studies summarized in the PGWDB were conducted with many objectives and study designs, the results may reflect conditions where no lactofen or acifluorfen had been used or where there is a low susceptibility to ground-water contamination. Therefore, EFED is not confident that the monitoring reflects the potential contamination of ground water from acifluorfen.

A small-scale prospective ground-water monitoring study was conducted for acifluorfen-sodium in a vulnerable area of Wisconsin. Acifluorfen was detected in 56 out of 283 samples (20%) with concentrations ranging from 1 to 46 µg/L. The study duration was from 4/20/88 to 4/12/89 and acifluorfen detections occurred from 9/14/88 through 4/12/89 (final sampling). The average concentration for the five detections on 4/12/89, the last sampling time, was 15.2 µg/L. The overall mean for the 56 detections was 8.36 µg/L. The (long term) average of the 10 sampling dates during this period was 7.33 µg/L. The registrant also conducted a retrospective monitoring study. They analyzed for acifluorfen residues in shallow soil samples and monitoring wells at five different sites. No acifluorfen was found in the wells in the retrospective monitoring study.

The monitoring study with the highest residues was the small-scale prospective ground-water study, was the one that was conducted in a vulnerable area with maximum use rates. Thus the prospective study was a targeted study (use was known). This study provided information with the highest degree of confidence, because the hydrology and acifluorfen use were known (*e.g.*, the detection came from a known use). What is not as well known is how this site compares to other use sites. Although the EPA is confident that the prospective study was conducted at a vulnerable site. The other monitoring studies were not specifically conducted for acifluorfen. Some sampling or study sites were probably in vulnerable areas, but the relationship between acifluorfen use and the monitoring sites, sampling dates, and so on are not well known (or not known). Use rates were not known but are probably variable.

Ground Water Modeling: Tier I modeling for ground water used the SCI-GROW model to estimate potential ground water concentrations for acifluorfen and acifluorfen as a degradate of lactofen under hydrologically vulnerable conditions. SCI-GROW (Screening Concentration in Ground Water) is screening model developed in OPP (Barrett, 1997) to estimate pesticide concentrations under hydrologically vulnerable conditions.

There is much greater uncertainty associated with the groundwater acifluorfen concentrations predicted by SCI-GROW, because of the uncertainty of the K_{oc} and K_{ads} values. Since acifluorfen is an anion (negative charge) and of influence of pH and clay and mineral type and amount on sorption.

A number of examples of estimated acifluorfen concentrations with different fate parameters are provided in Table 4. Two half-life values were used, the mean and the upper 90th percent value of the aerobic soil metabolism half-life. The concentrations predicted assuming 100 percent conversion of lactofen to acifluorfen are presented as an "upper bound", because the rate of acifluorfen formation is not known (or considered).

Since SCI-GROW requires K_{oc} rather than K_d, a K_{oc} of 100 was used. Since K_d varies inversely with pH, the specific value of K_d or K_{oc} would depend upon site characteristics. Assuming a K_d of 0.1 rather than 1, there is a 10 percent or more increase in the estimated acifluorfen concentration. Using a K_{oc} of 10, an application rate of 0.75 lb ai/A for acifluorfen (rate used in the Wisconsin prospective study), and half-lives of 84 and 121 days, concentrations of 8.0 and 15.5 µg/L, respectively, were estimated by SCI-GROW. These values are similar to the mean concentration observed in the Wisconsin prospective ground water study. Using the same Wisconsin application rate for acifluorfen, a K_{oc} of 100, and half-lives of 84 or 121 days, the estimated SCI-GROW concentrations would be 0.84 and 1.34 µg/L, respectively. Thus SCI-GROW underestimates the concentrations observed in the Wisconsin prospective ground-water study

Table 4. Estimated ground water concentrations for acifluorfen using SCI-GROW with different assumptions concerning fate parameters and application rate (or % of lactofen converted to acifluorfen.

Application (lb ai/A)	Half-life (days)	K_{oc} (assume OC=1%)	Concentration (µg/L)
0.17[1]	84	100 (K_d = 1)	0.19
0.17	121	100 (K_d = 1)	0.30
0.17	84	10 (K_d = 0.1)	1.81
0.17	121	10 (K_d = 0.1)	3.51
0.40[2]	84	10 (K_d = 0.1)	4.26
0.40	121	100 (K_d = 1)	0.71
0.40	84	10 (K_d = 0.1)	8.27
0.40	121	100 (K_d = 1)	0.45

Table 4. Estimated ground water concentrations for acifluorfen using SCI-GROW with different assumptions concerning fate parameters and application rate (or % of lactofen converted to acifluorfen.

Application (lb ai/A)	Half-life (days)	K_{oc} (assume OC=1%)	Concentration (µg/L)
0.50[3]	84	10 ($K_d = 0.1$)	5.33
0.50	121	10 ($K_d = 0.1$)	10.33
0.50	84	100 ($K_d = 1$)	0.56
0.50	121	100 ($K_d = 1$)	0.89

[1] Application rate reflects conversion from 0.4 lb ai/A to 0.32 lb ai/A for banding, and multiplied by 0.523 (proportion of acifluorfen/applied lactofen).
[2] Maximum lactofen rate (and amount) on cotton, assume 100 percent conversion to acifluorfen.
[3] Maximum acifluorfen application (and amount) allowed per season for acifluorfen on soybeans.

The concentration of acifluorfen in ground water as simulated by (SCI-GROW) depends upon the input parameters. Table 4 shows the result of changing the K_{oc} and aerobic soil metabolism half-life values used can dramatically influence the estimated concentrations. SCI-GROW underestimates the acifluorfen concentrations seen at the prospective ground-water monitoring site in Wisconsin when making normal assumptions about the fate properties selected.

Surface Water Resources

Acifluorfen has a potential to contaminate through run-off and ground water discharge to surface water bodies. Because acifluorfen does not readily bind to sediment and degrades by hydrolysis and degrades slowly by microbial activity, aquatic photolysis appears to be a major route of dissipation of acifluorfen in surface water. Thus acifluorfen may persist where light penetration is limited. Environmental factors such as soil temperature and soil water content influences soil microbial activity and thus, acifluorfen's degradation rate in soil and also possibly in water.

Surface Water Modeling: PRZM and EXAMS models were used to provide additional estimates of potential surface water concentrations for acifluorfen used on soybeans and from lactofen converted to acifluorfen on cotton and soybeans. Standard scenarios and guidance modeling input parameters thah were developed by OPP were used. Input parameters for each PRZM simulation, along with the input files, and descriptions of scenarios modeled for acifluorfen can be found in Appendix L. Soil, cropping and management inputs were obtained from local agricultural personnel or by the PIC (PRZM Input Collator) data base. EXAMS environmental inputs were taken from the Georgia Pond scenario (for ecological exposure) and the Index Reservoirs for the Loring Silt Loam in Yazoo County, Mississippi for cotton and soybeans and the Lynchburg loamy sand in Georgia for soybeans (for drinking water exposure). The concentrations predicted in the Index Reservoir by PRZM/EXAMS are then multiplied by the percent crop area for each crop. The maximum percent (as a decimal fraction) crop area (PCA) that have been developed by OPP are 0.41 for soybeans and 0.20 for cotton. The estimated acifluorfen concentrations for the different scenarios are summarized in the following table.

Table 5. Estimated environmental concentrations (ecological exposure and drinking water) for acifluorfen on cotton (degradate of lactofen) and acifluorfen on soybeans with PRZM/EXAMS and index reservoir concentrations adjusted for maximum percent crop areas (PCA)

		Surface Water Acifluorfen Concentration (µg/L)		
Crop (chemical)	Water Body	1-in-10 year Maximum	1-in-10 year Average	Multi-Year Average
Cotton (lactofen)	Pond	11.29[1]	5.68[1]	3.21[1]
Cotton (lactofen)	Index Reservoir	24.60 [4.92][2]	4.93 [0.99][2]	1.72 [0.34][2]
Soybean (Acifluorfen)	Pond (MS)	21.11[1]	11.53[1]	6.72[1]
Soybean (Acifluorfen)	Index Reservoir (MS)	34.21 [14.03][3]	7.24 [2.97][3]	3.41 [1.40][3]
Soybean (Acifluorfen)	Pond (GA)	9.76[1]	5.34[1]	3.33[1]
Soybean (Acifluorfen)	Index Reservoir (GA)	18.40 [7.54][3]	4.19[1.72][3]	2.48 [1.02][3]

[1] Estimated Environmental Concentrations for ecological exposure assessments.
[2] Estimated Drinking Water Concentration (EDWC) Unadjusted and [Adjusted] for PCA of 0.20.
[3] Estimated Drinking Water Concentration (EDWC) Unadjusted and [Adjusted] for PCA of 0.41.

Several acifluorfen degradates were identified in water. Their persistence is not known. Aquatic degradation information for lactofen is lacking, which increases the uncertainty of our understanding of the fate of these compounds in surface water. Lactofen is not mobile or persistent. It is unlikely to leach to ground water. Lactofen's fate in an aquatic system (surface water) is less clear, but it is not persistent (in soil) and would have an affinity to bind to sediment rather than remain in solution. Whether bound lactofen will degrade to acifluorfen is not known.

REFERENCES

Jones, R. David Jones and Sidney Abel. 1997. Use of a Crop Area Factor in Estimating Surface-Water-Source Drinking Water Exposure. Presentation to the FIFRA Science Advisory Panel, December, 1997.

U.S. Environmental Protection Agency. 2000. *Draft* Guidance for Use of the Index Reservoir and Percent Crop Area Factor in Drinking Water Exposure Assessments. (3/21/2000).

Input Parameters for the Standard EXAMS Index Reservoir

Table 6. 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^3h^{-1}	0 $m^3 h^{-1}$	see text

Table 7. 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)[**]	3.0×10^{-5}	standard pond

[*] JTURB(1) = 1, ITURB(1) = 2; ** each monthly parameter set to this value.

Table 8. 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 9. EXAMS II external environmental and location parameters for the Index Reservoir.		
Parameter	Value	Source
Precipitation (RAIN)	0 mm ·month^{-1}	
Atmospheric Turbulence (ATURB)	2.00 km	standard pond
Evaporation Rate (EVAP)	0 mm month^{-1}	
Wind Speed (WIND)	1 m ·sec^{-1}	standard pond
Air Mass Type (AMASS)	Rural (R)	
Elevation (ELEV)	54.9 m	USGS map
Latitude (LAT)	39.12° N	USGS map
Longitude (LONG)	90.05° W	USGS map

Table 10. EXAMS II biological characterization parameters for the Index Reservoir.			
Parameter	Limnic	Benthic	Source
Bacterial Plankton Population Density (BACPL)	1 cfu cm^{-3}		see text
Benthic Bacteria Population Density (BNBAC)		37 cfu (100 g)$^{-1}$	see text
Bacterial Plankton Biomass (PLMAS)	0.40 mg L^{-1}		standard pond
Benthic Bacteria Biomass (BNMAS)		6.0x10^{-3} g m^{-2}	standard pond

Table 11. 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 ·L^{-1}	standard pond
chlorophylls and pheophytins (CHL)	5x10^{-3} mg L^{-1}	standard pond
pH (PH)	7	standard pond
pOH (POH)	7	standard pond

Table 12. 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

APPENDIX L.
PRZM Input, EXAMS Output Summary Data and EXAMS chemical and environment input files.

The PRZM input file and the corresponding EXAMS estimated summary data are given for the key scenarios modeled and discussed in the RED.

INPUT

```
ACIFLU0RFEN  FROM  APPLICATION TO COTTON FROM LACTOFEN

*** source of acifluorfen is lactofen (0.375 lb ai/a * 0.523 convrsion
*** pond no drift
*** PRZM 3.1 Input data File, MSCOTacf.inp***
*** Standard Scenario Draft Final April 10, 1998 ***
*** Location: Yazoo County, Mississippi; MLRA: O-134 ***
*** Weather: MET131.MET Jackson, MS ***
*** Manning's N: Assume fallow surface with residues not more than 1 ton/acre ***
*** See MSCOTTN1.wpd for scenario description and metadata ***
*** Modeler must input chemical specific information where all "X's" appear ***
Chemical: Acifluorfen - degradate of lactofen assumme 52.3% lactofen goes to acifluorfen (3 days
later)
Location: Mississippi; Crop: cotton;  MLRA: O-134
    0.76    0.15       0   17.00       1       1
       4
    0.49    0.40    0.75   10.00    5.80       4    6.00   354.0
       3
       1    0.20  125.00   98.00       3  99  93  92                 0.00  120.00
       2    0.20  125.00   98.00       3  94  84  83                 0.00  120.00
       3    0.20  125.00   98.00       3  99  83  83                 0.00  120.00
       1       3
0101 2109 2209
0.63 0.16 0.18
0.02 0.02 0.02
       2       3
0105 0709 2209
0.16 0.13 0.13
0.02 0.02 0.02
       3       3
0105 0709 2209
0.16 0.13 0.09
0.02 0.02 0.02
      20
  01 564  07 964  220964       1
  01 565  07 965  220965       2
  01 566  07 966  220966       3
  01 567  07 967  220967       1
  01 568  07 968  220968       2
  01 569  07 969  220969       3
  01 570  07 970  220970       1
  01 571  07 971  220971       2
  01 572  07 972  220972       3
  01 573  07 973  220973       1
  01 574  07 974  220974       2
  01 575  07 975  220975       3
  01 576  07 976  220976       1
  01 577  07 977  220977       2
  01 578  07 978  220978       3
  01 579  07 979  220979       1
  01 580  07 980  220980       2
  01 581  07 981  220981       3
  01 582  07 982  220982       1
  01 583  07 983  220983       2
Application schedule:  1 (soil) apps @ 00.19kg/ha @100% eff w/ 0% drift
      20       1       0       0
acifluorfen Kd =1; AESM t1/2 =  121 days anaesm t1/2= 84 days
  17 564  0 5 1.00  0.19 1.00 0.00
  17 565  0 5 1.00  0.19 1.00 0.00
  17 566  0 5 1.00  0.19 1.00 0.00
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  17 567  0 5 1.00  0.19 1.00 0.00
  17 568  0 5 1.00  0.19 1.00 0.00
  17 569  0 5 1.00  0.19 1.00 0.00
  17 570  0 5 1.00  0.19 1.00 0.00
  17 571  0 5 1.00  0.19 1.00 0.00
  17 572  0 5 1.00  0.19 1.00 0.00
  17 573  0 5 1.00  0.19 1.00 0.00
  17 574  0 5 1.00  0.19 1.00 0.00
  17 575  0 5 1.00  0.19 1.00 0.00
  17 576  0 5 1.00  0.19 1.00 0.00
  17 577  0 5 1.00  0.19 1.00 0.00
  17 578  0 5 1.00  0.19 1.00 0.00
  17 579  0 5 1.00  0.19 1.00 0.00
  17 580  0 5 1.00  0.19 1.00 0.00
  17 581  0 5 1.00  0.19 1.00 0.00
  17 582  0 5 1.00  0.19 1.00 0.00
  17 583  0 5 1.00  0.19 1.00 0.00
    0.00       1    0.00
Soil Series: Loring silt loam; Hydrogic Group C
  155.00    0.00   0   0   0   0   0   0   0   0   0
    0.00    0.00   0.000
       6
       1   13.00   1.400   0.385   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.385   0.151   2.180    1.00
       2   23.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.490    1.00
       3   33.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.160    1.00
       4   30.00   1.450   0.340   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.340   0.125   0.124    1.00
       5   23.00   1.490   0.335   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.335   0.137   0.070    1.00
       6   33.00   1.510   0.343   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.343   0.147   0.060    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
       1  -----
       7    DAY
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5


     mscotacf.inp  lactofen 0.375 lb ai/a * 0.523 = acifluorfen
     pond, no drift
```

OUTPUT

```
           WATER COLUMN DISSOLVED CONCENTRATION (PPB)


  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1964     2.437     2.419     2.359     2.302     2.206     1.154
  1965     1.341     1.335     1.312     1.261     1.222      .872
  1966     4.716     4.697     4.584     4.287     4.063     2.231
  1967    14.770    14.660    14.320    13.690    13.040     7.565
  1968     7.549     7.519     7.392     7.105     6.885     5.721
  1969     3.749     3.734     3.672     3.530     3.421     2.474
  1970     3.720     3.692     3.578     3.433     3.276     2.145
  1971     1.987     1.979     1.946     1.870     1.812     1.366
  1972      .905      .899      .872      .814      .772      .670
  1973     5.438     5.401     5.290     4.963     4.720     2.612
  1974     2.745     2.734     2.688     2.584     2.504     1.949
  1975     1.235     1.230     1.209     1.163     1.127      .877
  1976    11.570    11.480    11.120    10.470     9.955     5.317
  1977     5.856     5.832     5.733     5.511     5.340     4.215
```

```
  1978     5.848     5.810     5.708     5.389     5.122     3.481
  1979     7.237     7.183     6.974     6.685     6.389     4.251
  1980     3.952     3.936     3.869     3.719     3.604     2.865
  1981     7.824     7.771     7.641     7.183     6.816     4.056
  1982     8.804     8.739     8.624     8.091     7.661     5.161
  1983     8.240     8.187     7.979     7.463     7.079     5.151

                       SORTED FOR PLOTTING
                       ------ --- --------

      PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
      ----      ----   -------    ------    ------    ------    ------
      .048    14.770    14.660    14.320    13.690    13.040     7.565
      .095    11.570    11.480    11.120    10.470     9.955     5.721
      .143     8.804     8.739     8.624     8.091     7.661     5.317
      .190     8.240     8.187     7.979     7.463     7.079     5.161
      .238     7.824     7.771     7.641     7.183     6.885     5.151
      .286     7.549     7.519     7.392     7.105     6.816     4.251
      .333     7.237     7.183     6.974     6.685     6.389     4.215
      .381     5.856     5.832     5.733     5.511     5.340     4.056
      .429     5.848     5.810     5.708     5.389     5.122     3.481
      .476     5.438     5.401     5.290     4.963     4.720     2.865
      .524     4.716     4.697     4.584     4.287     4.063     2.612
      .571     3.952     3.936     3.869     3.719     3.604     2.474
      .619     3.749     3.734     3.672     3.530     3.421     2.231
      .667     3.720     3.692     3.578     3.433     3.276     2.145
      .714     2.745     2.734     2.688     2.584     2.504     1.949
      .762     2.437     2.419     2.359     2.302     2.206     1.366
      .810     1.987     1.979     1.946     1.870     1.812     1.154
      .857     1.341     1.335     1.312     1.261     1.222      .877
      .905     1.235     1.230     1.209     1.163     1.127      .872
      .952      .905      .899      .872      .814      .772      .670

      1/10    11.293    11.206    10.870    10.232     9.726     5.681


     MEAN OF ANNUAL VALUES =    3.207

     STANDARD DEVIATION OF ANNUAL VALUES =    1.917

     UPPER 90% CONFIDENCE LIMIT ON MEAN =    3.849
```

INPUT

INDEX RESERVOIR

```
*** source of acifluorfen is lactofen (0.375 lb ai/a * 0.523 convrsion
*** index reservoir no drift
*** PRZM 3.1 Input data File, MSCOTacf.inr***
*** INDEX RESERVOIR March 6, 2000
*** Standard Scenario Draft Final April 10, 1998 ***
*** Location: Yazoo County, Mississippi; MLRA: O-134 ***
*** Weather: MET131.MET Jackson, MS ***
*** Manning's N: Assume fallow surface with residues not more than 1 ton/acre ***
*** See MSCOTTN1.wpd for scenario description and metadata ***
*** Modeler must input chemical specific information where all "X's" appear ***
Chemical: Acifluorfen - degradate of lactofen assumme 52.3% lactofen goes to acifluorfen (3 days
later)
Location: Mississippi; Crop: cotton;  MLRA: O-134
    0.76    0.15       0   17.00       1       1
       4
    0.49    0.40    0.75  172.80    5.80       4    6.00   464.0
       3
       1    0.20  125.00   98.00       3  99  93  92                0.00  120.00
       2    0.20  125.00   98.00       3  94  84  83                0.00  120.00
       3    0.20  125.00   98.00       3  99  83  83                0.00  120.00
       1       3
0101 2109 2209
0.63 0.16 0.18
0.02 0.02 0.02
       2       3
0105 0709 2209
0.16 0.13 0.13
0.02 0.02 0.02
```

```
       3       3
0105 0709 2209
0.16 0.13 0.09
0.02 0.02 0.02
      20
  01 564  07 964  220964       1
  01 565  07 965  220965       2
  01 566  07 966  220966       3
  01 567  07 967  220967       1
  01 568  07 968  220968       2
  01 569  07 969  220969       3
  01 570  07 970  220970       1
  01 571  07 971  220971       2
  01 572  07 972  220972       3
  01 573  07 973  220973       1
  01 574  07 974  220974       2
  01 575  07 975  220975       3
  01 576  07 976  220976       1
  01 577  07 977  220977       2
  01 578  07 978  220978       3
  01 579  07 979  220979       1
  01 580  07 980  220980       2
  01 581  07 981  220981       3
  01 582  07 982  220982       1
  01 583  07 983  220983       2
Application schedule:  1 (soil) apps @ 00.19kg/ha @100% eff w/ 0% drift
      20       1       0       0
acifluorfen Kd =1; AESM t1/2 =  121 days anaesm t1/2= 84 days
  17 564  0 5 1.00  0.19 1.00 0.00
  17 565  0 5 1.00  0.19 1.00 0.00
  17 566  0 5 1.00  0.19 1.00 0.00
  17 567  0 5 1.00  0.19 1.00 0.00
  17 568  0 5 1.00  0.19 1.00 0.00
  17 569  0 5 1.00  0.19 1.00 0.00
  17 570  0 5 1.00  0.19 1.00 0.00
  17 571  0 5 1.00  0.19 1.00 0.00
  17 572  0 5 1.00  0.19 1.00 0.00
  17 573  0 5 1.00  0.19 1.00 0.00
  17 574  0 5 1.00  0.19 1.00 0.00
  17 575  0 5 1.00  0.19 1.00 0.00
  17 576  0 5 1.00  0.19 1.00 0.00
  17 577  0 5 1.00  0.19 1.00 0.00
  17 578  0 5 1.00  0.19 1.00 0.00
  17 579  0 5 1.00  0.19 1.00 0.00
  17 580  0 5 1.00  0.19 1.00 0.00
  17 581  0 5 1.00  0.19 1.00 0.00
  17 582  0 5 1.00  0.19 1.00 0.00
  17 583  0 5 1.00  0.19 1.00 0.00
    0.00       1    0.00
Soil Series: Loring silt loam; Hydrogic Group C
  155.00    0.00   0   0   0   0   0   0   0   0   0
    0.00    0.00   0.000
       6
       1   13.00   1.400   0.385   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.385   0.151   2.180    1.00
       2   23.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.490    1.00
       3   33.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.160    1.00
       4   30.00   1.450   0.340   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.340   0.125   0.124    1.00
       5   23.00   1.490   0.335   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.335   0.137   0.070    1.00
       6   33.00   1.510   0.343   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.343   0.147   0.060    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
       1  -----
       7    DAY
    PRCP    TSER   0   0
```

```
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

OUTPUT

```
mscotacf.inr aciflurw.chm index reservoir
     lactofen 0.375 lb ai/a * 0.523 = acifluorfen
     pond, no drift

          WATER COLUMN DISSOLVED CONCENTRATION (PPB)


  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1964     5.824     5.657     5.048     4.107     3.471     1.229
  1965     0.308     0.300     0.271     0.217     0.184     0.076
  1966    10.230     9.996     9.092     7.040     5.864     1.952
  1967    30.520    29.770    27.420    21.800    18.280     6.368
  1968     4.762     4.629     4.109     3.403     2.869     1.167
  1969     0.392     0.381     0.337     0.294     0.258     0.127
  1970     6.412     6.226     5.560     4.479     3.774     1.270
  1971     0.540     0.524     0.468     0.371     0.310     0.166
  1972     0.838     0.814     0.720     0.557     0.465     0.155
  1973    11.760    11.430    10.590     8.290     6.938     2.331
  1974     1.157     1.123     0.995     0.766     0.637     0.308
  1975     0.444     0.435     0.394     0.306     0.264     0.106
  1976    25.610    24.870    22.870    18.070    15.110     5.130
  1977     2.453     2.382     2.109     1.797     1.552     0.745
  1978     9.281     9.021     8.148     6.390     5.337     1.780
  1979    12.260    11.910    10.560     8.523     7.205     2.631
  1980     1.875     1.823     1.619     1.285     1.083     0.478
  1981    15.470    15.030    13.690    10.660     8.891     2.946
  1982    14.740    14.320    13.020    10.140     8.484     3.098
  1983    11.380    11.100     9.946     7.682     6.408     2.278


                       SORTED FOR PLOTTING
                       ------ --- --------

      PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
      ----      ----   -------    ------    ------    ------    ------
     0.048    30.520    29.770    27.420    21.800    18.280     6.368
     0.095    25.610    24.870    22.870    18.070    15.110     5.130
     0.143    15.470    15.030    13.690    10.660     8.891     3.098
     0.190    14.740    14.320    13.020    10.140     8.484     2.946
     0.238    12.260    11.910    10.590     8.523     7.205     2.631
     0.286    11.760    11.430    10.560     8.290     6.938     2.331
     0.333    11.380    11.100     9.946     7.682     6.408     2.278
     0.381    10.230     9.996     9.092     7.040     5.864     1.952
     0.429     9.281     9.021     8.148     6.390     5.337     1.780
     0.476     6.412     6.226     5.560     4.479     3.774     1.270
     0.524     5.824     5.657     5.048     4.107     3.471     1.229
     0.571     4.762     4.629     4.109     3.403     2.869     1.167
     0.619     2.453     2.382     2.109     1.797     1.552     0.745
     0.667     1.875     1.823     1.619     1.285     1.083     0.478
     0.714     1.157     1.123     0.995     0.766     0.637     0.308
     0.762     0.838     0.814     0.720     0.557     0.465     0.166
     0.810     0.540     0.524     0.468     0.371     0.310     0.155
     0.857     0.444     0.435     0.394     0.306     0.264     0.127
     0.905     0.392     0.381     0.337     0.294     0.258     0.106
     0.952     0.308     0.300     0.271     0.217     0.184     0.076

      1/10    24.596    23.886    21.952    17.329    14.488     4.927

     MEAN OF ANNUAL VALUES =    1.717

     STANDARD DEVIATION OF ANNUAL VALUES =    1.719

     UPPER 90% CONFIDENCE LIMIT ON MEAN =    2.293
```

INPUT

```
*** PRZM 3.1 Input data File, MSCOTac2.inp***
*** Standard Scenario Draft Final April 10, 1998 ***
*** Location: Yazoo County, Mississippi; MLRA: O-134 ***
*** Weather: MET131.MET Jackson, MS ***
*** Manning's N: Assume fallow surface with residues not more than 1 ton/acre ***
*** See MSCOTTN1.wpd for scenario description and metadata ***
*** Modeler must input chemical specific information where all "X's" appear ***
Chemical: Acifluorfen - degradate of lactofen assumme 52.3% lactofen goes to acifluorfen (3 days
later)
Location: Mississippi; Crop: cotton;  MLRA: O-134
    0.76    0.15       0   17.00       1       1
       4
    0.49    0.40    0.75   10.00    5.80       4    6.00   354.0
       3
       1    0.20  125.00   98.00       3  99  93  92                0.00  120.00
       2    0.20  125.00   98.00       3  94  84  83                0.00  120.00
       3    0.20  125.00   98.00       3  99  83  83                0.00  120.00
       1       3
0101 2109 2209
0.63 0.16 0.18
0.02 0.02 0.02
       2       3
0105 0709 2209
0.16 0.13 0.13
0.02 0.02 0.02
       3       3
0105 0709 2209
0.16 0.13 0.09
0.02 0.02 0.02
      20
  01 564  07 964  220964       1
  01 565  07 965  220965       2
  01 566  07 966  220966       3
  01 567  07 967  220967       1
  01 568  07 968  220968       2
  01 569  07 969  220969       3
  01 570  07 970  220970       1
  01 571  07 971  220971       2
  01 572  07 972  220972       3
  01 573  07 973  220973       1
  01 574  07 974  220974       2
  01 575  07 975  220975       3
  01 576  07 976  220976       1
  01 577  07 977  220977       2
  01 578  07 978  220978       3
  01 579  07 979  220979       1
  01 580  07 980  220980       2
  01 581  07 981  220981       3
  01 582  07 982  220982       1
  01 583  07 983  220983       2
Application schedule:  2 (soil) apps @ 00.095 kg/ha @100% eff w/ 0% drift
      40       1       0       0
acifluorfen Kd =1    ; AESM t1/2 =  121 days anaesm t1/2= 84 days
  17 564  0 5 1.00 0.095 1.00 0.00
  03 664  0 5 1.00 0.095 1.00 0.00
  17 565  0 5 1.00 0.095 1.00 0.00
  03 665  0 5 1.00 0.095 1.00 0.00
  17 566  0 5 1.00 0.095 1.00 0.00
  03 666  0 5 1.00 0.095 1.00 0.00
  17 567  0 5 1.00 0.095 1.00 0.00
  03 667  0 5 1.00 0.095 1.00 0.00
  17 568  0 5 1.00 0.095 1.00 0.00
  03 668  0 5 1.00 0.095 1.00 0.00
  17 569  0 5 1.00 0.095 1.00 0.00
  03 669  0 5 1.00 0.095 1.00 0.00
  17 570  0 5 1.00 0.095 1.00 0.00
  03 670  0 5 1.00 0.095 1.00 0.00
  17 571  0 5 1.00 0.095 1.00 0.00
  03 671  0 5 1.00 0.095 1.00 0.00
  17 572  0 5 1.00 0.095 1.00 0.00
  03 672  0 5 1.00 0.095 1.00 0.00
  17 573  0 5 1.00 0.095 1.00 0.00
  03 673  0 5 1.00 0.095 1.00 0.00
  17 574  0 5 1.00 0.095 1.00 0.00
  03 674  0 5 1.00 0.095 1.00 0.00
  17 575  0 5 1.00 0.095 1.00 0.00
  03 675  0 5 1.00 0.095 1.00 0.00
```

```
  17 576  0 5 1.00 0.095 1.00 0.00
  03 676  0 5 1.00 0.095 1.00 0.00
  17 577  0 5 1.00 0.095 1.00 0.00
  03 677  0 5 1.00 0.095 1.00 0.00
  17 578  0 5 1.00 0.095 1.00 0.00
  03 678  0 5 1.00 0.095 1.00 0.00
  17 579  0 5 1.00 0.095 1.00 0.00
```

```
  03 679  0 5 1.00 0.095 1.00 0.00
  17 580  0 5 1.00 0.095 1.00 0.00
  03 680  0 5 1.00 0.095 1.00 0.00
  17 581  0 5 1.00 0.095 1.00 0.00
  03 681  0 5 1.00 0.095 1.00 0.00
  17 582  0 5 1.00 0.095 1.00 0.00
  03 682  0 5 1.00 0.095 1.00 0.00
  17 583  0 5 1.00 0.095 1.00 0.00
  03 683  0 5 1.00 0.095 1.00 0.00
    0.00       1    0.00
Soil Series: Loring silt loam; Hydrogic Group C
  155.00    0.00   0   0   0   0   0   0   0   0   0
    0.00    0.00   0.000
       6
       1   13.00   1.400   0.385   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.385   0.151   2.180    1.00
       2   23.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.490    1.00
       3   33.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.160    1.00
       4   30.00   1.450   0.340   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.340   0.125   0.124   13.39
       5   23.00   1.490   0.335   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.335   0.137   0.070    1.00
       6   33.00   1.510   0.343   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.343   0.147   0.060    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
       1  -----
       7    DAY
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

OUTPUT

```
     mscotac2.inp


           WATER COLUMN DISSOLVED CONCENTRATION (PPB)


  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1964     2.062     2.045     2.014     1.881     1.783      .948
  1965     1.181     1.176     1.156     1.111     1.077      .782
  1966     2.507     2.496     2.437     2.285     2.169     1.252
  1967    10.240    10.160     9.963     9.396     8.909     5.302
  1968     5.874     5.851     5.751     5.528     5.356     4.219
  1969     2.648     2.637     2.593     2.493     2.416     1.764
  1970     2.387     2.369     2.295     2.209     2.142     1.483
```

```
1971     1.441     1.431     1.395     1.323     1.282     1.113
1972      .884      .878      .852      .795      .754      .641
1973     2.884     2.865     2.806     2.635     2.577     1.578
1974     3.314     3.289     3.189     2.970     2.811     1.950
1975     1.704     1.697     1.668     1.603     1.554     1.226
1976     6.140     6.093     5.927     5.844     5.664     3.244
1977     3.590     3.564     3.461     3.341     3.208     2.814
1978     3.398     3.377     3.314     3.129     3.021     2.209
1979    10.960    10.880    10.620    10.420    10.060     5.724
1980     6.349     6.323     6.216     5.975     5.789     4.376
1981     5.342     5.308     5.142     4.978     4.903     3.460
1982    10.500    10.420    10.310     9.700     9.187     5.595
1983     6.557     6.516     6.359     5.964     5.668     4.728

                     SORTED FOR PLOTTING
                     ------ --- --------

    PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
    ----      ----   -------    ------    ------    ------    ------
    .048    10.960    10.880    10.620    10.420    10.060     5.724
     .095    10.500    10.420    10.310     9.700     9.187     5.595
    .143    10.240    10.160     9.963     9.396     8.909     5.302
    .190     6.557     6.516     6.359     5.975     5.789     4.728
    .238     6.349     6.323     6.216     5.964     5.668     4.376
    .286     6.140     6.093     5.927     5.844     5.664     4.219
    .333     5.874     5.851     5.751     5.528     5.356     3.460
    .381     5.342     5.308     5.142     4.978     4.903     3.244
    .429     3.590     3.564     3.461     3.341     3.208     2.814
    .476     3.398     3.377     3.314     3.129     3.021     2.209
    .524     3.314     3.289     3.189     2.970     2.811     1.950
    .571     2.884     2.865     2.806     2.635     2.577     1.764
    .619     2.648     2.637     2.593     2.493     2.416     1.578
    .667     2.507     2.496     2.437     2.285     2.169     1.483


    .714     2.387     2.369     2.295     2.209     2.142     1.252
    .762     2.062     2.045     2.014     1.881     1.783     1.226
    .810     1.704     1.697     1.668     1.603     1.554     1.113
    .857     1.441     1.431     1.395     1.323     1.282      .948
    .905     1.181     1.176     1.156     1.111     1.077      .782
    .952      .884      .878      .852      .795      .754      .641

    1/10    10.474    10.394    10.275     9.670     9.159     5.566

   MEAN OF ANNUAL VALUES =    2.720

   STANDARD DEVIATION OF ANNUAL VALUES =    1.726
   UPPER 90% CONFIDENCE LIMIT ON MEAN =  3.298
```

INPUT

```
*** PRZM 3.1 Input data File, mssoyac6.inp***
*** Standard Scenario Draft Final may 28, 1998 ***
*** Location: Yazoo County, Mississippi; MLRA: O-134 ***
*** Weather: MET131.MET Jackson, MS ***
*** Manning's N: Assume fallow surface with residues not more than 1 ton/acre ***
*** See MSCOTTN1.wpd for scenario description and metadata ***
*** Modeler must input chemical specific information where all "X's" appear ***
Chemical: acifluorfen - max single application on soybeans 2 pts or 0.5 lb ai/ac
Location: Mississippi; Crop: soybean; MLRA: O-134
    0.76    0.15       0   17.00       1       1
       4
    0.49    0.40    0.75   10.00    5.80       4    6.00   354.0
       3
       1    0.20  125.00   98.00       3  99  93  92                0.00  120.00
       2    0.20  125.00   98.00       3  94  84  83                0.00  120.00
       3    0.20  125.00   98.00       3  99  83  83                0.00  120.00
       1       3
0101 2109 2209
0.63 0.16 0.18
0.02 0.02 0.02
       2       3
0105 0709 2209
0.16 0.13 0.13
0.02 0.02 0.02
       3       3
0105 0709 2209
0.16 0.13 0.09
0.02 0.02 0.02
      20
  01 564  07 964  220964       1
  01 565  07 965  220965       2
  01 566  07 966  220966       3
  01 567  07 967  220967       1
  01 568  07 968  220968       2
  01 569  07 969  220969       3
  01 570  07 970  220970       1
  01 571  07 971  220971       2
  01 572  07 972  220972       3
  01 573  07 973  220973       1
  01 574  07 974  220974       2
  01 575  07 975  220975       3
  01 576  07 976  220976       1
  01 577  07 977  220977       2
  01 578  07 978  220978       3
  01 579  07 979  220979       1
  01 580  07 980  220980       2
  01 581  07 981  220981       3
  01 582  07 982  220982       1
  01 583  07 983  220983       2
Application schedule:  1 (soil) apps @  0.42kg/ha @ 95% eff w/ 5% drift
      20       1       0       0
acifluorfen Kd =.1; AESM t1/2 =  121 days anaesm t1/2= 84 days
  15 564  0 2 0.00  0.42 0.95 0.05
  15 565  0 2 0.00  0.42 0.95 0.05
  15 566  0 2 0.00  0.42 0.95 0.05
  15 567  0 2 0.00  0.42 0.95 0.05
  15 568  0 2 0.00  0.42 0.95 0.05
  15 569  0 2 0.00  0.42 0.95 0.05
  15 570  0 2 0.00  0.42 0.95 0.05
  15 571  0 2 0.00  0.42 0.95 0.05
  15 572  0 2 0.00  0.42 0.95 0.05
  15 573  0 2 0.00  0.42 0.95 0.05
  15 574  0 2 0.00  0.42 0.95 0.05
  15 575  0 2 0.00  0.42 0.95 0.05
  15 576  0 2 0.00  0.42 0.95 0.05
  15 577  0 2 0.00  0.42 0.95 0.05
```

```
  15 578  0 2 0.00  0.42 0.95 0.05
  15 579  0 2 0.00  0.42 0.95 0.05
  15 580  0 2 0.00  0.42 0.95 0.05
  15 581  0 2 0.00  0.42 0.95 0.05
  15 582  0 2 0.00  0.42 0.95 0.05
  15 583  0 2 0.00  0.42 0.95 0.05
    0.00       1    0.00
   0.000     0.0    0.50
Soil Series: Loring silt loam; Hydrogic Group C
  155.00    0.00   0   0   0   0   0   0   0   0   0
    0.00    0.00   0.000
       6
       1   13.00   1.400   0.385   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.385   0.151   2.180    1.00
       2   23.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.490    1.00
       3   33.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.160    1.00
       4   30.00   1.450   0.340   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.340   0.125   0.124    1.00
       5   23.00   1.490   0.335   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.335   0.137   0.070    1.00
       6   33.00   1.510   0.343   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.343   0.147   0.060    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
       1  -----
       7    DAY
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

OUTPUT

```
     mssoyac6.inp  1 appl soybeans at 0.375 lb ai/ac


           WATER COLUMN DISSOLVED CONCENTRATION (PPB)


  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1964     4.415     4.383     4.269     4.156     3.982     2.124
  1965     2.828     2.810     2.740     2.583     2.458     2.032
  1966     7.664     7.631     7.452     6.969     6.605     3.792
  1967    15.930    15.860    15.640    14.770    14.040     8.535
  1968     9.594     9.536     9.271     8.823     8.415     6.869
  1969     4.844     4.824     4.743     4.560     4.419     3.678
  1970     6.358     6.310     6.120     5.851     5.582     3.659
  1971     3.601     3.576     3.476     3.401     3.270     2.775
  1972     2.675     2.656     2.578     2.431     2.381     1.855
  1973     9.059     8.998     8.812     8.272     7.866     4.516
  1974     4.889     4.855     4.714     4.490     4.336     3.711
  1975     5.554     5.518     5.385     5.092     4.843     3.323
  1976    17.500    17.370    16.830    15.870    15.090     8.660
  1977     8.881     8.845     8.696     8.359     8.099     6.829
  1978     6.876     6.832     6.677     6.274     5.960     4.503
  1979    10.890    10.810    10.490    10.080     9.645     6.098
  1980    13.460    13.370    13.160    12.350    11.730     7.869
  1981    10.990    10.920    10.700    10.050     9.538     6.976
  1982    13.450    13.340    13.160    12.360    11.700     7.769
  1983    14.890    14.830    14.440    13.630    12.960     9.014
```

```
                       SORTED FOR PLOTTING
                       ------ --- --------

      PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
      ----      ----   -------    ------    ------    ------    ------
      .048    17.500    17.370    16.830    15.870    15.090     9.014
      .095    15.930    15.860    15.640    14.770    14.040     8.660
      .143    14.890    14.830    14.440    13.630    12.960     8.535
      .190    13.460    13.370    13.160    12.360    11.730     7.869
      .238    13.450    13.340    13.160    12.350    11.700     7.769
      .286    10.990    10.920    10.700    10.080     9.645     6.976
      .333    10.890    10.810    10.490    10.050     9.538     6.869
      .381     9.594     9.536     9.271     8.823     8.415     6.829
      .429     9.059     8.998     8.812     8.359     8.099     6.098
      .476     8.881     8.845     8.696     8.272     7.866     4.516
      .524     7.664     7.631     7.452     6.969     6.605     4.503
      .571     6.876     6.832     6.677     6.274     5.960     3.792
      .619     6.358     6.310     6.120     5.851     5.582     3.711
      .667     5.554     5.518     5.385     5.092     4.843     3.678
      .714     4.889     4.855     4.743     4.560     4.419     3.659
      .762     4.844     4.824     4.714     4.490     4.336     3.323
      .810     4.415     4.383     4.269     4.156     3.982     2.775
      .857     3.601     3.576     3.476     3.401     3.270     2.124
      .905     2.828     2.810     2.740     2.583     2.458     2.032
      .952     2.675     2.656     2.578     2.431     2.381     1.855

      1/10    15.826    15.757    15.520    14.656    13.932     8.648


     MEAN OF ANNUAL VALUES =    5.229

     STANDARD DEVIATION OF ANNUAL VALUES =    2.414

     UPPER 90% CONFIDENCE LIMIT ON MEAN =    6.038
```

INPUT

```
*** PRZM 3.1 Input data File, mssoyacf.inp***
*** Standard Scenario Draft Final may 28, 1998 ***
*** Location: Yazoo County, Mississippi; MLRA: O-134 ***
*** Weather: MET131.MET Jackson, MS ***
*** Manning's N: Assume fallow surface with residues not more than 1 ton/acre ***
*** See MSCOTTN1.wpd for scenario description and metadata ***
*** Modeler must input chemical specific information where all "X's" appear ***
Chemical: Acifluorfen - max single application on soybeans 2 pts or 0.5 lb ai/ac
Location: Mississippi; Crop: soybean; MLRA: O-134
    0.76    0.15       0   17.00       1       1
       4
    0.49    0.40    0.75   10.00    5.80       4    6.00   354.0
       3
       1    0.20  125.00   98.00       3  99  93  92                0.00  120.00
       2    0.20  125.00   98.00       3  94  84  83                0.00  120.00
       3    0.20  125.00   98.00       3  99  83  83                0.00  120.00
       1       3
0101 2109 2209
0.63 0.16 0.18
0.02 0.02 0.02
       2       3
0105 0709 2209
0.16 0.13 0.13
0.02 0.02 0.02
       3       3
0105 0709 2209
0.16 0.13 0.09
0.02 0.02 0.02
      20
  01 564  07 964  220964       1
  01 565  07 965  220965       2
  01 566  07 966  220966       3
  01 567  07 967  220967       1
  01 568  07 968  220968       2
  01 569  07 969  220969       3
  01 570  07 970  220970       1
  01 571  07 971  220971       2
  01 572  07 972  220972       3
  01 573  07 973  220973       1
  01 574  07 974  220974       2
```

```
  01 575  07 975  220975       3
  01 576  07 976  220976       1
  01 577  07 977  220977       2
  01 578  07 978  220978       3
  01 579  07 979  220979       1
  01 580  07 980  220980       2
  01 581  07 981  220981       3
  01 582  07 982  220982       1
  01 583  07 983  220983       2
Application schedule:  1 (soil) apps @  0.56kg/ha @ 95% eff w/ 5% drift
      20       1       0       0
acifluorfen Kd =1; AESM t1/2 =  121 days anaesm t1/2= 84 days
  15 564  0 2 0.00  0.56 0.95 0.05
  15 565  0 2 0.00  0.56 0.95 0.05
  15 566  0 2 0.00  0.56 0.95 0.05
  15 567  0 2 0.00  0.56 0.95 0.05
  15 568  0 2 0.00  0.56 0.95 0.05
  15 569  0 2 0.00  0.56 0.95 0.05
  15 570  0 2 0.00  0.56 0.95 0.05
  15 571  0 2 0.00  0.56 0.95 0.05
  15 572  0 2 0.00  0.56 0.95 0.05
  15 573  0 2 0.00  0.56 0.95 0.05
  15 574  0 2 0.00  0.56 0.95 0.05
  15 575  0 2 0.00  0.56 0.95 0.05
  15 576  0 2 0.00  0.56 0.95 0.05
  15 577  0 2 0.00  0.56 0.95 0.05
  15 578  0 2 0.00  0.56 0.95 0.05
  15 579  0 2 0.00  0.56 0.95 0.05
  15 580  0 2 0.00  0.56 0.95 0.05
  15 581  0 2 0.00  0.56 0.95 0.05
  15 582  0 2 0.00  0.56 0.95 0.05
  15 583  0 2 0.00  0.56 0.95 0.05
    0.00       1    0.00
   0.000     0.0    0.50
Soil Series: Loring silt loam; Hydrogic Group C
  155.00    0.00   0   0   0   0   0   0   0   0   0
    0.00    0.00   0.000
       6
       1   13.00   1.400   0.385   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.385   0.151   2.180    1.00
       2   23.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.490    1.00
       3   33.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.160    1.00
       4   30.00   1.450   0.340   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.340   0.125   0.124   13.39
       5   23.00   1.490   0.335   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.335   0.137   0.070    1.00
       6   33.00   1.510   0.343   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.343   0.147   0.060    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
       1  -----
       7    DAY
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

OUTPUT

```
     mssoyacf.inp 1 app at 0.375 lb ai/ac


           WATER COLUMN DISSOLVED CONCENTRATION (PPB)
```

```
  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1964     5.887     5.844     5.692     5.541     5.309     2.832
  1965     3.770     3.747     3.653     3.444     3.277     2.709
  1966    10.220    10.180     9.938     9.293     8.808     5.057
  1967    21.250    21.140    20.850    19.700    18.720    11.380
  1968    12.790    12.710    12.360    11.760    11.220     9.158
  1969     6.458     6.432     6.324     6.081     5.892     4.904
  1970     8.477     8.414     8.161     7.802     7.443     4.879
  1971     4.802     4.769     4.635     4.534     4.360     3.701
  1972     3.567     3.542     3.437     3.241     3.175     2.473
  1973    12.080    12.000    11.750    11.030    10.490     6.023
  1974     6.519     6.474     6.287     5.988     5.783     4.950
  1975     7.406     7.358     7.181     6.790     6.459     4.432
  1976    23.330    23.150    22.440    21.160    20.110    11.550
  1977    11.840    11.790    11.590    11.140    10.800     9.105
  1978     9.168     9.110     8.903     8.365     7.947     6.004
  1979    14.520    14.410    13.990    13.440    12.860     8.129
  1980    17.950    17.830    17.550    16.470    15.640    10.480
  1981    14.650    14.560    14.270    13.390    12.720     9.301
  1982    17.930    17.790    17.550    16.480    15.610    10.360
  1983    19.850    19.770    19.250    18.180    17.280    12.020


                       SORTED FOR PLOTTING
                       ------ --- --------

      PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
      ----      ----   -------    ------    ------    ------    ------
      .048    23.330    23.150    22.440    21.160    20.110    12.020
      .095    21.250    21.140    20.850    19.700    18.720    11.550
      .143    19.850    19.770    19.250    18.180    17.280    11.380
      .190    17.950    17.830    17.550    16.480    15.640    10.480
      .238    17.930    17.790    17.550    16.470    15.610    10.360
      .286    14.650    14.560    14.270    13.440    12.860     9.301
      .333    14.520    14.410    13.990    13.390    12.720     9.158
      .381    12.790    12.710    12.360    11.760    11.220     9.105
      .429    12.080    12.000    11.750    11.140    10.800     8.129
      .476    11.840    11.790    11.590    11.030    10.490     6.023
      .524    10.220    10.180     9.938     9.293     8.808     6.004
      .571     9.168     9.110     8.903     8.365     7.947     5.057
      .619     8.477     8.414     8.161     7.802     7.443     4.950
      .667     7.406     7.358     7.181     6.790     6.459     4.904
      .714     6.519     6.474     6.324     6.081     5.892     4.879
      .762     6.458     6.432     6.287     5.988     5.783     4.432
      .810     5.887     5.844     5.692     5.541     5.309     3.701
      .857     4.802     4.769     4.635     4.534     4.360     2.832
      .905     3.770     3.747     3.653     3.444     3.277     2.709
      .952     3.567     3.542     3.437     3.241     3.175     2.473

      1/10    21.110    21.003    20.690    19.548    18.576    11.533


     MEAN OF ANNUAL VALUES =    6.972

     STANDARD DEVIATION OF ANNUAL VALUES =    3.218

     UPPER 90% CONFIDENCE LIMIT ON MEAN =    8.050
```

INPUT

```
*** Przm 3.12 input file mssoyacf.inr   index reservoir
***        ******** INDEX RESERVOIR ******************
*** old PRZM 3.1 Input data File, mssoyacf.inp***
*** Standard Scenario Draft Final MAR 01, 2000 ***
*** Location: Yazoo County, Mississippi; MLRA: O-134 ***
*** Weather: MET131.MET Jackson, MS ***
*** Manning's N: Assume fallow surface with residues not more than 1 ton/acre ***
*** See MSCOTTN1.wpd for scenario description and metadata ***
*** Modeler must input chemical specific information where all "X's" appear ***
Chemical: Acifluorfen - max single application on soybeans 2 pts or 0.5 lb ai/ac
Location: Mississippi; Crop: soybean; MLRA: O-134
    0.76    0.15       0   17.00       1       1
       4
    0.49    0.40    0.75  172.80    5.80       4    6.00   464.0
       3
```

```
       1    0.20  125.00   98.00       3  99  93  92                0.00  120.00
       2    0.20  125.00   98.00       3  94  84  83                0.00  120.00
       3    0.20  125.00   98.00       3  99  83  83                0.00  120.00
       1       3
0101 2109 2209
0.63 0.16 0.18
0.02 0.02 0.02
       2       3
0105 0709 2209
0.16 0.13 0.13
0.02 0.02 0.02
       3       3
0105 0709 2209
0.16 0.13 0.09
0.02 0.02 0.02
      20
  01 564  07 964  220964       1
  01 565  07 965  220965       2
  01 566  07 966  220966       3
  01 567  07 967  220967       1
  01 568  07 968  220968       2
  01 569  07 969  220969       3
  01 570  07 970  220970       1
  01 571  07 971  220971       2
  01 572  07 972  220972       3
  01 573  07 973  220973       1
  01 574  07 974  220974       2
  01 575  07 975  220975       3
  01 576  07 976  220976       1
  01 577  07 977  220977       2
  01 578  07 978  220978       3
  01 579  07 979  220979       1
  01 580  07 980  220980       2
  01 581  07 981  220981       3
  01 582  07 982  220982       1
  01 583  07 983  220983       2
Application schedule:  1 (soil) apps @  0.56kg/ha @ 95% eff w/ 5% drift
      20       1       0       0
acifluorfen Kd =1; AESM t1/2 =  121 days anaesm t1/2= 84 days
  15 564  0 2 0.00  0.560.9500.162
  15 565  0 2 0.00  0.560.9500.162
  15 566  0 2 0.00  0.560.9500.162
  15 567  0 2 0.00  0.560.9500.162
  15 568  0 2 0.00  0.560.9500.162
  15 569  0 2 0.00  0.560.9500.162
  15 570  0 2 0.00  0.560.9500.162
  15 571  0 2 0.00  0.560.9500.162
  15 572  0 2 0.00  0.560.9500.162
  15 573  0 2 0.00  0.560.9500.162
  15 574  0 2 0.00  0.560.9500.162
  15 575  0 2 0.00  0.560.9500.162
  15 576  0 2 0.00  0.560.9500.162
  15 577  0 2 0.00  0.560.9500.162
  15 578  0 2 0.00  0.560.9500.162
  15 579  0 2 0.00  0.560.9500.162
  15 580  0 2 0.00  0.560.9500.162
  15 581  0 2 0.00  0.560.9500.162
  15 582  0 2 0.00  0.560.9500.162
  15 583  0 2 0.00  0.560.9500.162
    0.00       1    0.00
   0.000     0.0    0.50
Soil Series: Loring silt loam; Hydrogic Group C
  155.00    0.00   0   0   0   0   0   0   0   0   0
    0.00    0.00   0.000
       6
       1   13.00   1.400   0.385   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.385   0.151   2.180    1.00
       2   23.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.490    1.00
       3   33.00   1.400   0.370   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.370   0.146   0.160    1.00
       4   30.00   1.450   0.340   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.340   0.125   0.124   13.39
```

```
       5   23.00   1.490   0.335   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.335   0.137   0.070    1.00
       6   33.00   1.510   0.343   0.000   0.000   0.000
          0.0083  0.0083   0.000
           1.000   0.343   0.147   0.060    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
       1  -----
       7    DAY
    PRCP    TSER   0   0
    RUNF    TSER   0   0
    INFL    TSER   1   1
    ESLS    TSER   0   0   1.E3
    RFLX    TSER   0   0   1.E5
    EFLX    TSER   0   0   1.E5
    RZFX    TSER   0   0   1.E5
```

OUTPUT

```
mssoyacf.inr aciflurw.chm index reservoir

          WATER COLUMN DISSOLVED CONCENTRATION (PPB)


  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1964    13.540    13.150    11.720     9.526     8.071     2.973
  1965     3.437     3.341     2.977     2.339     1.956     0.770
  1966    20.690    20.300    18.400    14.240    11.860     3.944
  1967    41.420    40.340    36.540    28.650    24.180     8.535
  1968    11.550    11.230    10.170     8.348     7.022     2.572
  1969     3.404     3.309     3.035     2.645     2.291     0.867
  1970    14.270    13.850    12.380     9.923     8.358     2.945
  1971     3.464     3.364     2.991     2.793     2.412     0.946
  1972     3.628     3.523     3.118     2.820     2.516     0.882
  1973    24.450    23.790    22.050    17.240    14.420     4.855
  1974     4.956     4.813     4.260     3.577     3.128     1.248
  1975    11.780    11.450    10.230     8.046     6.726     2.338
  1976    47.210    45.840    42.290    33.330    27.880     9.581
  1977     7.093     6.887     6.097     5.049     4.444     1.992
  1978    11.210    10.900     9.766     7.602     6.362     2.170
  1979    26.130    25.370    22.500    18.180    15.380     5.637
  1980    29.030    28.240    25.660    19.910    16.600     5.657
  1981    19.560    19.070    17.260    13.420    11.180     3.893
  1982    30.100    29.220    26.550    20.710    17.370     6.364
  1983    29.340    28.630    26.480    20.830    17.400     6.147


                       SORTED FOR PLOTTING
                       ------ --- --------

      PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
      ----      ----   -------    ------    ------    ------    ------
     0.048    47.210    45.840    42.290    33.330    27.880     9.581
     0.095    41.420    40.340    36.540    28.650    24.180     8.535
     0.143    30.100    29.220    26.550    20.830    17.400     6.364
     0.190    29.340    28.630    26.480    20.710    17.370     6.147
     0.238    29.030    28.240    25.660    19.910    16.600     5.657
     0.286    26.130    25.370    22.500    18.180    15.380     5.637
     0.333    24.450    23.790    22.050    17.240    14.420     4.855
     0.381    20.690    20.300    18.400    14.240    11.860     3.944
     0.429    19.560    19.070    17.260    13.420    11.180     3.893
     0.476    14.270    13.850    12.380     9.923     8.358     2.973
     0.524    13.540    13.150    11.720     9.526     8.071     2.945
     0.571    11.780    11.450    10.230     8.348     7.022     2.572
     0.619    11.550    11.230    10.170     8.046     6.726     2.338
     0.667    11.210    10.900     9.766     7.602     6.362     2.170
     0.714     7.093     6.887     6.097     5.049     4.444     1.992
     0.762     4.956     4.813     4.260     3.577     3.128     1.248
     0.810     3.628     3.523     3.118     2.820     2.516     0.946
     0.857     3.464     3.364     3.035     2.793     2.412     0.882
     0.905     3.437     3.341     2.991     2.645     2.291     0.867
     0.952     3.404     3.309     2.977     2.339     1.956     0.770

      1/10    40.288    39.228    35.541    27.868    23.502     8.318
```

```
     MEAN OF ANNUAL VALUES =    3.716

     STANDARD DEVIATION OF ANNUAL VALUES =    2.592

     UPPER 90% CONFIDENCE LIMIT ON MEAN =    4.584
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INPUT

Georgia Scenario

```
*** GASYBEA2.INP March 9, 2000, April 5, 2000
*** STANDARD POND drift = 0.05
*** ORIGINAL standard scenario gasbean.inp March 8, 2000
*** 2 applications of acifluorfen at 0.25 lb ai/ac
*** SOYBEANS - LYNCHBURG LOAMY SAND, GA - Jim Lin
*** T1/2 = 121.6 DAY OR 0.0057 Kd = 1.00
ACIFLUORFEN
Location: MLRA: P-133A; Georgia
   0.750   0.150       0   17.00       1       3
       4
    0.42    1.00    1.00    10.0               3    2.00   354.0
       1
       1    0.20   22.00  100.00       3  91  85  88                0.00   80.00
       1       3
0101  0107  0109
0.50  0.50  0.50
0.023 0.023 0.023
      36
   1 748  171048   11148   1
   1 749  171049   11149   1
   1 750  171050   11150   1
   1 751  171051   11151   1
   1 752  171052   11152   1
   1 753  171053   11153   1
   1 754  171054   11154   1
   1 755  171055   11155   1
   1 756  171056   11156   1
   1 757  171057   11157   1
   1 758  171058   11158   1
   1 759  171059   11159   1
   1 760  171060   11160   1
   1 761  171061   11161   1
   1 762  171062   11162   1
   1 763  171063   11163   1
   1 764  171064   11164   1
   1 765  171065   11165   1
   1 766  171066   11166   1
   1 767  171067   11167   1
   1 768  171068   11168   1
   1 769  171069   11169   1
   1 770  171070   11170   1
   1 771  171071   11171   1
   1 772  171072   11172   1
   1 773  171073   11173   1
   1 774  171074   11174   1
   1 775  171075   11175   1
   1 776  171076   11176   1
   1 777  171077   11177   1
   1 778  171078   11178   1
   1 779  171079   11179   1
   1 780  171080   11180   1
   1 781  171081   11181   1
   1 782  171082   11182   1
   1 783  171083   11183   1
Application Schedule: 2 aerial appl. at 0.25 lbai/ac or 0.28 kgai/ha
      72       1       0       0
ACIFLUORFEN  KOC:   ; AESM T1/2=
  140748  0 2 0.00  0.28 0.95 0.05
  280748  0 2 0.00  0.28 0.95 0.05
  140749  0 2 0.00  0.28 0.95 0.05
  280749  0 2 0.00  0.28 0.95 0.05
  140750  0 2 0.00  0.28 0.95 0.05
  280750  0 2 0.00  0.28 0.95 0.05
  140751  0 2 0.00  0.28 0.95 0.05
  280751  0 2 0.00  0.28 0.95 0.05
  140752  0 2 0.00  0.28 0.95 0.05
  280752  0 2 0.00  0.28 0.95 0.05
```

```
  140753  0 2 0.00  0.28 0.95 0.05
  280753  0 2 0.00  0.28 0.95 0.05
  140754  0 2 0.00  0.28 0.95 0.05
  280754  0 2 0.00  0.28 0.95 0.05
  140755  0 2 0.00  0.28 0.95 0.05
  280755  0 2 0.00  0.28 0.95 0.05
  140756  0 2 0.00  0.28 0.95 0.05
  280756  0 2 0.00  0.28 0.95 0.05
  140757  0 2 0.00  0.28 0.95 0.05
  280757  0 2 0.00  0.28 0.95 0.05
  140758  0 2 0.00  0.28 0.95 0.05
  280758  0 2 0.00  0.28 0.95 0.05
  140759  0 2 0.00  0.28 0.95 0.05
  280759  0 2 0.00  0.28 0.95 0.05
  140760  0 2 0.00  0.28 0.95 0.05
  280760  0 2 0.00  0.28 0.95 0.05
  140761  0 2 0.00  0.28 0.95 0.05
  280761  0 2 0.00  0.28 0.95 0.05
  140762  0 2 0.00  0.28 0.95 0.05
  280762  0 2 0.00  0.28 0.95 0.05
  140763  0 2 0.00  0.28 0.95 0.05
  280763  0 2 0.00  0.28 0.95 0.05
  140764  0 2 0.00  0.28 0.95 0.05
  280764  0 2 0.00  0.28 0.95 0.05
  140765  0 2 0.00  0.28 0.95 0.05
  280765  0 2 0.00  0.28 0.95 0.05
  140766  0 2 0.00  0.28 0.95 0.05
  280766  0 2 0.00  0.28 0.95 0.05
  140767  0 2 0.00  0.28 0.95 0.05
  280767  0 2 0.00  0.28 0.95 0.05
  140768  0 2 0.00  0.28 0.95 0.05
  280768  0 2 0.00  0.28 0.95 0.05
  140769  0 2 0.00  0.28 0.95 0.05
  280769  0 2 0.00  0.28 0.95 0.05
  140770  0 2 0.00  0.28 0.95 0.05
  280770  0 2 0.00  0.28 0.95 0.05
  140771  0 2 0.00  0.28 0.95 0.05
  280771  0 2 0.00  0.28 0.95 0.05
  140772  0 2 0.00  0.28 0.95 0.05
  280772  0 2 0.00  0.28 0.95 0.05
  140773  0 2 0.00  0.28 0.95 0.05
  280773  0 2 0.00  0.28 0.95 0.05
  140774  0 2 0.00  0.28 0.95 0.05
  280774  0 2 0.00  0.28 0.95 0.05
  140775  0 2 0.00  0.28 0.95 0.05
  280775  0 2 0.00  0.28 0.95 0.05
  140776  0 2 0.00  0.28 0.95 0.05
  280776  0 2 0.00  0.28 0.95 0.05
  140777  0 2 0.00  0.28 0.95 0.05
  280777  0 2 0.00  0.28 0.95 0.05
  140778  0 2 0.00  0.28 0.95 0.05
  280778  0 2 0.00  0.28 0.95 0.05
  140779  0 2 0.00  0.28 0.95 0.05
  280779  0 2 0.00  0.28 0.95 0.05
  140780  0 2 0.00  0.28 0.95 0.05
  280780  0 2 0.00  0.28 0.95 0.05
  140781  0 2 0.00  0.28 0.95 0.05
  280781  0 2 0.00  0.28 0.95 0.05
  140782  0 2 0.00  0.28 0.95 0.05
  280782  0 2 0.00  0.28 0.95 0.05
  140783  0 2 0.00  0.28 0.95 0.05
  280783  0 2 0.00  0.28 0.95 0.05
     0.0       1     0.0
    0.00   0.000     0.5
LYNCHBERG LOAMY SAND; HYDROLOGIC GROUP C
  100.00           0   0   0   0   0   0   0   0   0
     0.0     0.0     0.0
       2
       1   26.00   1.700   0.140   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.104   0.034   2.900    1.00
       2   74.00   1.500   0.232   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.232   0.112   0.174    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
```

```
       1  -----
       1    DAY
    RUNF    TSER   0   0
```

OUTPUT

```
gasybea2.inp 2 app @0.25 lbai/a acifluor mspond

          WATER COLUMN DISSOLVED CONCENTRATION (PPB)


  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1948     6.427     6.356     6.091     5.572     5.244     2.202
  1949     6.589     6.524     6.240     5.897     5.570     3.844
  1950    10.110    10.010     9.573     9.163     8.870     5.269
  1951     7.135     7.059     6.749     6.169     5.844     5.081
  1952     5.758     5.696     5.490     5.037     4.750     3.694
  1953     4.062     4.025     3.897     3.656     3.505     2.972
  1954     6.604     6.538     6.256     5.891     5.548     3.521
  1955     3.705     3.688     3.618     3.460     3.337     2.755
  1956     4.623     4.577     4.418     4.093     3.896     2.450
  1957     4.216     4.171     3.990     3.835     3.711     2.727
  1958     3.675     3.639     3.492     3.193     3.044     2.444
  1959     3.091     3.060     2.927     2.710     2.614     2.004
  1960     5.577     5.518     5.281     4.834     4.572     2.646
  1961     3.941     3.904     3.757     3.509     3.442     2.848
  1962     3.862     3.821     3.708     3.528     3.338     2.466
  1963     3.535     3.500     3.391     3.238     3.153     2.322
  1964     2.651     2.625     2.561     2.415     2.308     1.965
  1965     7.527     7.450     7.206     6.605     6.208     3.151
  1966     4.368     4.326     4.189     4.005     3.862     3.406
  1967     3.288     3.256     3.115     2.897     2.740     2.287
  1968     2.743     2.713     2.618     2.434     2.304     1.763
  1969     4.062     4.017     3.841     3.496     3.289     1.999
  1970     6.401     6.331     6.064     5.676     5.380     3.178
  1971     6.068     6.006     5.760     5.262     4.951     3.548
  1972    12.880    12.790    12.220    11.100    10.410     5.519
  1973    13.150    13.010    12.590    12.000    11.350     7.661
  1974     8.780     8.689     8.429     7.737     7.305     6.228
  1975     6.367     6.299     6.146     5.630     5.313     4.385
  1976     3.832     3.795     3.641     3.460     3.337     2.871
  1977     9.613     9.537     9.255     8.431     7.917     4.099
  1978     6.839     6.766     6.467     5.902     5.610     4.614
  1979     4.379     4.336     4.150     3.793     3.658     3.182
  1980     3.065     3.035     2.903     2.643     2.578     2.145
  1981     2.521     2.494     2.438     2.309     2.198     1.743
  1982     5.636     5.575     5.328     5.078     4.842     2.622
  1983     4.558     4.509     4.312     3.966     3.767     3.035


                       SORTED FOR PLOTTING
                       ------ --- --------

      PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
      ----      ----   -------    ------    ------    ------    ------
     0.027    13.150    13.010    12.590    12.000    11.350     7.661
     0.054    12.880    12.790    12.220    11.100    10.410     6.228
     0.081    10.110    10.010     9.573     9.163     8.870     5.519
     0.108     9.613     9.537     9.255     8.431     7.917     5.269
     0.135     8.780     8.689     8.429     7.737     7.305     5.081
     0.162     7.527     7.450     7.206     6.605     6.208     4.614
     0.189     7.135     7.059     6.749     6.169     5.844     4.385
     0.216     6.839     6.766     6.467     5.902     5.610     4.099
     0.243     6.604     6.538     6.256     5.897     5.570     3.844
     0.270     6.589     6.524     6.240     5.891     5.548     3.694
     0.297     6.427     6.356     6.146     5.676     5.380     3.548
     0.324     6.401     6.331     6.091     5.630     5.313     3.521
     0.351     6.367     6.299     6.064     5.572     5.244     3.406
     0.378     6.068     6.006     5.760     5.262     4.951     3.182
     0.405     5.758     5.696     5.490     5.078     4.842     3.178
     0.432     5.636     5.575     5.328     5.037     4.750     3.151
     0.459     5.577     5.518     5.281     4.834     4.572     3.035
     0.486     4.623     4.577     4.418     4.093     3.896     2.972
     0.514     4.558     4.509     4.312     4.005     3.862     2.871
     0.541     4.379     4.336     4.189     3.966     3.767     2.848
     0.568     4.368     4.326     4.150     3.835     3.711     2.755
```

```
     0.595     4.216     4.171     3.990     3.793     3.658     2.727
     0.622     4.062     4.025     3.897     3.656     3.505     2.646
     0.649     4.062     4.017     3.841     3.528     3.442     2.622
     0.676     3.941     3.904     3.757     3.509     3.338     2.466
     0.703     3.862     3.821     3.708     3.496     3.337     2.450
     0.730     3.832     3.795     3.641     3.460     3.337     2.444
     0.757     3.705     3.688     3.618     3.460     3.289     2.322
     0.784     3.675     3.639     3.492     3.238     3.153     2.287
     0.811     3.535     3.500     3.391     3.193     3.044     2.202
     0.838     3.288     3.256     3.115     2.897     2.740     2.145
     0.865     3.091     3.060     2.927     2.710     2.614     2.004
     0.892     3.065     3.035     2.903     2.643     2.578     1.999
     0.919     2.743     2.713     2.618     2.434     2.308     1.965
     0.946     2.651     2.625     2.561     2.415     2.304     1.763
     0.973     2.521     2.494     2.438     2.309     2.198     1.743

      1/10     9.762     9.679     9.350     8.651     8.203     5.344


     MEAN OF ANNUAL VALUES =    3.296

     STANDARD DEVIATION OF ANNUAL VALUES =    1.335

     UPPER 90% CONFIDENCE LIMIT ON MEAN =    3.625
```

INPUT

```
*** GASYBEA2.INP March 9, 2000, April 5, 2000
*** index reservoir drift = 0.16  HL = 600 m
*** ORIGINAL standard scenario gasbean.inp March 8, 2000
*** 2 applications of acifluorfen at 0.25 lb ai/ac
*** SOYBEANS - LYNCHBURG LOAMY SAND, GA - Jim Lin
*** T1/2 = 121.6 DAY OR 0.0057 Kd = 1.00
ACIFLUORFEN
Location: MLRA: P-133A; Georgia
   0.750   0.150       0   17.00       1       3
       4
    0.42    1.00    1.00   172.8               3    2.00   600.0
       1
       1    0.20   22.00  100.00       3  91  85  88                0.00   80.00
       1       3
0101  0107  0109
0.50  0.50  0.50
0.023 0.023 0.023
      36
   1 748  171048   11148   1
   1 749  171049   11149   1
   1 750  171050   11150   1
   1 751  171051   11151   1
   1 752  171052   11152   1
   1 753  171053   11153   1
   1 754  171054   11154   1
   1 755  171055   11155   1
   1 756  171056   11156   1
   1 757  171057   11157   1
   1 758  171058   11158   1
   1 759  171059   11159   1
   1 760  171060   11160   1
   1 761  171061   11161   1
   1 762  171062   11162   1
   1 763  171063   11163   1
   1 764  171064   11164   1
   1 765  171065   11165   1
   1 766  171066   11166   1
   1 767  171067   11167   1
   1 768  171068   11168   1
   1 769  171069   11169   1
   1 770  171070   11170   1
   1 771  171071   11171   1
   1 772  171072   11172   1
   1 773  171073   11173   1
   1 774  171074   11174   1
   1 775  171075   11175   1
   1 776  171076   11176   1
   1 777  171077   11177   1
   1 778  171078   11178   1
   1 779  171079   11179   1
```

```
   1 780  171080   11180   1
   1 781  171081   11181   1
   1 782  171082   11182   1
   1 783  171083   11183   1
Application Schedule: 2 aerial appl. at 0.25 lbai/ac or 0.28 kgai/ha
      72       1       0       0
ACIFLUORFEN  KOC:   ; AESM T1/2=
  140748  0 2 0.00  0.28 0.95 0.16
  280748  0 2 0.00  0.28 0.95 0.16
  140749  0 2 0.00  0.28 0.95 0.16
  280749  0 2 0.00  0.28 0.95 0.16
  140750  0 2 0.00  0.28 0.95 0.16
  280750  0 2 0.00  0.28 0.95 0.16
  140751  0 2 0.00  0.28 0.95 0.16
  280751  0 2 0.00  0.28 0.95 0.16
  140752  0 2 0.00  0.28 0.95 0.16
  280752  0 2 0.00  0.28 0.95 0.16
  140753  0 2 0.00  0.28 0.95 0.16
  280753  0 2 0.00  0.28 0.95 0.16
  140754  0 2 0.00  0.28 0.95 0.16
  280754  0 2 0.00  0.28 0.95 0.16
  140755  0 2 0.00  0.28 0.95 0.16
  280755  0 2 0.00  0.28 0.95 0.16
  140756  0 2 0.00  0.28 0.95 0.16
  280756  0 2 0.00  0.28 0.95 0.16
  140757  0 2 0.00  0.28 0.95 0.16
  280757  0 2 0.00  0.28 0.95 0.16
  140758  0 2 0.00  0.28 0.95 0.16
  280758  0 2 0.00  0.28 0.95 0.16
  140759  0 2 0.00  0.28 0.95 0.16
  280759  0 2 0.00  0.28 0.95 0.16
  140760  0 2 0.00  0.28 0.95 0.16
  280760  0 2 0.00  0.28 0.95 0.16
  140761  0 2 0.00  0.28 0.95 0.16
  280761  0 2 0.00  0.28 0.95 0.16
  140762  0 2 0.00  0.28 0.95 0.16
  280762  0 2 0.00  0.28 0.95 0.16
  140763  0 2 0.00  0.28 0.95 0.16
  280763  0 2 0.00  0.28 0.95 0.16
  140764  0 2 0.00  0.28 0.95 0.16
  280764  0 2 0.00  0.28 0.95 0.16
  140765  0 2 0.00  0.28 0.95 0.16
  280765  0 2 0.00  0.28 0.95 0.16
  140766  0 2 0.00  0.28 0.95 0.16
  280766  0 2 0.00  0.28 0.95 0.16
  140767  0 2 0.00  0.28 0.95 0.16
  280767  0 2 0.00  0.28 0.95 0.16
  140768  0 2 0.00  0.28 0.95 0.16
  280768  0 2 0.00  0.28 0.95 0.16
  140769  0 2 0.00  0.28 0.95 0.16
  280769  0 2 0.00  0.28 0.95 0.16
  140770  0 2 0.00  0.28 0.95 0.16
  280770  0 2 0.00  0.28 0.95 0.16
  140771  0 2 0.00  0.28 0.95 0.16
  280771  0 2 0.00  0.28 0.95 0.16
  140772  0 2 0.00  0.28 0.95 0.16
  280772  0 2 0.00  0.28 0.95 0.16
  140773  0 2 0.00  0.28 0.95 0.16
  280773  0 2 0.00  0.28 0.95 0.16
  140774  0 2 0.00  0.28 0.95 0.16
  280774  0 2 0.00  0.28 0.95 0.16
  140775  0 2 0.00  0.28 0.95 0.16
  280775  0 2 0.00  0.28 0.95 0.16
  140776  0 2 0.00  0.28 0.95 0.16
  280776  0 2 0.00  0.28 0.95 0.16
  140777  0 2 0.00  0.28 0.95 0.16
  280777  0 2 0.00  0.28 0.95 0.16
  140778  0 2 0.00  0.28 0.95 0.16
  280778  0 2 0.00  0.28 0.95 0.16
  140779  0 2 0.00  0.28 0.95 0.16
  280779  0 2 0.00  0.28 0.95 0.16
  140780  0 2 0.00  0.28 0.95 0.16
  280780  0 2 0.00  0.28 0.95 0.16
  140781  0 2 0.00  0.28 0.95 0.16
  280781  0 2 0.00  0.28 0.95 0.16
  140782  0 2 0.00  0.28 0.95 0.16
  280782  0 2 0.00  0.28 0.95 0.16
```

```
  140783  0 2 0.00  0.28 0.95 0.16
  280783  0 2 0.00  0.28 0.95 0.16
     0.0       1     0.0
    0.00   0.000     0.5
LYNCHBERG LOAMY SAND; HYDROLOGIC GROUP C
  100.00           0   0   0   0   0   0   0   0   0
     0.0     0.0     0.0
       2
       1   26.00   1.700   0.140   0.000   0.000   0.000
          0.0057  0.0057   0.000
           0.100   0.104   0.034   2.900    1.00
       2   74.00   1.500   0.232   0.000   0.000   0.000
          0.0057  0.0057   0.000
           1.000   0.232   0.112   0.174    1.00
       0
    WATR    YEAR      10    PEST    YEAR      10    CONC    YEAR      10   1
       1
       1  -----
       1    DAY
    RUNF    TSER   0   0
```

OUTPUT

```
gasybea2.inr irgasoy.env 2 app #0.25 lbai/a

          WATER COLUMN DISSOLVED CONCENTRATION (PPB)


  YEAR      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
  ----      ----   -------    ------    ------    ------    ------
  1948    14.430    14.040    12.770    10.130     8.624     3.033
  1949    10.360    10.080     9.550     8.053     6.906     2.763
  1950    17.800    17.310    15.560    14.130    12.690     4.501
  1951     9.289     9.038     8.067     6.390     5.581     2.489
  1952     8.407     8.180     7.536     6.006     5.109     1.987
  1953     5.090     4.957     4.455     3.595     3.542     1.658
  1954    11.200    10.900    10.370     8.581     7.324     2.675
  1955     3.684     3.584     3.256     2.595     2.271     1.078
  1956     7.907     7.691     6.998     6.009     5.266     1.853
  1957     6.061     5.897     5.266     4.798     4.446     1.844
  1958     5.141     5.000     4.510     3.616     3.170     1.348
  1959     4.423     4.302     3.839     3.229     2.913     1.155
  1960    10.310    10.040     9.020     7.485     6.542     2.346
  1961     4.987     4.859     4.361     3.919     3.591     1.592
  1962     5.817     5.658     5.238     4.442     3.808     1.496
  1963     5.209     5.067     4.623     4.121     3.742     1.487
  1964     3.280     3.191     2.975     2.523     2.243     0.995
  1965    15.770    15.340    13.900    11.060     9.382     3.170
  1966     4.926     4.791     4.277     3.639     3.413     1.668
  1967     4.309     4.192     3.757     3.094     2.693     1.124
  1968     3.846     3.742     3.497     2.881     2.530     0.993
  1969     7.461     7.259     6.491     5.116     4.376     1.577
  1970    11.350    11.040    10.310     8.804     7.570     2.743
  1971     9.846     9.578     8.641     6.857     5.831     2.258
  1972    26.470    25.900    23.160    18.220    15.430     5.159
  1973    21.310    20.730    19.290    16.630    14.280     5.364
  1974    11.300    11.040    10.270     8.198     7.092     3.101
  1975     8.556     8.323     7.835     6.296     5.403     2.246
  1976     4.483     4.360     3.913     3.201     2.762     1.208
  1977    19.800    19.260    17.760    14.060    11.940     4.050
  1978     9.504     9.247     8.253     6.616     5.825     2.528
  1979     5.359     5.213     4.656     3.681     3.139     1.380
  1980     4.094     3.982     3.553     2.842     2.611     1.097
  1981     3.286     3.197     2.975     2.640     2.312     0.969
  1982    10.320    10.130     9.411     8.202     7.144     2.478
  1983     6.357     6.185     5.525     4.539     3.974     1.760


                       SORTED FOR PLOTTING
                       ------ --- --------

      PROB      PEAK   96 HOUR    21 DAY    60 DAY    90 DAY    YEARLY
      ----      ----   -------    ------    ------    ------    ------
     0.027    26.470    25.900    23.160    18.220    15.430     5.364
     0.054    21.310    20.730    19.290    16.630    14.280     5.159
     0.081    19.800    19.260    17.760    14.130    12.690     4.501
     0.108    17.800    17.310    15.560    14.060    11.940     4.050
```

```
     0.135    15.770    15.340    13.900    11.060     9.382     3.170
     0.162    14.430    14.040    12.770    10.130     8.624     3.101
     0.189    11.350    11.040    10.370     8.804     7.570     3.033
     0.216    11.300    11.040    10.310     8.581     7.324     2.763
     0.243    11.200    10.900    10.270     8.202     7.144     2.743
     0.270    10.360    10.130     9.550     8.198     7.092     2.675
     0.297    10.320    10.080     9.411     8.053     6.906     2.528
     0.324    10.310    10.040     9.020     7.485     6.542     2.489
     0.351     9.846     9.578     8.641     6.857     5.831     2.478
     0.378     9.504     9.247     8.253     6.616     5.825     2.346
     0.405     9.289     9.038     8.067     6.390     5.581     2.258
     0.432     8.556     8.323     7.835     6.296     5.403     2.246
     0.459     8.407     8.180     7.536     6.009     5.266     1.987
     0.486     7.907     7.691     6.998     6.006     5.109     1.853
     0.514     7.461     7.259     6.491     5.116     4.446     1.844
     0.541     6.357     6.185     5.525     4.798     4.376     1.760
     0.568     6.061     5.897     5.266     4.539     3.974     1.668
     0.595     5.817     5.658     5.238     4.442     3.808     1.658
     0.622     5.359     5.213     4.656     4.121     3.742     1.592
     0.649     5.209     5.067     4.623     3.919     3.591     1.577
     0.676     5.141     5.000     4.510     3.681     3.542     1.496
     0.703     5.090     4.957     4.455     3.639     3.413     1.487
     0.730     4.987     4.859     4.361     3.616     3.170     1.380
     0.757     4.926     4.791     4.277     3.595     3.139     1.348
     0.784     4.483     4.360     3.913     3.229     2.913     1.208
     0.811     4.423     4.302     3.839     3.201     2.762     1.155
     0.838     4.309     4.192     3.757     3.094     2.693     1.124
     0.865     4.094     3.982     3.553     2.881     2.611     1.097
     0.892     3.846     3.742     3.497     2.842     2.530     1.078
     0.919     3.684     3.584     3.256     2.640     2.312     0.995
     0.946     3.286     3.197     2.975     2.595     2.271     0.993
     0.973     3.280     3.191     2.975     2.523     2.243     0.969

      1/10    18.400    17.895    16.220    14.081    12.165     4.185


     MEAN OF ANNUAL VALUES =    2.199

     STANDARD DEVIATION OF ANNUAL VALUES =    1.139

     UPPER 90% CONFIDENCE LIMIT ON MEAN =    2.480
```

**4APPENDIX 11. Part Five. EXAMS Chemistry and Environment files.

EXAMS Chemistry Input File for acifluorfen:

```
Acifluorfen with aquatic degradation
1 0 0 0 0 0 0
 383.7    0.0000    0.0000
0.0000    1.5100E-130.0000    0.0000    0.0000
2.5000E+050.0000     1.000    0.0000    0.0000
 1.000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
7.5000E-030.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
0.0000    0.0000    0.0000
8.2300E-058.2300E-058.2300E-050.0000
```

```
  2.000     2.000     2.000    0.0000
 1.7200E-041.7200E-041.7200E-040.0000
  2.000     2.000     2.000    0.000
```

EXAMS ENVIRONMENT FILES

POND Environment File

```
Mspond
    2
LB
 33.95     83.00     200.0
2.0000E+04 500.0
1.0000E+041.0000E+04
 2.000    5.0000E-02
0.0000    0.0000
 100.0     100.0
 100.0     100.0
    2
    1    2
    0    1
 1.000     1.000
    1
    1
    2
1.0000E+04
 1.025
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 6.000     15.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
```

```
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 9.000     16.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 12.00     17.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 16.00     18.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
```

```
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 20.00     19.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 24.00     20.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
```

```
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 26.00     21.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 28.00     20.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
```

```
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 25.00     19.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 18.00     18.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
```

```
 25.00     25.00
 13.00     17.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
 25.00     25.00
 25.00     25.00
 10.00     16.00
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
```

Mississippi Yazoo County Cotton Index Reservoir

Index reservoir for Yazoo Co, MS cotton

```
    2
LB
 39.12     90.05     54.90
1.4400E+05 2630.
5.2609E+045.2609E+04
 2.740    5.0000E-02
0.0000    0.0000
```

```
 640.0     640.0
 82.20     82.20
    2
    1    2
    0    1
 1.000     1.000
    1
    1
    2
1.0000E+04
 1.395
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 1.090     1.090
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
```

```
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 6.260     6.260
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 13.21     13.21
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
```

```
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 18.61     18.61
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 23.73     23.73
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
```

```
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 26.09     26.09
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 25.04     25.04
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 20.91     20.91
 7.000     7.000
 7.000     7.000
0.0000
```

```
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 14.50     14.50
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
 7.040     7.040
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
```

```
3.0000E-05
 1.000     1.000
 71.64    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000    0.0000
0.0000
0.0000
0.3000
0.0000
 2.000
R
 1.190    0.0000
0.0000    0.0000
 30.00    0.0000
 1.850     1.850
 137.0     137.0
4.0000E-024.0000E-02
0.0000    0.0000
0.0000    0.0000
0.9900    0.9900
 7.000     7.000
 7.000     7.000
0.0000
 1.000    0.0000
 37.00     37.00
0.4000    0.0000
0.0000    6.0000E-03
 8.000    0.0000
 5.000     5.000
5.0000E-030.0000
 5.000    0.0000
0.0000    0.0000
```